Glenn County Planning & Public Works Agency

Multi-Jurisdiction Hazard Mitigation Plan

Prepared for:

Andy Popper, Associate Planner
Glenn County Planning and Public Works Agency
777 North Colusa Street
Willows, CA 95988

September 26, 2014

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Andy Popper, Associate Planner
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777 North Colusa Street
Willows, CA 95988

RE: Multi-Jurisdiction Hazard Mitigation Plan

Dear Mr. Popper:

Witt O'Brien's, LLC (Witt O'Brien's) appreciates the opportunity to offer this proposal to the Glenn County Planning and Public Works Agency (the County) to provide a Multi-Jurisdiction Hazard Mitigation Plan, as announced in the County's RFP.

Witt O'Brien's will provide the County with assistance in identifying risks, planning to reduce future losses, and implementing comprehensive mitigation solutions. We understand that hazard mitigation solutions must have broad-based involvement and commitment to be effective. We are adept at team building and know how to foster community participation every step of the way. Witt O'Brien's further ensures the success of your hazard mitigation efforts through our comprehensive understanding of all federal and state mitigation rules and regulations, environmental/historic considerations, hazard identification and risk assessment, benefit-cost analysis (BCA), federal planning requirements, and project management capabilities.

Witt O'Brien's has provided Multi-Jurisdiction Pre-Disaster Hazard Mitigation services for small to large local governments, counties, cities, and private entities. Our project manager for this project, Kelly George, is a nationally-recognized expert who recently led efforts on the Ward County (North Dakota) Multi-Jurisdictional Hazard Mitigation Plan Update, which included 13 participating jurisdictions, and the Alamo Area Council of Government (Texas) Regional Multi-Jurisdictional Hazard Mitigation Plan Update, which included more than 55 participating jurisdictions.

If awarded the contract under consideration here, Witt O'Brien's would respectfully request that the County consider including the following provision in the agreement:

> "Neither party shall be liable for, and each party expressly waives and releases the other party from, and against, any and all consequential, indirect, punitive, or special damages."

If you have any questions, please do not hesitate to contact David Killen, Senior Proposal Manager, at 818 Town & Country Blvd, Suite 200, Houston, TX 77024, (281) 320-9796, or at dkillen@wittobriens.com. We pledge our strongest commitment to serving Glenn County.

Sincerely yours,

K. Tim Perkins

K. Tim Perkins, President and Chief Operating Officer
Witt O'Brien's

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Introduction

Witt O'Brien's is a global leader in preparedness, crisis management, and disaster response and recovery with the depth of experience and capability to provide services across the crisis and disaster life cycle. Witt O'Brien's is uniquely positioned to bring together policy architects and technical experts in public safety with leaders from all levels of government and private sector partners to forge solutions to emergency management challenges.

Witt O'Brien's brings a new approach to the crisis and disaster industry by combining extensive real world experience with innovative planning, training, exercise, and technology solutions focused on controlling the outcome.

Nationwide, Witt O'Brien's has approximately 300 full-time employees. This number is bolstered by several hundred contractors, including both seasoned emergency responders and top subject-matter experts in a variety of emergency management fields. Clients appreciate that we are small enough to be highly responsive to client needs, while also possessing the depth of resources, experience, and expertise necessary to produce the highest quality of work.

A. Project Understanding

Witt O'Brien's clearly understands and supports the intent to comply with current regulatory requirements and to establish the County's eligibility for important federal grants and programs. It is equally clear the work will support the County's long-term commitment to reduce risk and improve emergency management capabilities. Witt O'Brien's also understands the required experience and expertise to support and successfully deliver on this effort. Witt O'Brien's is capable and ready to develop the County's hazard mitigation plan to ensure that the information in it is valid, current, and properly documented.

The proposed scope for the update of the Glenn County Multi-Jurisdiction Hazard Mitigation Plan is based on the combined experience of Witt O'Brien's and will comply with all requirements of Disaster Mitigation Act of 2000 (DMA 2000) and FEMA's *Local Mitigation Plan Review Guide.* This will allow for plan approval to be secured from FEMA Region IX and the California Governor's Office of Emergency Services (CALEMA), which is required to establigh the eligibility of the participating jurisdictions for future federal funding arising from the plan.

Based on the state and local Mitigation Planning How-To-Guides (FEMA Publication Series 386), the proposed planning process for the plan development shall be consistent with the four core phases of hazard mitigation planning as promoted by FEMA. This work plan description is subject to change during negotiations:

- **Organizing Resources for the Planning Process**—activities include meetings with the Glenn County Multi-Jurisdiction Hazard Mitigation Plan Steering Committee, as well as departmental working groups, public participation activities, and documentation of the plan development process;
- **Identification of Potential Hazards and Risk Assessment**—development of an asset inventory and completion of a risk assessment, as well as identification of implications of future development relative to the identified and profiled hazards in the hazard mitigation plan, including hazard profiling, mapping, and a risk/vulnerability assessment;
- **Development of the Mitigation Strategy**—after review and consideration of the vulnerabilities identified by the risk assessment, identification of mitigation goals, assessment of capabilities relative to the selected hazard mitigation goals, identification of action items and projects to reflect all of the above, and development of a revised implementation strategy; and
- **Providing Mechanisms for Plan Maintenance and Integration**—institutionalizing the steering committee membership, adjusting criteria for future plan monitoring, developing procedures for future updates, and developing processes for incorporation of the final plan into other existing planning mechanisms, at both the state and local levels.

Furthermore, the planning process will comply with the needs of Glenn County in that Witt O'Brien's will:

- review historical information, including presidential-declared disasters, to ensure that all hazards are addressed in the plan;

- formulate the plan in keeping with the changes in federal regulations and FEMA policies;
- review the National Flood Insurance Program (NFIP) Manual, various building moratoriums, and the implementation of new building standards and requirements;
- coordinate with municipal and county planning and zoning experts;
- compare the previous disasters and future potential hazards with the most critical and essential needs of the county and the participating jurisdictions;
- identify structures experiencing repetitive loss which are insured by the NFIP;
- rank each mitigation project and assign costs, along with responsible parties, to each project;
- identify areas of concern which demonstrate conditions of repetitive loss and, where possible, cross-reference these structures with previously-insured NFIP structures;
- identify specific mitigative actions that may be taken based on identified priorities and goals;
- lay out and map critical infrastructure elements, critical assets, and vulnerable population areas to visually depict areas of high risk; and
- review the *State of California Multi-Hazard Mitigation Plan (2013)* to ensure a compatible approach between the participating jurisdictions and the State of California's hazard mitigation efforts and goals.

B. Scope of Work

Scope

Witt O'Brien's proposes the following scope of work for this effort:

Task A – Planning and Organization

The following task descriptions are based in part on FEMA Publication 386-1, *Getting Started: Building Support for Mitigation Planning.*

Document Request and Review

Witt O'Brien's will review existing relevant documents provided by the County and the participating jurisdictions as background for the planning effort, including any and all local mitigation strategies completed by participating jurisdictions, the *State of California Multi-Hazard Mitigation Plan (2013)*, general plans, emergency operations plans, fire management plans, flood hazard requirements, and other relevant documents as appropriate.

Capability Assessment and Recommendations

Witt O'Brien's will assess the current capability and capacity of the County and the participating jurisdictions regarding "Planning and Organization," including ongoing planning and organization efforts from other planning mechanisms, and will prepare recommendations to assist the participating jurisdictions in refining their efforts (per FEMA 386-1) including:

- **Assess Community Support:** Based on a review of the membership on the County's steering committee, Witt O'Brien's will prepare a list of other entities or members of the community that may need to be included in the public participation process.
- **Build the Steering Committee:** Based on a review of the local agencies and departments included in the steering committee, Witt O'Brien's will prepare a list of other county departments, municipal representatives, and external stakeholders that may need to be included.
- **Engage the Public:** Witt O'Brien's will assist the County in developing a strategy for public participation, including specific attention to the following elements as identified in FEMA 386-1, Step Three:
    - Identify the public—to ensure as broad a level of participation as possible;
    - Organize public participation activities—to make the most effective use of participating jurisdiction and consultant resources; and
    - Develop a public education campaign—focusing on the best way to reach each type of stakeholder. This work will include identifying roles and responsibilities for Witt O'Brien's as well as the participating jurisdictions.

Project Kick-off Meeting

Witt O'Brien's will prepare for and conduct a project kickoff meeting with the steering committee to discuss a draft work plan and general schedule, additional resource/reference materials, and recommendations regarding participant planning and organization efforts.

Note: *Witt O'Brien's preparations for the kick-off meeting will include producing and distributing an information packet to steering committee members that will include agendas and copies of all materials to be discussed at the meeting. Review and distribution timeframes for all meetings will be established so that steering committee members will receive information packets via email for review prior to meeting dates. Follow-up efforts for each of these meetings will include minutes of the meeting for distribution to all attendees and to include as an appendix in the plan.*

Note: *Preparations for and after each public meeting will include:*

- *Text for press releases/public announcements*
- *Meeting agendas*
- *Sign-in sheets*
- *Comment forms to collect participant feedback (in addition to any comments provided during the meeting)*
- *Summary handouts of issues to be covered at each meeting (in formats suitable for posting by participating jurisdiction's websites)*
- *Exhibits and/or MS PowerPoint presentations as appropriate to the issues to be covered at each meeting (in formats suitable for posting by participating jurisdiction's websites)*
- *Summary of comments made by participants, formatted for response by the appropriate participating jurisdictions and/or the steering committee as part of the final plan*

Note: *It is assumed that the County will be responsible for logistics for all meetings and coordination with the steering committee members regarding the date, time, and location for all meetings. An agenda item for this first meeting will include identifying dates and locations for subsequent steering committee and working group meetings and other related aspects of the project.*

Task B – Risk Assessment, Vulnerability Assessment, Estimating Losses

The following task descriptions are based in part on FEMA Publications 386-2, 386-6 and 386-7, *Understanding Your Risks: Identifying Hazards and Estimating Losses, Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning,* and *Integrating Manmade Hazards into Hazard Mitigation Planning.*

Note: *During this project, concurrent studies and planning efforts may yield additional data and results that could be utilized in this plan. To avoid duplication of efforts to the extent possible, Witt O'Brien's will confer with the County and the participating jurisdictions at the start of the work under Task B and periodically throughout the work effort to determine whether to proceed with the efforts described below or to incorporate results from others that will be available in a timely manner.*

However, once an authorized task is underway or completed, Witt O'Brien's will not be able to incorporate data or information from others without the possibility of incurring additional costs. Witt O'Brien's will indicate any such situations at the time in advance of starting any such work effort.

Validate Hazard Identification

The hazards to be considered in this planning effort include, but may not be limited to:

- **Natural Hazards:** drought, extreme cold, extreme heat, wildfire (forest and range), flood/flash flood, earthquakes, earth slide, erosion, subsidence, extreme winds, and epidemics (human and animal)
- **Technological Hazards (consistent with FEMA 386-7):** including accidental and intentional acts regarding hazardous materials releases (fixed and in transit), chemical hazards, biological hazards, nuclear, radiological, fire/explosion, cyber, communications, and power disruption or outages, dam/levee failure, and transportation accidents (motor vehicle, rail, aircraft, and pipeline incidents)

Validate Hazard Profiles

The hazards listed in Task B.1 will be profiled by Witt O'Brien's using available data to determine the historical occurrences and the possible location(s) of occurrence, extent/magnitude, and probability of future occurrences for the study area.

Vulnerability Assessment/Inventory Assets

Witt O'Brien's will use existing data sources to create an inventory of assets that are exposed to the hazards identified and profiled in the preceding tasks. The inventory will be organized under the following categories:

- publicly owned/operated facilities;
- publicly owned/operated critical facilities; and
- private sector properties and facilities.

Estimate Losses

Witt O'Brien's will build off of existing resources and use the results of the above tasks to develop estimates of losses to existing assets for the identified hazards. Based on available data, losses for existing assets will be estimated and then accumulated for three different components, as data allows:

- physical damage to structures;
- damage to contents; and
- loss of function or use.

Steering Committee HIRA meeting

Witt O'Brien's will brief the steering committee on the validation process and new material related to the development of Hazard Identification and Risk Assessment (HIRA) and Loss Estimation. This meeting may not be open to the public.

Task C—Hazard Mitigation Strategy / Actions and Implementation

The following task descriptions are based in part on FEMA Publication 386-3, *Developing the Mitigation Plan: Identifying Mitigation Actions and Implementation Strategies* and the *Local Mitigation Plan Review Guide* (October 1, 2011).

Validate and Develop Mitigation Goals and Objectives

Based on input from the steering committee and interested parties regarding the results of Task B, consideration of work already accomplished in the *State of California Multi-Hazard Mitigation Plan (2013)*, and a review of new occurrences and data, Witt O'Brien's will validate mitigation goals and strategies in the state's Hazard Mitigation Plan and prepare a draft listing of recommended goals and objectives. This list will be provided to the steering committee members for review.

Identify and Prioritize Draft Mitigation Actions through Face-to-Face Meetings

Based on conceptual goals and objectives expressed by the steering committee and the participating jurisdictions, Witt O'Brien's will prepare and provide the following:

- preliminary mitigation actions list
- preliminary assessment of each action's technical feasibility and potential cost-effectiveness
- proposed evaluation criteria for prioritizing mitigation actions

Witt O'Brien's will then meet face-to-face with the participating jurisdictions, as well as other members of the steering committee, as appropriate. These meetings may not be open to the public, except in cases in which participating jurisdiction points of contact or others determine such participation is appropriate. This is proposed to be done in an open-house format, wherein each participant or group signs up for a time slot to meet with Witt O'Brien's. In these meetings, proposed mitigation actions will be discussed, and actions will be developed based upon strategies and actions, repetitive loss / severe repetitive loss data, asset inventories, hazard identifications, risk assessments, and on-the-ground knowledge of hazard and risk.

Local knowledge will also be tapped to develop responsible agencies, approximate timelines, approximate budgets, local priorities, and sources of local match funds. This information will be combined with and vetted against Witt O'Brien's's knowledge and experience in mitigation strategies and actions and FEMA grant programs and guidelines.

Note: *Witt O'Brien's bases this proposal on three to four committee meetings, two public meetings, one data collection meeting with each participating jurisdiction, and other meetings as required to collect data or review results. Some meetings may be virtual, such as those for data/results review for individual jurisdictions, depending on scheduling and availability of participants.*

Note: *Evaluation criteria may be based on the STAPLE(E) criteria per FEMA 386-3 including the following seven categories, which will be refined to include consistency with existing plans and land development ordinances:*

- *Social*

- *Technical*
- *Administrative*
- *Political*
- *Legal*
- *Economic*
- *Environmental*

Prepare an Implementation Strategy

Based on input from the steering committee and interested parties regarding the proposed mitigation actions, Witt O'Brien's will prepare and provide a reliminary implementation strategy. The preliminary implementation strategy will reflect priorities for mitigation actions previously discussed but also include information regarding responsible agencies and parties for carrying out the implementation of the plan, prerequisites for the work to begin, generalized cost estimates and implementation timetables (where appropriate), funding opportunities, and proposed measures for monitoring progress and success.

Steering Committee Draft – Glenn County Multi-Jurisdiction Hazard Mitigation Plan

This initial version of the plan will be a compilation of previous documents produced and reviewed as deliverables under previous tasks, including the Goals, Objectives, Mitigation Actions, and Implementation Strategy prepared under Task C. This will also incorporate all additional text necessary to meet DMA 2000 local mitigation plan requirements. This draft, and all subsequent versions, will be thoroughly documented to allow for ease of verification of the information contained in the draft.

This document will need to be reviewed by the participating jurisdictions and the steering committee and any necessary revisions made prior to Task C.6 (below). This will also be a good opportunity to distribute copies of the draft to agencies that were contacted earlier in the process within the County and neighboring counties and jurisdictions.

Note: *It is assumed that comments from all reviewers for all plan documents will be compiled before transmittal to Witt O'Brien's.*

Public review of Draft Multi-Jurisdiction Hazard Mitigation Plan

Public meeting review of the Draft Multi-Jurisdiction Hazard Mitigation Plan would be conducted at this point in time. After this point, arrangements for the public to review draft documentation for the plan can be made through the participating jurisdiction's websites and/or by placing record copies in public libraries and other accessible locations. Also, the meetings in which elected officials will consider and adopt the plan are open meetings, and it is assumed that members of the public will have additional opportunities to voice support or concern at those meetings.

CALEMA/FEMA Draft – Glenn County Multi-Jurisdiction Hazard Mitigation Plan

A final draft version of the Plan will be prepared for formal submittal to CALEMA and FEMA Region IX. This draft will be accompanied by a completed plan review tool.

CALEMA and FEMA Region IX comments will be reviewed Witt O'Brien's and the steering committee to determine how to respond. Witt O'Brien's will support the County's efforts to negotiate any areas of contention or disagreement between the participating jurisdictions and CALEMA and/or FEMA Region IX staff regarding the review comments. Once agreement is reached for how to proceed, Witt O'Brien's will produce the final draft plan for final review by the participating jurisdictions. It is assumed that part of this process may involve resubmittal of sections or small passages of text to CALEMA and/or FEMA (after review by the County) to confirm that all comments have been adequately addressed.

Final Glenn County Multi-Jurisdiction Hazard Mitigation Plan

Witt O'Brien's will prepare the final edition of the plan for adoption by all involved jurisdictions and approval by CALEMA and FEMA Region IX in both an electronic and printed format specified by the County.

Task D—Implementation of the All Hazards Mitigation Plan

The following task descriptions are based in part on FEMA Publications 386-4, *Bringing the Plan to Life: Implementing the Hazard Mitigation Plan.*

Project Close-out Meeting

Witt O'Brien's will prepare for and conduct a final meeting with the steering committee to:

- discuss Witt O'Brien's recommendations and hand-offs regarding implementation;
- hand off all remaining deliverables, including digital files for all documents produced under this contract;
- discuss with and train County and participating community representatives regarding the plan's content and plan maintenance procedures;
- review participating jurisdictions' draft adoption resolutions; and
- provide the final version of the implementation strategy in a spreadsheet format (MS Excel) that will allow the County to segregate actions according to responsible parties but also lend itself to the development of detailed implementation timelines and work schedules by the responsible parties.

Ensuring Quality and Timeliness

Success in Witt O'Brien's past projects has been due in large part to the breadth and depth of technical and professional experience Witt O'Brien's staff possesses. Projects such as the work with the County have a lot of "moving parts." To keep track of all the issues and requirements, Witt O'Brien's has developed some standard project management and quality control protocols as follows.

This section details Witt O'Brien's Project Management Approach and Quality Controls, to include reporting, service-level agreements for response, resources, documentation management, and invoicing transparency.

Under this contract, Witt O'Brien's general methodology to serve the County involves the use of tried and tested management controls and QA/QC procedures designed to deliver results and demonstrate compliance with components of this RFP. The Witt O'Brien's Planning Team clearly understands that this multi-layered, multi-disciplinary project demands excellent project management, quality assurance, and process and quality control mechanisms/methodologies in order for us to complete all task orders and projects successfully and on time. This section provides information on the controls that assist us to provide quality service and assurance to the products we develop for our clients.

Witt O'Brien's Project Management Stages

Witt O'Brien's trained project managers are well-versed in the Project Management Institute's (PMI's) widely-accepted Guide and Standards. Witt O'Brien's is committed to providing the necessary resources to complete all of the scoped work resulting from this contract and to do so, the role of project manager is critical to keep the process moving smoothly. The project manager will provide the day-to-day oversight of the project and ensure Witt O'Brien's ability to complete the services as described in our proposal.

Witt O'Brien's has the knowledge and proven ability to deliver products that satisfy the needs of its clients. Past successes were due in large part to the breadth and depth of technical and professional experience of Witt O'Brien's staff, but such success is also the product of established procedures and techniques for managing the work—**in particular, applying the right resources at the right times.** To keep track of all the issues and requirements, Witt O'Brien's has developed some standard control protocols for application. These procedures have been at the core of our company's ability to meet and exceed client expectations. These management methodologies and controls generally fall within six specific areas; following that, Witt O'Brien's project management methodologies will be discussed. They are described in greater detail below:

1. **Contract Management**
2. **Work Planning and Resource Loading**
3. **Continuity**
4. **Project Controls, Communications, and Cost Controls**
5. **Quality Assurance / Quality Controls Processes**
6. **Risk Management**

1 – Contract Management

Witt O'Brien's focuses on ensuring and maintaining customer satisfaction and building long-lasting relationships as with the County—Witt O'Brien's takes pride in ownership and meeting/exceeding the needs of clients.

The project manager will directly control the activities of all members of the planning team and coordinate all project related communications with the County's contract manager. Witt O'Brien's management processes, as part of good contract management, are comprised of Process Controls, Cost Controls, Quality Controls, and Communications Controls.

Typically the principal-in-charge has overall contractual responsibility but will engage only as needed per requests from the client or the project manager and for escalation should the need arise. The principal-in-charge may, at times, check in proactively on the project in absence of any issues to ensure customer satisfaction and relationship management.

2 – Work Planning, Resource Loading and Staffing Plan

In managing the work effort under this contract, planning to ensure that opportunities are not missed and staff members are fully utilized is critical ("level of commitment"). As part of her responsibilities, Witt O'Brien's project manager will implement communications protocols to ensure that the County has visibility into how personnel are being utilized and will receive reports that include metrics that provide indicators as to the burdens being carried by each staff member. Using this information, the project manager will routinely identify opportunities to make better use of existing personnel or prepare recommendations for client consideration related to how staffing numbers or composition may be adjusted to improve efficiency and effectiveness.

She will then engage on a daily basis with the County's staff to support work planning efforts, as well as on subject-specific planning efforts such as workforce utilization, project or issue resolution efforts, and other matters. These discussions may include subject matter experts from Witt O'Brien's as requested by client management to provide assurances that the topics discussed maximize the combined knowledge, experience, and insights of the experts deployed in support of the work efforts.

As standard Witt O'Brien's practice, recognizing that staffing changes may be required for a variety of reasons, Witt O'Brien's has the capability to identify back-up staff for the main positions and will

maintain a back-up roster subject to the approval of the County throughout the project as required (see below, Continuity).

This proposal identifies an experienced team of available resources with extensive experience in all facets of preparedness and hazard mitigation. However, if the demands of the project require additional staffing, the approach will be to seek out and hire firms and/or individuals who have local, county or regional experience in preparedness and are best suited for optimal results.

When needed, Witt O'Brien's has the ability and access, the reach-back, and the resources from which to draw to ramp up expertise, knowledge bases, support, and experience—assembling teams of consultants that best meet the needs of each client and within a short turnaround.

3 – Continuity

When selecting personnel for assigned tasks, Witt O'Brien's sets expectations that its experts will remain on that project until it is completed and their assistance is no longer required. This could mean that team members may be on extended deployment so that clients can retain institutional knowledge and limit disruption that often results from regular changes in personnel.

Should a change in personnel be required, however, the project manager will notify the County about the circumstances, and will propose qualified replacement personnel as soon as practicable.

4 – Project Controls, Communications, and Cost Controls

In working with clients, Witt O'Brien's understands its job is to support the client, not to supplant it. Witt O'Brien's also understands that meeting the expectations of the client in providing that support requires the use of robust project controls and tools (to include "dedicated resources") designed to ensure the client remains informed and in-charge, and that consultant work remains properly focused.

For these reasons, Witt O'Brien's has established project controls, reporting procedures, and cost controls that ensure effective communication and provide work accountability, so that the client—and partner—has access to the information it needs and the visibility into consultant work efforts to both monitor and direct consultant activities. In addition, below, IT and other dedicated resources and tools that will enable success are discussed.

- The project manager will report at least monthly to County counterparts, in order to discuss progress being made, challenges being experienced, and strategies for the delivery of quality services. The content of these reports will be determined after discussion with the County, to ensure that the information necessary to meet the County's sub-grant reporting requirements and information obligations is provided.
- Witt O'Brien's understands that both technical and administrative issues may arise that will require immediate attention at the appropriate levels of management in order to quickly mitigate potential cost implications. Accordingly, Witt O'Brien's must be able to notify the County's project/contract manager quickly of potential areas of concern and recommend ways to resolve those issues. Effective communication is fundamental to cost control.

- Witt O'Brien's will use regular staff conference calls to provide an opportunity for team members to exchange information with each other and Witt O'Brien's management. These calls will highlight issues that require client attention and provide for the free flow of information and discussion of conditions that impact the work effort, and ensure that all partners in the recovery effort remain informed and involved.
- In an effort to be responsive to client requirements, Witt O'Brien's will utilize periodic meetings to allow personnel to meet with and discuss issues with the County. The timing and structure of these meetings will vary based on County needs and requirements but will certainly be designed to provide responsiveness to client information demands and to offer an opportunity for two-way communication.
- Witt O'Brien's will be prepared to use a standard reporting regimen where the team of experts provides written summaries of issues, project status, and other information (as defined the County) to assist with the ability to track work effort, concerns, priorities, and project status. The schedule and content of these reports will be designed to meet the County's needs and to ensure that it can effectively manage overall operations.
- Witt O'Brien's will maintain a log of communications and copies of all correspondence in a format that is accessible to the County (digital and/or hard copy) so any and all interactions are recorded and can be referenced during or after the contract period. For example, Witt O'Brien's maintains a secure but accessible, web-based file transfer site (Microsoft SharePoint™) where documents and correspondence can be made available via password-controlled access conditions.
- In addition to standard reporting, all meetings will result in a written meeting summary per format and content to be agreed upon with the contract manager as standard practice and in accordance with your needs. The distribution list for meeting summaries will be determined in consultation with the contract manager.
- In addition to SharePoint as a secure but accessible repository of documents and data, use of IT tools such as survey tools, and online meeting and audio/video/conferencing capabilities may also be considered.
- Witt O'Brien's knows that effectively managing project objectives, tasks and milestones is critical. To manage project and support client communications, project management tools such as Microsoft (MS) Project™ and/or MS Visio™ may be used.
- Witt O'Brien's also uses the latest Geographic Information System (GIS) technology (if required/applicable). Witt O'Brien's uses GIS and other technology such as interactive web applications so that data is accessible and transferable.

As an example, Witt O'Brien's has utilized the expertise of its Technology Solutions to assist one of its clients in the Northeast in mapping the locations of improved public and private facilities that could be in imminent danger from debris in its rivers and streams from the flooding caused by Tropical Storm Irene. Witt O'Brien's work history also includes hurricanes Katrina, Rita, Gustav, and Ike; the Iowa Floods; Haiti Earthquake; the BP Deepwater Horizon Oil Spill; and local, state, and university hazard mitigation plan development. As part of its technical services process, Witt O'Brien's collects, process, and conducts spatial analysis on historical data. Raw data sources may include FEMA's national disaster history database; NOAA's Storm Prediction Center; the National

Hurricane Center; US Environmental Protection Agency; US Geological Survey; US Census Bureau; National Response Center; US Department of Transportation; critical cnfrastructure, USACE and/or development of local data to develop static maps critical to executive decision-making. In addition to static maps, Witt O'Brien's routinely deploys interactive programs allowing end users flexibility to drill down into their data.

To summarize this section for **Project Controls, Communications, and Cost Controls,** Witt O'Brien's is completely equipped with the necessary hardware (computers, scanners, telephones, etc.) and software technologies and tools (such as the Microsoft Office Suite of applications, company E-mail, Microsoft Visio and Project, survey software tools, GIS tools, conferencing/whiteboard tools, proprietary applications, etc.) needed to support all communications that will impact successful project implementation from timeline to cost.

5 – Quality Assurance / Quality Controls Processes

As part of the commitment to foster continual improvement of our team members, Witt O'Brien's implements a series of measures to ensure that personnel remain informed of the latest program updates and best practices. This, in turn, helps team members to perform their duties with maximum effectiveness and benefit from the company's continuing experiences around the country.

As regular practice, Witt O'Brien's holds staff meetings, provides briefings and training, distributes documentation about program changes, shares success stories, and discusses problem resolution strategies with both permanent staff and consultants on an ongoing basis throughout the life of project activities.

Witt O'Brien's provides opportunities for information exchange with face-to-face meetings, conference calls, and even formal trainings and seminars offered by outside of client work time. These measures offer Witt O'Brien's personnel a support network that can keep staff highly informed about recent program changes and successful practices, and helps them to keep their skills honed to achieve the best possible results for the client.

Witt O'Brien's emphasizes the need for quality in its work efforts. Management, from the project manager to the branch-level consultant managers, review consultant work and documentation on an ongoing basis. All efforts are made to identify and refocus work efforts while they are in-process, rather than after they have been completed, to maximize work efficiency, reduce time and expense associated with work efforts, and produce better results. This methodology provides the client with greater assurances that what they are receiving, and the work that is being done on their behalf, is focused and produces desired results.

6 – Risk Management and Prevention of Disruptions

Above, under the heading, Quality Philosophy, Risk Management was mentioned. Witt O'Brien's project quality management philosophy stresses professional, proactive project management. Witt O'Brien's recognizes that friction is inevitable in any large, multi-party planning process, so it works aggressively to resolve issues before they disrupt work by:

- **Ensuring resource availability.** This is the responsibility of the Project Manager. For this project, Kelly George holds this role, ensuring that all necessary resources will be applied to the work. Ms. George is a seasoned, well-versed, experienced, detail-oriented, and highly customer-focused project manager.
- **Establishing clear expectations.** Setting clear expectations and agreeing upon them leads to a healthy working relationship between contractor and client, and between the client and stakeholders. Witt O'Brien's will engage the County in straightforward discussions to set reasonable expectations.
- **Maintaining clear and open lines of communication.** This results in accurate conveyance of information and work products, and leads to a more productive relationship. Witt O'Brien's has a designated primary point-of-contact, and this person will work closely with the identified County point-of-contact.

Through the implementation of these management and quality protocols, procedures, and processes, Witt O'Brien's clearly demonstrates its obligation to establishing the structure, communications, and accountability systems necessary to complete the scope of work for this solicitation. The ability to keep leadership apprised of critical situations and issues and demonstrate the effectiveness of consultant work efforts will have significant and positive impacts on this very important effort.

Witt O'Brien's will employ all necessary equipment, personnel, software/hardware and any other necessary resources to fulfill the project needs identified to complete the scope of work identified.

Accessibility
Witt O'Brien's has a robust support system in place with a policy of open accessibility to all for supporting the project team, whether financially, administratively, or with strategic advice and management.

Witt O'Brien's fundamentally focuses on ensuring and maintaining customer satisfaction and building long-lasting relationships and stresses this from all staff—personnel take pride in ownership and meeting/exceeding the needs of clients.

Any issues, should they arise, will be handled with the utmost attention and priority.

The Witt O'Brien's Team will dedicate required resources—human and technological—to this project for the entire lifecycle.

Operating with Integrity
Witt O'Brien's integrity impacts decision-making at all junctures of its work—from the openness of communication to the fairness of prices to placing the County's interests above the company's pocketbook. Witt O'Brien's hires people who share the values of honesty, respect, and fairness and who want to do the right thing. They, in turn, treat everyone—coworkers, clients, regulators, and stakeholders—respectfully and honestly.

Witt O'Brien's is committed to its clients and partners and as such, is committed to completing this project on or before the RFP's stated draft completion date of April 30, 2015 , providing there is

cooperation, support, participation, and response from the County and the participating jurisdictions as necessary to maintain the timeline.

C. Project Team

Kelly George—Project Manager

Kelly George is a nationally recognized hazard mitigation and hazard mitigation planning expert, with more than 10 years of hazard mitigation planning, grants management, project and application development, and project management experience. She brings a broad perspective to her work, having worked for and with various levels of government and non-profit organizations.

Ms. George has worked on a range of hazard mitigation plan updates and new implementations. She led efforts on the Alamo Area Council of Governments (Texas) Regional Multi-Jurisdictional Hazard Mitigation Plan Update, which included more than 55 participating jurisdictions, and the Tulane University Hazard Mitigation Plan. She was also responsible for the development of the local mitigation plan incorporation strategy for the 2011 State of Rhode Island Hazard Mitigation Plan Update and the development of the Severe Repetitive Loss Strategy and capability assessment for the U.S. Virgin Islands Territorial Hazard Mitigation Plan 2011 Update.

As Project Manager, she was responsible for Hazard Identification and Risk Assessment (HIRA) development for Pearl River Community College, Mississippi Delta Community College, Itawamba Community College, and the Jackson County Hazard Mitigation Plan Updates in Mississippi. Ms. George also served as Project Manager in the development of a comprehensive Threat and Hazard Identification and Risk Assessment (THIRA) for the Miami-Fort Lauderdale UASI Region, which includes Palm Beach, Broward, Miami-Dade, and Monroe counties in Florida. Ms. George served as Project Manager for the development of a mitigation plan for the University of Louisiana at Monroe and the update of the multi-jurisdictional hazard mitigation plan for Ward County, North Dakota.

In addition, Ms. George served as the senior mitigation planner responsible for the development of the hazard mitigation plan for the University of Texas Medical Branch. This plan, which was developed in approximately six weeks, addressed a wide range of hazards, risks, and vulnerabilities for a medical school and healthcare complex located on a barrier island. She currently serves as the hazard mitigation/404 expert for the University, where she is responsible for the development and implementation of more than $50 million in 404 projects.

Ms. George worked for the City of Galveston, Texas, in the wake of Hurricane Ike, where she was responsible for eligibility determination of mitigation project proposals submitted by the City and for the development of its hazard mitigation plan. She identified mitigation projects for Hazard Mitigation Grant Program (HMGP) application development consideration and also developed, researched, and drafted HMGP applications. Ms. George provided mitigation planning guidance to the City of Galveston's Planning and Community Department and researched and drafted analyses of policy issues related to HMGP eligibility. She also worked with the City's Floodplain Manager to ensure all HMGP and Public Assistance (PA) proposals adhered to the City's floodplain ordinance. She has provided application, project, and HMGP process information to City officials and leadership, and she has completed 406 proposal reviews for various categories of Project Worksheets (PWs). She has developed projects and applications for combined FEMA and

Community Development Block Grant (CDBG) funding, including eligibility requirements, and provided guidance to City staff and contractors.

Ms. George also supported the State of Iowa in the implementation of their nearly $400 million HMGP program following the devastating floods that affected the State in 2008. Prior to that, Ms. George served as a Disaster Assistance Employee (DAE) for FEMA Region IV, responsible for reviewing and approving local community hazard mitigation plans and ensuring that revisions of plans met guidance and legislative criteria.

Employment History

- Witt O'Brien's, Disaster Program Manager, 2008 - Present
- FEMA, Disaster Assistance Employee – Hazard Mitigation Cadre (Region IV), 2004 - 2008
- Athens-Clarke County Fire and Emergency Services, Intern, 2004 - 2004
- Disaster Services, American Red Cross, East Georgia Chapter, Director, 2001 - 2003

Registrations, Certifications & Training

- Certified Federal Grants Manager, Grants Management Certification—Federal Track (MCI)
- Certified Floodplain Manager (CFM), Association of State Floodplain Managers
- Managing Federals Grants & Cooperative Agreements for Recipients (MCI)
- Certified Disaster Services Instructor, American Red Cross
- National Emergency Management Information System (NEMIS) proficient
- FEMA Professional Development Series Certificate

Education

- Master of Public Administration (2005), Jacksonville State University
- Bachelor of Arts (2001), English, University of Memphis

Recent & Relevant Project Experience

State Level Hazard Mitigation Planning

Developed the local mitigation plan incorporation strategy for the State of Rhode Island 2011 Hazard Mitigation Plan Update, as well as the Severe Repetitive Loss Strategy and capability assessment for the U.S. Virgin Islands Territorial Hazard Mitigation Plan 2011 Update.

Local Level Hazard Mitigation Planning

Updated the Alamo Area Council of Governments (Texas) Regional Multi-Jurisdictional Hazard Mitigation Plan Update. Developed the Hazard Identification and Risk Assessment (HIRA) for Jackson County, Mississippi. Updated the Ward County, North Dakota, Multi-Jurisdictional Hazard Mitigation Plan.

Higher Education Hazard Mitigation Planning

Served as Senior Mitigation Planner for the University of Texas Medical Branch hazard mitigation plan. Developed hazard mitigation plans for the University of Louisiana at Monroe and Tulane University. Developed the HIRAs for Pearl River Community College, Mississippi Delta Community College, and Itawamba Community College.

Shenetia Magee-Henderson—Senior Planner

Shenetia Magee-Henderson brings more than 10 years of top-level planning and hazard mitigation experience to Witt O'Brien's. Ms. Magee-Henderson has developed strong interpersonal and communication skills and has demonstrated ability to engage and sustain the participation of broad groups of stakeholders in planning processes to address mitigation planning, including continuity of operations planning and evacuation planning.

Ms. Magee-Henderson has worked with the New Jersey State Police, Emergency Management Division to develop and implement their hazard mitigation planning program. In addition to assisting with the development of the NJSP's Mitigation Planning Standard Operation Procedures, she also coordinated with consultants to assist in updating the New Jersey State Hazard Mitigation Plan, where she revised existing documents and developed templates for planning grant applications, letters, and extraordinary circumstances requests to assist in day-to-day operations; and reviewed projects for mitigation planning compliance. Ms. Magee-Henderson worked with federal, state, and local governments to define parameters for operations within the mitigation planning section to develop, interpret, and implement policies, and she obtained 100 percent grant approval of all 14 mitigation planning grants funded under DR-4086 for Hurricane Sandy.

Ms. Magee-Henderson also worked with the State of Louisiana Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP) to support the state in its efforts to initiate and implement the Planning Pilot Grant Program (PPGP) developed by the Federal Emergency Management Agency (FEMA). She provided technical support to 13 parishes seeking to update or amend their FEMA-approved hazard mitigation plans through the PPGP and traditional hazard mitigation planning, and she provided reviews of potential projects for possible eligibility and funding in addition to providing assistance to six Special Districts seeking to create hazard mitigation plans.

Employment History

- Witt O'Brien's, LLC, Mitigation Specialist II, 2013 – Present
- Providence Engineering, LLC, Senior Planner, 2012-2013
- James Lee Witt Associates (now Witt O'Brien's), Recovery Specialist, 2007-2011
- Federal Emergency Management Agency, Region IV, Lead Planner, 2005-2007
- Department of Housing and Community Development, Associate Planner, 2005
- The Mayor's Youth Initiative (Jackson, MS), Outreach Program Supervisor, 2000-2005

Registrations, Certifications & Training

- Certified Grants Manager
- National Information Management System (NIMS) Certified
- National Emergency Management Information System (NEMIS)
- FEMA courses taken

Education

- Master of Business Administration (2012), Sustainability: Renewable Energy, Marylhurst University
- Master of Arts (2001), Urban and Regional Planning, concentration in Housing and Community Development, Jackson State University
- Bachelor of Science (1998), Biology, Jackson State University

Recent & Relevant Project Experience

BP Deepwater Horizon MC-252 Oil Spill, Biloxi, Mississippi

Met with political, business, and community stakeholders impacted by the Deepwater Horizon Incident throughout the State of Mississippi. Supported BP in recovery objectives and assisted to shape them into implementable, efficient, and impacting initiatives. Met with high-level BP officials regarding Witt Associates activities in the field relating to meeting results with community stakeholders and governmental entity officials and representatives.

State of Louisiana GOHSEP Planning Pilot Grant Program

Supported the State of Louisiana in its efforts to initiate and implement the Planning Pilot Grant Program and the Hazard Mitigation Planning Program developed by the FEMA. Provided support to 18 parishes seeking to update or amend their FEMA-approved hazard mitigation plans through the Planning Pilot Grant Program following Hurricanes Katrina and Hurricane Rita.

State Recognized Indian Tribe, Louisiana

Provided technical support to one state-recognized Indian Tribe (spanning six different parishes) and six Special Districts seeking to create hazard mitigation plans for the first time, with 95% projection completion at time of departure.

State of Mississippi Mitigation Planning

Oversaw and coordinated all Federal activities related to Mitigation Planning for the State of Mississippi, which included, but was not limited to, implementing Federal policy and procedur

Jacob Halley—GIS Planner

Jacob Halley has more than 10 years of experience in emergency and disaster management, leading in the development and execution of all-hazards community mitigation, preparation, response, and recovery programs.

Mr. Halley's most recent roles consisted of providing technical assistance to the Louisiana GOHSEP Hazard Mitigation Planning Section, as well as providing planning support to the State of North Dakota following the 2011 floods. He worked in support of a legislatively-mandated flood study for the State, including data collection, cataloguing, and analysis; interviewing stakeholders; and providing GIS support to study efforts.

In Louisiana, Mr. Halley worked with two parishes that participated in the Planning Pilot Grant Program, the first of its kind in the nation. From 2009 to 2011, Mr. Halley served as planner and GIS Specialist in the development of seven local hazard mitigation plans in the State of Louisiana. From 2011 to 2012, Mr. Halley assisted GOHSEP in reviewing hazard mitigation plans. Mr. Halley reviewed and provided technical assistance for approximately 30 parish, city, and university plans prior to each plan receiving formal FEMA approval.

Previously, Mr. Halley worked for Hatch Mott MacDonald in Monroe, Louisiana, where he served as a project technician for all emergency planning projects in Louisiana. In addition to providing specified planning products, Mr. Halley assisted existing clients with recovery services in response to Hurricanes Ivan, Katrina, and Rita. He is also the owner/operator of a digital mapping and consulting services company in Louisiana, working for local government, private nonprofit and for-profit organizations. He completed a project for D'Arbonne water system in Union Parish that consisted of mapping infrastructure and teaching the client to use ArcGIS software.

Mr. Halley was also part of a contract with state agencies to assist with the After-Action Report for Hurricanes Katrina and Rita, and he assisted Catahoula and Union Parishes with the FEMA Disaster Recovery programs for reimbursement. He provided technical and logistical support to six local emergency operations plan reviews and development projects. The plan review process included all-hazards analysis and team building activities. Additionally, he helped to develop five local homeland security exercise projects that included tabletop and full-scale exercises, and he conducted flood response tabletop exercises in response to Mississippi River high water in February 2005 and February 2006.

Employment History

- Witt O'Brien's, Disaster Recovery Specialist, 2009 – Present
- Halley GIS Solutions, LLC, Owner/Operator, 2009 – 2012
- Ouachita Parish, Louisiana, Assistant Emergency Manager, 2007 – 2009
- Holtzclaw Engineering, LLC, Project Consultant, 2006 – 2007
- Hatch Mott MacDonald, Emergency Management Consultant, 2004 – 2006
- Union Parish, Louisiana, Assistant Emergency Manager, 2004 – 2007

Registrations, Certifications & Training

- Homeland Security Exercise and Evaluation Program (HSEEP) Certified, Train the Trainer Certified

- National Weather Service Training – Severe Storms Spotter Basic and Advanced, Winter Storm Preparedness
- FEMA Community Relations Officer, 2004 Season (Atlanta, GA)
- Member, Natural Hazard Mitigation Association (NHMA)
- National Incident Management System (NIMS) training
- Trimble Geo XT and Juno ST
- Garmin 4 and 12
- ArcGIS, ArcPad and TerraSync

Education

- Geographic Information Science (GISc), 112 credited hours, Louisiana Tech University

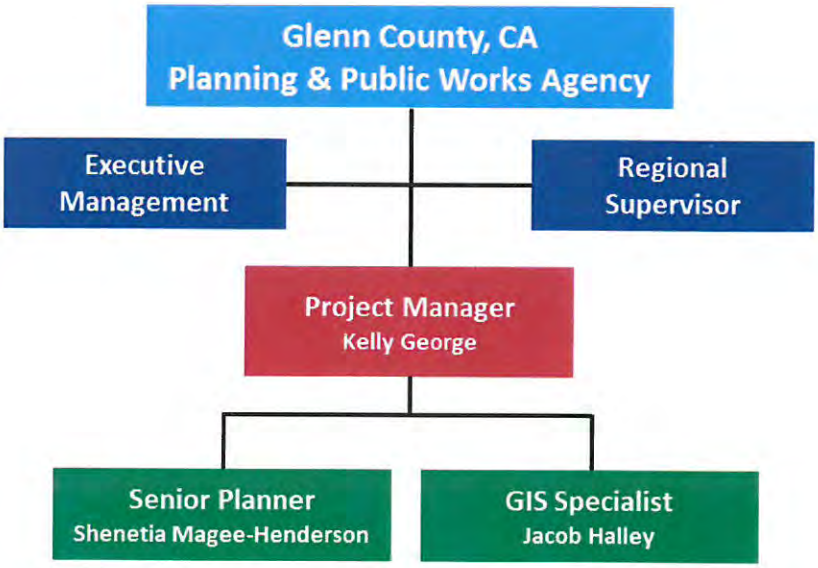
Recent & Relevant Project Experience

State of Louisiana Hazard Mitigation Planning Pilot Grant Program

Worked with two Louisiana Parishes participating in the Planning Pilot Grant Program, the first of its kind in the nation; collected and assembled data to be used for the projects selected by each parish as their top priorities. Also served as project consultant for hazard mitigation pilot programs in Union, Lincoln, and Washington Parishes; performed unsupervised on-site inspections of private and government facilities to enhance structures to make them hurricane resistant.

Louisiana Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP)

Served as planner and GIS Specialist in the development of seven local hazard mitigation plans. Assisted GOHSEP in review hazard mitigation plans; reviewed and provided technical assistance for approximately 30 plans prior to formal FEMA approval.



D. Qualifications

Witt O'Brien's has been providing emergency management support to clients since our founding in 2001. Witt O'Brien's has experience at the state and local levels with hazard mitigation planning, and has provided this experience to clients across the US.

Witt O'Brien's has a unique perspective on pre-disaster hazard mitigation planning consistent with the Disaster Mitigation Act of 2000 (DMA 2000), which stems from the involvement of Witt O'Brien's personnel in the development of mitigation planning in the US, from the inception of the program through implementation of the most recent pilot programs. The descriptions on the following pages represent just a sampling of the experience the Witt O'Brien's team will provide to Glenn County.

Building on their in-depth and comprehensive experience with the DMA 2000 program, proposed key staff have worked with dozens of state and local emergency management agencies – representing many hundreds of municipalities – over recent years to develop and implement FEMA approved statewide, multi-jurisdictional and local level DMA 2000 hazard mitigation plans. Our staff is adept at managing the state/FEMA review process for hazard mitigation plans, and is experienced with both levels of the governmental review and approval process. This experience is valuable to our clients, who often find themselves frustrated with the process and the expectations of the reviewing agencies.

A small selection of relevant experience below shows Witt O'Brien's depth and breadth of hazard mitigation planning.

Selected Hazard Mitigation Planning Project Clients	
State of Louisiana (2011)	Pointe Coupee Parish, Louisiana (2011)
State of Rhode Island (2011)	Polk County, Iowa (2010)
US Virgin Islands (2011)	Salem County, New Jersey (2010/2011)
Caldwell Parish, Louisiana (2011)	Sussex County, New Jersey (2011)
Camden County, New Jersey (2010/2011)	Union County, New Jersey (2012)
Chatham County, Georgia(2010)	Union Parish, Louisiana (2011)
Concordia Parish, Louisiana (2011)	Ward County, North Dakota (2013)
Cumberland County, New Jersey (2010/2011)	Warren County, New Jersey (2011)
Gloucester County, New Jersey (2010/2011)	Washington Parish, Louisiana (2010)
Hunterdon County, New Jersey (2011)	Lincoln Parish, Louisiana (2011)
Jackson Parish, Louisiana (2011)	City of Galveston, Texas (2011)
Mercer County, New Jersey (2011)	Alamo Area Council of Governments (2012)
Middlesex County, New Jersey (2011)	Tulane University (2012)
Morris County, New Jersey (2010)	The University of Louisiana at Lafayette (2010)
Pacific County, Washington (2009)	The University of Louisiana at Monroe (2013)
Passaic County, New Jersey (2011)	The University of Texas Medical Branch (2011)

Since 2001, Witt O'Brien's has been a leading public safety and crisis management firm operating in the United States and internationally, and has displayed consistent financial stability. Specifically, Witt O'Brien's has demonstrated the ability to simultaneously carry staffing and mobilization costs for hundreds of employees and consultants across multiple disasters and projects.

Witt O'Brien's has the capability and capacity to provide level of resources and type of skills required and to deliver these services in terms of prior experience and resources. The Witt O'Brien's Planning Team has:

- A history of meeting project deadlines and successfully working with short deadlines,
- Experience working with and successfully completing multi-layered, multi-disciplinary projects on time,
- Completing similar projects working with a wide range of stakeholders, that included information and data gathering, data entry, data management, strategic planning, leading group consensus; designing, leading and organizing workshops and tabletops, and
- Extensive knowledge and experience in hazard mitigation and risk assessment project work.

E. Work Samples

A sample of similar work recently completed has been provided on a separate compact disk for your review.

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Section 01
Executive Summary

1.1 Overview
1.2 Organization of the Plan (Updated)
1.3 Hazards Identification and Risk Assessment
1.4 Mitigation Strategy
1.5 Planning Process
1.6 Adoption and Approval
1.7 Implementation
1.8 Monitoring and Updating the Plan

1.1 Overview

On October 30, 2000, the President signed into law the Disaster Mitigation Act of 2000, also known as DMA 2000. Among its other features, DMA 2000 established a requirement that in order to remain eligible for federal disaster assistance and grant funds, local and state governments must develop and adopt hazard mitigation plans. On February 26, 2002, the Federal Emergency Management Agency (FEMA) published an Interim Final Rule (IFR) that set forth the guidance and regulations under which such plans are supposed to be developed. The IFR provides detailed descriptions of both the planning process that states and localities are required to observe and the contents of the plan that emerges. This Ward County Hazard Mitigation Plan (the Plan) responds to those requirements.

The primary point of contact for this Plan is:

Amanda Schooling
Ward County Emergency Management Director
315 3rd Street Southeast
Box 5005
Minot, ND 58701
701.857.6534
amanda.schooling@wardnd.com

The primary point of contact for all participating jurisdictions can be found in Section 18 (Plan Monitoring and Maintenance).

Hazard mitigation is often defined as actions taken to reduce the effects of natural hazards on a place and its population. Ward County and its incorporated municipalities developed this Plan

because of increasing awareness that natural hazards have the potential to affect people, physical assets, and operations throughout the County and Municipalities.

The purpose of a hazard mitigation plan is to rationalize the process of determining appropriate hazard mitigation actions. The document includes a detailed characterization of natural hazards that can affect the planning area; a risk assessment that describes potential losses to physical assets, people, and operations; a set of goals and actions that will guide mitigation activities throughout the planning area; and a detailed plan for implementing and monitoring the Plan.

This Plan focuses on seven hazards with potential for damaging physical assets, people, and operations in the planning area, and an additional hazard that is specific to Ward County. These hazards are:

- Communicable disease
- Drought
- Fire
- Flood
- Severe summer storms
- Severe winter storms
- Hazardous materials incident
- Landslides (Ward County only)

1.2 Organization of the Plan (Updated)

The Plan is organized to parallel the structure provided in the IFR, and to reflect the changes in the review process that were implemented in October 2012, with the enactment of the *Local Mitigation Plan Review Guide*. For the ease of review and use, the Plan Update was significantly reformatted from the 2008 Plan. The Plan has 17 sections.

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There are references to the IFR throughout the Plan. Where possible, these provide specific section and subsection notations to aid the review process. A completed Plan Review Tool (PRT) is included in Appendix E to this Plan.

1.3 Hazard Identification and Risk Assessment

1.3.1 Hazard Identification

Sections 4-16 of this Plan include detailed descriptions of the process that was used to assess and prioritize the planning area's risks from and vulnerability to hazards, qualitative risk assessments each participating jurisdiction, and more detailed assessments for certain asset classes. More than 20 hazards were considered by the Ward County Plan Update Steering Committee (the Steering Committee). The Steering Committee considered such factors as the history of occurrence, the probability of a future occurrence, the potential vulnerabilities in their communities, and the availability of data regarding the hazard. After discussion and consideration, the Steering Committee determined that seven hazards had the potential to impact the entire planning area, and that an additional hazard presented a risk to Ward County alone.

1.3.2 Risk Assessment

Risk is a numerical indication of potential future damages. All hazards profiled received a qualitative risk assessment. This assessment was completed through an exercise conducted at Meeting 2 (documented in Section 3). Details of this exercise, as well as the results, can be found in Sections 4-16.

After discussion and consideration, the Steering Committee determined that six of the profiled hazards posed significant enough risk to warrant a quantitative risk assessment, to include estimates of future damages.

1.4 Mitigation Strategy

The Mitigation Strategy is the real-world implementation plan to address the hazards, risks, and vulnerabilities identified in the HIRA.

Since the 2008 Plan was approved, Ward County has implemented a wide array of mitigation actions. Some of these implemented actions were intended to address flooding concerns throughout the County; others addressed communications, response, and equipment needs throughout the County. Since the 2011 flooding that devastated communities throughout the County, significant mitigation actions have been contemplated, applied for, or implemented. Many of these actions seek or sought to acquire flood-damaged or at-risk properties throughout the County, to reduce or eliminate the risk to these structures, and the resulting need for response, recovery, and cleanup, using a variety of funding sources. Additionally, the City of Burlington was awarded funding for a warning siren project, and the City of Minot has been awarded funding for emergency power generators and to design and construct flood protection for their critical infrastructure.

Sections 4-16 of this Plan Update describe the mitigation strategy for this Plan Update. These sections present the strategy by jurisdiction and priority, and describe the funding required, sources of funding, the level of support and types of available resources, and the timing of the action.

Note: The 2008 Plan listed all actions within the Mitigation Strategy under Ward County, rather than by municipal jurisdiction. Therefore, all notations regarding the disposition of these actions into the 2013 Plan appears in Section 16, which contains Ward County's Mitigation Strategy.

1.5 Planning Process

Section 3 provides details about the process that was used to develop this Plan. The process closely followed the guidance in the *FEMA 386* series of planning guidance, which recommend a four-stage process for developing mitigation plans.

- Step 1: Organize resources
- Step 2: Assess risks
- Step 3: Develop a mitigation plan
- Step 4: Implement the plan and monitor progress

Step 1: Organizing Resources is described in Section 3. The section includes details about who was involved, the processes that were used to establish leadership and advisory groups, and public and other outreach and involvement efforts.

Step 2: Risk Assessment was completed by the Steering Committee. A Hazard Identification and Risk Assessment for each participating jurisdiction is included in Sections 4-16 of the Plan.

Step 3: **Development of the Mitigation Plan** is described in Section 3 and Sections 4 - 16. Section 3 includes details about who was involved, the processes that were used, and the

products that were developed. Sections 4-16 include specific details about the identification and development of mitigation goals and actions based upon the HIRA. Section 17 contains a summary of the HIRA for the planning area.

Step 4: Implementing the Plan is described in Section 18, which includes details about who is responsible for implementation of specific strategies and actions; and in Section 18, the Monitoring and Maintenance section, which describes long-term implementation through periodic updates and reviews.

1.6 Adoption and Approval

The Steering Committee was responsible for the development and review of this Plan, and recommended that it be adopted by all participating jurisdictions. Consistent with that recommendation, each governing body approved this Hazard Mitigation Plan; dates of adoption for each jurisdiction can be found in Appendix B.

Following approval, the Plan was submitted to the North Dakota Department of Emergency Services (NDDES) and FEMA Region VIII. NDDES and FEMA reviewed and approved the Plan in September 2013. Copies of all approval and adoption documentation can be found in Appendix B.

1.7 Implementation

The implementation process is described as part of the specific actions in the Mitigation Strategy in Sections 4-16, as well as in Section 18 (Plan Monitoring and Maintenance).

1.8 Monitoring and Updating the Plan

Section 18 (Plan Monitoring and Maintenance) describes the schedule and procedures for ensuring that the Plan stays current. The section identifies when the Plan must be updated, who is responsible for monitoring the Plan, and ensuring that the update procedures are implemented. This section provides a combination of cyclical dates (oriented toward FEMA requirements) and triggering events that will initiate amendments and updates to the Plan.

Section 02
Planning Area Profile

2.1 Introduction
2.2 Profile of the Planning Area
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2.1 Introduction

The recommendations in the Ward County Hazard Mitigation Plan are based in large part on identification of past and potential problems due to natural and selected man-made hazards. As part of the process of identifying potential problems, it is useful to understand the characteristics of the communities that participated in the Plan.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

2.2 Profile of the Planning Area

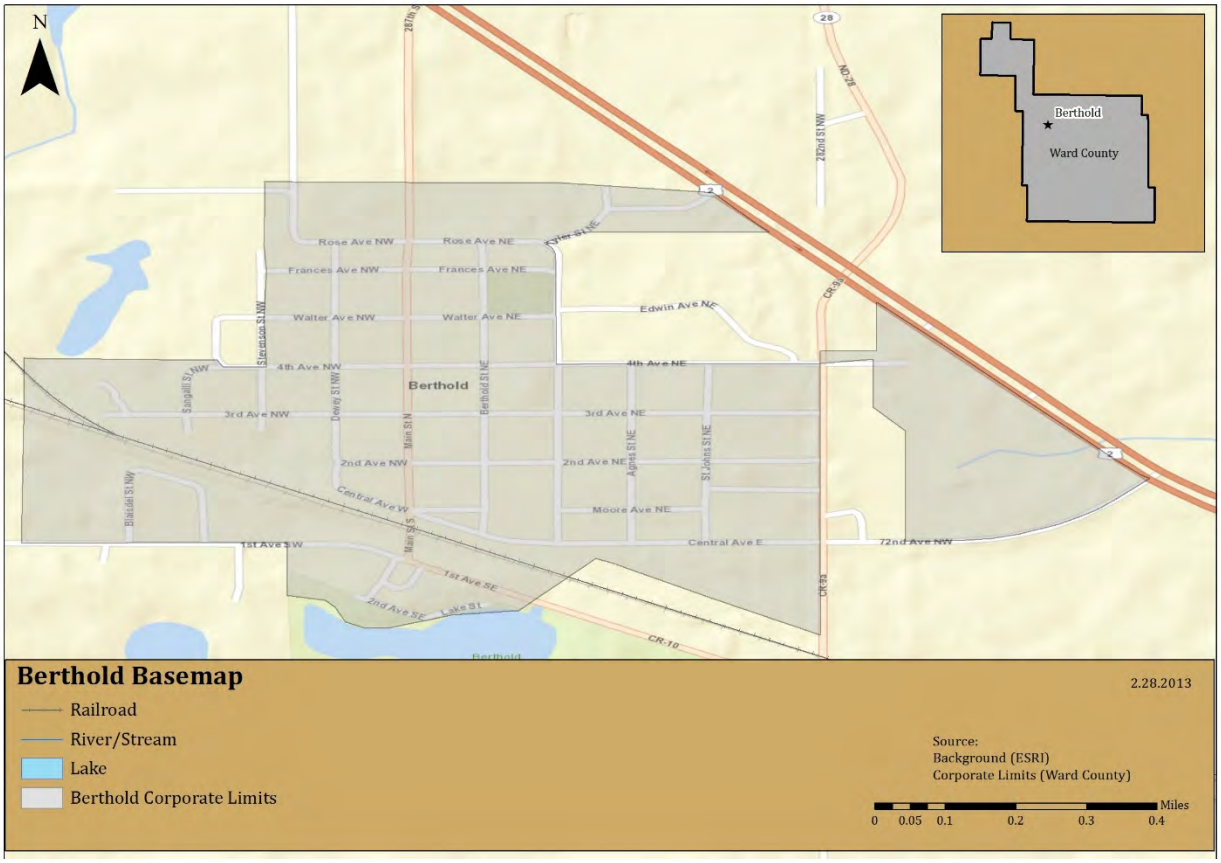
2.2.1 City of Berthold

Berthold was founded in 1900, and is the 5th largest community in Ward County, ND. Berthold sits between ND State Highway 2, Ward County Highway 10, the Burlington Northern Santa Fe Railroad, and Ward County Highway 28

Geography

The City of Berthold occupies .37 miles^2 in Ward County, ND. All of the area occupied by Berthold is land. Figure 2.2.1-1 (following) illustrates the area occupied by Berthold, and its location within Ward County.

Figure 2.2.1-1
City of Berthold Basemap



According to the US Fish and Wildlife Service, Berthold is surrounded by small freshwater emergent wetlands; these areas are often saturated and periodically flood soils.

Population
As of the 2010 Census, there were 454 people living in Berthold; this is a 2.6% decline from the 2000 Census. In 2010, the average household size was 2.73, and the average family was comprised of 3.31 people. The median age of residents was 37.2 years. 33% of residents were under 18 years of age, and 13.2% were over 65 years of age.

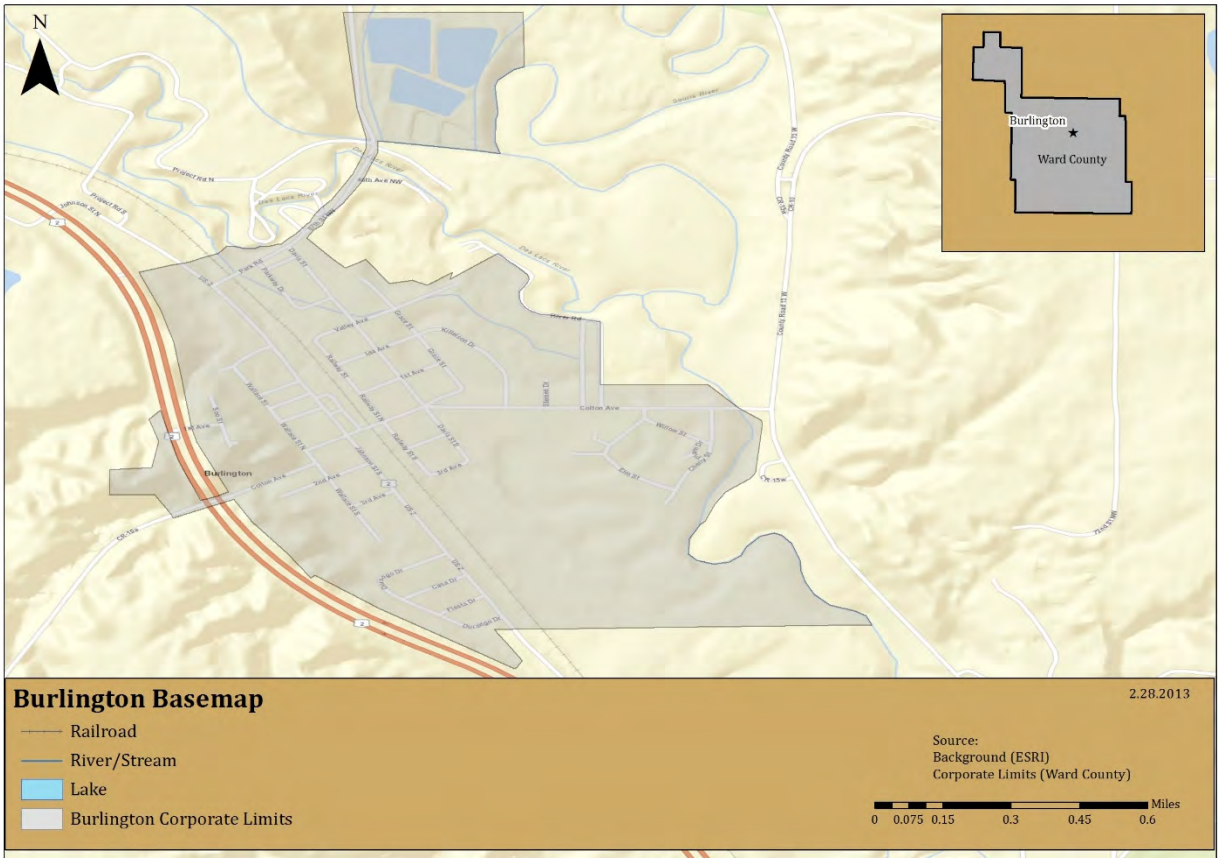
Emergency Services and Critical Assets
Berthold has a fire station, an ambulance service, a police department, a city hall, and a school that serves as a public shelter when the need arises. In addition, the city has and maintains emergency alert sirens, which are used to warn residents of impending hazards.

2.2.2 City of Burlington

Founded in 1883, Burlington is the oldest city in Ward County, and was the county seat until 1888. The original Ward County Courthouse was located in Burlington, and was later moved to the North Dakota State Fairgrounds (in Minot), where it serves as an historical exhibit for the Ward County Historical Society. Burlington was also home to the first newspaper in western North Dakota (the *Burlington Reporter,* which would eventually become the *Minot Daily News).*

Geography
The city is located directly next to the confluence of the Des Lacs and Souris (Mouse) Rivers, and occupies an area of .64 mi^2. All of the area occupied by Burlington is land. Figure 2.2.2-1 (following) illustrates the area occupied by Burlington, and its location within Ward County.

Figure 2.2.2-1
City of Burlington Basemap



Population
As of the 2010 Census, there were 1,060 people living in Burlington; this is a 3.3% decrease from the 2000 Census. The median age of residents was 33 years in 2010. Residents were fairly evenly split in gender, with 50.8% of the population being female. 28.8% of total residents were under the age of 18, and 7.8% were aged 65 or older.

There were 399 households, with an average household size of 2.66 persons. 40.4% of households had children under 18 years of age, and 8.3% had someone living alone that was 65 years or older.

Emergency Services and Critical Assets
Burlington has a volunteer fire department, which has a current membership of 25 firefighters that respond to 50-70 calls per year. In addition, the Burlington 1st Responders are a group of 15 state-certified first responders, who respond to medical emergencies in advance of the arrival of an ambulance.

The city also has its own police department, a city hall, a senior center, an emergency shelter, and several emergency alert sirens, which are used to warn residents of impending hazards. The elementary school is located in Burlington, and students attend high school in nearby Des Lacs.

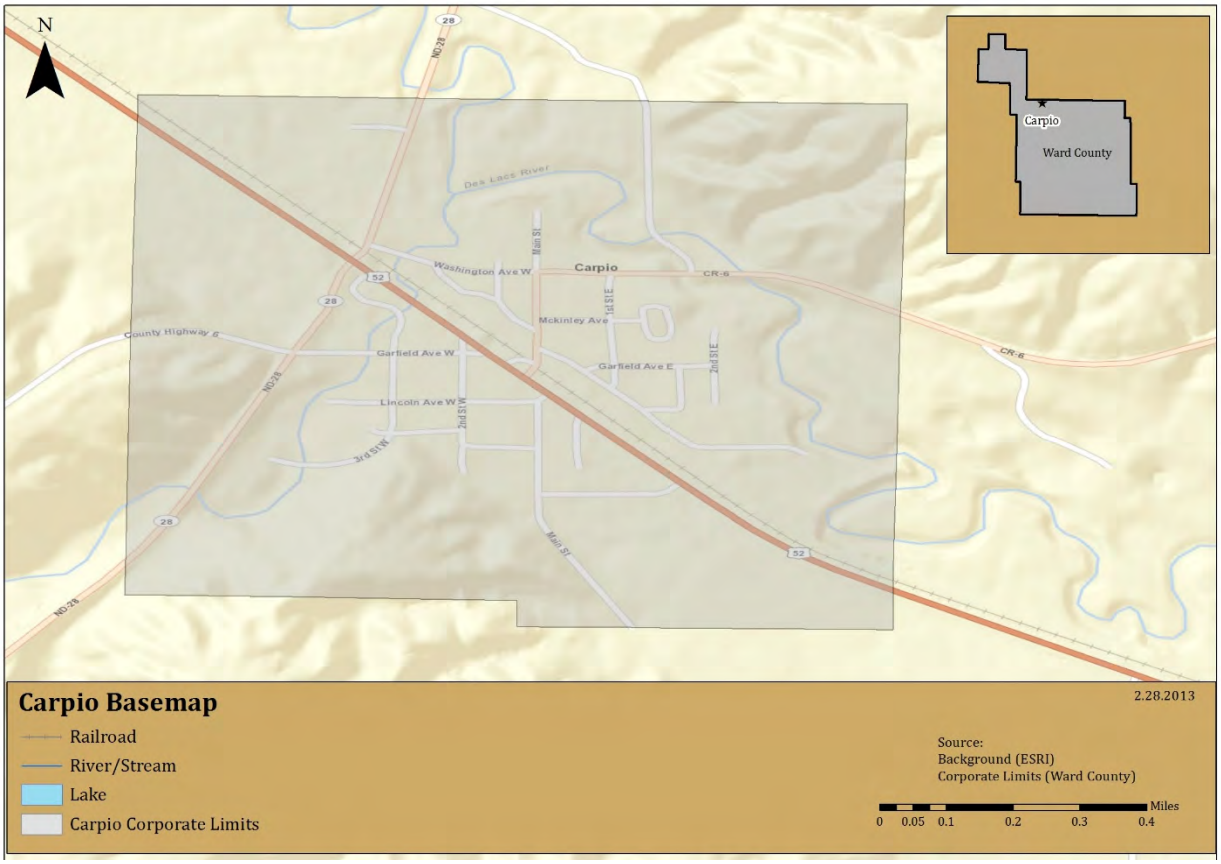
2.2.3 City of Carpio

Carpio was founded in 1898. It is thought that the name of the city originated with the first Post Office, which operated out of a railroad car – making it the Car PO – though other possibilities for the origin of the name also exist.

Geography

The city occupies an area of .59 mi². All of the area occupied by Carpio is land. Figure 2.2.3-1 (following) illustrates the area occupied by Carpio, and its location within Ward County.

Figure 2.2.3-1
City of Carpio Basemap



Population

According to the 2010 Census, there were 157 residents of Carpio; this is a 6.1% increase from the 2000 Census. These 157 residents were organized into 71 households. 26.8% of these households

included children below 18 years of age, and 12.7% were comprised on someone over 65 years of age who lived alone.

The median age of a Carpio resident was 43.5 years. 21.7% of residents were below age 18, and 21% were over 65. The population skews slightly in favor of males, who make up 56.7% of the total population.

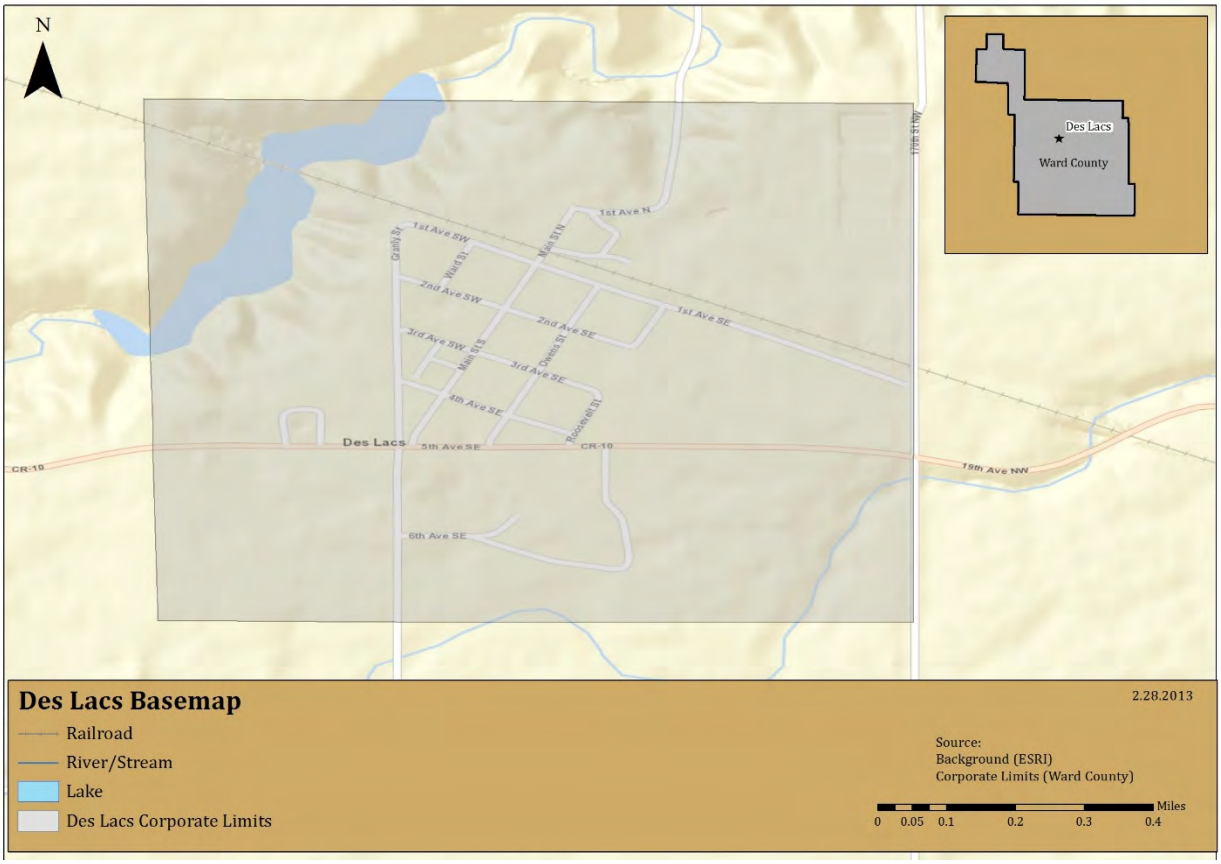
Emergency Services and Critical Assets
Carpio has a Fire Protection District, ambulance service, a city hall, an emergency shelter (located at the Carpio Lutheran Church), and an emergency alert siren, which is used to warn residents of hazardous conditions. Law enforcement is provided by the Ward County Sheriff's Department.

2.2.4 City of Des Lacs

The city of Des Lacs was founded in 1888. It was named for the *Riviere de Lacs*, now known as the Des Lacs River. The city shares its name with an important bird sanctuary nearby, known as the Des Lacs national Wildlife Refuge, which is managed by the US Fish and Wildlife Service, and is home to elk, moose, bison, sheep, and tens of thousands of birds.

Geography
The city occupies an area of .56 mi^2. Of the area occupied by Des Lacs, .53 mi^2 is land, and the remaining area is water. Figure 2.2.4-1 (following) illustrates the area occupied by Des Lacs, and its location within Ward County.

Figure 2.2.4-1
City of Des Lacs Basemap



Population
The 2010 Census counted 204 people residing in Des Lacs, a 2.4% decrease from 2000. These 204 people live in 78 households, with an average household size of 2.62 people. 32.1% of households included at least one child below the age of 18. 5.1% of households were made up of someone over age 65 that lived alone.

The median age of Des Lacs residents was 40 years old. 25.5% of residents were below 18 years of age, and another 14.2% of residents were over 65 years of age. The population was fairly evenly split along gender lines, with a slight edge (50.5%) to males.

Emergency Services and Critical Assets
Des Lacs has a fire department and an emergency shelter, as well as an emergency alert and warning siren. The city also has a city hall and a high school (the elementary school is located in Burlington). Law enforcement is provided by the Ward County Sheriff's Department.

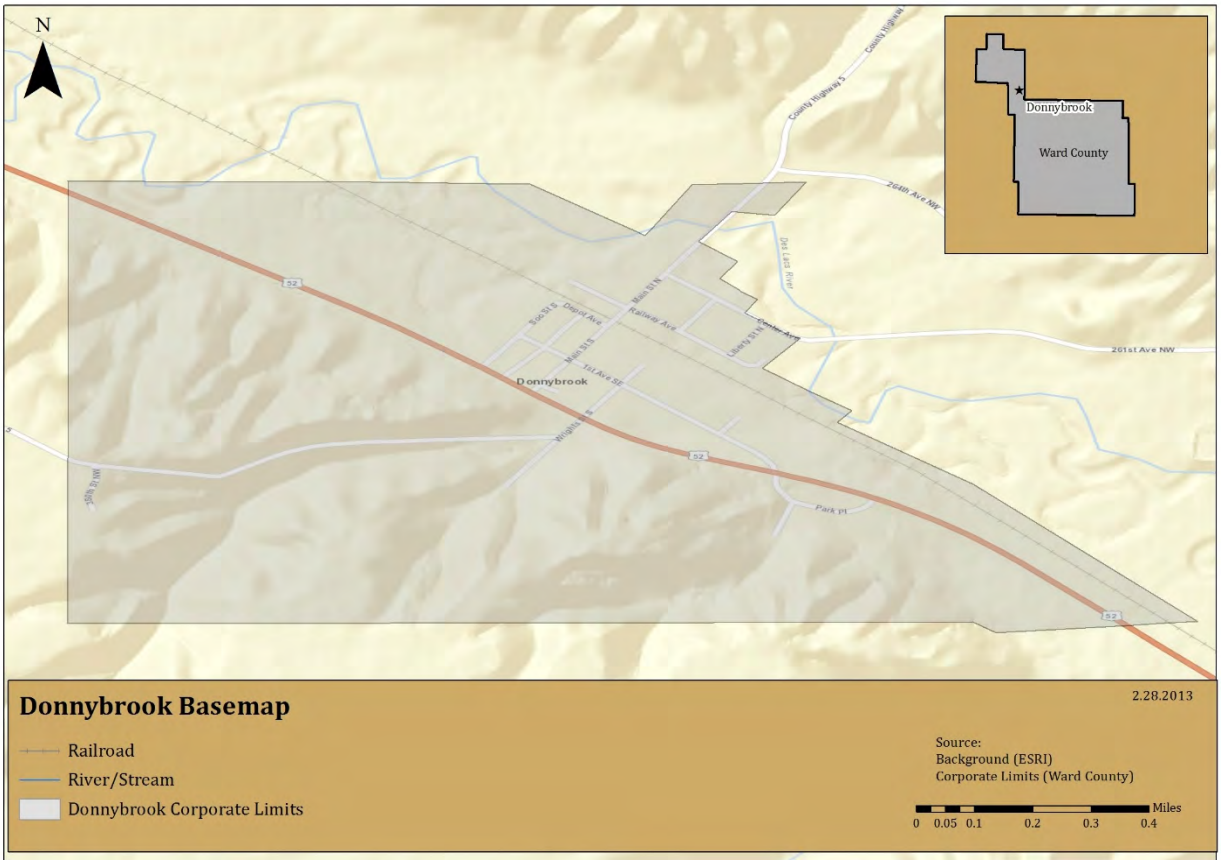
2.2.5 City of Donnybrook

Donnybrook was incorporated in 1898, along the main line of the Soo Line Railroad, which is operated by the Canadian Pacific Railway.

Geography

The city occupies an area of .70 mi^2. All of the area occupied by Donnybrook is land. Figure 2.2.5-1 (below) illustrates the area occupied by Donnybrook, and its location within Ward County.

Figure 2.2.5-1
City of Donnybrook Basemap



Population

As of the 2010 Census, there were 59 residents of Donnybrook, a 34.4% decrease from 2000. Those 59 people lived in 29 households, with an average household size of 2.50 people. 17.2% of households included at least one child below the age of 18. 17.2% of households were made up of someone over age 65 that lived alone.

The median age of Donnybrook residents was 51.9 years old. 15.3% of residents were below 18 years of age, and another 18.6% of residents were over 65 years of age. The population slightly favored females, who made up 52.5% of the 2010 population.

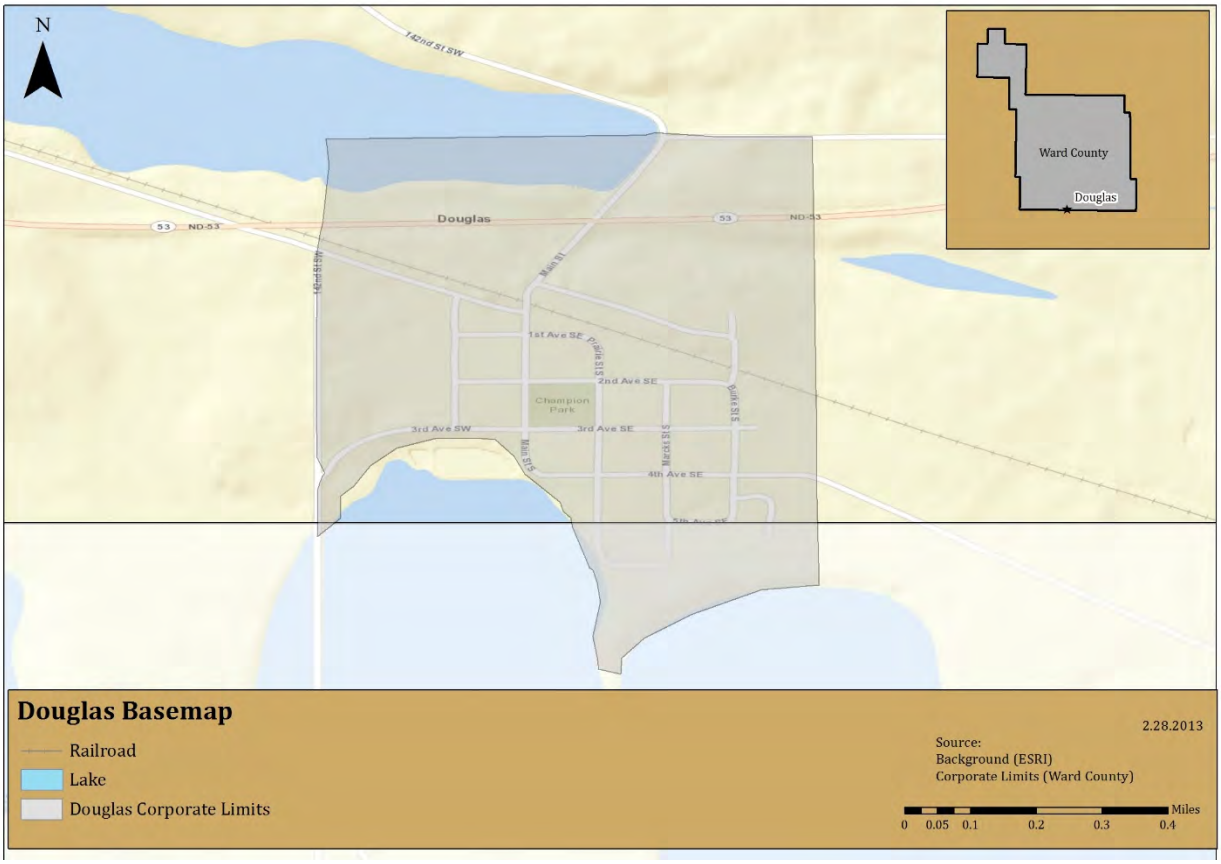
Emergency Services and Critical Assets
Donnybrook has a fire department and a city hall. Law enforcement is provided by the Ward County Sheriff's Department.

2.2.6 City of Douglas

Douglas was founded in 1906, and is located mostly to the south of Highway 53.

Geography
The city occupies an area of .31 mi^2. Most of the area occupied by Douglas (.29 mi^2) is land; the remaining area is water. Figure 2.2.6-1 (below) illustrates the area occupied by Douglas, and its location within Ward County.

Figure 2.2.6-1
City of Douglas Basemap



Population
As of the 2010 Census, there were 64 residents of Douglas, which is unchanged from the 2000 Census. Those 64 people made up 28 households, with an average household size of 2.29 people. 32.1% of households included at least one child below the age of 18. 10.7% of households were made up of someone over age 65 that lived alone.

The median age of Douglas residents was 49.3 years old. 26.6% of residents were below 18 years of age, and another 15.6% of residents were over 65 years of age. The population favored females, who made up 57.8% of the 2010 population.

Emergency Services and Critical Assets
Douglas has a fire department. There is no city hall in Douglas, but the City Council has arranged to meet at the Senior Center, which is privately owned. Douglas does have and operates an emergency alert siren, which is used to notify residents of hazardous conditions. Law enforcement is provided by the Ward County Sheriff's Department.

2.2.7 City of Kenmare

Founded in 1897, Kenmare is home to Goosefest, which is an annual hunting festival that occurs during the migration of snow geese, and to the headquarters of the Des Lacs National Wildlife Refuge.

Geography
The city occupies an area of 1.24 mi^2, all of which is land. Though the City does not occupy any water area, it is located along the Des Lacs River. Figure 2.2.7-1 (following) illustrates the area occupied by Kenmare, and its location within Ward County.

Figure 2.2.7-1
City of Kenmare Basemap

Population
The 2010 Census placed the population of Kenmare at 1,096, an increase of 1.4% from the 2000 Census. The population was organized into 480 households, with an average household size of 2.18 people. 25% of households included at least one child below the age of 18. 18.7% of households were made up of someone over age 65 that lived alone.

The median age of Kenmare residents was 46.7 years old. 21.4% of residents were below 18 years of age, and another 23.6% of residents were over 65 years of age. The population was fairly evenly divided along gender lines, with a slight advantage (50.5%) to males.

Emergency Services and Critical Assets
Kenmare has a police department, a fire department, ambulance service, an emergency shelter, and a 25 bed hospital. It is also home to an airport, a newspaper, and significant utility infrastructure, as well as a rural fire department.

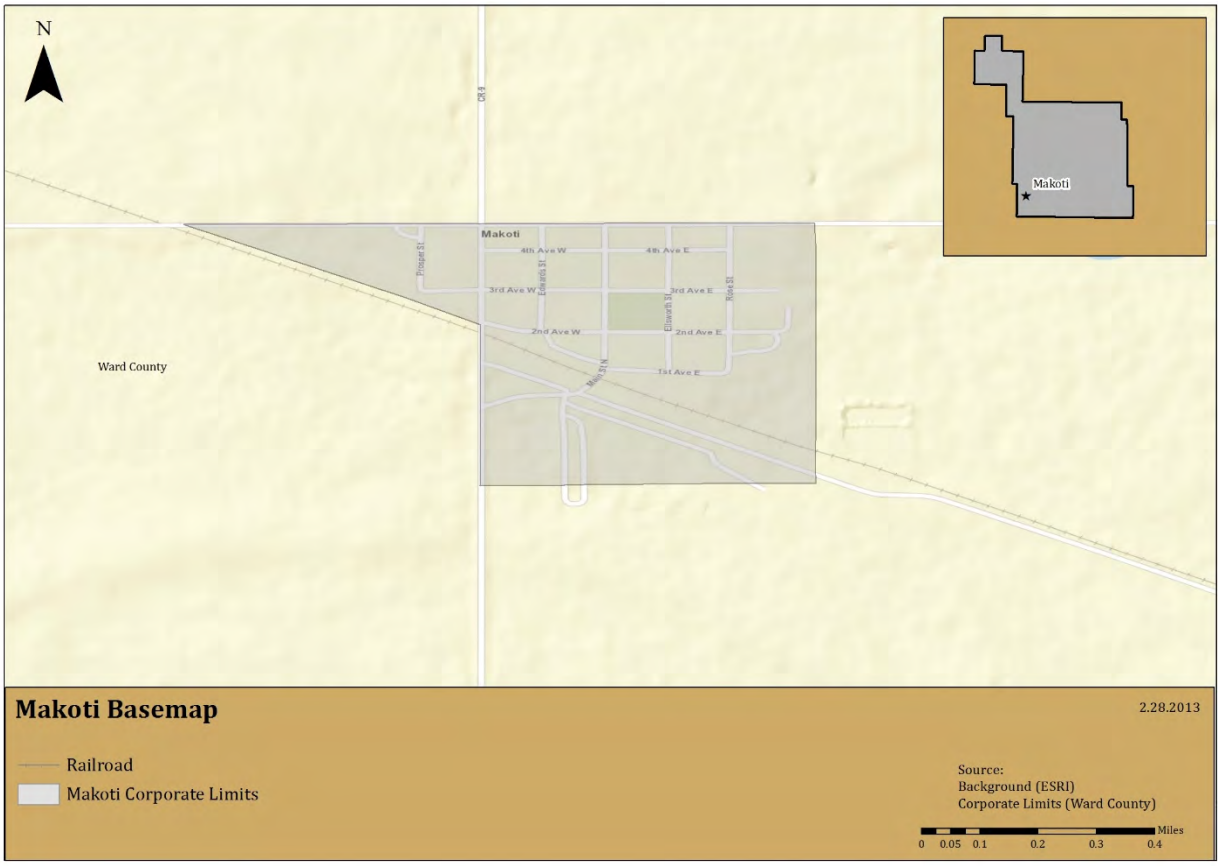
2.2.8 City of Makoti

Founded in 1911, Makoti was incorporated in 1916. The city is adjacent to the tribal lands (known as the Fort Berthold Reservation) of the Mandan, Hidatsa, and Arikara Nations (known as the Three Affiliated Tribes). In 2012, the Tribes proposed to construct and operate a 13,000 barrel-per-day petroleum refinery, which would be built on reservation lands, adjacent to Makoti.

Geography

The city occupies an area of .20 mi^2, all of which is land. Figure 2.2.8-1 (below) illustrates the area occupied by Makoti, and its location within Ward County.

Figure 2.2.8-1
City of Makoti Basemap



Population

According to the 2010 Census, the population of Makoti was 154, an increase of 6.2% from the 2000 Census. The population was organized into 71 households, with an average household size of 2.17 people. 21.1% of households included at least one child below the age of 18. 18.4% of households were made up of someone over age 65 that lived alone.

The median age of Makoti residents was 47.5 years old. 24% of residents were below 18 years of age, and another 23.4% of residents were over 65 years of age. The population was slightly dominated by males, who made up 53.2%of the 2010 population.

Emergency Services and Critical Assets
Makoti has ambulance service and a fire hall, which is home to the Ryder-Makoti Fire Protection District, as well as a high school, which serves as an emergency shelter for residents. (Elementary school children attend school in nearby Ryder and Plaza.) There is also a VFW hall, a senior center, and a community pool located in the city park. Law enforcement is provided by the Ward County Sheriff's Department.

2.2.9 City of Minot

Founded in 1886, Minot was settled at the end of the Great Northern Railroad (now BNSF Railway). It was incorporated in 1887. In the 1950s, the area experienced a boom, due to the construction of the Minot Air Force Base, located 13 miles north of the city, and the Garrison Dam, which is located 50 miles south of the city. Minot is the county seat of Ward County, the fourth largest city in North Dakota, and serves as a trading center for a large portion of northern North Dakota, southwestern Manitoba (Canada) and southeastern Saskatchewan (Canada).

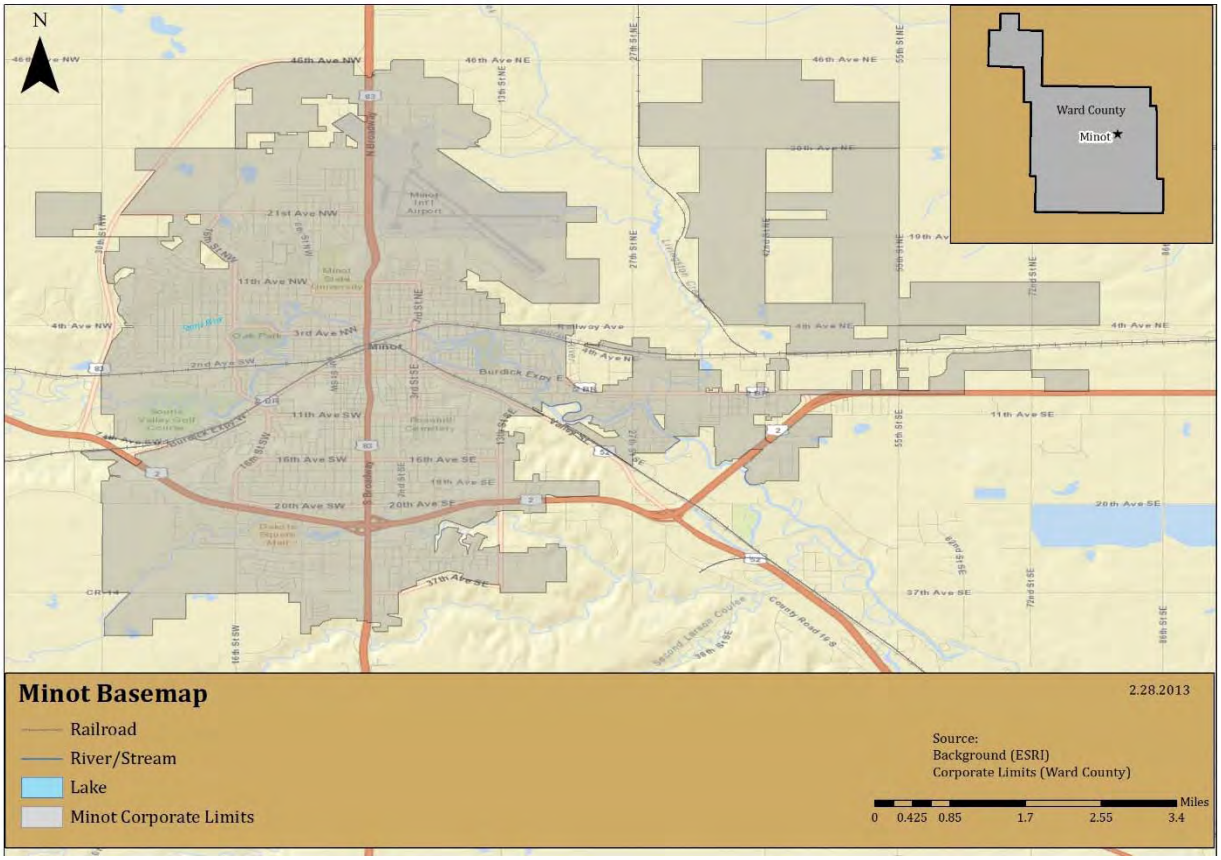
Minot's economy is closely tied to the Minot Air Force Base. With the increase in activity in the Bakken Formation, Minot has seen a significant increase in population, and the resulting expected infrastructure needs.

Minot State University is located within the city. There are several media outlets in Minot, including KMOT-TV and KXMC-TV. In addition, the city is home to the *Minot Daily News.*

Geography
The city occupies an area of 23.93 mi^2, the majority of which is land; approximately .02 mi^2 is water, comprised of the Souris (Mouse) River, several oxbow lakes, and a few creeks. The city rests largely in a valley. The elevation at the river is 1,556 feet above sea level; by comparison, the airport (which was constructed on a hill above the valley) sits at 1,716 feet above sea level. The Souris (Mouse) River divides the city roughly in half, and runs roughly through the center of the valley.

Figure 2.2.9-1 (following) illustrates the area occupied by Minot, and its location within Ward County.

Figure 2.2.9-1
City of Minot Basemap



Population
According to the 2010 Census, the population of Minot was 40,888, an increase of 11.8% from the 2000 Census. The 2011 Census estimate placed the population at 42,485, an increase of 3.9% in a single year. In 2012, the Minot Area Development Corporate estimated in population residing within the city limits at between 46,000 and 47,000 – significantly higher than either the 2010 Census or the 2011 Census estimate. This dramatic increase is attributed to the increase in activity in the Bakken Formation, and is expected to continue for the foreseeable future.

The 2010 Census population was organized into 17,863 households, with an average household size of 2.20 people. 26.3% of households included at least one child below the age of 18. 11.7% of households were made up of someone over age 65 that lived alone.

According to the 1020 Census, the median age of Minot residents was 33.8 years old. 21.1% of residents were below 18 years of age, and another 15% of residents were over 65 years of age. The population was slightly dominated by females, who made up 50.7%of the 2010 population.

Employers
Minot Air Force Base (AFB) is the economic center of the region, contributing an estimated $493.3M to the local economy in 2011. $291.5 of that estimate was payroll, to the estimates 12,852 people (military, family, and civilian workers) who reside on the base. The AFB is home to the most housing of any Air Force Base in the US.

Trinity Health is the largest private employer within the city, employing 2,720 people as of 2013. According to the Minot Chamber of Commerce (2010), Minot Public Schools is the largest public employer in the city, employing 1,547 people. Other significant employers in the city include:

- ING Minot Service Center: 934 employees
- Minot State University: 450 employees
- City of Minot: 300 employees
- Ward County: 220 employees

Emergency Services and Critical Assets
Minot has a fire department that also provides hazardous materials response services, alarm/suppression equipment inspections, and assist with the US EPA's Tier II reporting requirements. The city is also home to the Minot Rural Fire Department, who services the Minot Rural Fire Protection District, which covers an area of approximately 275 mi^2, occupied by approximately 5,800 people.

Minot also maintains a police department, which provides law enforcement services within the city limits. In addition to law enforcement services, the department also provides a variety of public education services (DARE, juvenile diversion programs, CrimeStoppers, etc.), and also assists with the EPA's Tier II reporting requirements.

The city is serviced by Community Ambulance, and is home to Trinity Health. Trinity is not only the largest employer in the city; it is also the primary medical care provider for the region. Founded in 1922, Trinity Health is a non-profit healthcare system, providing a network of care that includes nursing homes, skilled nursing care, clinics, and medical arts buildings. Trinity's primary hospital in Minot has 251 beds, and includes a NICU, a Level 2 Trauma Center, a Cardiac Center, a Neurosurgery Center, and is capable of receiving helicopter ambulance patients.

Minot is home to an international airport, which is owned and operated by the city. Four carriers operate through the facility, which has customs services and rental car services on site. Minot is also home to the State Fair Grounds, which acts as a staging area for larger disaster or emergency events.

The city has agreements with an array of churches and schools to use those facilities as emergency shelters, should they be needed. The city also has extensive infrastructure, including flood control

infrastructure, as well as emergency alert sirens throughout the city, which are used to warn residents of hazardous conditions or situations.

2.2.10 City of Ryder

Originally known as Centerville, the city of Ryder was incorporated in 1906.

Geography

The city occupies an area of .34 mi^2, the vast majority of which is land. .01mi^2 of the area of Ryder is water. Figure 2.2.10-1 (below) illustrates the area occupied by Ryder and its location within Ward County.

Figure 2.2.10-1
City of Ryder Basemap

Population

According to the 2010 Census, the population of Ryder was 85, a decrease of 7.6% from the 2000 Census. The population was organized into 42 households, with an average household size of 2.02 people. 26.2% of households included at least one child below the age of 18. 23.8% of households were made up of someone over age 65 that lived alone.

The median age of Ryder residents was 48.5 years old. 18.8% of residents were below 18 years of age, and another 28.2% of residents were over 65 years of age. The population was dominated by males, who made up 58.8% of the 2010 population.

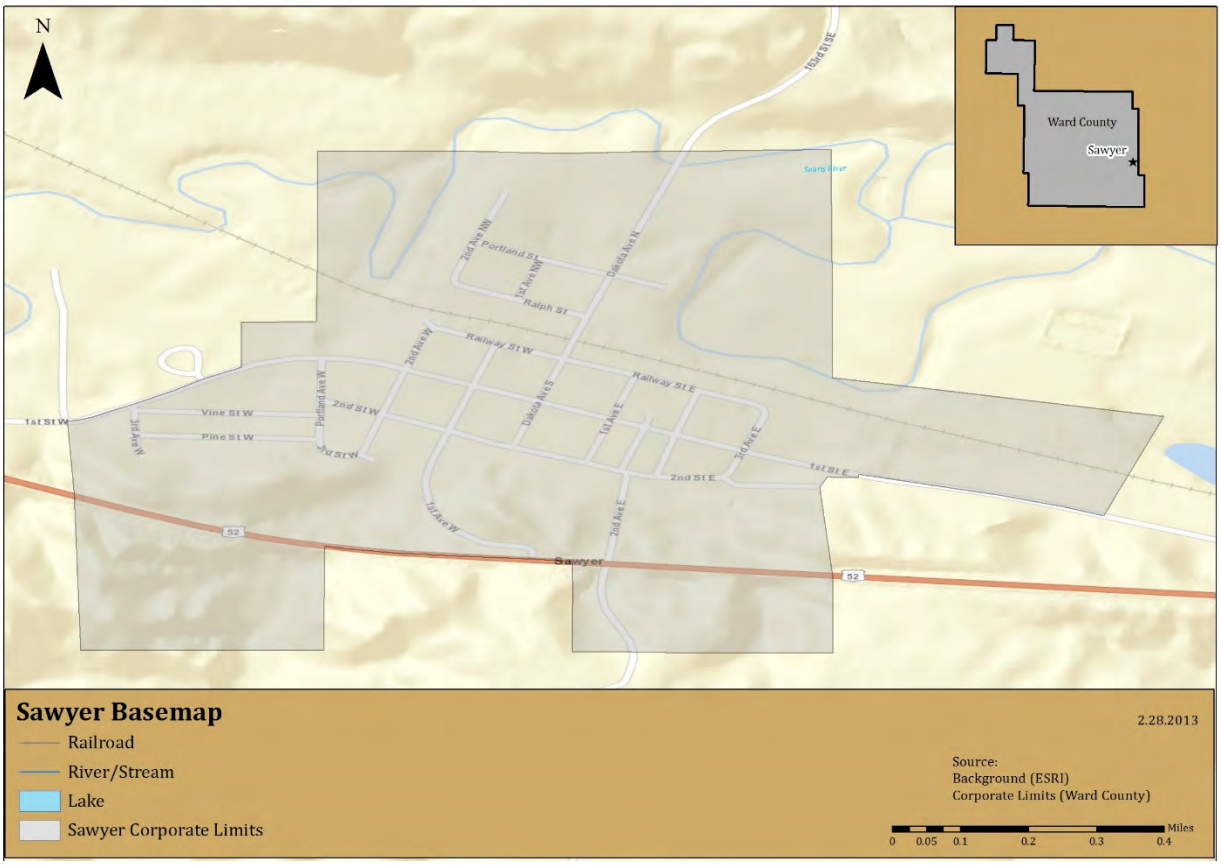
Emergency Services and Critical Assets
Ryder has ambulance service and served by the Ryder-Makoti Fire Protection District, as well as an elementary school, which serves as an emergency shelter for residents. (High school children attend school in nearby Makoti.) A second shelter is located in the basement of the Cenex building. Law enforcement is provided by the Ward County Sheriff's Department.

2.2.11 City of Sawyer

Located in eastern Ward County, Sawyer was founded in 1898.

Geography
The city occupies an area of .48 mi^2, all of which is land. Figure 2.2.11-1 (below) illustrates the area occupied by Sawyer and its location within Ward County.

Figure 2.2.11-1
City of Sawyer Basemap



Population
According to the 2010 Census, the population of Sawyer was 357, a decrease of 5.3% from the 2000 Census. The population was organized into 139 households, with an average household size of 2.57 people. 35.3% of households included at least one child below the age of 18. 10.8% of households were made up of someone over age 65 that lived alone.

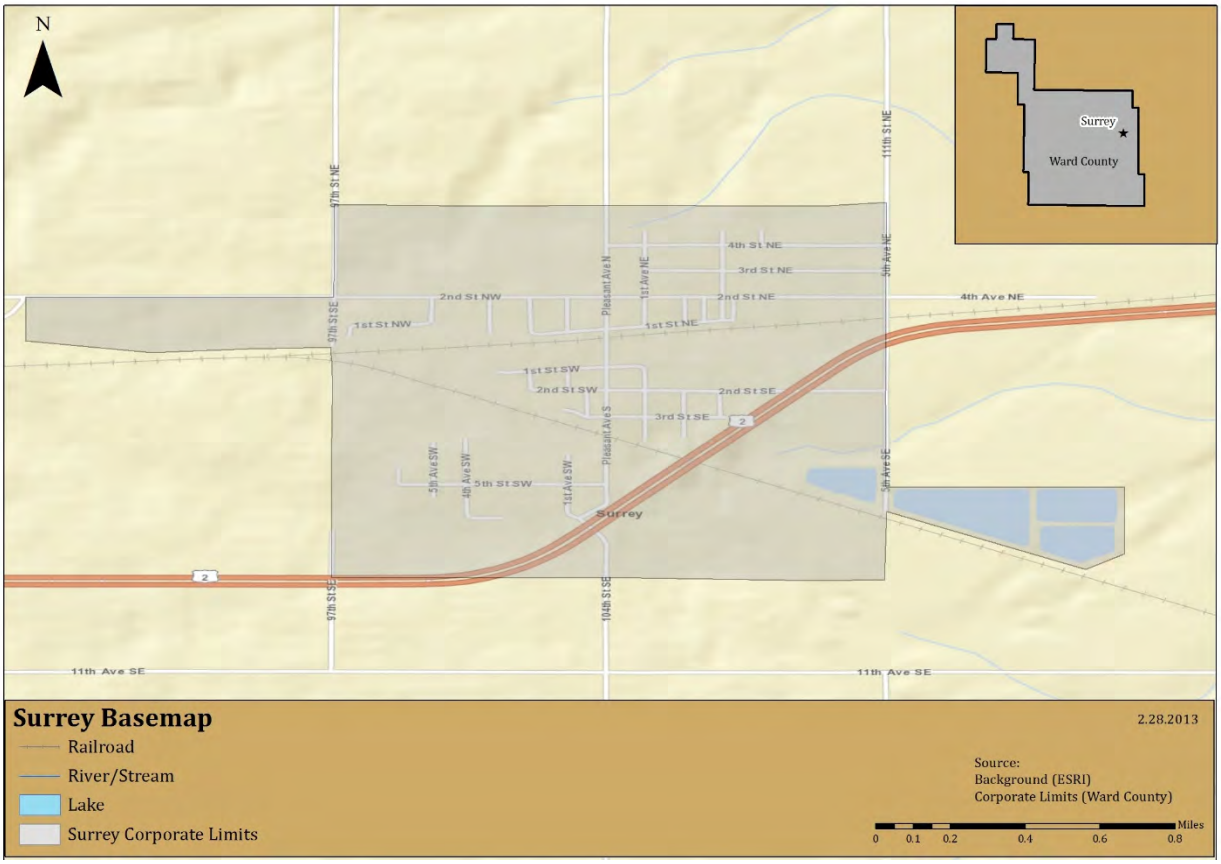
The median age of Sawyer residents was 38.4 years old. 28% of residents were below 18 years of age, and another 11.8% of residents were over 65 years of age. The population skewed towards males, who made up 52.4% of the 2010 population.

Emergency Services and Critical Assets
Sawyer has ambulance service (through Community Ambulance of Minot) and is served by the Sawyer Fire Protection District, as well as both an elementary school and a high school, which serve as emergency shelters. There is a city hall located in Sawyer, as well as a senior center. The city has a siren, used as an emergency alert and warning device, and other critical infrastructure, including pump and lift stations. Law enforcement is provided by the Ward County Sheriff's Department.

2.2.12 City of Surrey
Founded in 1900 along the Great Northern Railway (now BNSF), Surrey was incorporated in 1951.

Geography
The city occupies an area of .99 mi^2, all but .01 mi^2 of which is land. Figure 2.2.12-1 (following) illustrates the area occupied by Surrey and its location within Ward County.

Figure 2.2.12-1
City of Surrey Basemap



Population
According to the 2010 Census, the population of Surrey was 934, an increase of 1.9% from the 2000 Census. The population was organized into 334 households, with an average household size of 2.80 people. 39.2% of households included at least one child below the age of 18. 3.3% of households were made up of someone over age 65 that lived alone.

The median age of Surrey residents was 32.5 years old. 28.2% of residents were below 18 years of age, and another 7.8% of residents were over 65 years of age. The population skewed slightly male, who made up 51.2% of the 2010 population.

Emergency Services and Critical Assets
Sawyer has ambulance service (through Community Ambulance of Minot), a police department, a fire department, and a city hall. There is also an elementary school, which serve as an emergency shelter. Additional shelters are located in the senior center and the First Lutheran Church. Surrey has significant infrastructure and two emergency alert sirens, which are used to notify residents of hazardous conditions.

2.2.13 Ward County

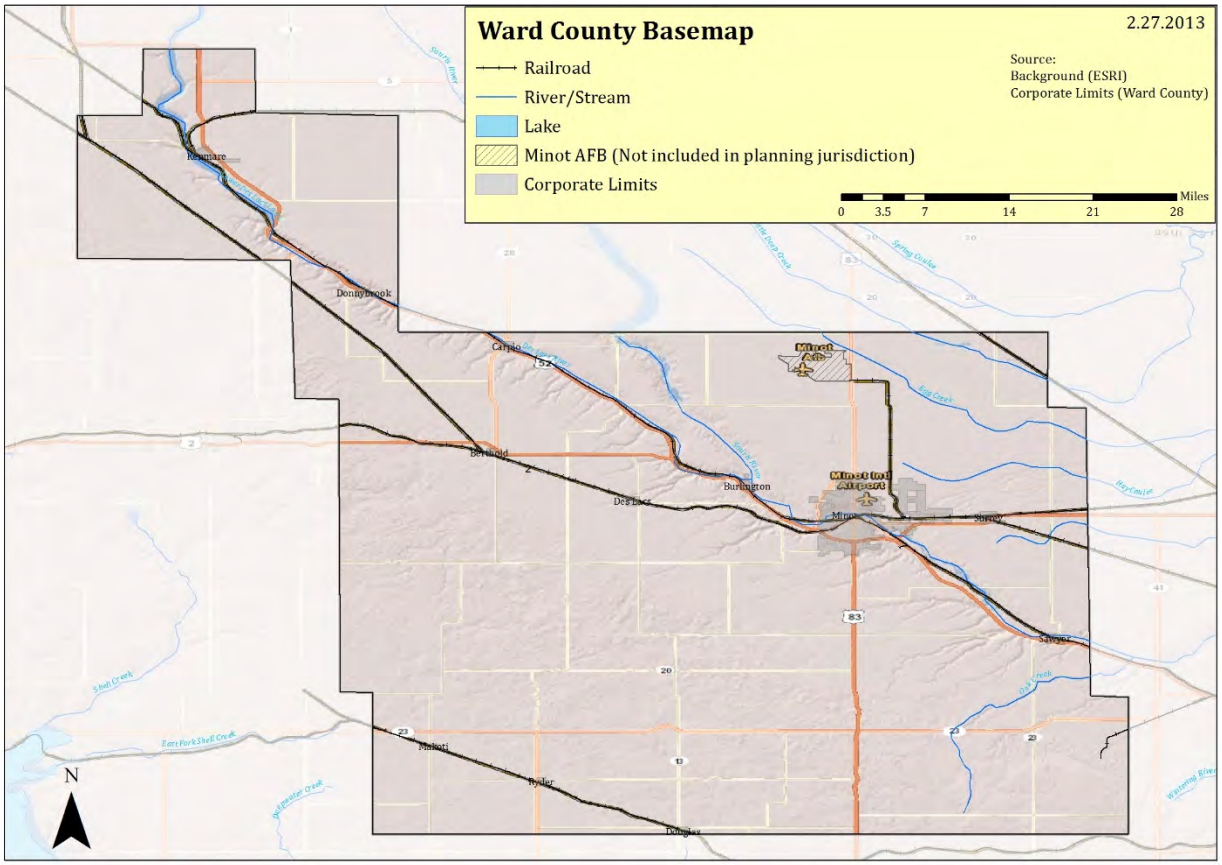
Created in 1885 by the Dakota Territory legislature, Ward County is located in the northwest portion of North Dakota. Of the 53 counties in the state, Ward County ranks fifth in area. It is home to 12 incorporated cities, 56 incorporated townships, and one unincorporated township.

Geography

The county occupies a total area of 2,056 mi^2, the majority of which (2,013 mi^2) is land; the remaining area (2.11%) is water. The entire county is glaciated. The north, northeast, northwest, and southeast portions of the county are generally flat, with occasional undulations and a simple drainage pattern. Areas to the southwest and extreme northwest corners of the county are hummocky, rolling terrain, or stagnation moraine. These areas have uncommon drainage patterns; in some cases, there is no appreciable drainage pattern at all. The extreme southwestern corner of the county is level to gently rolling plain, which slopes to the Missouri River with a sparse drainage pattern.

Figure 2.2.13-1 (below) illustrates the area occupied by Ward County, as well as the major hydrology and transportation routes through the county.

Figure 2.2.13-1
Ward County Basemap



Hydrology
Wetlands, lakes, rivers, streams, and coulees are abundant throughout the county. Ward County is home to portions of both the Des Lacs River and the Souris (Mouse) River Basins. Significant lakes in the county include Rice Lake, Makoti Lake, Hiddenwood Lake, Upper Des Lacs Lake, Lower Des Lacs Lake, North Carlson Lake, and South Carlson Lake. The natural drainage is mainly to the southeast and northeast, though much of the county does not have a well-established drainage system.

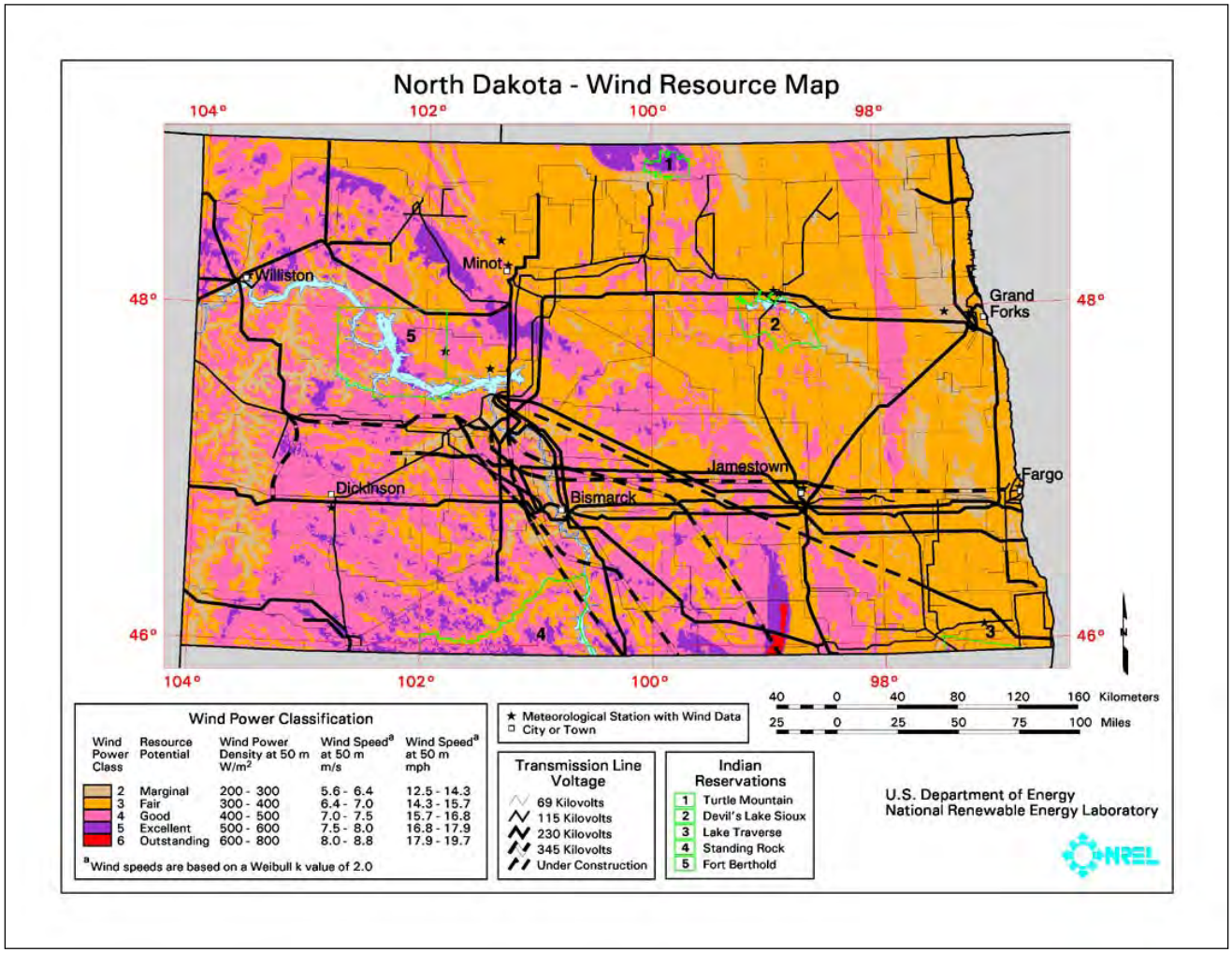
Vegetation
Native vegetation consists of mixed native grasses, forbs, and shrubs. The most common grass species are western wheatgrass, big and little bluestem, needle-and-thread, green needle grass, switch grass, and Indian grass. Trees and shrubs grow on the northern and eastern faces of valley breaks and river bottoms. The most common tree species include green ash, willow, aspen, chokeberry, and wild plum. There are approximately 5,000 acres of native woodland, which is primarily located along bottomland, in the Souris River Basin, and in various coulees.

Natural Resources
As a largely agricultural area, soil is a critical resource in Ward County, as it provides the medium for agriculture and the grazing plants for livestock. Other abundant natural resources in the county include rivers, lakes, wildlife, gravel, and wetlands.

Census data shows that the county has approximately 1,172 farms, with an average acreage of 1,030. Soil erosion due to wind and water is a concern in the county. On steep grades, rain washes out gullies in cultivated fields, and fields cultivated in the fall suffer further erosion from wind. To combat this erosion, Ward County is enrolled in the Conservation Reserve Program, which is a voluntary USDA/FSA program available to agriculture producers to help them best use environmentally sensitive land for conservation benefits. Those enrolled in the program plant long-term, resource conserving crops, which help to improve the quality of the water, control soil erosion, and encourage wildlife habitat. In exchange, the FSA provides rental payments and cost-share assistance. This program has helped to mitigate the erosion problem in the agricultural lands of Ward County.

Wind is another natural resource that Ward County has in abundance, as seen in Figure 2.2.13-2 (following). To utilize this resource, the county has aggressively pursued wind produced energy technology and production.

Figure 2.2.13-2
North Dakota Wind Resource Map



Climate

The average annual temperature range for Ward County is 37°F - 43°F. January is typically the coldest month, with average temperatures ranging from 2°F to 17°F. By contract, July is usually the warmest month, with average temperatures ranging from 67°F to 73°F. In an average year, Ward County experiences 110-119 days each year where the temperatures are above freezing. The warmest temperature recorded in the county was 109°F, recorded on June 20, 1910. The coldest temperature, recoded on February 15, 1936, was -49°F.

Precipitation is usually light during the winter months, as low pressure systems forming on the eastern slopes of the Rocky Mountains in Canada or in the northern Pacific Ocean frequently move southeastward through North Dakota. Nearly all of the moisture-laden low pressure systems that result in large amounts of snowfall follow tracks that carry them through the southern portion of the state, and therefore generally miss Ward County. Most of the snow that does fall is low-

moisture ("dry"), granular snow that is easily distributed by winter winds. The average annual precipitation in Ward County is 15-17 inches.

The average wind speed in the county is approximately 23 MPH. The highest recorded non-tornadic wind speed recorded in the county was at Minot Air Force Base in July 1997, when the speed measures 119 MPH. The average wind speed direction in the county is northwest, though wind from all directions occurs with regularity.

The relative humidity in the county varies widely in the summer, spanning from 50% to about 85%. In the winter, humidity averages from 50% to about 75%.

Population
As of the 2010 Census, the population of Ward County was 61,675. As of July 2012, the Census Bureau estimated the population to be 64, 798, an increase of 5.1% in 24 months. Children under 18 years of age make up approximately 24% of the population, and those over 65 account for just under 13%. As of 2010, the county had a population density of 30.6 persons per square mile, which was significantly higher than the state average of 9.7 persons per square mile.

Transportation
Ward County - and particularly the city of Minot - serves as a central hub for north-central and northwestern North Dakota, as well as parts of Montana and the Canadian provinces of Manitoba and Saskatchewan. The county's transportation system has three major highways (Highway 83, the Highway 83 Bypass, and Highway 2/52), and multiple railways, as well as several airports.

Highway 83 runs north-south from the Canadian border through Minot, Bismarck and into South Dakota. Highway 2/52 runs roughly northwest to southeast through the county, its northwest end connecting to several Canadian border crossings in northwestern North Dakota.

The Highway 83 Bypass allows responders to bypass the northwestern portion of the city of Minot by connecting Highway 2/52 on the west side of the city with Highway 83 on the extreme north end of the city limits. In the largest city, Minot, response routes may be hampered by a limited number of highway, railroad and river crossings (bridges) available to emergency responders. Highway crossing access in the more rural areas actually improves as the highways provide direct access from secondary roads; there are no formal on and off ramps as found on most other highways. Rural highway crossing access is tempered by the fact that the majority of the non-urban roads are two lane, compacted dirt roads with a limited number of cross roads and turnaround areas. Often these dirt roads are not well marked.

The highways transiting Ward County carry a high volume of heavy truck traffic. Cargo varies widely, encompassing the entire spectrum of truck-transportable items. Loads of industrial chemicals and hazardous materials transit the county daily. Hazardous military cargo also transits the county as the 91st Space Wing at Minot Air Force Base services the missile sites situated throughout the county.

There are three railroad systems running through Ward County and they follow most state highway routes with the city of Minot being the hub. The railroad system runs through all of the 12 incorporated cities throughout the county. The railroads provide a major artery of rail cargo and passenger traffic from Seattle through Spokane, Portland, and St. Paul to Chicago. Several railroad choke points exist throughout the county. Two choke points are especially noteworthy: the 6th Street. SW overpass in Minot, which serves both cargo and passenger rail traffic, and Trestle Valley which is a particularly heavily used cargo train artery on the extreme southwestern side of Minot. Railroad crossing access, like highway crossing access, improves in the non-urban portions of the county.

Numerous freight trains traverse Ward County daily. Hauled freight includes all manner of raw and finished goods as well as tank cars of industrial and agricultural chemicals. Passenger train service by Amtrak consists of one daily long-distance train, the Empire Builder that provides service from Chicago – Minneapolis/St. Paul – Seattle/Portland via Fargo, Grand Forks, Devils Lake, Rugby, Minot, Stanley, and Williston.

Streams and rivers in Ward County do not support commercial traffic and are limited to recreational use. River crossings are limited throughout the county and in many cases require responders to take a less than optimal route to reach an incident site. The city of Minot's road system is laid out in a classic "cardinal points" layout; most roads run directly north-south or east-west. Additionally a large proportion of the streets are numbered rather than named. Streets run east-west and are designated north or south based on their location from Central Avenue. Avenues run north-south and are designated east or west by their direction from Main Street (an extension of Highway 83).

Ward County has numerous small asphalt and dirt strips to support crop dusting operations. The majority of crop dusting operations occur between mid to late summer. Additionally, Ward County is host to Minot International Airport, Stanley Municipal Airport, and Minot Air Force Base. Other regional airports include Mohall, Garrison and Stanley Municipal Airports.

- Minot International Airport – (FAA designator MOT) is located northeast of the city of Minot. MOT has two active runways, and is currently served by four commercial carriers.
- Minot Air Force Base – (FAA designator MIB) Located 10 miles north of the city of Minot, MIB has one active runway. This runway is stressed for very heavy aircraft and has the capability of handling the largest aircraft flying today. Air traffic at MIB is primarily restricted to military aircraft and averages 82 flights per day. Airfield operations are not continuous and prior permission to land there is required. In emergency/exceptional situations, the Base Commander can approve landing of any aircraft at the base. Kenmare Municipal Airport – (FAA Designator 7K5) is located1 mile SE of the city of Kenmare. The single runway has a load rating of 12,000 pounds, and is suitable for light aircraft only.

Section 03
Planning Process

3.1 Interim Final Rule Requirement for the Planning Process
3.2 Description of the Plan Update Process
3.2.1 Data Sources for Plan Preparation
3.2.2 How the Plan Was Prepared (Overview)
5.2.2.1 Step 1: Organize Resources
5.2.2.2 Step 2: Assess Risks
5.2.2.3 Step 3: Develop the Mitigation Plan (Update)
5.2.2.4 Step 4: Implement the Plan and Monitor Progress
3.3 Involvement by the Public and Other Interested Parties
5.3.1 Public Involvement in the Plan
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3.4 Review and Incorporation of Plans, Studies, Reports, and Other Information
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3.1 Interim Final Rule Requirements for the Planning Process

Requirement §201.6(b): *An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:*

(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;

(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private, and non-profit interests to be involved in the planning process; and

(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

Requirement §201.6(c)(1): *[The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.*

3.2 Description of the Plan Update Process

This section describes how the Plan Update was prepared.

3.2.1 Data Sources for Plan Preparation

As required by the published guidance, this Plan is an update to the 2008 Plan. As such, all applicable data that remains accurate and relevant has been incorporated into this Plan Update. Where data is no longer applicable or accurate, it has been replaced with current data, or with data that is applicable.

In addition to the 2008 Plan, a variety of data sources were used to create this Plan Update, including:

- Ward County Emergency Management Agency;
- Ward County Highway Department;
- North Dakota Department of Emergency Services;
- North Dakota State Water Commission;
- First District Health Unit;
- Minot State University;
- National Weather Service;
- Federal Emergency Management Agency; and
- US Forest Service.

A complete listing of data used can be found in Section 3.4.

3.2.2 How the Plan Update was Prepared (Overview)

The Ward County Hazard Mitigation Plan Update was prepared in accordance with the process established in the *State and Local Mitigation Planning How-to Guides* (FEMA Publication Series 386) produced by the Federal Emergency Management Agency (FEMA), and the requirements of the February 26, 2002 Interim Final Rule (IFR). The process established in the FEMA 386 guides includes four basic steps.

- **Step 1**: Organize resources
- **Step 2**: Assess risks
- **Step 3**: Develop a mitigation plan (update)
- **Step 4**: Implement the plan and monitor progress

3.2.2.1 Step 1: Organize Resources

This Plan Update was developed through a partnership between Ward County's Emergency Management Director and Ward County's Local Emergency Planning Committee (LEPC). At the beginning of the process, a consultant firm, Witt O'Brien's (formerly Witt Associates), was hired to provide technical support to the County and municipalities, to facilitate the plan update process, and to produce the plan update document.

The LEPC served as the Steering Committee for the Plan Update. The Steering Committee was comprised of representatives from municipalities and public entities that wished to participate in

the planning effort. These representatives had knowledge of their jurisdiction's risks and vulnerabilities. The duties and responsibilities of the Steering Committee consisted of: representing their municipality/agency/department's interests, serving as the point of contact for their municipality/agency/department, and completing necessary planning tasks, including data collection, identification of local mitigation actions, and reviewing the Plan Update products. The Steering Committee identified the most significant hazards for a risk assessment to be completed.

Table 3.2.2.1-1
Ward County Hazard Mitigation Plan Update Steering Committee Members

Ward County Hazard Mitigation Plan Update Steering Committee Members		
Name	**Title**	**Municipality/Agency/Department/Organization**
Clayton Fegley	Squad Leader	City of Berthold Ambulance Service
Al Schmidt	Chief	City of Berthold Police Department
Keith Crabb	Chief	City of Burlington Police Department
Jeff Weaver	Director	City of Burlington Public Works Department
Kalvin Myers	Mayor/Fire Chief	City of Carpio / Carpio Fire Department
Ross Rivers	Councilmember	City of Carpio City Council
Darrell Francis	Councilmember	City of Des Lacs City Council
Mark Norby	Chief	City of Des Lacs Fire Department
Dennis Huff	Mayor	City of Donnybrook
Bill Gagnon	Councilmember	City of Douglas City Council
Chuck Leet	City Council President	City of Kenmare City Council
Barb Wiedmer	Auditor	City of Kenmare
Corrie Fischer	Councilmember	City of Makoti
Tim Beach	Assistant Chief	City of Minot Fire Department
DeVawn Beckman	PSAP Manager	City of Minot Central Dispatch
CJ Craven	Chief	City of Minot Fire Department
Darin Egge	911 Coordinator /Lieutenant	City of Minot Police Department
Brian Horinka	Superintendent	City of Minot Transit Department
Dan Jonasson	Director	City of Minot Public Works Department
Lance Meyer	City Engineer	City of Minot Engineering Department
Jason Olson	Chief	City of Minot Police Department
Rob White	Captain	City of Minot Police Department
Jody Reinisch	Mayor	City of Ryder
Cody Rotelick	Auditor	City of Sawyer
Jennifer Johns	Deputy Auditor	City of Surrey
Mark Chilson	Field Supervisor	Community Ambulance Service
Rex Weltikol	Chief	Minot Rural Fire Department
Bob Barnard	Captain	Ward County Sheriff's Department
Dan Green	Assistant	Ward County Emergency Management Agency
Heather Harris	Assistant	Ward County Emergency Management Agency
Steven Kukowski	Sheriff	Ward County Sheriff's Department
Dana Larsen	County Engineer	Ward County Highway Department
Jim Mertz	GIS Specialist	Ward County Highway Department
Jack Nybakken	Commissioner	Ward County Commission
Robert Roed	Lieutenant	Ward County Sheriff's Office
Amanda Schooling	Director	Ward County Emergency Management Agency
Jamie Hyatt	Organizations NCO	North Dakota National Guard

Ward County Hazard Mitigation Plan Update Steering Committee Members		
Name	**Title**	**Municipality/Agency/Department/Organization**
Jose Estrada	Emergency Preparedness and Response Coordinator	First District Health Unit
Brandon Neiss	Campus Security Officer	Minot State University
Dave Kohlman	Vice President, Facilities	Trinity Health
Randy Schwan	Vice President	Trinity Health
Art Haskins	Emergency Response Coordinator	Enbridge Pipelines

Meeting Schedule

There were several meetings conducted during the development of the Plan Update. These meetings are described in the table below (Table 3.2.2.1-2). The meetings focused primarily on the review of work-in-progress for the development of the Plan Update. However, in some cases, the meetings were working sessions for identification of potential mitigation actions for each participating jurisdiction.

Table 3.2.2.1-2
Ward County Plan Update Meeting Schedule and Summary

Ward County Mitigation Plan Update Project Meeting Schedule and Summary		
Date	**Meeting Name**	**Meeting Summary**
January 02, 2013	LEPC Meeting	Preliminary discussion of potential hazards/threats that each participating jurisdiction has concerns regarding, and general identification of needed mitigation actions to address these hazards/threats.
February 07, 2013	LEPC Meeting (Steering Committee Meeting #1)	Overview of plan update process and requirements; completed hazard identification exercise; discussed how risk assessment would be conducted; reviewed asset criticality ranking criteria; discussed idea of conducting capability assessment survey
March 07, 2013	LEPC Meeting (Steering Committee Meeting #2)	Overview of progress to date; reviewed asset criticality rankings and asset listings; completed qualitative/quantitative risk assessment determination exercise; determined updates to hazard mitigation goals for Plan Update
April 01, 2013	Municipality Meeting City of Des Lacs	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption
April 01, 2013	Municipality Meeting City of Burlington	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption

Ward County Mitigation Plan Update Project Meeting Schedule and Summary		
Date	**Meeting Name**	**Meeting Summary**
April 01, 2013	Municipality Meeting City of Ryder	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption
April 01, 2013	Municipality Meeting City of Surrey	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption
April 01, 2013	Municipality Meeting City of Donnybrook	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption
April 02, 2013	Municipality Meeting City of Minot	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption
April 02, 2013	Municipality Meeting City of Sawyer	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption
April 03, 2013	Municipality Meeting City of Berthold	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption
April 03, 2013	Municipality Meeting City of Douglas	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption
April 03, 2013	Municipality Meeting City of Makoti	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption
April 04, 2013	Municipality Meeting City of Kenmare	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption
April 04, 2013	Municipality Meeting City of Carpio	Reviewed Plan Update goals; determined mitigation actions for strategy; prioritized actions within strategy; discussed next steps and path to plan adoption
April 04, 2013	LEPC Meeting (Steering Committee Meeting #3)	Overview of progress to date; reviewed risk assessment imagery; reviewed capability assessment information; discussed next steps and path to plan approval/adoption
April 05, 2013	Municipality Meeting Ward County	Reviewed and updated existing mitigation strategy; added additional mitigation actions to strategy; prioritized actions within strategy

Appendix C contains documentation for these meetings including agendas, sign-up sheets, presentation materials, and meeting notes as appropriate.

3.2.2.2 Step 2: Assess Risks

In accordance with general mitigation planning practice, as well as the process FEMA established in its *How-to Guides*, the risk assessment forms the basis for this Plan Update by quantifying and rationalizing information about how natural and manmade hazards affect Ward County and its municipalities.

The processes used to complete the hazard identification and risk assessments, and the results of these activities, are described in Sections 04-16 of this Plan Update. The assessment determined several aspects of the risks of hazards faced by the planning area:

- The hazards that are most likely to affect the planning area;
- How often those hazards are expected to impact the planning area;
- The expected severity of those hazards;
- What areas of the planning area are likely to be affected by those hazards;
- How the planning area's assets, operations, people, and infrastructure may be impacted by those hazards; and
- The expected future losses if the identified risks are not mitigated.

The Steering Committee first considered all hazards with the potential to impact the planning area. An exercise was held at the Steering Committee's Kickoff Meeting detailing the hazards considered in the 2008 Plan, the hazards considered in other planning efforts (including the State Hazard Mitigation Plan), and a listing of additional hazards that could be considered for inclusion in the Plan Update. Members were asked to consider the hazard history, to consider any other hazards that were not included in the initial listing, and to provide their thoughts on which hazards should be included in the Plan Update.

Next, through examination by and discussion among the members, the Steering Committee reduced the initial list of hazards to the 08 hazards that were considered the most relevant for this type of planning process. These hazards are as follows:

- Communicable Disease;
- Drought;
- Fire;
- Flood;
- Landslides (county only);
- Severe Summer Storms;
- Severe Winter Storms; and
- Hazardous Materials Incidents.

These are considered by the Steering Committee to represent the predominant risks to the planning area.

These profiled hazards were further analyzed, to determine the actual risk to the planning area, residents, and assets from these hazards. The list was further refined, to analyze those hazards which were determined to pose the most significant risks to the participating jurisdictions and their assets. All profiled hazards received a qualitative risk assessment. The hazards selected to receive a quantitative risk assessment were:

- Communicable Disease;
- Fire;
- Flood;
- Severe Summer Storms;
- Severe Winter Storms; and
- Hazardous Materials Incidents.

For each of these hazards the consultants performed detailed risk assessments, i.e. calculations of future expected damages, expressed in dollars where appropriate. These results were discussed in detail with the Steering Committee at a meeting, and determinations were made as to each hazard's risk to People Life Safety, Buildings and Critical Facilities, and Infrastructure. The results of the risk assessment were also made available to the public during the public review and comment periods (see Section 3.3). The full process and results of this work is presented in the Risk Assessment portion of this Plan Update.

3.2.2.3 Step 3: Develop the Mitigation Plan (Update)

The Steering Committee in response to the results of the risk assessment, determined that the goals of the 2008 Plan were sufficient and applicable, with a few changes. A capability assessment was also conducted to help determine the baseline capability and capacity of the planning area to implement hazard mitigation projects. The capability assessment in the 2008 Plan addressed Ward County as a whole, and did not account for variances between the jurisdictions. The updated capability assessment accounts for the variances.

Each jurisdiction in the planning area developed their own mitigation strategy, which is based on the hazards, risks, and vulnerabilities identified in their individual HIRA. The actions described in the strategies are all within the existing capabilities and capacities of the jurisdictions, and will serve to further the mitigation, recovery, and resiliency goals of the jurisdictions.

3.2.2.4 Step 4: Implement the Plan and Monitor Progress

Finally, the Steering Committee identified a process for on-going monitoring and revisions to the Plan Update over the next five years. Section 18 details the resulting monitoring, evaluation, and plan update procedures.

3.3 Involvement by the Public and Other Interested Parties

3.3.1 Public Involvement in the Plan

Public Comment

The Steering Committee provided opportunities for public comment throughout the Plan Update process.

The Steering Committee was comprised of different types of agencies including but not limited to: City departments, non-profits, state agencies, and educational entities. This group met several times during the process discussing, among other things, the planning requirements, incorporation of data, and data analysis. Comments received during these meetings were used in the formulation of the Hazard Mitigation Plan Update.

For the first public comment period, no formal meeting was held. Rather, the draft plan update and a comment form were posted to the County's website and in the major newspaper of the region, the *Minot Daily News*. In addition, many participating jurisdictions opted to post their own notices. This comment period began prior to the Plan Update's submission to NDDES for review. Prior to submission of the Plan Update for review by NDDES and FEMA, the draft plan update was available to the public for comment for 14 days. No comments were received during this period.

The Steering Committee held a second public comment period after NDDES/FEMA approval, and prior to adoption by the City Councils and County Commission, in order to provide further opportunity for residents, local businesses, neighboring jurisdictions, and all other interested parties to comment.

Documentation of these public comment periods can be found in Appendix D.

3.3.2 Other Interested Party Involvement in the Plan Update

While a portion of the Steering Committee was comprised of City and County staff and leaders, outside partners and agencies were invited and encouraged to participate in the plan update process. The participants recognize that they rely on outside agencies and organizations, and that these organizations bring valuable information to the mitigation planning process. Invitees to the planning process included neighboring communities, outside agencies, businesses, academia, private non-profits and other interested parties. The following parties participated in the Plan Update's Steering Committee:

- Enbridge Pipeline;
- Minot State University;
- North Dakota National Guard;
- Trinity Health; and
- First District Health Unit.

In addition, prior to formal adoption of the Plan Update, development and emergency management officials representing the communities surrounding Ward County will be specifically contacted, and asked to provide their comments and suggestions on the draft Plan Update. These officials will be provided with a copy of the draft Plan Update, and will be given ample time to respond to this request. Any and all responses received will be reviewed and considered, and any accepted suggestions will be incorporated into the Plan Update prior to adoption.

3.4 Review and Incorporation of Plans, Studies, and Other Information

3.4.1 Federal Government

Key federal sources of information and pre-existing planning work are presented in Table 3.4.1-1 (below).

Table 3.4.1-1
Federal Documents and Data Utilized

Federal Documents and Data Utilized in Plan Update	
Existing Program/Policy/Technical Documents	**Method of Incorporation into the Plan Update**
FEMA Disaster Declarations database and other general hazard data	Used in hazard identification and risk assessment (HIRA) development and history of loss data for multiple hazards
FEMA/Nation Flood Insurance Program Flood Maps (Flood Insurance Rate Maps, Digital Flood Insurance Rate Maps (DFIRM))	Used in developing HIRA and mitigation strategies
FEMA Hazards US (HAZUS)	Used in developing critical facilities inventories
FEMA Benefit Cost Analysis methodology	Used in prioritizing mitigation strategy actions
FEMA Community Status Book, Community Rating System Eligible Communities	Used in developing capability assessments and mitigation strategy
FEMA Tornado Activity in the United States	Used in developing HIRA and history of loss data
National Oceanic and Atmospheric Administration (NOAA)/National Climatic Data Center (NCDC) database	Used in developing history and description of major hazard events for multiple hazards
NOAA Storm Prediction Center	Used in developing HIRA and mitigation strategies
United States Army Corps of Engineers	Used in developing HIRA and mitigation strategies
United States Census Bureau data	Used in developing various risk assessments and establishing planning context
United States Geological Survey (USGS)	Used in developing HIRA and loss data
United States Environmental Protection Agency Toxic Release Inventory	Used in developing HIRA and mitigation strategies
United States Department of Transportation Hazardous Materials Incident Data	Used in developing HIRA and mitigation strategies
US Department of Agriculture (USDA) National Fire Plan	Used in developing HIRA
US Forest Service	Used in developing HIRA and mitigation strategies
Homeland Security Information Portal	Used in developing HIRA

3.4.2 State of North Dakota

Selected state sources of information and pre-existing planning work are presented in this section.

2011 State of North Dakota Multi-Hazard Mitigation Plan

The State of North Dakota completed the current 2011 State Multi-Hazard Mitigation Plan (SHMP) to meet the requirements of IFR Section 201.4(d), which mandates that states update their mitigation plans every three years, "to reflect changes in development, progress in state wide mitigation efforts, and changes in priorities."

The SHMP is the demonstration of the State of North Dakota's commitment to reduce risks from natural hazards and serves as a guide for both state and local decision makers as they commit resources to reducing the effects of natural hazards on lives and property. It is designed to outline a strategy to reduce risks from natural hazards in North Dakota, and to aid state and local emergency management officials in developing hazard reduction programs.

The State of North Dakota uses the SHMP as a way to provide data to local and regional governments to support their mitigation planning processes, and to provide guidance on best practices. North Dakota Department of Emergency Services (NDDES) staff also is available during the draft plan update development to answer any questions or provide guidance and assistance.

The SHMP describes the state's commitment to local hazard mitigation in the following way:

> Shortsighted development patterns have contributed to making some North Dakota communities extremely vulnerable to flooding, winter and summer storms, wildland fire, and other hazards. The State Hazard Mitigation Team can work with communities to reduce their vulnerability by educating about inappropriate land uses and by encouraging the acquisition, relocation, or retrofitting of existing vulnerable structures, along with the protection of valuable natural resources. If a disaster should strike any one of these communities, the State Hazard Mitigation Team can assist the community in building back better and stronger than before.
>
> Through experience, the team has learned that communities will face significant challenges during post-disaster redevelopment on balancing the driving need for rapid recovery with implementing long-term hazard mitigation. The necessity of meeting basic needs and resettling displaced populations immediately following a disaster often overshadows the more abstract, longer-term sustainability considerations. Once full-scale reconstruction is initiated, it is difficult to modify projects in progress to meet sustainability objectives. This phenomenon highlights the need for pre-disaster mitigation planning that incorporates principles of sustainable development within the context of reconstruction so that communities can more easily rebuild in a manner that will make them less vulnerable to future hazard events and improve their residents' quality of life.
>
> The State Hazard Mitigation Team strongly believes that much of the work in hazard mitigation and sustainable development must be carried out at the local level. It is at the local level where land use decisions are made, growth and development take place, and where the impacts of natural hazards are most direct. The team has always supported local self-sufficiency and reliance, providing assistance to communities where it is needed, but allowing local initiatives to take the lead. As noted within this plan, a major goal of the team is to build and support such local capacity and commitment.

The State Hazard Mitigation Team realizes that establishing a true statewide mitigation ethic will take hard work, and quite possibly will require major paradigm shifts among many different entities. State agencies, units of local and tribal government, non-profit organizations, businesses and industries, and private citizens will have to become more involved. This plan is meant to be the first step in that direction.

The purpose of this Multi-Hazard Mitigation Plan is to:

- Serve as a consolidated, comprehensive source of statewide hazard information
- Educate government leaders and the public on their vulnerabilities
- Prioritize and promote cost-effective mitigation solutions
- Provide guidance to organizations and agencies statewide regarding hazard mitigation
- Support requests for grant funding
- Encourage long-term community sustainability
- Improve coordination of mitigation efforts across the state.

Wherever possible, this Plan has incorporates information and recommendations consistent with the State of North Dakota Multi-Hazard Mitigation Plan. The plan is available for download from:

http://www.nd.gov/des/uploads/resources/658/state-mhmp---2011.pdf

Other State of North Dakota Information

In addition to the SHMP, selected state sources of information and pre-existing planning work are presented in Table 3.4.2-1 (below).

Table 3.4.2-1
Other State Documents and Data Utilized

State Documents and Data Utilized	
Existing Program/Policy/Technical Documents	**Method of Incorporation into the Plan Update**
State of North Dakota Multi-Hazard Mitigation Plan (2011)	Used in development of HIRA, capability assessment, and mitigation strategy
Data from the North Dakota Department of Emergency Services	Used in development of HIRA, capability assessment, and mitigation strategy
Data from the State Water Commission	Used in development of HIRA, capability assessment, and mitigation strategy
Date from the State Department of Public Health	Used in development of HIRA, capability assessment, and mitigation strategy
Data from the ND State University System	Used in development of HIRA, capability assessment, and mitigation strategy
The Mouse River Enhanced Flood Protection Plan Preliminary Report	Used in development of HIRA and mitigation strategies
State Water Commission Strategic Plan (2011-2013)	Used in development of HIRA and mitigation strategies
Souris Basin Regional Recovery Strategy	Used in development of HIRA, capability assessments, and mitigation strategies

3.4.3 Ward County

Ward County has enacted a Home Rule Charter. From the Charter:

> Subject to the limitations imposed by the North Dakota Constitution, state law, and this charter, the home rule powers of Ward County will be vested in the Board of County Commissioners. The Board of County Commissioners shall have plenary power to enact ordinances and resolutions to carry out and give effect to the express and implied powers granted in this charter and to prescribe the functions of government to be performed under this charter.

Key County sources of information and pre-existing planning work are presented in Table 3.4.3-1 (below).

Table 3.4.3-1
County Documents and Data Utilized

County Documents and Data Utilized	
Existing Program/Policy/Technical Documents	**Method of Incorporation into the Plan Update**
Construction and Building Permits Data	Used in establishing planning context, development of mitigation strategies
GIS database maps, infrastructure, hazards	Used to develop HIRA and mitigation strategies
Emergency Operations Plan	Used to develop HIRA, capability assessments, and mitigation strategies
Data related to critical assets	Used to develop HIRA, capability assessments, and mitigation strategies
Repetitive Loss /Severe Repetitive Loss (RL/SRL) inventory and data	Used to develop HIRA, capability assessments, and mitigation strategies
Website materials (various)	Used to develop HIRA, planning context, capability assessments, and mitigation strategies
Hazard and vulnerability data	Used to develop HIRA and mitigation strategies
Ward County ground water studies	Used to develop HIRA and mitigation strategies

3.4.4 Municipal Resources

Other key sources of information and pre-existing planning work, including regional and academic resources, are presented in Table 3.4.4-1 (following).

Table 3.4.4-1
Municipal Documents and Data Utilized

Other Documents and Data Utilized	
Existing Program/Policy/Technical Documents	**Method of Incorporation into the Plan Update**
Comprehensive Plans, land use plans/ordinances (various municipalities, as available)	Used to develop HIRA, planning context, capability assessments, and mitigation strategies
Zoning and subdivision ordinances (various municipalities, as available)	Used to develop HIRA, planning context, capability assessments, and mitigation strategies

Other Documents and Data Utilized	
Existing Program/Policy/Technical Documents	**Method of Incorporation into the Plan Update**
Hazard and vulnerability data (various municipalities, as available)	Used to develop HIRA, planning context, capability assessments, and mitigation strategies
Asset valuation data (various municipalities, as available)	Used to develop HIRA, planning context, capability assessments, and mitigation strategies
Recovery plans and documents (various municipalities, as available)	Used to develop HIRA, capability assessments, and mitigation strategies

It is important to note here that not all municipalities in the Plan Update have the same level of planning and zoning framework. For many of the municipalities, there is no official framework or document; rather, they rely on familiarity with the community or on documents published by other communities, such as the City of Minot or Ward County. Where community-specific documents and plans existed, they were reviewed and incorporated into this Plan Update, including those published by the City of Minot. Where no such documents and plans existed, a more informal process occurred, via conversations with local officials and others with knowledge.

Section 04
City of Berthold: HIRA, Capability Assessment, and Mitigation Strategy

4.1 IFR for Hazard Identification and Risk Assessment
4.2 Hazard Identification (Updated)
4.2.1 Overview of Berthold's History of Hazards and Potential Hazards
4.2.2 Hazard Profiles
4.3 Risk Assessment (Updated)
4.3.1 Risk Assessment Methodology
4.3.2 Risk and Vulnerability Assessment
4.4 Capability Assessment (Updated)
4.5 Mitigation Strategy (Updated)
4.5.1 Mitigation Goals
4.5.2 Mitigation Actions

4.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..*

Requirement §201.6(c)(2)(ii)(C): *[The plan* ***should*** *describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment* ***must*** *assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Berthold.

4.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Berthold. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

4.2.1 Overview of Berthold's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 18 weather-related hazard events have occurred in the city of Berthold since 1998, including the following number and types of hazard events:

- Flood – 1
- Funnel cloud/tornado – 2
- Hail – 12

- Thunderstorm - 3

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 4.2.1-1 (following) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 4.2.1-1
Presidential Disaster Declarations – City of Berthold

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Berthold

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 4.2.1-2 (below and following).

Table 4.2.1-2
Preliminary Hazard Identification and Determinations – City of Berthold

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Berthold	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Berthold	Reason for Exclusion and other notes
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Berthold	Reason for Exclusion and other notes
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

4.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

4.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk.

Table 4.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 4.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the

severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Berthold.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 4.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 4.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 4.2.2.1-3 (following) provides the details of pertussis outbreaks since 2007.

Table 4.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 4.2.2.1-4 (below) provides occurrence information for rabies.

Table 4.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Berthold did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Berthold, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Berthold, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard

Based on the available data, there have been no occurrences of communicable disease within the city of Berthold. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

4.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Berthold are subject to the drought hazard.

Extent and Severity of the Hazard
Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.
- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

Table 4.2.2.2-1 (below) provides the PDSI classifications.

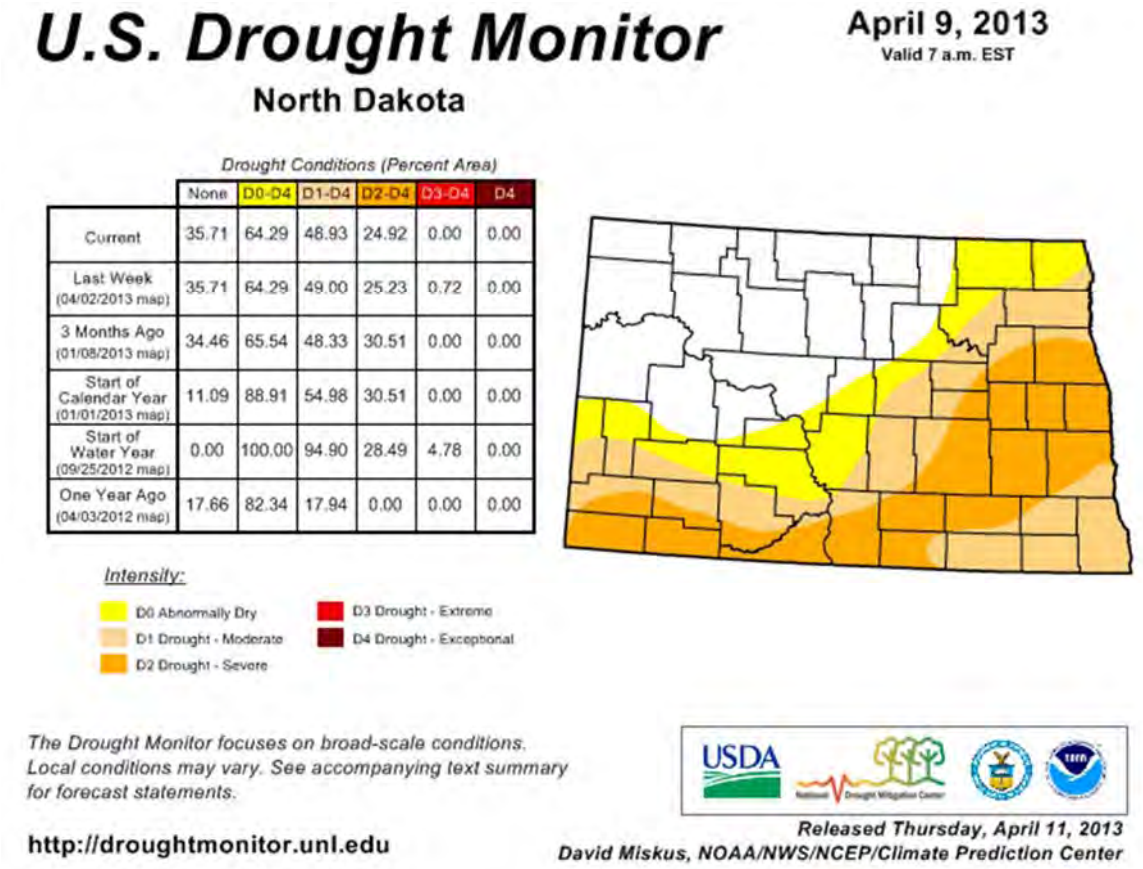
Table 4.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested

Classification	Description	Range of Possible Impacts
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Berthold are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 4.2.2.2-1 (following).

Figure 4.2.2.2-1
US Drought Monitor – North Dakota
(Source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 4.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Berthold – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

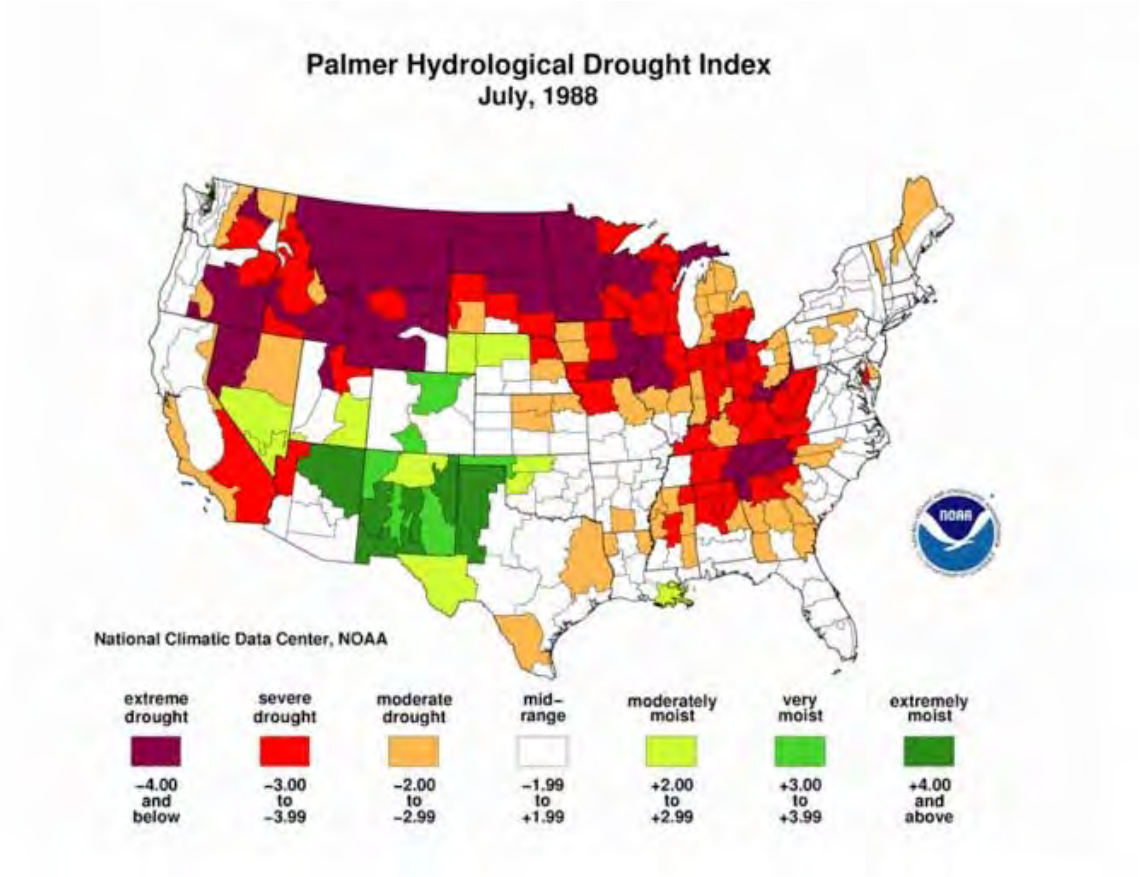
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Berthold. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 4.2.2.2-2 (following), the entire state – including the city of Berthold – was categorized as being in extreme drought during this time.

Figure 4.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(Source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Berthold) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years.

4.2.2.3 Fire
This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

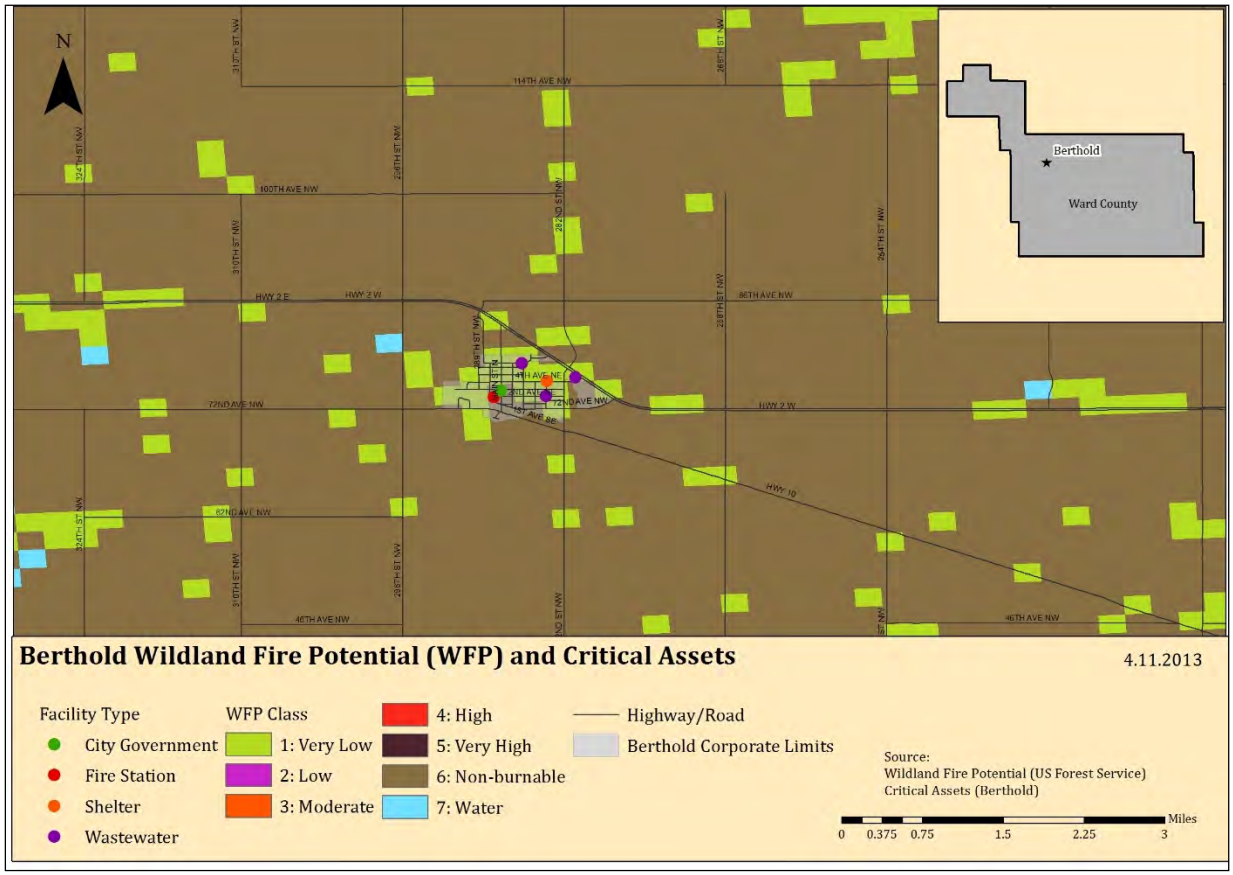
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 4.2.2.3-1 (following) illustrates the wildland fire potential for the city of Berthold, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 4.2.2.3-1
City of Berthold – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard

The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 4.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System.

Table 4.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Based on data obtained from the National Reporting System, the city of Berthold has experienced at least two structure fires since 2008. There were no reports of wildfires in the city since 2008, or of wildfires that impacted the city.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in the city of Berthold at least once in every five years, but less than annually. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence.

4.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters,*

from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard
Berthold has no FEMA-identified or mapped Special Flood Hazard Area within its corporate limits.

Extent and Severity of the Hazard
In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 4.2.2.4-1 (below).

Table 4.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.

Zone Designation	Percent Annual Chance of Flood	Description
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 4.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 4.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

Term	Definition
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

The city of Berthold is not currently a member of the NFIP, and has no identified or mapped Special Flood Hazard Areas, as defined by the NFIP. In addition, there are no designated Repetitive Loss or Severe Repetitive Loss properties within the city of Berthold.

Potential Impact of the Hazard
Flooding is the most frequent natural disaster in the US, and is one that occurs frequently in both North Dakota and in Ward County, though not necessarily in the city of Berthold.

Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Within the city of Berthold, there are no recorded incidents of flooding.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs less than once every five years in the city of Berthold. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is low.

4.2.2.5 Severe Summer Storms

This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

Extreme Heat
Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail
Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning
Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms

Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard

Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Berthold.

Extent and Severity of the Hazard

Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat

The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.
- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI,

NWS uses the Heat Index Chart, found in Figure 4.2.2.5-1(below). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous. Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 4.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail

The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 4.2.2.5-1 (below) provides details of these scales.

Table 4.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33”	Pea	No damage
H1	Potentially Damaging	0.33” – 0.60”	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60” – 0.80”	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80” – 1.20”	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20” – 1.60”	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60” – 2.0”	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0” – 2.4”	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4” – 3.0”	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0” – 3.5”	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5” – 4.0”	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning

The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to

life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.

- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the wider sections cool more slowly and remain visible longer, appearing as a string of beads.
- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- **Ground-to-Cloud Lightning.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning**. Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning**. Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of

lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 4.2.2.5-2 (below) provides this severity scale.

Table 4.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 4.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 4.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Table 4.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 4.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Given that Berthold is smaller than 15 miles in diameter, it is possible for the entire jurisdiction to be impacted by the same thunderstorm at any given time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Berthold are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail
Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning
Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 4.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 4.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties
- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact on life due to thunderstorm and associated hazards in Berthold would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard
Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least 10 occurrences of the summer storm hazard since 1998. (Note: Records prior to 1998 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 4.2.2.5-6 (below) provides details of these recorded incidents.

Table 4.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Description	Magnitude (if applicable)
July 06, 1998	Hail	1.75”
July 13, 1999	Hail, Tornado	Hail: 1.75”, .88” Tornado: Unknown

Date	Description	Magnitude (if applicable)
August 08, 1999	Hail	1.0"
August 07, 2000	Hail	.88"
August 11, 2000	Thunderstorm/Wind	52 MPH
July 14, 2004	Hail	1"
June 14, 2008	Hail, Thunderstorm/Wind	Hail: 1" Wind: 61 MPH
May 29, 2010	Hail	1"
June 24, 2010	Funnel Cloud	NA
August 09, 2010	Hail, Thunderstorm/Wind	Hail: 1" Wind: 52 MPH
July 28, 2011	Hail	1"

Probability of a Future Occurrence of the Hazard
In the 14 year period for which records are available, the summer storm hazard has occurred at least ten times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is moderate, as the summer storm hazard occurs at least once every five years.

4.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard
Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow
The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than ¼ mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold
What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice
The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Berthold.

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

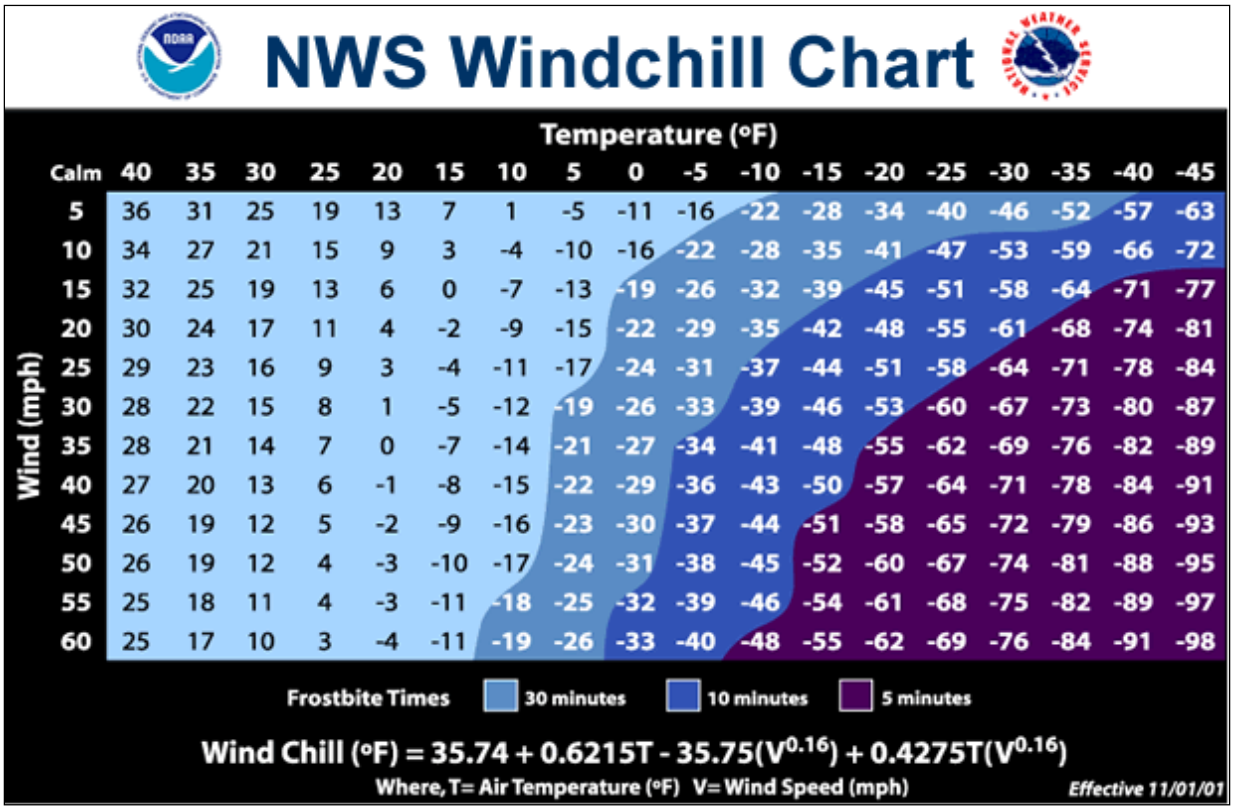
- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold

Winter temperatures in Berthold typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 4.2.2.6-1 (following) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 4.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)



NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

- **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.
- **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard

Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard

According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes, accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.
- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.
- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the

season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard
Based on the data available, winter storms occur in or otherwise impact the city of Berthold at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

4.2.2.7 Hazardous Materials Incident
This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard
Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard
The locations in Berthold most at risk from a hazardous materials incident are those that are in proximity to either locations that store/use hazardous materials or that are adjacent to transportation or transmission lines. The following figures (4.2.2.7-1 through 4.2.2.7-3) illustrate these locations in Berthold.

Figure 4.2.2.7-1
Hazardous Materials Locations – Fixed Sites

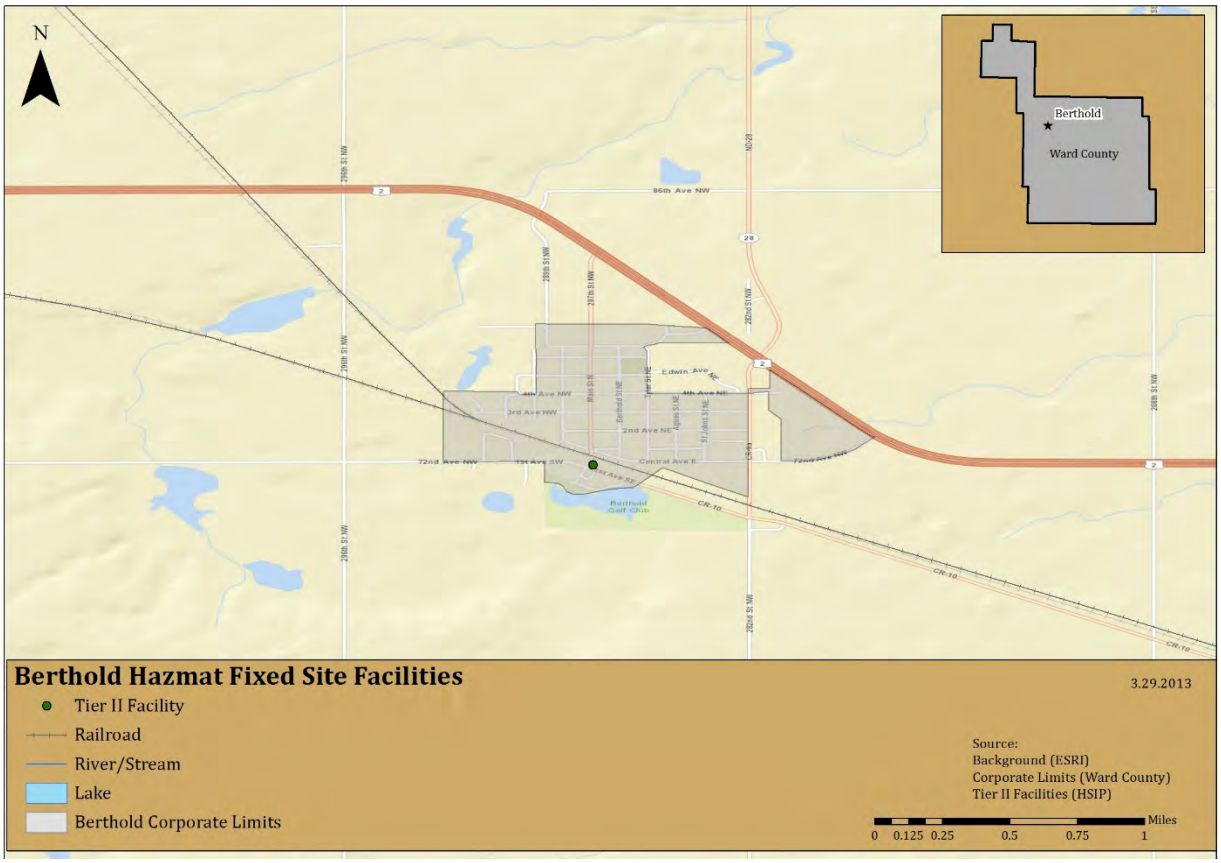


Figure 4.2.2.7-2
Hazardous Materials Locations – Railroads

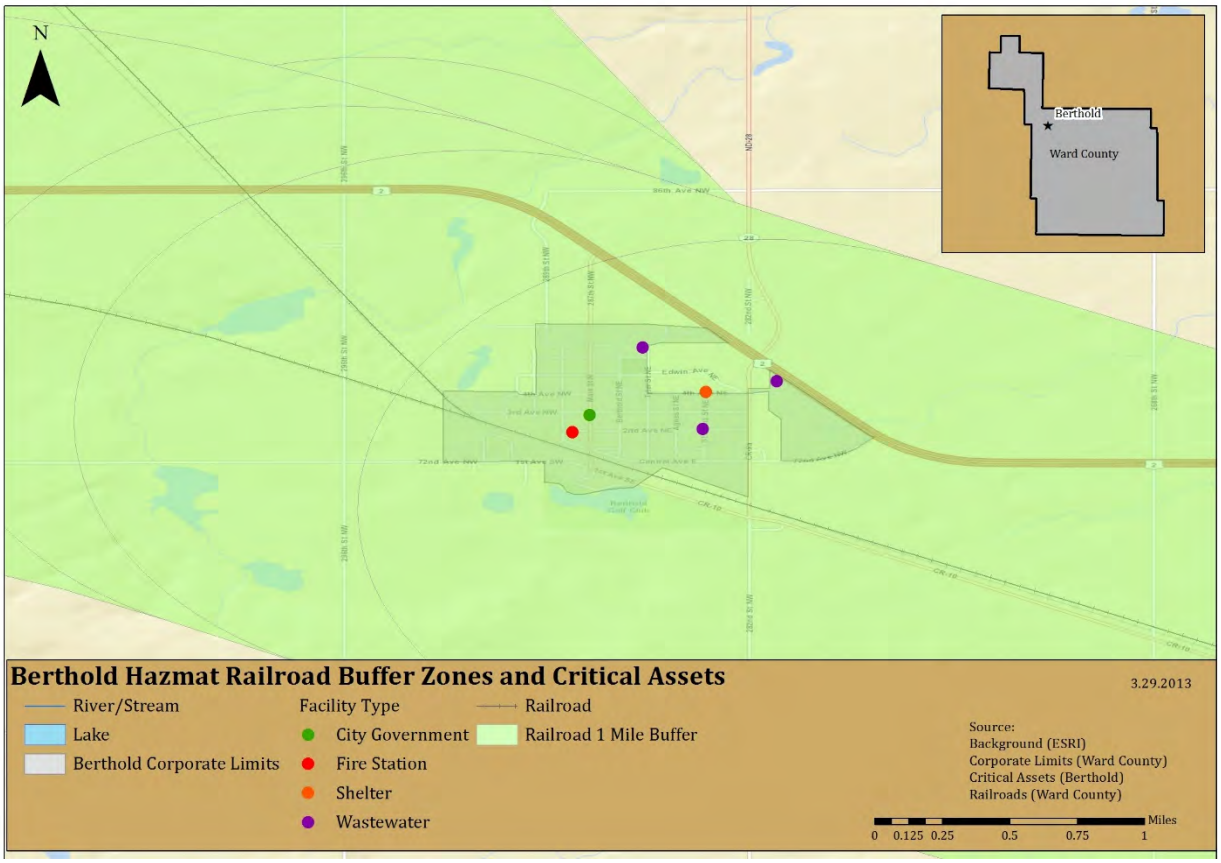
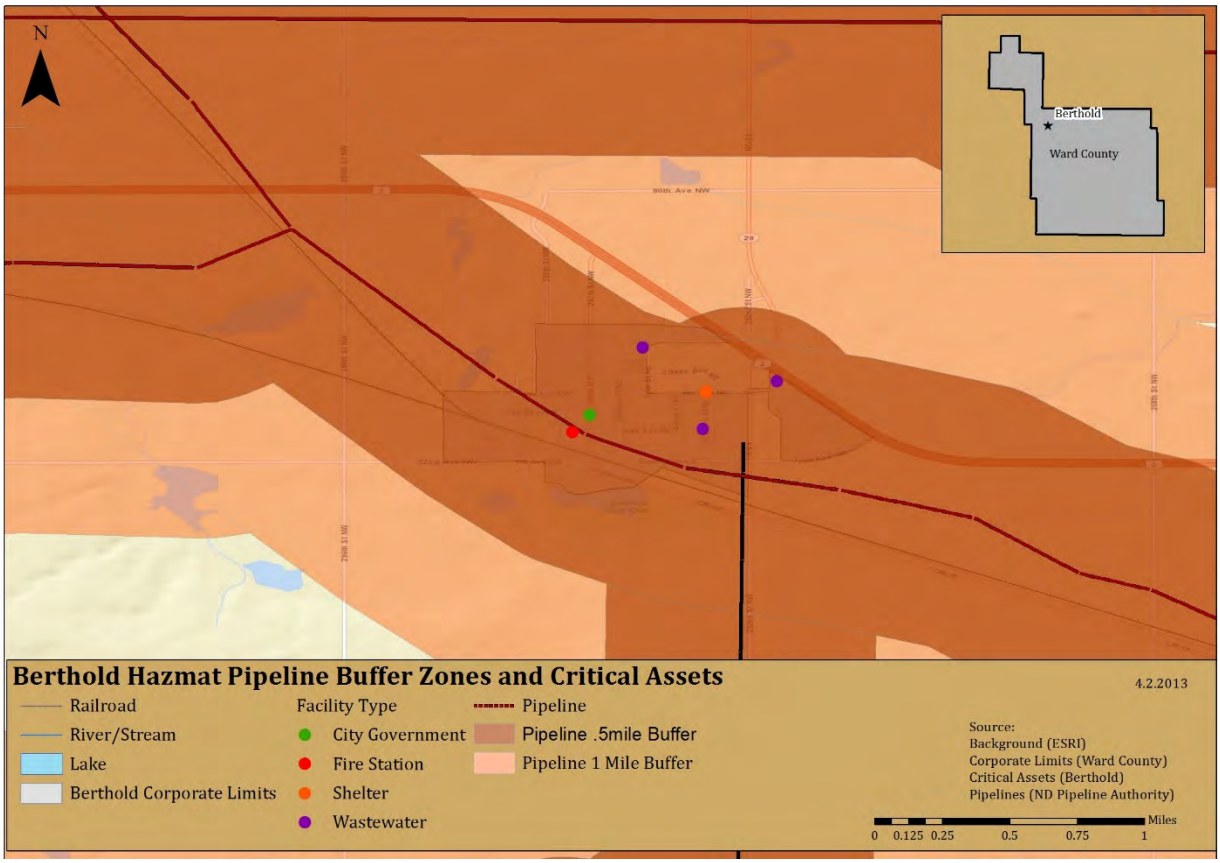


Figure 4.2.2.7-3
Hazardous Materials Locations – Pipelines



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, no Tier II reports from the city of Berthold have been submitted to the EPA since 1987, the year that the EPA began keeping such reports.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in both Ward County, though not necessarily in the city of Berthold. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

4.3 Risk Assessment (Updated)

The following table (Table 4.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Berthold.

Table 4.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

4.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Berthold from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

Impact Scale Methodology
The potential impacts of each hazard were discussed by the Steering Committee. For the purposes of this discussion, a qualitative impact scale was developed, and was used by the Steering Committee in their discussions. As a result of these discussions, each hazard was assigned a qualitative impact ranking. This scale appears in Table 4.3.1-1 (below).

Table 4.3.1-1
Hazard Impact Scale

Term	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Low	Some minor injuries possible, but no fatalities	Cosmetic damages expected to assets; Infrastructure loss of function for less than 24 hours expected	System delivery delayed or temporarily interrupted; Interruptions in service delivery of less than 24 hours expected
Moderate	Injuries expected; Fatalities possible	Some structural damages to light construction (<50 % damage); Infrastructure loss of function for 24-72 hours expected	System delivery failures expected; Interruptions in service delivery of 24-72 hours expected
High	Serious and numerous injuries expected; Fatalities expected	Some structures irreparably damaged (>50% damage); Infrastructure loss of function for 72+ hours expected	Long-term system failures/damages expected; Cancellation of services (72+ hours) expected
Not Applicable	Hazard does not have the potential to impact people or life safety	Hazard does not have the potential to impact assets or infrastructure	Hazard does not have the potential to impact service delivery

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Berthold to the identified and profiled hazards.

Critical Assets
The following table (Table 4.3.1-1) provides details of the critical assets contained within the city of Berthold.

Table 4.3.1-1
Critical Assets – City of Berthold

Asset Name	Asset Use /Function	Street Number	Street Name	Estimated Value
Berthold Fire Protection District	Emergency Services	17	2nd Avenue NW	$175,496
Berthold Ambulance	Emergency Services	223	Main Street North	$175,496
Berthold School	Shelter	401	4th Avenue NE	$18,350
Berthold City Hall	Government	223	Main Street North	$175,496
Berthold Police Department	Government	223	Main Street North	$175,496
Lift Station	Utility	--	Cenex Gas Station	$63,206
Lift Station	Utility	--	Rose Avenue & Taylor Street	$63,206
Lift Station	Utility	--	St. John & 2nd Avenue	$63,206
Total estimated value of identified critical assets:				**$909,952**

Note on asset values: Valuation data for assets within the city was unavailable at the time this plan update was developed. All valuations used in the following estimates of potential losses are derived from an average of available data for the same or similar types of assets from other jurisdictions. The assessment that follows is an estimate only, and may not correlate with actual occurrences of the damage caused by the hazards described.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

4.3.2 Risk and Vulnerability Assessment

4.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by

communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 454 people residing in Berthold. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

Between the 2000 and 2010 Censuses, Berthold experienced a decrease in the population of the municipality (466 to 454). As of the 2012 Census Estimate, however, the population of Berthold was estimated to have rebounded, and to have surpassed the 2010 mark (477). Despite this estimated increase in the population, the existing development and resources of the municipality remain sufficient to mitigate the potential impacts of this hazard, particularly when combined with the resources available to them through the state's departments of health and emergency services, who are available to provide support in the event of an occurrence of the hazard.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 4.3.1-1 (previous).

The representatives from the city of Berthold determined that communicable disease has the potential to cause the impacts described in Table 4.3.2.1-1 (below).

Table 4.3.2.1-1
Qualitative Hazard Impacts – Communicable Disease

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Communicable Disease	Low	Low	Low

Estimate of Potential Losses – Quantitative
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Berthold represents 1% of the total population of Ward County, or 454 people. While an

outbreak of communicable disease in Berthold is unlikely to have significant impacts outside of Berthold, an outbreak could have significant impacts within the city.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness rate in Berthold that is similar to the illness rate across the county, the following numbers of people in Berthold could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Berthold accounts for 1% of the county population. This equates to 45 cases of influenza in Berthold, on average, that could potentially impact the city.
- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Berthold accounts for 1% of the county population. This equates to 65 cases of pertussis in Berthold, on average, that could potentially impact the city.

Identified Data Limitations
There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;
- Data regarding projected population changes; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

4.3.2.2 Drought

Vulnerability to the Hazard
Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies depend largely on agriculture, such as the state of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result

in significant societal disruption, which can worsen as the resource becomes more and more precious.

Berthold has not experienced any significant changes or improvements in development in the previous five years, as it relates to their water supply or delivery system, nor have they experienced significant increases or decreases to their agriculture or livestock development. The slight increase in estimated population is not expected to strain the existing development and resources, in the event of an occurrence of the drought hazard.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 4.3.1-1 (previous).

The representatives from the city of Berthold determined that drought has the potential to cause the impacts described in Table 4.3.2.2-1 (below).

Table 4.3.2.2-1
Qualitative Hazard Impacts – Drought

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Drought	Low	Low	Low

Estimate of Potential Losses – Quantitative
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no quantitative risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no quantitative risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;

- Data regarding projected/expected development changes;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

4.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

According to the 2012 Census estimate, Berthold has experienced a slight increase in population from the 2010 Census count. As a result of this increase in population, a need was identified for additional warning sirens in the city of Berthold, to ensure that the entire population could be warned of impending fire hazards.

As of 2000, there were 181 housing units in the municipality; in 2010, this number decreased to 178 units. No significant other development has occurred in the municipality. Therefore, the potential impacts to the municipality from the fire hazard have remained fairly constant and unchanged since the 2008 plan, with no development-induced increases or decreases during this time.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 4.3.1-1 (previous).

The representatives from the city of Berthold determined that fire has the potential to cause the impacts described in Table 4.3.2.3-1 (following).

Table 4.3.2.3-1
Qualitative Hazard Impacts – Fire

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Fire	Moderate	Moderate/High	Moderate

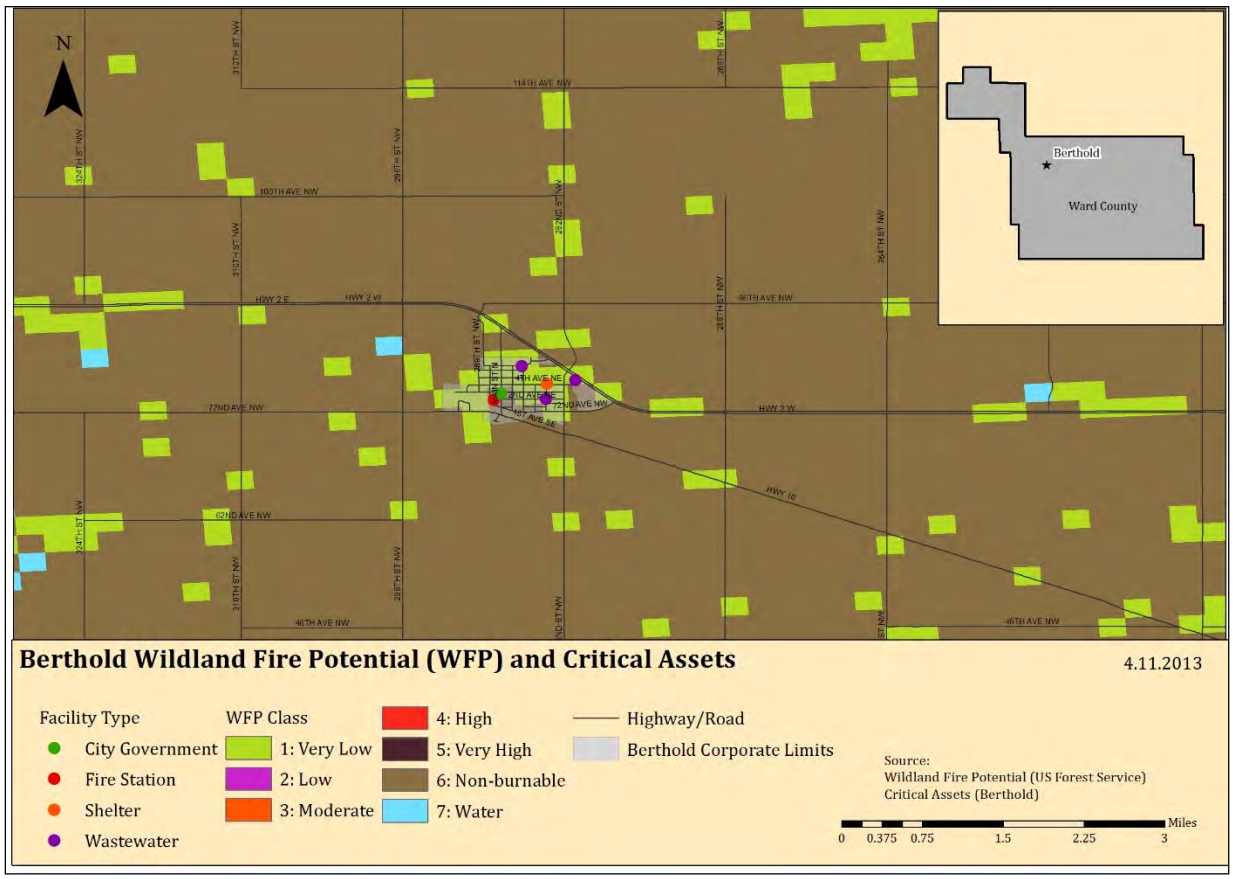
Estimate of Potential Losses – Quantitative
All structures within the city of Berthold are at risk from fire. According to the 2010 Census, there are 180 housing units in the city; 167 of these units are occupied, and 13 are vacant. The majority of these structures are heated by natural gas. The median value of owner-occupied housing units (which represent to vast majority of housing units in Berthold) is $118,200, as of the 2010 Census. This equates to potential residential losses of $21,276,000.

In addition, all identified critical assets (identified in Table 4.3.1-1) within the city have the potential to be lost to fire. These assets have a combine estimated value of $909,952.

Using the US Forest Service's Wildland Fire Potential data, the city of Berthold and its critical assets were mapped. Based on this data set, the city of Berthold has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of fire potential (i.e., risk) actually may exist.

Figure 4.3.2.3-1 (following) illustrates this fire potential in relation to the identified critical assets for the city.

Figure 4.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

4.3.2.4 Flood

Vulnerability to the Hazard
Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

Given that there is no identified or mapped flood hazard area within the city limits of Berthold, neither the slight increase in population nor the relative stability of development factor in to considerations of the potential impacts to Berthold from flooding. However, the experience of the 2011 flooding throughout the planning area (despite the lack of identified flood hazard areas within the municipality) reinforced the need to be able to provide adequate warning to residents. Therefore, a need for additional warning sirens was identified.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 4.3.1-1 (previous).

The representatives from the city of Berthold determined that flooding has the potential to cause the impacts described in Table 4.3.2.4-1 (below).

Table 4.3.2.4-1
Qualitative Hazard Impacts – Flood

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Flood	Low	Low/Moderate	Low/Moderate

Estimate of Potential Losses – Quantitative
It was the determination of the Steering Committee that quantitative risk assessments related to flooding should be performed for those areas within Ward County that contained a mapped or identified flood hazard area, and that all other areas should receive a qualitative assessment only.

In light of this determination, no quantitative risk assessment has been performed for this hazard for the city of Berthold.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the city limits;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and

- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

4.3.2.5 Severe Summer Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Development throughout Berthold has remained relatively unchanged since the 2008 plan. The municipality has experienced a slight increase in the estimated population. Despite this increase, no increase in the vulnerability or the potential impacts from the summer storm hazard were identified during the development of this Plan Update. The shelter capacity of the municipality was not identified as a concern during the update process, though a need for additional warning sirens was identified as a need to mitigate potential impacts from this hazard.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 4.3.1-1 (previous).

The representatives from the city of Berthold determined that severe summer storms have the potential to cause the impacts described in Table 4.3.2.5-1 (following).

Table 4.3.2.5-1
Qualitative Hazard Impacts – Severe Summer Storm

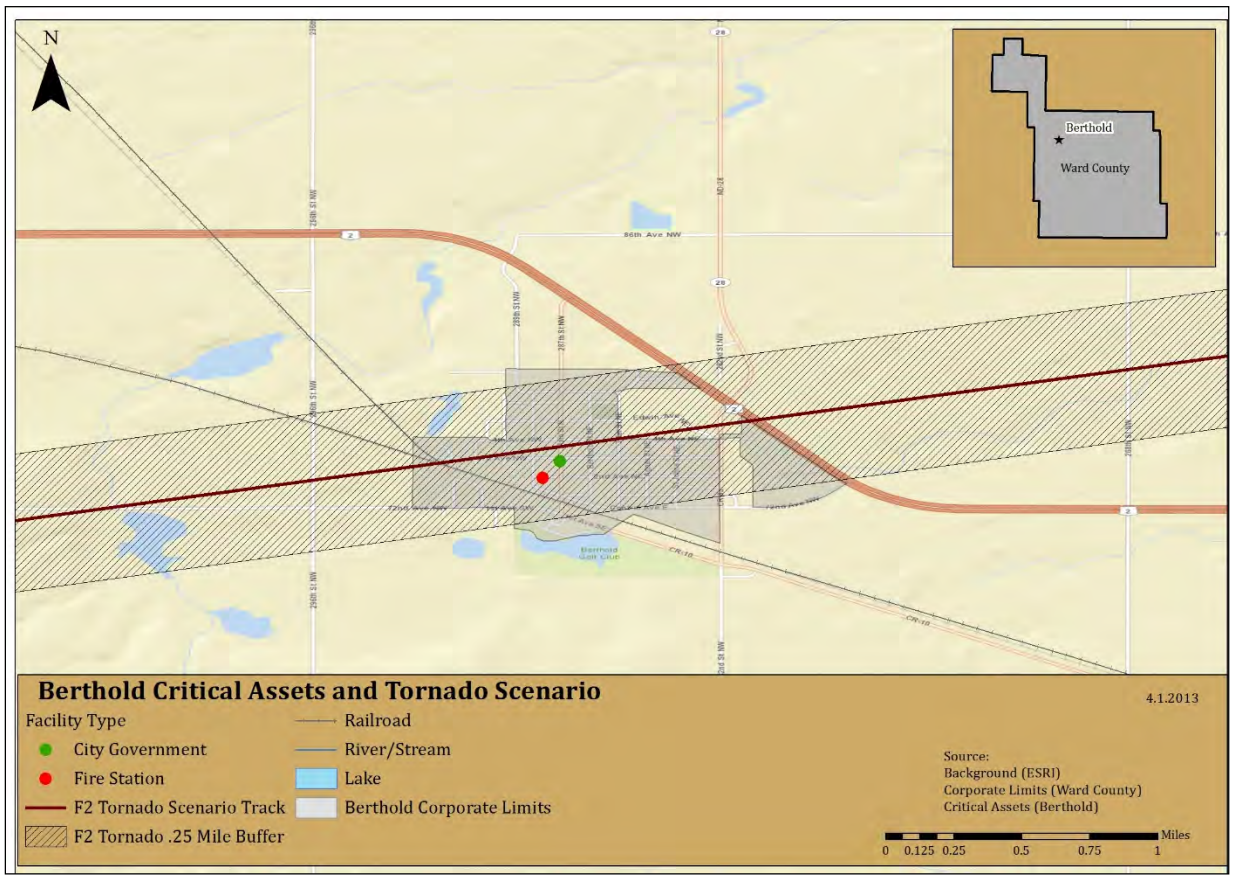
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Summer Storm	Low/Moderate	Moderate	Moderate/Low

Estimate of Potential Losses – Quantitative
Severe summer storms are a non-spatial hazard that can and do affect the entire city of Berthold. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Berthold are at risk from severe summer storms. According to the 2010 Census, there are 180 housing units in the city; 167 of these units are occupied, and 13 are vacant. The median value of owner-occupied housing units (which represent to vast majority of housing units in Berthold) is $118,200, as of the 2010 Census. This equates to residential assets of approximately $21,276,000. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $2,127,600.

In addition, all identified critical assets (identified in Table 4.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of $909,952. For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Berthold. Figure 4.3.2.5-1 (following) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 4.3.2.5-1
Tornado Scenario – City of Berthold



As seen in the above figure, in such a scenario the majority of the city of Berthold would be damaged, including all critical assets (government and emergency services).

Finally, the 454 residents of Berthold are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 8% (children under 5) and almost 10% (those over 70) of the population of Berthold. Combined, these two groups account for 18% of the population, a total of 82 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limit;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and

- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

4.3.2.6 Severe Winter Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Berthold's development has remained relatively unchanged since the 2008 plan; this includes its utility infrastructure. No concerns regarding the impact of development on the utility infrastructure, as related to the winter storm hazard, were identified during the plan update process. There has been a slight increase in population since the 2008 plan, which resulted in an identified need for additional warning sirens, to ensure that the entire population can be warned of hazardous situations.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 4.3.1-1 (previous).

The representatives from the city of Berthold determined that severe winter storms have the potential to cause the impacts described in Table 4.3.2.6-1 (following).

Table 4.3.2.6-1
Qualitative Hazard Impacts – Severe Winter Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Winter Storm	Low	Low/Moderate	Moderate/Low

Estimate of Potential Losses – Quantitative
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Berthold. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Berthold are at risk from severe winter storms. According to the 2010 Census, there are 180 housing units in the city; 167 of these units are occupied, and 13 are vacant. The median value of owner-occupied housing units (which represent to vast majority of housing units in Berthold) is $118,200, as of the 2010 Census. This equates to residential assets of approximately $21,276,000. If 1% of these residential assets were damaged by a severe winter storm, this would result in losses of $212,760.

In addition, all identified critical assets (identified in Table 4.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of $909,952. If these critical assets suffered a 10% loss, the resulting damage would equate to $90,995.

Finally, the 454 residents of Berthold are all at risk from the severe winter storm hazard. As previously stated, those most at risk from the extreme cold hazard are the very young and the elderly. These two groups account for 8% (children under 5) and almost 10% (those over 70) of the population of Berthold. Combined, these two groups account for 18% of the population, a total of 82 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

4.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

The surrounding area roadways have experienced increases in traffic and capacity in recent years, due in large part to the increase in energy activities throughout the state. This increase in traffic, while not directly impacting the city of Berthold, does increase the city's vulnerability, as an incident on the roadways could impact the city and its residents. As a result of this increased activity in the area, a need was identified for additional warning sirens in the city, to help mitigate the potential impacts of an incident on the city's residents.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 4.3.1-1 (previous).

The representatives from the city of Berthold determined that hazardous materials incidents have the potential to cause the impacts described in Table 4.3.2.7-1 (below).

Table 4.3.2.7-1
Qualitative Hazard Impacts – Hazardous Materials Incident

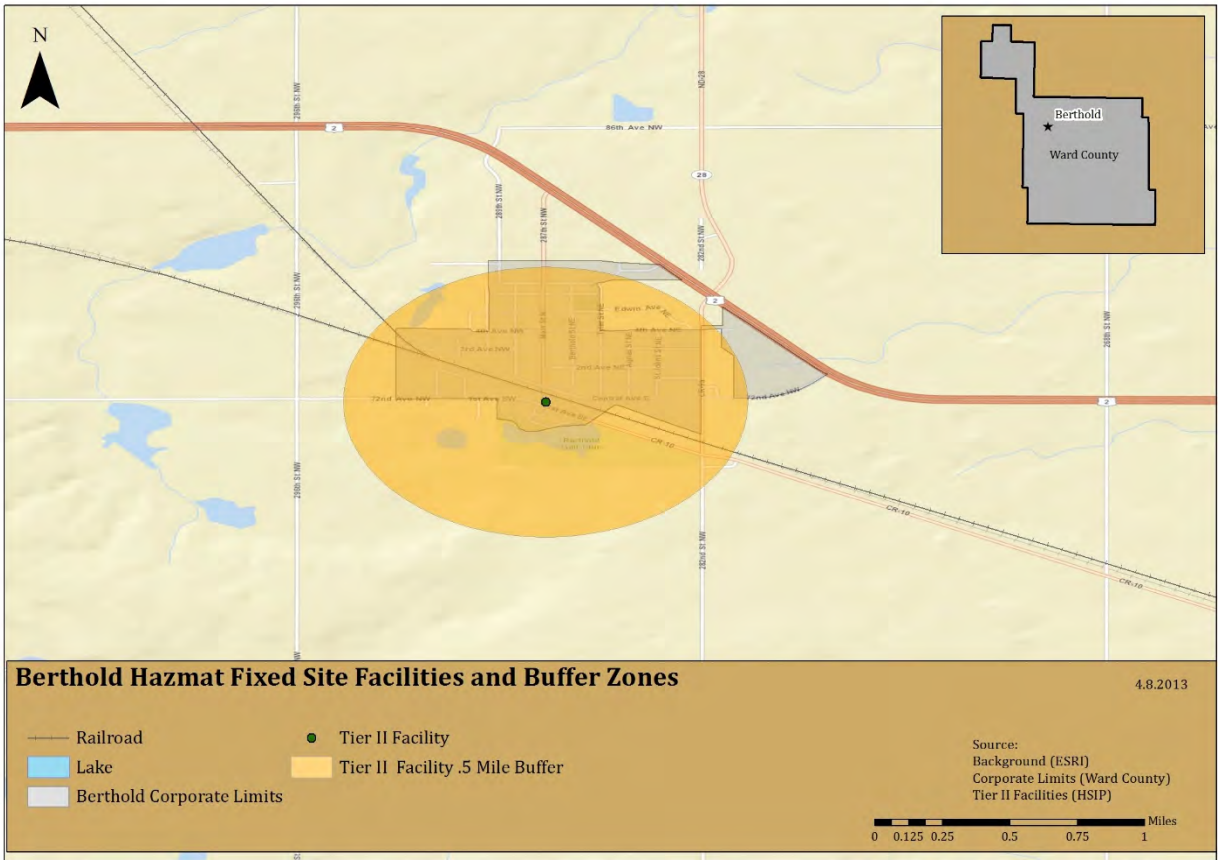
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Hazardous Materials Incident	Low/Moderate	Low	Moderate/High

Estimate of Potential Losses – Quantitative

For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Berthold – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

Berthold has one Tier II facility. Figure 4.3.2.7-1 (below) illustrates the location of this facility in relation to the city of Berthold, and provides a ½ mile buffer zone around this facility. For the purposes of this assessment, all assets within this buffer would be impacted to some degree.

Figure 4.3.2.7-1
Hazardous Materials Incident Scenario – Fixed Site Facilities

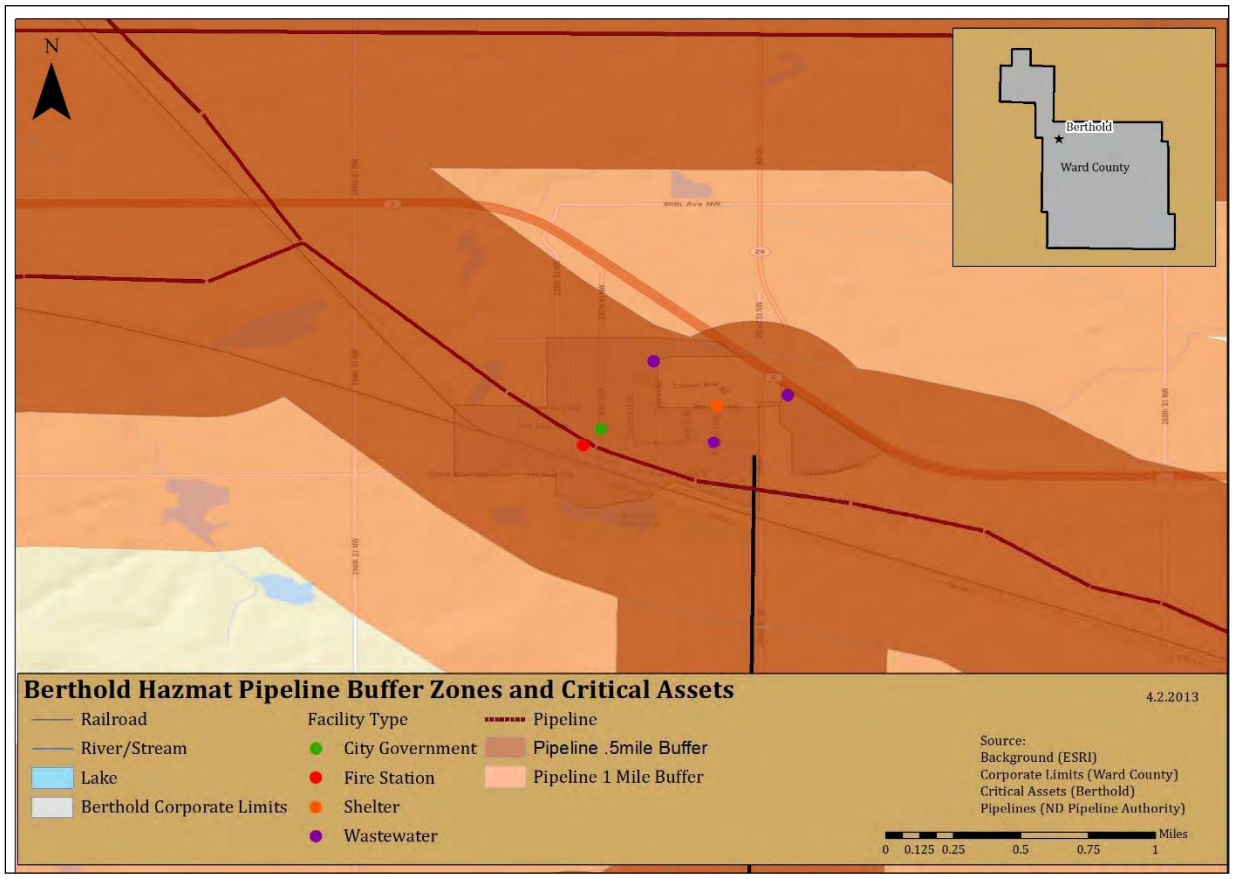


As seen in the image above, an incident at this facility would have the potential to impact the majority of the city of Berthold, depending on conditions and circumstances.

Pipelines also have the potential to cause significant impacts within the city of Berthold. Figure 4.3.2.7-2 (following) illustrates the location of the identified pipeline under the city, and

provides both the ½ mile and the one mile buffer zone around this pipeline. As seen in this image, all critical assets in the city of Berthold could be impacted by an incident with the pipeline, which could result in losses of at least $909,952 for critical assets.

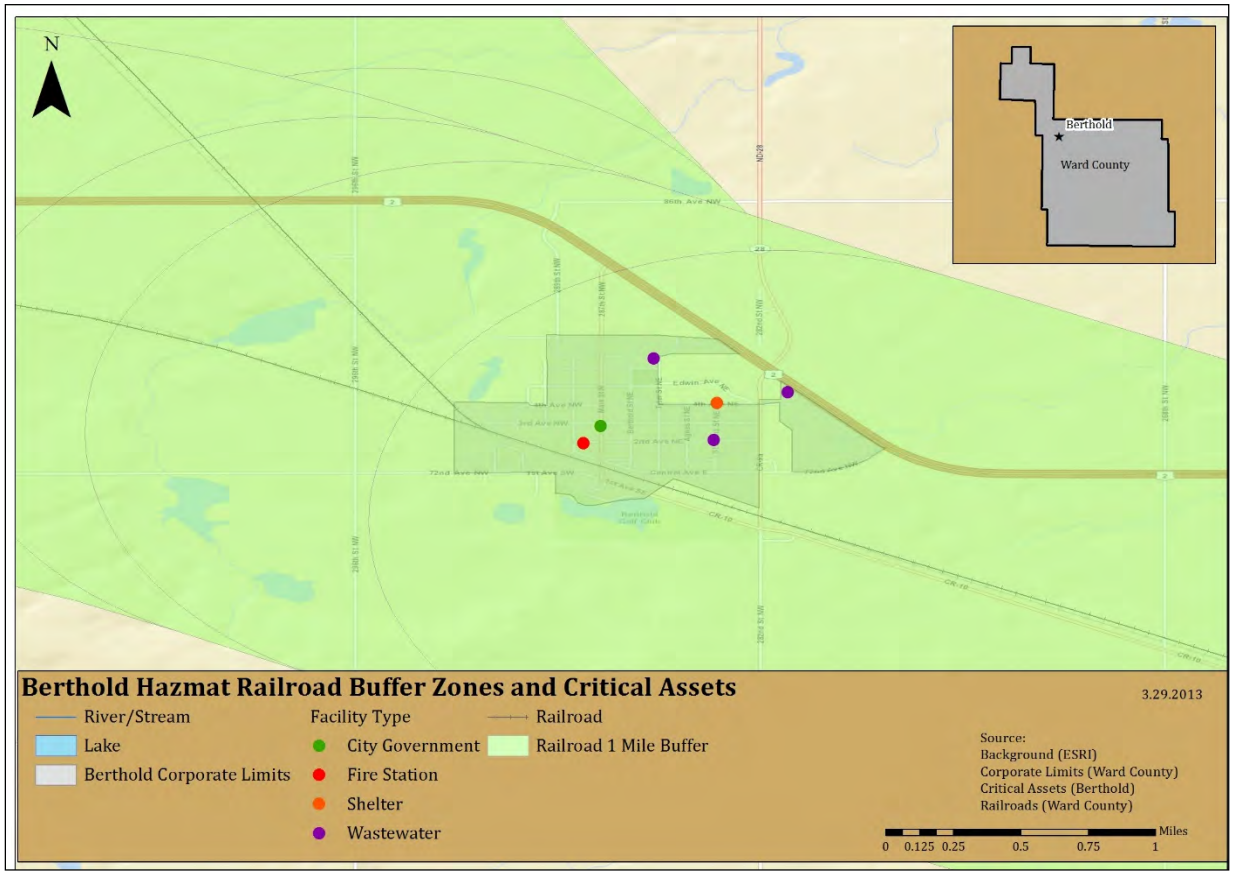
Figure 4.3.2.7-2
Hazardous Materials Incident Scenario – Pipelines



As is evident from the above image, the entire city could be impacted by an incident involving pipelines.

Finally, railroads also pose a significant hazardous materials threat to the city of Berthold, as railroads are routinely used to transport hazardous materials. Figure 4.3.2.7-3 (following) illustrates the location of the railroad, and provides the one mile buffer zone around this railroad. As seen in this image, all critical assets in the city of Berthold could be impacted by an incident with the railroad, which could result in losses of at least $909,952 for critical assets.

Figure 4.3.2.7-3
Hazardous Materials Incident Scenario – Railroads



As is evident from the above image, the entire city could be impacted by an incident hazardous materials and the railroad.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

4.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Berthold's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Extensive summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – staff has at least some familiarity with hazard mitigation programs, likely as a result of the significant flooding that occurred elsewhere in the county in 2011. However, mitigation does not currently play a role in decision-making for the city.
- **Current/ongoing mitigation efforts** – as of the development of this Plan update, there are no on-going mitigation efforts; however, there have been discussion regarding future efforts, and plans were being made to undertake efforts.
- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city.
- **Planning** – currently, the city does not have a disaster recovery or an evacuation plan, nor does it have a master or comprehensive plan, though there are ordinances that provide framework and guidance for decision-making and permitting.

- **Staff, personnel, and technical capability** – as of this Plan update, the city has some capability and capacity regarding hazard mitigation, though it could be improved with experience and additional resources; however, the city has a strong partnership with Ward County, who provides assistance and guidance when possible.

Like other municipalities within Ward County, Berthold relies on the framework established by the county and state government for technical assistance, and on the state and federal government for funding.

Conclusions and Recommendations
Berthold should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county towards this end.

4.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there **must** be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

4.5.1 Mitigation Goals

Table 4.5.1-1 (following) provides the mitigation goals that guide the city of Berthold's mitigation strategy.

Table 4.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

4.5.2 Mitigation Actions

Potential Mitigation Actions
Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions
Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of

special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Becoming a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions

Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (4.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (4.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped the city of Berthold to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 4.5.2-2. Table 4.5.2-1 (below) describes the basic criteria considered as part of the prioritization process.

Table 4.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.

STAPLEE	Criteria Explanation
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness

Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (4.5.2-2) provides the identified and prioritized mitigation strategy for the city of Berthold.

Table 4.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Join the NFIP; enforce floodplain management ordinance and practices	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Moderate	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Moderate	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Council	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; Ward County EMA	$500+	Moderate	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Purchase and install additional warning sirens	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council	NDDES & FEMA mitigation grant funding ; General funds; Ward County EMA	$30,000+	High	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Construct new all-in-one safety center (police/fire/ government)	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council	Grants; donations; private funding; TBD	$30,000+	High	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recent annexations and / or recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council	General funds; Ward County EMA	$500+	Moderate	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council	General fund; in-kind contributions; Ward County EMA	$500+	Moderate	
Goal 05: Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Identify solutions to drainage concerns – including culverts	Flood	New	New and Existing	City Council	NDDES & FEMA mitigation grant funds; in-kind contributions; Ward County EMA	$10,000+	Low	

Section 05
City of Burlington: HIRA, Capability Assessment, and Mitigation Strategy

5.1 IFR for Hazard Identification and Risk Assessment
5.2 Hazard Identification (Updated)
5.2.1 Overview of Burlington's History of Hazards and Potential Hazards
5.2.2 Hazard Profiles
5.3 Risk Assessment (Updated)
5.3.1 Risk Assessment Methodology
5.3.2 Risk and Vulnerability Assessment
5.4 Capability Assessment (Updated)
5.5 Mitigation Strategy (Updated)
5.5.1 Mitigation Goals
5.5.2 Mitigation Actions

5.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..*

Requirement §201.6(c)(2)(ii)(C): *[The plan* ***should*** *describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment* ***must*** *assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Burlington.

5.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Burlington. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

5.2.1 Overview of Burlington's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 15 weather-related hazard events have occurred in the city of Burlington since 1998, including the following number and types of hazard events:

- Flood/Flash Flood – 3
- Hail – 11
- Thunderstorm - 1

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 5.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 5.2.1-1
Presidential Disaster Declarations – City of Burlington

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Burlington

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 5.2.1-2 (below).

Table 5.2.1-2
Preliminary Hazard Identification and Determinations – City of Burlington

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Burlington	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Burlington	Reason for Exclusion and other notes
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Burlington	Reason for Exclusion and other notes
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

5.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

5.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk. Table 5.2.2.1-1 (following) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 5.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance

and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard
In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Burlington.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 5.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 5.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 5.2.2.1-3 (below) provides the details of pertussis outbreaks since 2007.

Table 5.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 5.2.2.1-4 (below) provides occurrence information for rabies.

Table 5.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Burlington did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Burlington, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Burlington, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been no occurrences of communicable disease within the city of Burlington. Therefore, using the scale provided earlier in this section, the probability

of a future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

5.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Burlington are subject to the drought hazard.

Extent and Severity of the Hazard
Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.
- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

Table 5.2.2.2-1 (below) provides the PDSI classifications.

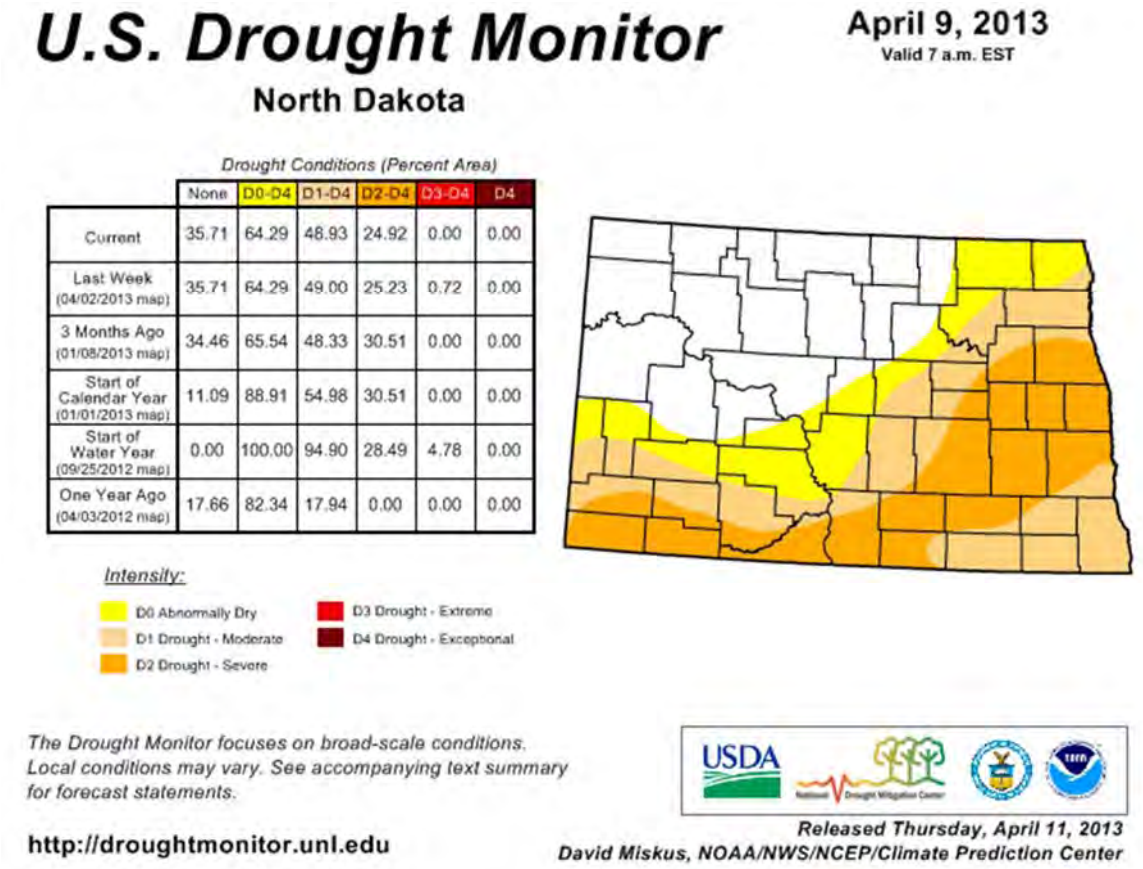
Table 5.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed

Classification	Description	Range of Possible Impacts
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Burlington are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 5.2.2.2-1 (following).

Figure 5.2.2.2-1
US Drought Monitor – North Dakota
(Source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 5.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Burlington – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

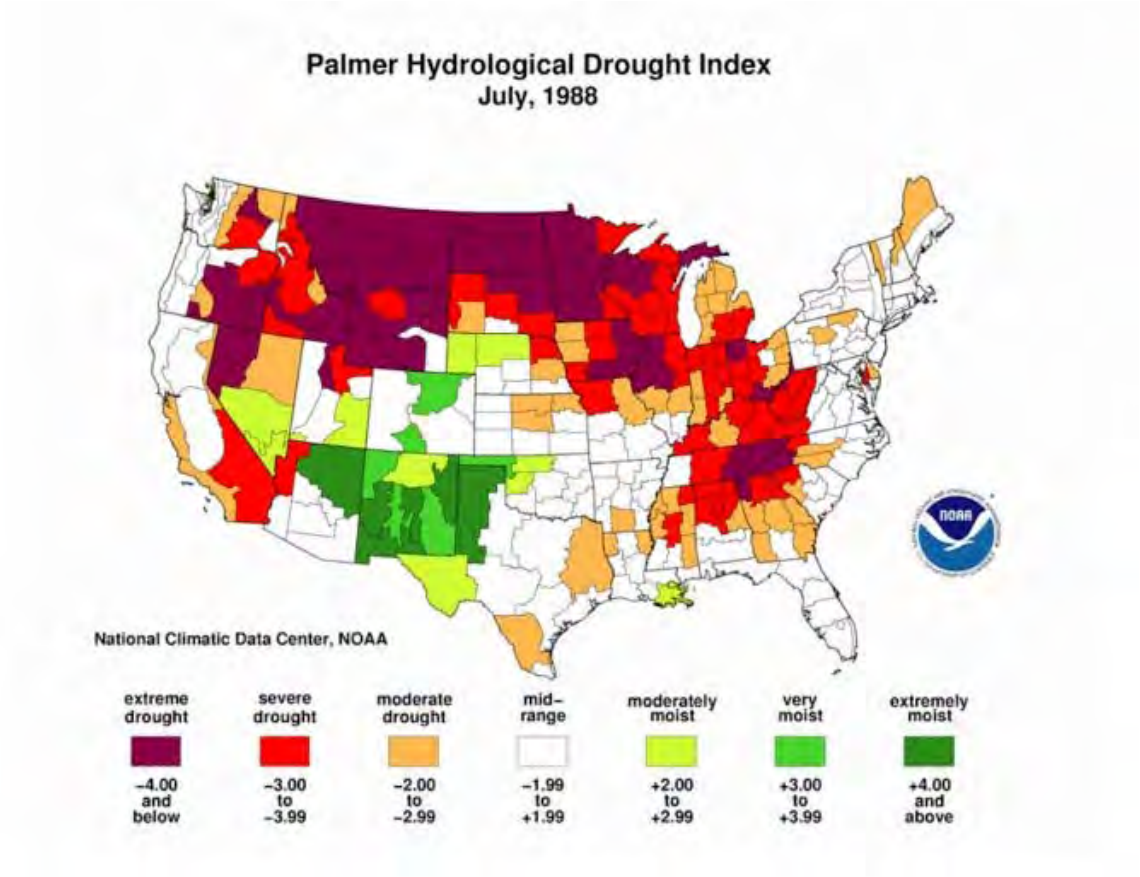
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Burlington. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 5.2.2.2-2 (following), the entire state – including the city of Burlington – was categorized as being in extreme drought during this time.

Figure 5.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(Source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Burlington) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years.

5.2.2.3 Fire
This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

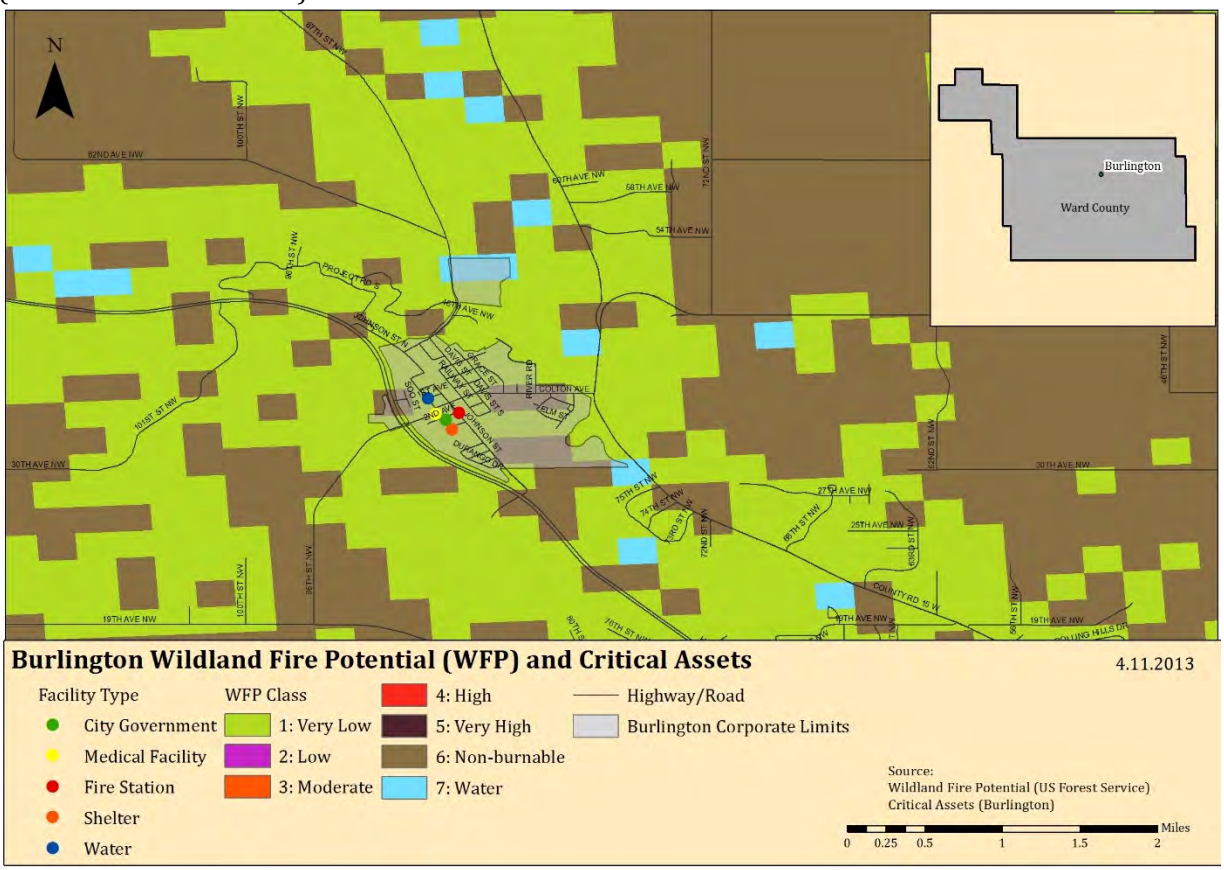
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 5.2.2.3-1 (following) illustrates the wildland fire potential for the city of Burlington, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 5.2.2.3-1
City of Burlington – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard
The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 5.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System.

Table 5.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the

destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Based on data obtained from the National Reporting System, the city of Burlington has experienced 49 structure fires from January 2008 and December 2012, an average of 9.8 structure fires per year. For this same time period, 36 wildland fires were responded to, an average of 7.2 per year.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in the city of Burlington at least once per year. Using the scale provided earlier in this section, this equates to a high probability of a future occurrence.

5.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.*

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise

sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

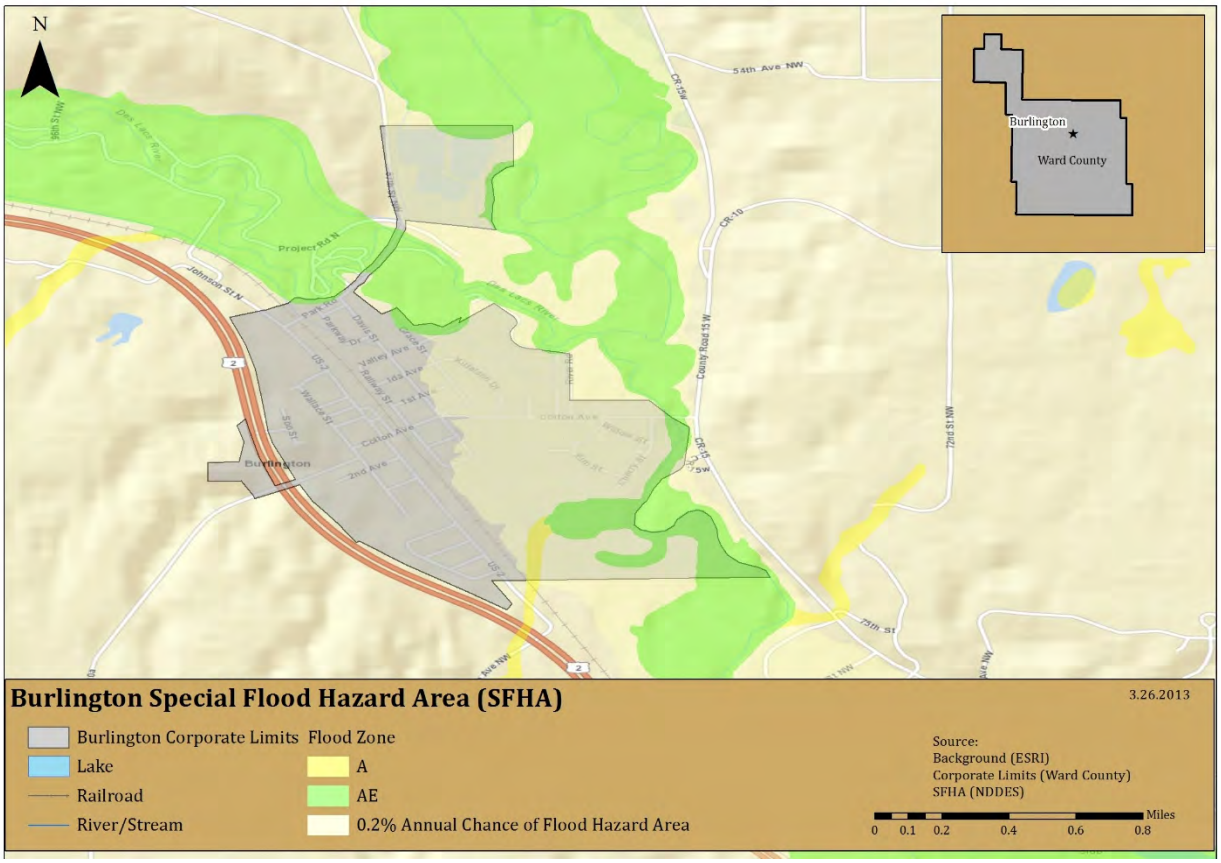
Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard

Burlington has significant areas of one percent annual chance floodplain just outside of its corporate limits, as well as some areas within its limits. Large portions of the city fall within the .02% annual chance floodplain. These areas are illustrated in Figure 5.2.2.4-1 (following).

Figure 5.2.2.4-1
Special Flood Hazard Areas



Extent and Severity of the Hazard

In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 5.5.2.4-1 (below).

Table 5.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.

Zone Designation	Percent Annual Chance of Flood	Description
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 5.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 5.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

Term	Definition
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

The city of Burlington is currently a member of the NFIP, and its membership is in good standing. There are no designated Repetitive Loss or Severe Repetitive Loss properties within the city of Burlington.

Potential Impact of the Hazard
Flooding is the most frequent natural disaster in the US, and is one that occurs with regularity in the city of Burlington.

Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A major flood occurred in the Souris River Basin in 1969, which greatly impacted the region –

including the city of Burlington. More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley. In the city of Burlington, damages of at least $1.1 M were recorded.

In addition, according to NCDC records, Burlington was inundated by flash flooding twice in 2010; these events resulted in property damages of at least $825,000.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs at least once every five years in the city of Burlington. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is moderate.

5.2.2.5 Severe Summer Storms
This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

> *Extreme Heat*
> Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.
>
> *Hail*
> Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.
>
> *Lightning*
> Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms
Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard
Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Burlington.

Extent and Severity of the Hazard
Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat
The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It

is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.

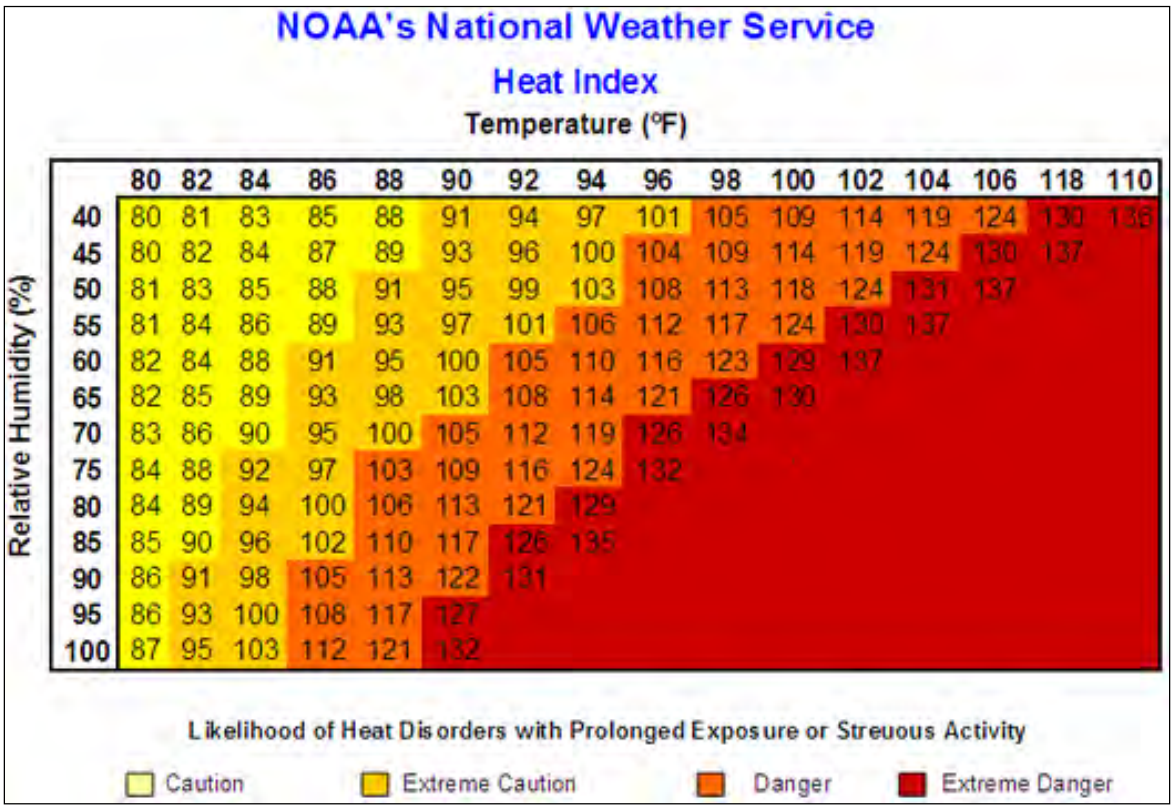
- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 5.2.2.5-1(following). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 5.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)



Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail
The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 5.2.2.5-1 (below) provides details of these scales.

Table 5.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33”	Pea	No damage
H1	Potentially Damaging	0.33” – 0.60”	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60” – 0.80”	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80” – 1.20”	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20” – 1.60”	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60” – 2.0”	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0” – 2.4”	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4” – 3.0”	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0” – 3.5”	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5” – 4.0”	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning

The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the

wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- **Ground-to-Cloud Lightning.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning**. Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning**. Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 5.2.2.5-2 (below) provides this severity scale.

Table 5.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 5.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 5.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			pattern, for it may never be identifiable through engineering studies

Table 5.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 5.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Given that Burlington is smaller than 15 miles in diameter, it is possible for the entire jurisdiction to be impacted by the same thunderstorm at any given time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Burlington are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 5.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 5.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties
- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact on life due to thunderstorm and associated hazards in Burlington would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard
Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least 12 occurrences of the summer storm hazard since 1994. (Note: Records prior to 1994 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 5.2.2.5-6 (below) provides details of these recorded incidents.

Table 5.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Description	Magnitude (if applicable)
May 21, 1994	Hail	.75”
July 27, 1997	Hail	.75”
July 13, 1999	Hail (2 occurrences)	1.75 and .75”
June 11, 2000	Hail	.75”
July 18, 2003	Hail	1.75”
May 28, 2006	Hail	1”
June 26, 2007	Thunderstorm/Wind	56 MPH
April 13, 2010	Hail	1”
May 27, 2010	Hail	1”
July 28, 2011	Hail (2 occurrences)	1”

Probability of a Future Occurrence of the Hazard
In the 18 year period for which records are available, the summer storm hazard has occurred at least ten times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is moderate, as the summer storm hazard occurs at least once every five years.

5.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard

Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow

The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold

What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice

The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations

of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Burlington.

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

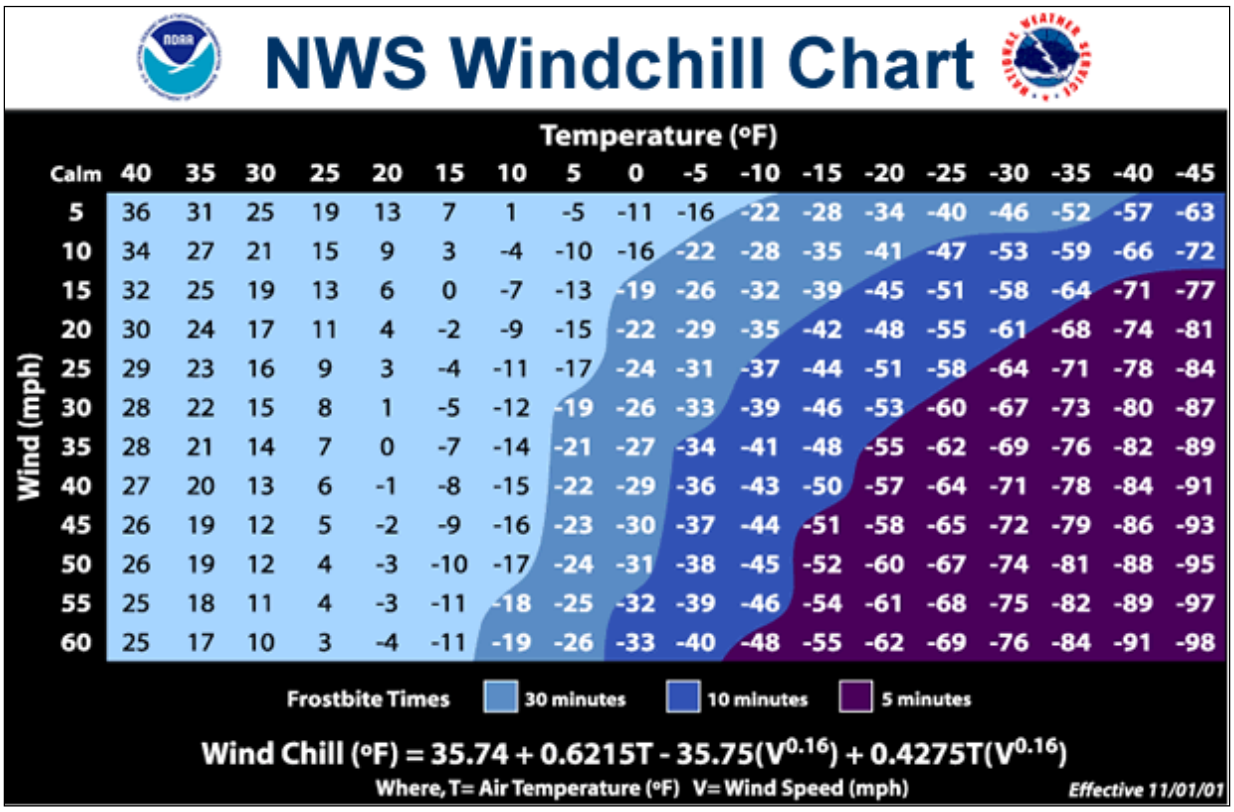
Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold
Winter temperatures in Burlington typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 5.2.2.6-1 (following) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 5.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)



Wind (mph)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Ice
Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

- **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.
- **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard
Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard
According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes,

accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.

- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.
- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard

Based on the data available, winter storms occur in or otherwise impact the city of Burlington at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

5.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard

Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard

The locations in Burlington most at risk from a hazardous materials incident are those that are in proximity to either locations that store/use hazardous materials or that are adjacent to transportation or transmission lines. The following figures (5.2.2.7-1 through 5.2.2.7-3) illustrate these locations in Burlington.

Figure 5.2.2.7-1
Hazardous Materials Locations – Fixed Sites

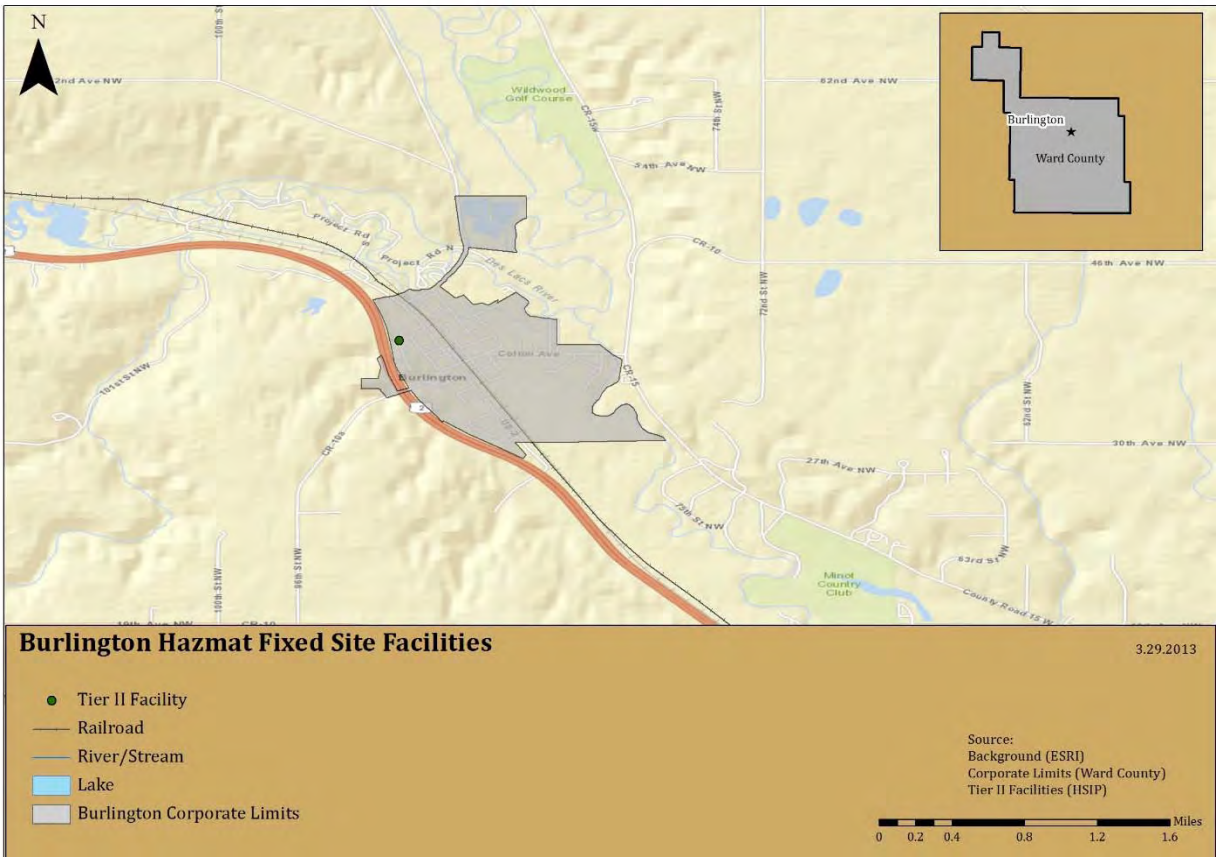


Figure 5.2.2.7-2
Hazardous Materials Locations – Railroads

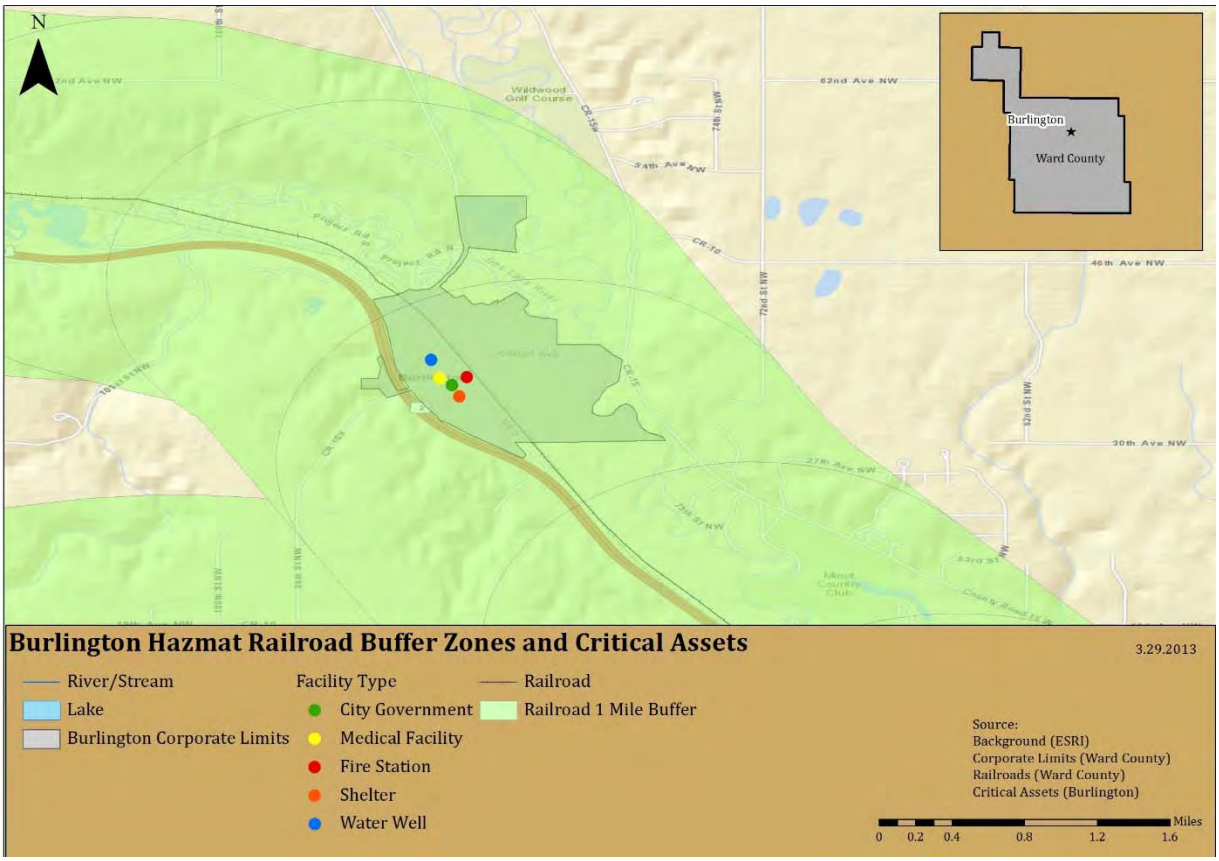
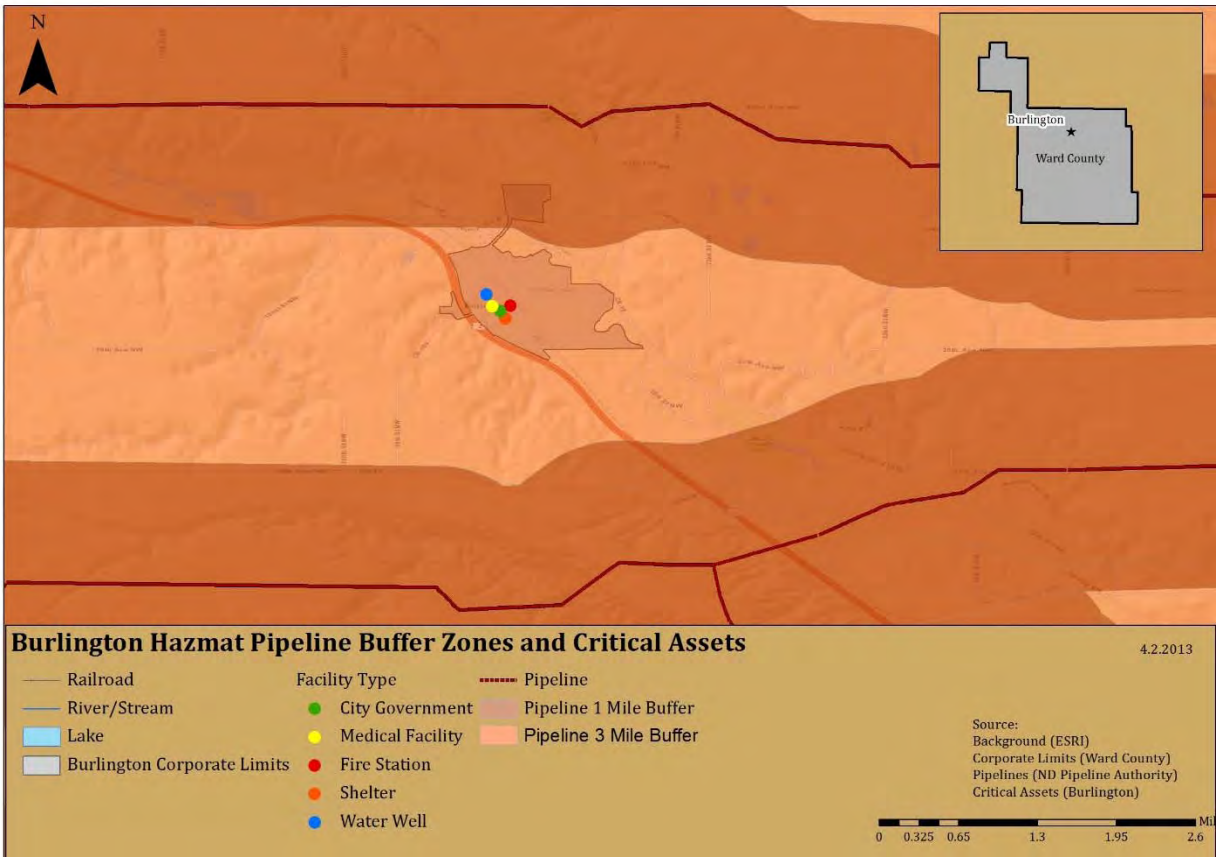


Figure 5.2.2.7-3
Hazardous Materials Locations – Pipelines



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, no Tier II reports from the city of Burlington have been submitted to the EPA since 1987, the year that the EPA began keeping such reports.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in both Ward County, though not necessarily in the city of Burlington. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

5.3 Risk Assessment (Updated)

The following table (Table 5.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Burlington.

Table 5.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

5.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Burlington from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

Impact Scale Methodology
The potential impacts of each hazard were discussed by the Steering Committee. For the purposes of this discussion, a qualitative impact scale was developed, and was used by the Steering Committee in their discussions. As a result of these discussions, each hazard was assigned a qualitative impact ranking. This scale appears in Table 5.3.1-1 (below).

Table 5.3.1-1
Hazard Impact Scale

Term	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Low	Some minor injuries possible, but no fatalities	Cosmetic damages expected to assets; Infrastructure loss of function for less than 24 hours expected	System delivery delayed or temporarily interrupted; Interruptions in service delivery of less than 24 hours expected
Moderate	Injuries expected; Fatalities possible	Some structural damages to light construction (<50 % damage); Infrastructure loss of function for 24-72 hours expected	System delivery failures expected; Interruptions in service delivery of 24-72 hours expected
High	Serious and numerous injuries expected; Fatalities expected	Some structures irreparably damaged (>50% damage); Infrastructure loss of function for 72+ hours expected	Long-term system failures/damages expected; Cancellation of services (72+ hours) expected
Not Applicable	Hazard does not have the potential to impact people or life safety	Hazard does not have the potential to impact assets or infrastructure	Hazard does not have the potential to impact service delivery

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Burlington to the identified and profiled hazards.

Critical Assets

The following table (Table 5.3.1-1) provides details of the critical assets contained within the city of Burlington.

Table 5.3.1-1
Critical Assets – City of Burlington

Asset Name	Asset Use /Function	Street Number	Street Name	Insured or Estimated Value
Burlington Fire Department	Emergency Services	225	Johnston Street North	$175,469*
Burlington First Responders	Emergency Services	NA	NA	$175,469*
Burlington Police Department	Emergency Services	225	North Wallace Street	$175,469
Burlington School	Education / Shelter	201	Wallace Street South	$200,000*
Burlington City Hall	Government	225	North Wallace Street	$350.903
Well #2	Utility	600	River Road	$37,115
Pump Station	Utility	225	North Wallace Street	$303,999
Water Treatment Plant	Utility	225	North Wallace Street	$880,046
Lift Station #2	Utility	--	Elm Street and East Colton Avenue	$63,206
Main Lift Station	Utility	--	--	$70,212
Well #3	Utility	300	River Road	$30,971
Water Storage Tank	Utility	10	1st Avenue	$396,353
Equipment Control Vault	Utility	225	North Wallace Street	$62,507
Well #4	Utility	101	Struman Drive	$30,971*
Siren	Emergency Alert	378	Johnson Street	$14,089
Siren	Emergency Alert	--	Kitterson Drive and Ada Avenue	$16,996
Pressure Reducing Vault	Utility	7301	Highway 2	$101,613
Senior Center	Community Building	19	Colton Avenue	$50,000*
Total estimated value of identified critical assets:				**$3,310,822**

**denotes estimated value rather than insured value.*

Note on asset values: Where possible and available, the asset values used in this assessment are based on actual insured values. Where these figures were not available, estimates were used

for some facilities. The assessment that follows is an estimate only, and may not correlate with actual occurrences of the damage caused by the hazards described.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

5.3.2 Risk and Vulnerability Assessment

5.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 1,060 people residing in Burlington. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

The estimated population of Burlington in 2011 was 1,102 – a 4% increase from the 2010 Census, which counted 1,060 residents. While not a significant increase in terms of the number of people (this increase resulted in a net population increase of 42 people), the result is an increased population that is vulnerable to the hazard.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 5.3.1-1 (previous).

The representatives from the city of Burlington determined that communicable disease has the potential to cause the impacts described in Table 5.3.2.1-1 (following).

Table 5.3.2.1-1
Qualitative Hazard Impacts – Communicable Disease

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Communicable Disease	Low	Low	Low

Estimate of Potential Losses – Quantitative
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Burlington represents ~2% of the total population of Ward County, or 1,060 people. While an outbreak of communicable disease in Burlington is unlikely to have significant impacts outside of Burlington, an outbreak could have significant impacts within the city.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness rate in Burlington that is similar to the illness rate across the county, the following numbers of people in Burlington could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Burlington accounts for ~2% of the county population. This equates to 90 cases of influenza in Burlington, on average, that could potentially impact the city.
- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Burlington accounts for ~2% of the county population. This equates to 129 cases of pertussis in Burlington, on average, that could potentially impact the city.

Identified Data Limitations
There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;
- Data regarding projected population changes; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

5.3.2.2 Drought

Vulnerability to the Hazard

Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies depend largely on agriculture, such as the State of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result in significant societal disruption, which can worsen as the resource becomes more and more precious.

Burlington is not a community that is economically reliant on agriculture, which is not a significant factor it the community's economy; therefore, a drought would not be expected to present an increase in terms of the economic vulnerability of the community. However, Burlington has experienced a small increase in population in recent years, and there are plans for increased development, particularly residential development, in the next few years. These increases will result in an increase in the community's vulnerability to the drought hazard, as more people and more structures will require more water and more water delivery resources. A decrease in the amount of available water, combine with an increase in population and structures, will present greater vulnerability to the drought hazard.

Estimate of Potential Losses – Qualitative

In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 5.3.1-1 (previous).

The representatives from the city of Burlington determined that drought has the potential to cause the impacts described in Table 5.3.2.2-1 (following).

Table 5.3.2.2-1
Qualitative Hazard Impacts – Drought

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Drought	Low	Low	Low

Estimate of Potential Losses – Quantitative
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no quantitative risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no quantitative risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

5.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

A comparison of the 200 Census, the 2010 Census, and the 2011 Census Estimate revealed an increase in population and housing units in the city. There are future plans for increased development in the city, which will result in more structures and more residents, once completed. These increases mean that Burlington's vulnerability to the fire hazard is increasing, and is expected to continue to increase for the foreseeable future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 5.3.1-1 (previous).

The representatives from the city of Burlington determined that fire has the potential to cause the impacts described in Table 5.3.2.3-1 (below).

Table 5.3.2.3-1
Qualitative Hazard Impacts – Fire

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Fire	Moderate	Moderate	Moderate

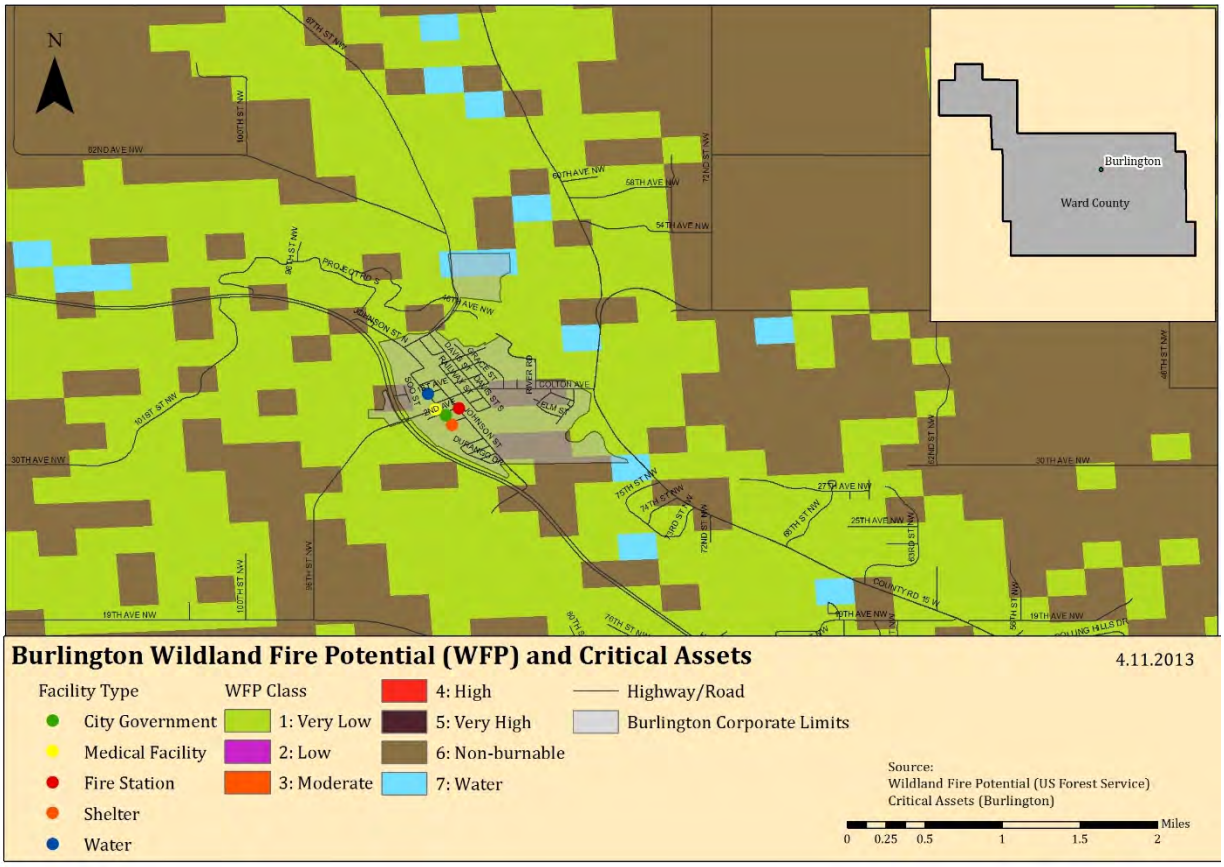
Estimate of Potential Losses – Quantitative
All structures within the city of Burlington are at risk from fire. According to the 2010 Census, there are 460 housing units in the city; 427 of these units are occupied, and 33 are vacant. The majority of these structures are heated by natural gas, though electricity account for approximately 20% of residential heating. The median value of single family housing in Burlington is $119,200, according to the 2010 Census. This equates to potential residential losses of $54,832,000.

In addition, all identified critical assets (identified in Table 5.3.1-1) within the city have the potential to be lost to fire. These assets have a combine estimated value of $3,310,822.

Using the US Forest Service's Wildland Fire Potential data, the city of Burlington and its critical assets were mapped. Based on this data set, the city of Burlington has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 5.3.2.3-1 (following) illustrates this fire potential in relation to the identified critical assets for the city.

Figure 5.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

5.3.2.4 Flood

Vulnerability to the Hazard
The city of Burlington has a history of flooding, and of experiencing damages and disruptions because of this flooding. This is unsurprising, given its location on the confluence of the Souris (Mouse) and Des Lacs Rivers.

Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

Flood damages also take considerable time to recover from. For example, as of the development of this Plan update, Burlington continues to work towards full recovery from the 2011 Souris (Mouse) River flooding.

The increase in Burlington's population increases the vulnerability to flooding faced by the city. The projected increases in residential development will further increase this vulnerability, as it will result in additional structures and people in the path of future flooding. Given that the entire community was evacuated in 2011 due to flooding, it is reasonable to assume that any future development in the city could also face this risk. To alleviate this vulnerability, the need for additional flood protection was identified during the update process, and is addressed in the mitigation strategy.

The city of Burlington is a member of the NFIP, and is in good standing with the program. As of February 2013, there were no NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the city of Burlington.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 5.3.1-1 (previous).

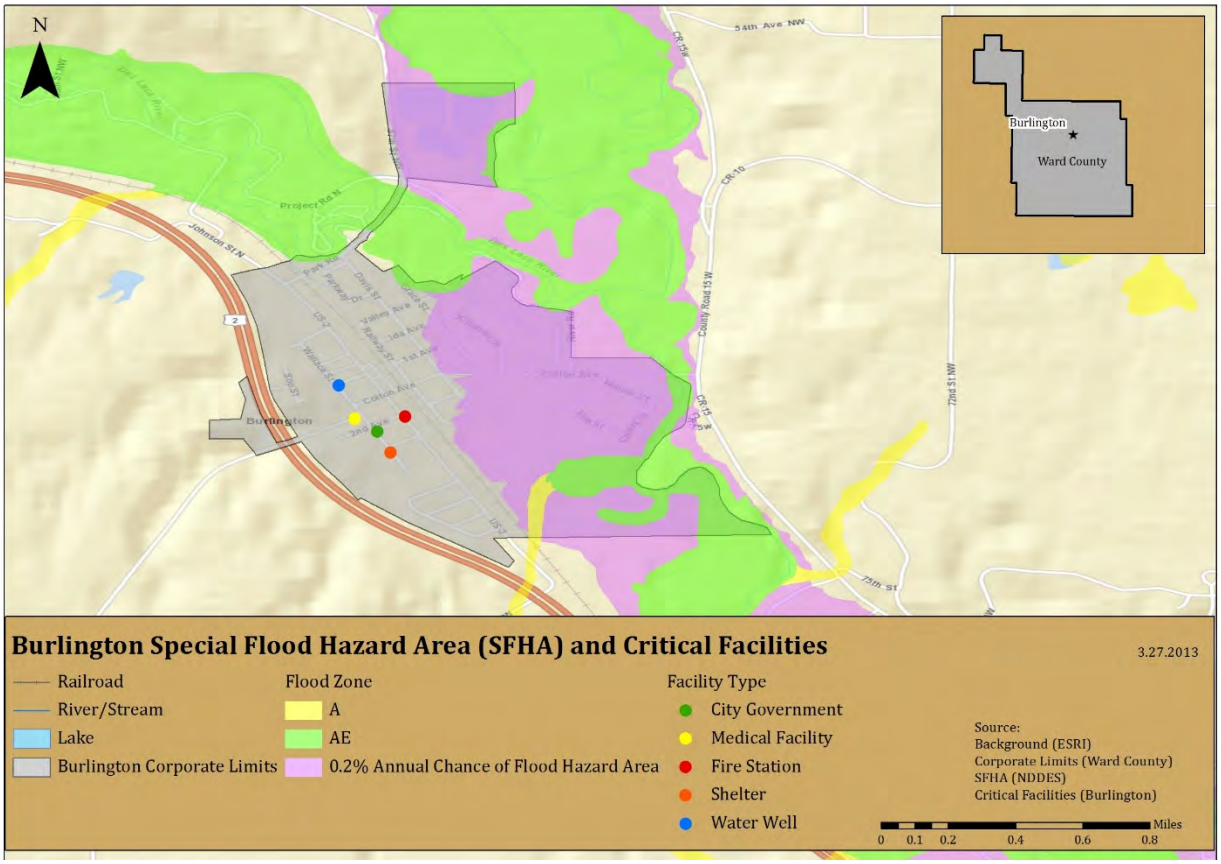
The representatives from the city of Burlington determined that flooding has the potential to cause the impacts described in Table 5.3.2.4-1 (below).

Table 5.3.2.4-1
Qualitative Hazard Impacts – Flood

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Flood	High	High	High

Estimate of Potential Losses – Quantitative
Burlington has significant floodplains, both within the corporate limits and just outside of the corporate limits. Figure 5.3.2.4-1 (following) illustrates the locations and boundaries of both the one percent annual chance floodplain and the .02% annual chance floodplain. Critical assets for the city have been overlaid onto this hazard boundary map.

Figure 5.3.2.4-1
Special Flood Hazard Areas and Burlington Critical Assets



As seen in the image above, Burlington's critical assets are located outside of any identified flood hazard area, and have limited exposure to the flood hazard. However, given that the NFIP estimates that 30% of flood damages occur outside of any identified floodplain, it is reasonable to assume that at least some losses would occur to these critical assets. Using the NFIP's estimate, a loss of 30% to Burlington's critical assets would equate to at least $993,246 in damages.

The same cannot be said for the rest of the structures in the city, however, many of which are located within or adjacent to identified floodplains. If 20% of the 460 residential structures in the city are damaged by flooding, this equates to 92 flood damaged structures. Given that the median price for a single-family housing unit in Burlington is $119,200, this scenario would result in $10,966,400 in structural flood losses. Assuming a contents value of 50% of structure value, an additional loss of $5,483,200 in contents and personal property could be expected.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the city limits;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

5.3.2.5 Severe Summer Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Burlington's recent increase in population, and its projected increase in development, results in increased vulnerability to summer storms. More people and more structures are exposed to the hazard, which increases the possibility of injury or fatality, and of damage or destruction. In addition, these increases mean that any utility service outage will impact more people and structures, which also increases the overall vulnerability to the hazard.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 5.3.1-1 (previous).

The representatives from the city of Burlington determined that severe summer storms have the potential to cause the impacts described in Table 5.3.2.5-1 (following).

Table 5.3.2.5-1
Qualitative Hazard Impacts – Severe Summer Storm

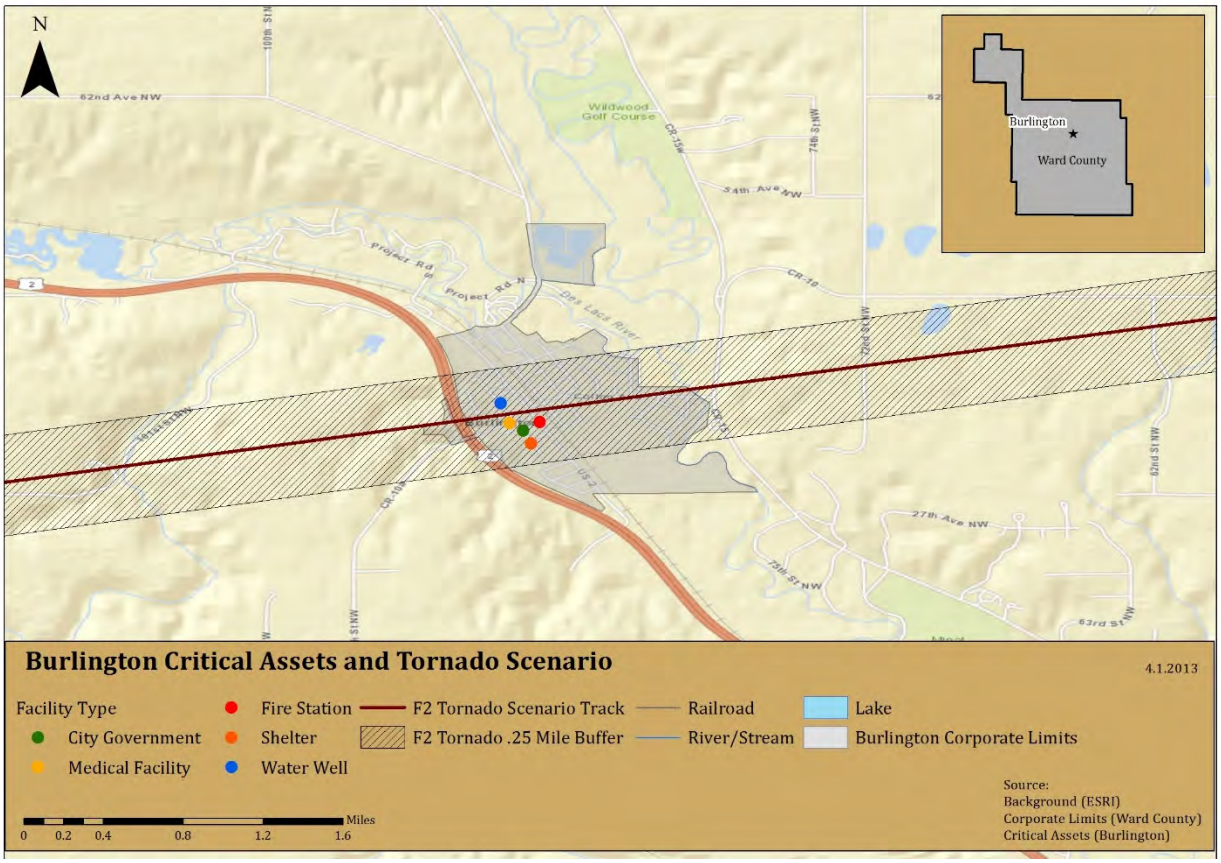
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Summer Storm	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative
Severe summer storms are a non-spatial hazard that can and do affect the entire city of Burlington. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Burlington are at risk from severe summer storms. According to the 2010 Census, there are 460 housing units in the city. The median value of these structures is $119,200, according to the 2010 Census. This equates to residential assets of approximately $54,832,000. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $5,483,200.

In addition, all identified critical assets (identified in Table 5.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of at least $3,310,820. For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Burlington. Figure 5.3.2.5-1 (following) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 5.3.2.5-1
Tornado Scenario – City of Burlington



As seen in the above figure, in such a scenario the majority of the city of Burlington would be damaged, including critical assets (government and emergency services). This scenario would result in significant damages to the city's infrastructure, and would greatly impact its ability to provide basic services, such as sewer and water.

Finally, the 1,060 residents of Burlington are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 8.2% (children under 5) and almost 5.6% (those over 70) of the population of Burlington. Combined, these two groups account for 13.8% of the population, a total of 142 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;

- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

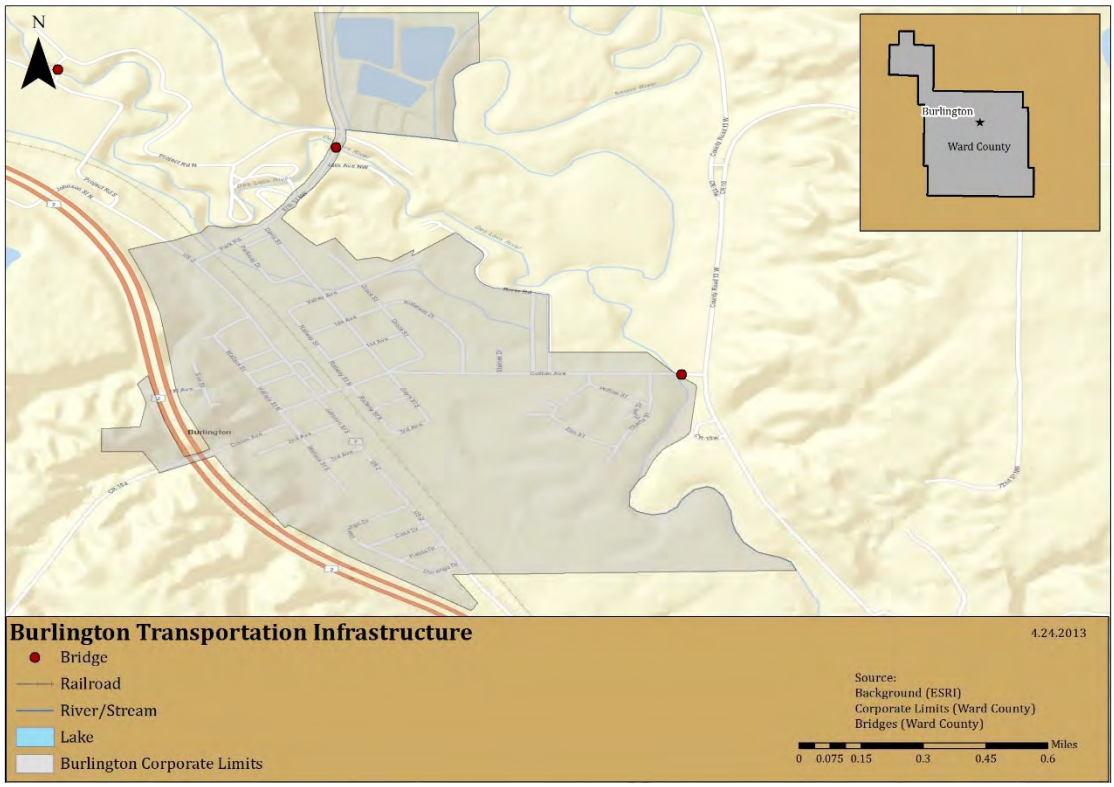
5.3.2.6 Severe Winter Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents. Figure 5.3.2.6-1 (following) provides the locations of bridges in and around the city, which typically ice over before surround roadways, making them treacherous for travel.

Figure 5.3.2.6-1
Burlington – Bridges



In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Burlington's recent increase in population, and its projected increase in development, results in increased vulnerability to winter storms. More people and more structures are exposed to the hazard, which increases the possibility of injury or fatality, and of damage or destruction. In addition, these increases mean that any utility service outage will impact more people and structures, which also increases the overall vulnerability to the hazard.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 5.3.1-1 (previous).

The representatives from the city of Burlington determined that severe winter storms have the potential to cause the impacts described in Table 5.3.2.6-1 (below).

Table 5.3.2.6-1
Qualitative Hazard Impacts – Severe Winter Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Winter Storm	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Burlington. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Burlington are at risk from severe winter storms. According to the 2010 Census, there are 460 housing units in the city. The median value of these structures is $119,200, according to the 2010 Census. This equates to residential assets of approximately $54,832,000. If 1% of these residential assets were damaged by a severe summer storm, this would result in losses of $548,320.

In addition, all identified critical assets (identified in Table 5.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of at least $3,310,820. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $331,082.

Finally, the 1,060 residents of Burlington are all at risk from the severe winter storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 8.2% (children under 5) and almost 5.6% (those over 70) of the population of Burlington. Combined, these two groups account for 13.8% of the population, a total of 142 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

5.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

The roadways surrounding Burlington – including Highway 2, which is a significant transportation route in the region – have experienced increases in traffic and capacity in recent years, due in large part to the increase in energy activities in the state. This increase in traffic increases the city's exposure and vulnerability to the hazardous materials incident hazard, as an incident on the roadways could have significant impacts in Burlington. As planned future development is constructed – and the resulting expected increases in population - these impacts and this vulnerability will continue to increase.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 5.3.1-1 (previous).

The representatives from the city of Burlington determined that hazardous materials incidents have the potential to cause the impacts described in Table 5.3.2.7-1 (following).

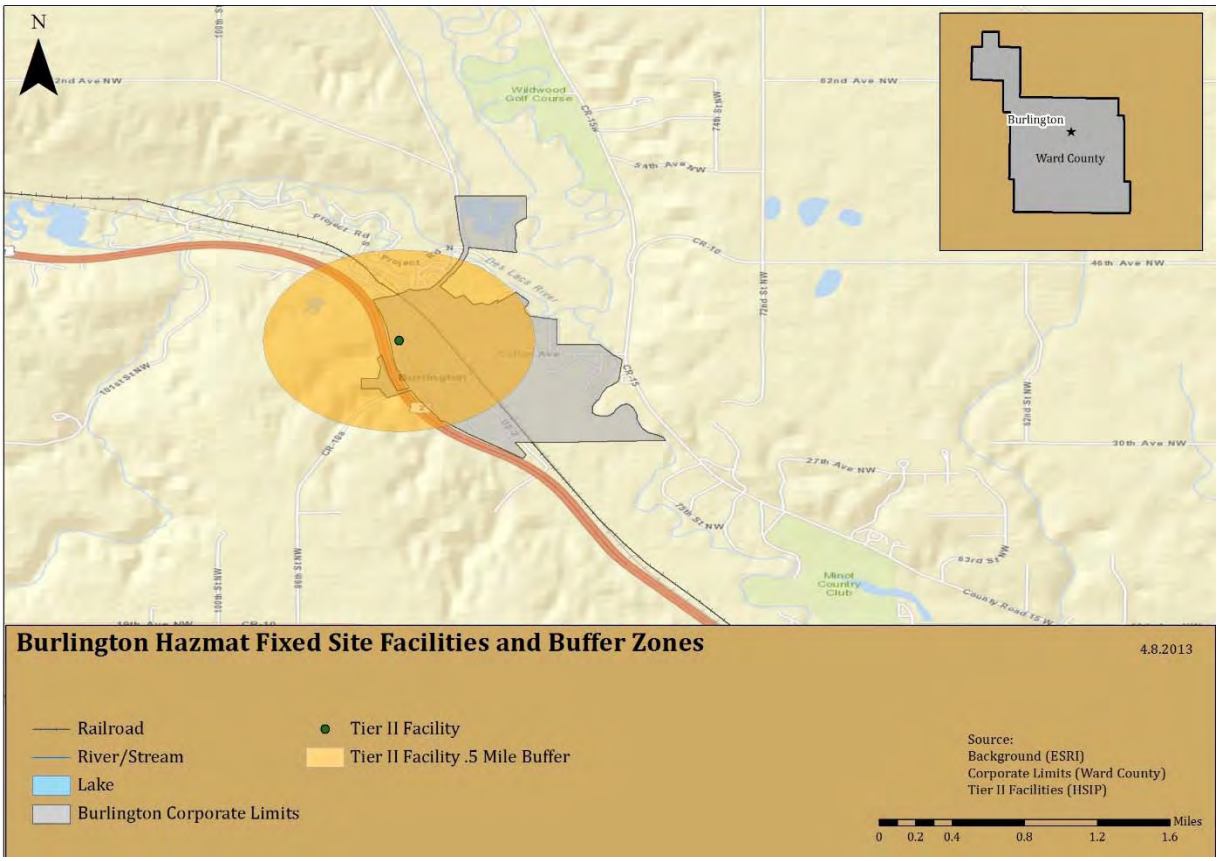
Table 5.3.2.7-1
Qualitative Hazard Impacts – Hazardous Materials Incident

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Hazardous Materials Incident	High	High	High

Estimate of Potential Losses – Quantitative
For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Burlington – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

Burlington has one Tier II facility. Figure 5.3.2.7-1 (following) illustrates the location of this facility in relation to the city of Burlington, and provides a ½ mile buffer zone around this facility. For the purposes of this assessment, all assets within this buffer would be impacted to some degree.

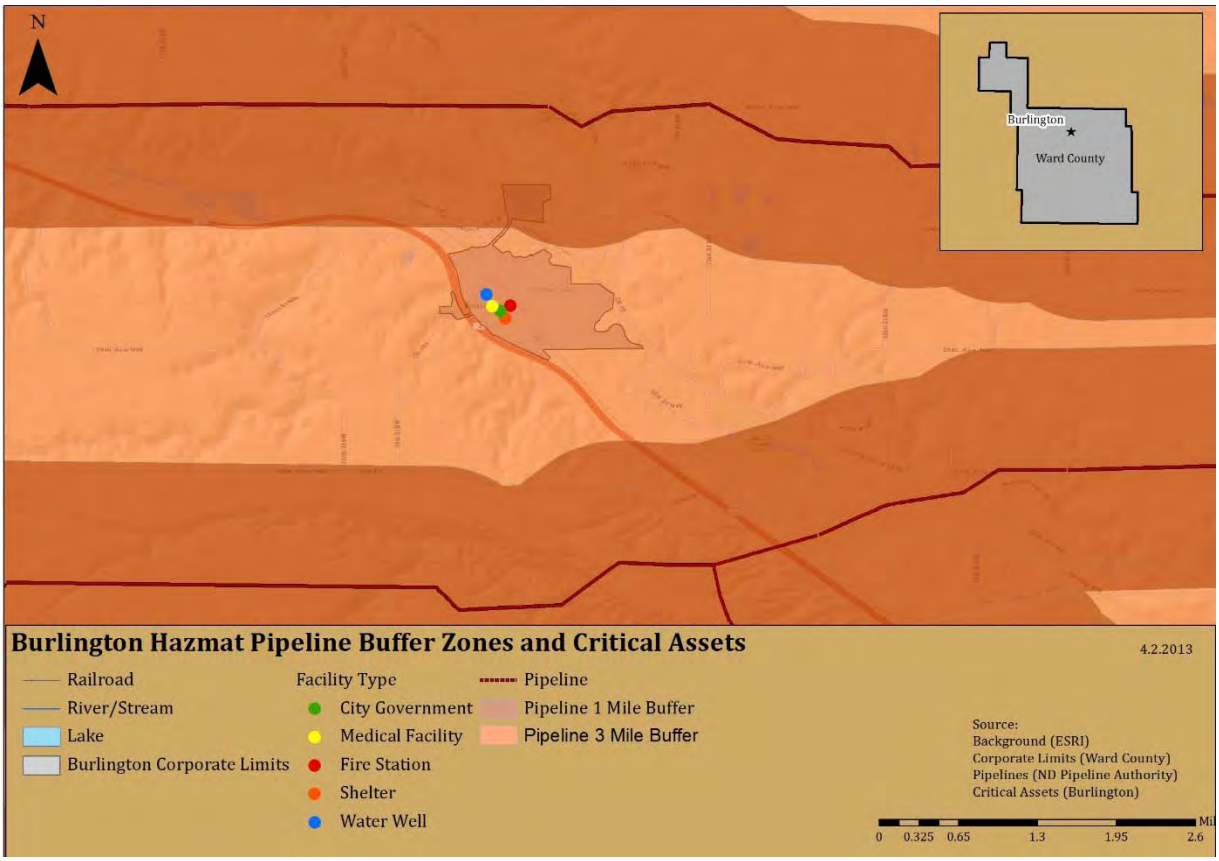
Figure 5.3.2.7-1
Hazardous Materials Incident Scenario – Fixed Site Facilities



As seen in the image above, an incident at this facility would have the potential to impact a significant portion of the city of Burlington, depending on conditions and circumstances.

Pipelines also have the potential to cause significant impacts within the city of Burlington. Figure 5.3.2.7-2 (following) illustrates the location of identified pipelines under the city (to the north and the south of the city limits), and provides both the ½ mile and the one mile buffer zone around this pipeline. As seen in this image, all critical assets in the city of Burlington could be impacted by an incident with the pipeline, which could result in losses of at least $3,310,820 for critical assets. These losses could be structural or physical damage, or could be a loss of function due to contamination or inaccessibility.

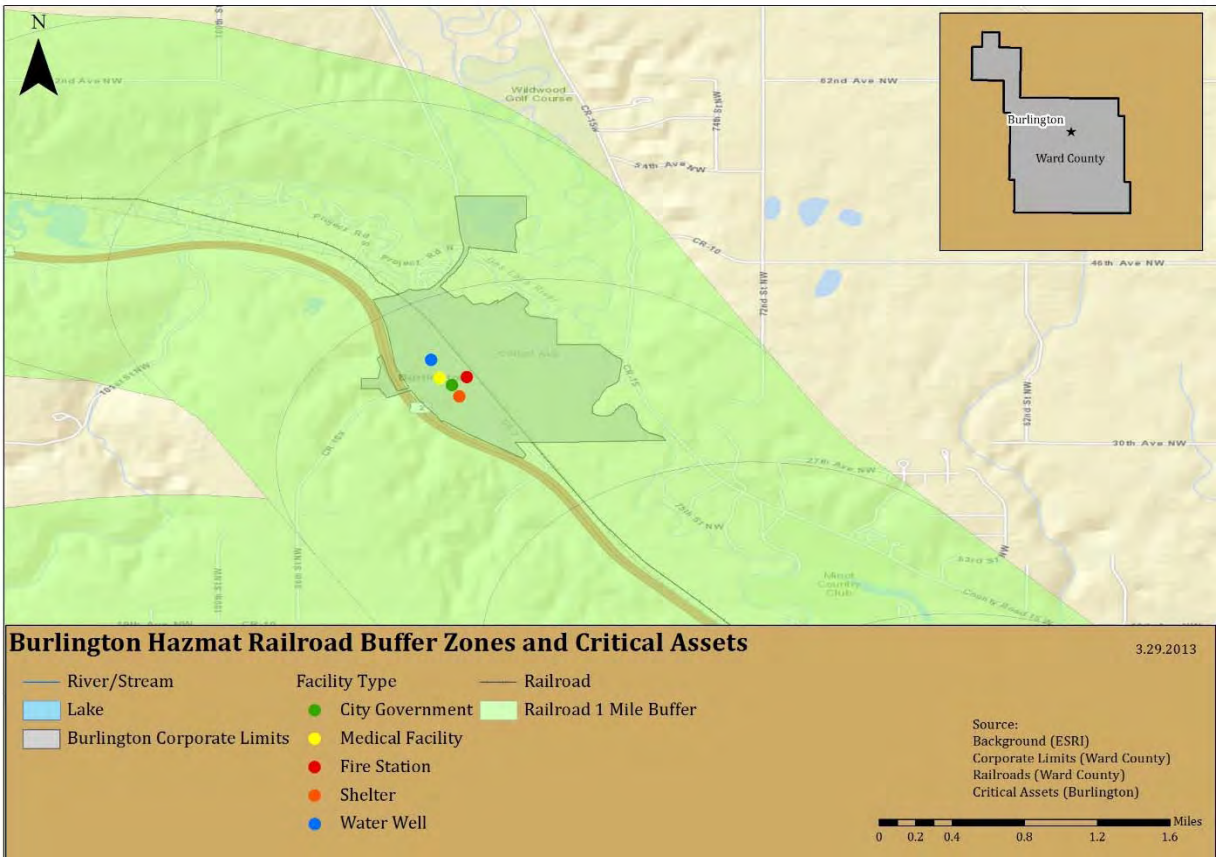
Figure 5.3.2.7-2
Hazardous Materials Incident Scenario – Pipelines



As is evident from the above image, the entire city could be impacted by an incident involving pipelines, depending on the substance involved, the location of the incident, and the specifics of the incident.

Finally, railroads also pose a significant hazardous materials threat to the city of Burlington, as railroads are routinely used to transport hazardous materials. Figure 5.3.2.7-3 (following) illustrates the location of the railroad, and provides the one mile buffer zone around this railroad. As seen in this image, all critical assets in the city of Burlington could be impacted by an incident with the railroad, which could result in losses of at least $3,310,820 for critical assets. These losses could be structural or physical damage, or could be a loss of function due to contamination or inaccessibility.

Figure 5.3.2.7-3
Hazardous Materials Incident Scenario – Railroads



As is evident from the above image, the entire city could be impacted by an incident hazardous materials and the railroad.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding projected/expected changes in development;
- Data regarding project population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

5.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Burlington's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the city has significant familiarity with hazard mitigation programs, and has implemented hazard mitigation projects in the wake of the 2011 Souris (Mouse) River flooding.
- **Current/ongoing mitigation efforts** – the city is currently working on property acquisition projects as a result of the 2011 flooding. In addition, the city maintains a listing of residents who will need additional assistance with evacuations, so that proper planning and timing can be ensured.
- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city. In addition, the city participates in mutual aid agreements.
- **Planning** – the city has a COOP plan, which has been used successfully in recent flood events (in 2009 and 2011). In addition, the city maintains a disaster recovery plan, which

proved to be successful in the aftermath of the 2011 flood. There is also an evacuation plan, which is administered by the Police and Fire Departments; the evacuation plan utilizes the resources of multiple agencies and departments, which requires a high level of coordination among the departments. Finally, the city has a master plan, practices stormwater management, and is a member of the NFIP.

- **Staff, personnel, and technical capability** – as of this Plan update, the city has a high capability and capacity regarding hazard mitigation, and is confident in their abilities to administer hazard mitigation projects and programs. Like most capabilities, it could be improved with experience and additional resources.

Like other municipalities within Ward County, Burlington utilizes the framework established by the county and state government for technical assistance, and relies on the state and federal government for funding.

Conclusions and Recommendations
Burlington should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county towards this end.

5.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there **must** be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

5.5.1 Mitigation Goals

Table 5.5.1-1 (below) provides the mitigation goals that guide the city of Burlington's mitigation strategy.

Table 5.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

5.5.2 Mitigation Actions

Potential Mitigation Actions

Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions

Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions

Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with

operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (5.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (5.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped the city of Burlington to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 5.5.2-2. Table 5.5.2-1 (following) describes the basic criteria considered as part of the prioritization process.

Table 5.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness
Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (5.5.2-2) provides the identified and prioritized mitigation strategy for the city of Burlington.

Table 5.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Continue to enforce floodplain management ordinance and practices	Flood	New	New and existing	City Council; Planning Department	General funds; Ward County EMA	$500+	Moderate	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	City Council; Planning Department	General funds; Ward County EMA	$500+	Low	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Council; City Auditor	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; Ward County EMA	$500+	High	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Determine the viability of the construction of a levee of other minor flood protection in flood-prone areas, to protect at-risk critical assets and infrastructure.	Flood	New	New and existing	City Council; Engineering; Planning Department	NDDES and FEMA mitigation grant funding. USACE; General funds, Ward County EMA	$30,000+	Low	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recent annexations and / or recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council; Planning Department; City Engineering	General funds; Ward County EMA	$500+	Low	
Goal 05: Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council; City Auditor; Planning Department; Public Works Department	General fund; in-kind contributions; Ward County EMA	$500+	Moderate	

Section 06
City of Carpio: HIRA, Capability Assessment, and Mitigation Strategy

6.1 IFR for Hazard Identification and Risk Assessment
6.2 Hazard Identification (Updated)
6.2.1 Overview of Carpio's History of Hazards and Potential Hazards
6.2.2 Hazard Profiles
6.3 Risk Assessment (Updated)
6.3.1 Risk Assessment Methodology
6.3.2 Risk and Vulnerability Assessment
6.4 Capability Assessment (Updated)
6.5 Mitigation Strategy (Updated)
6.5.1 Mitigation Goals
6.5.2 Mitigation Actions

6.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..*

Requirement §201.6(c)(2)(ii)(C): *[The plan* ***should*** *describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment* ***must*** *assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Carpio.

6.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Carpio. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

6.2.1 Overview of Carpio's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 09 weather-related hazard events have occurred in the city of Carpio since 1994, including the following number and types of hazard events:

- Flood – 2
- Hail – 3

- Thunderstorm – 1
- Tornado/Funnel Cloud - 3

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 6.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 6.2.1-1
Presidential Disaster Declarations – City of Carpio

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Carpio

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 6.2.1-2 (below).

Table 6.2.1-2
Preliminary Hazard Identification and Determinations – City of Carpio

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Carpio	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Carpio	Reason for Exclusion and other notes
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Carpio	Reason for Exclusion and other notes
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

6.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

6.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk.

Table 6.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 6.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the

severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Carpio.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 6.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 6.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 6.2.2.1-3 (following) provides the details of pertussis outbreaks since 2007.

Table 6.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 6.2.2.1-4 (below) provides occurrence information for rabies.

Table 6.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Carpio did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Carpio, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Carpio, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been no occurrences of communicable disease within the city of Carpio. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

6.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Carpio are subject to the drought hazard.

Extent and Severity of the Hazard
Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.

- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

Table 6.2.2.2-1 (below) provides the PDSI classifications.

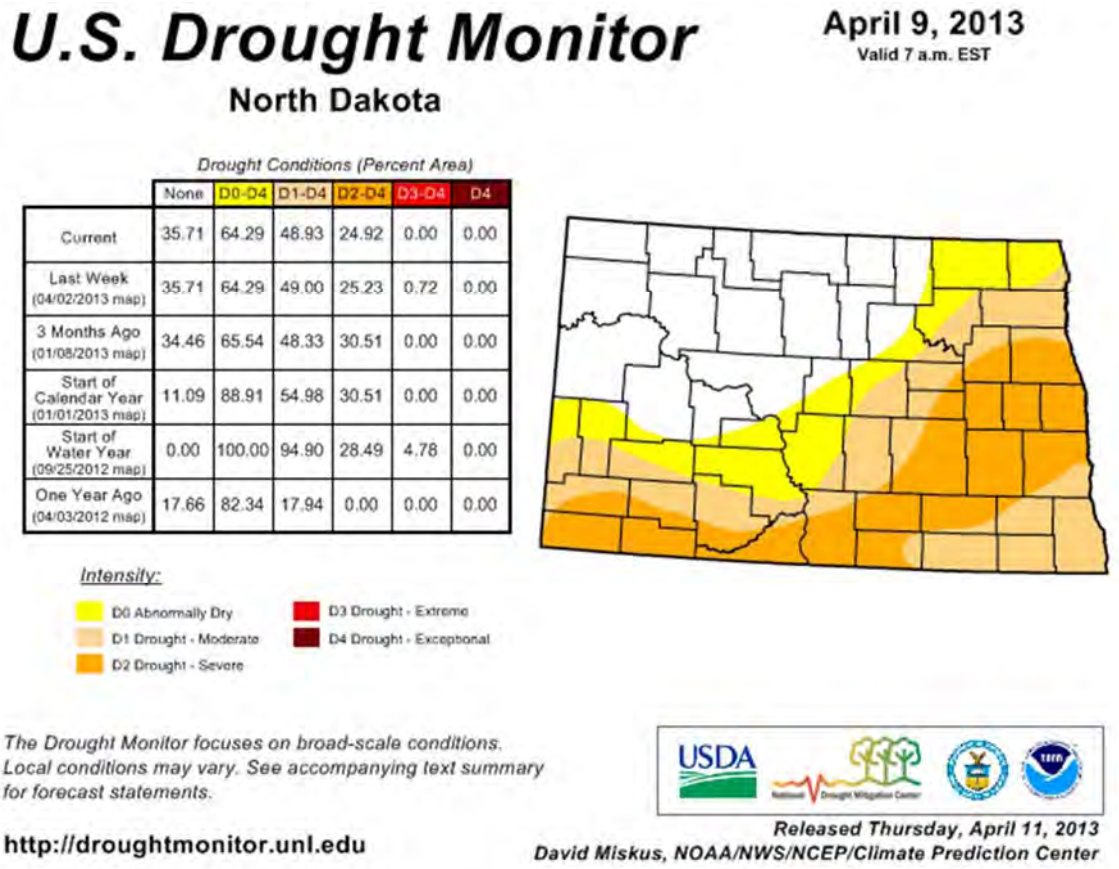
Table 6.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested

Classification	Description	Range of Possible Impacts
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Carpio are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 6.2.2.2-1 (following).

Figure 6.2.2.2-1
US Drought Monitor – North Dakota
(Source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 6.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Carpio – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

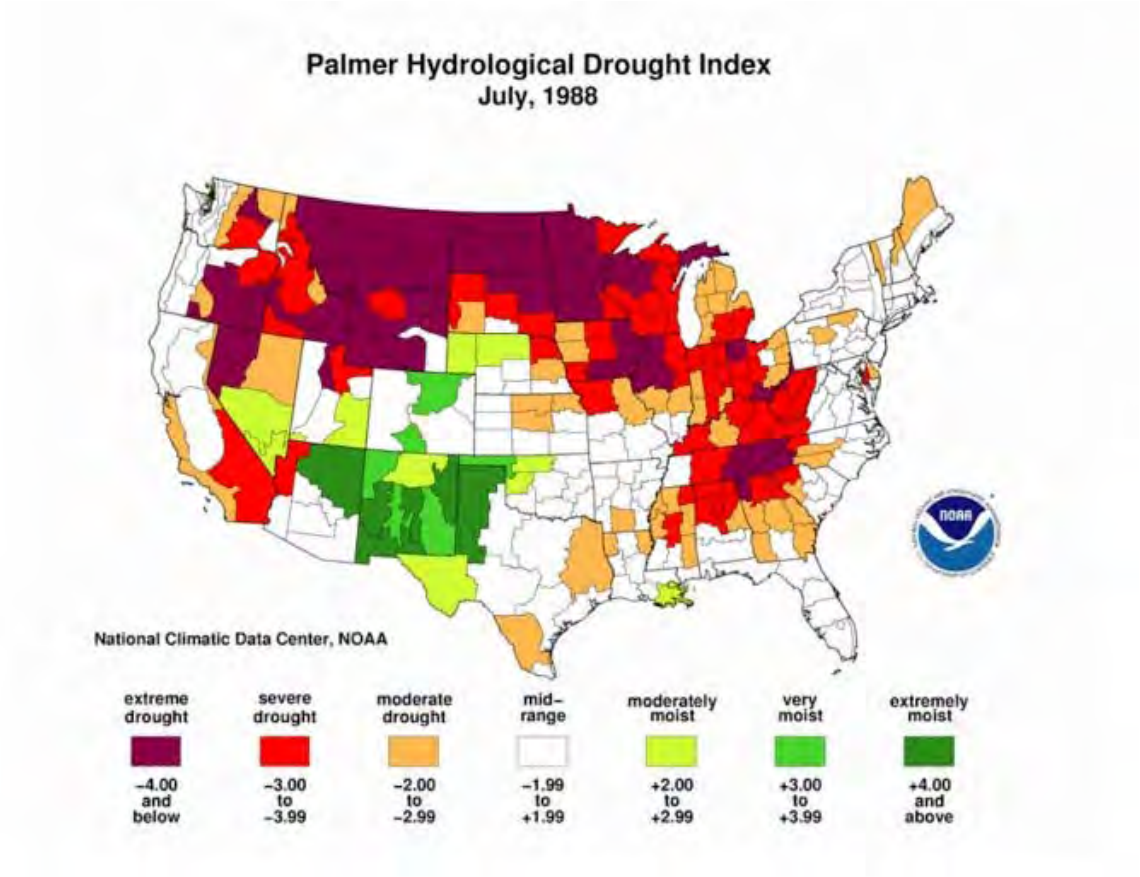
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Carpio. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 6.2.2.2-2 (following), the entire state – including the city of Carpio – was categorized as being in extreme drought during this time.

Figure 6.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(Source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Carpio) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years in more recent history.

6.2.2.3 Fire
This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

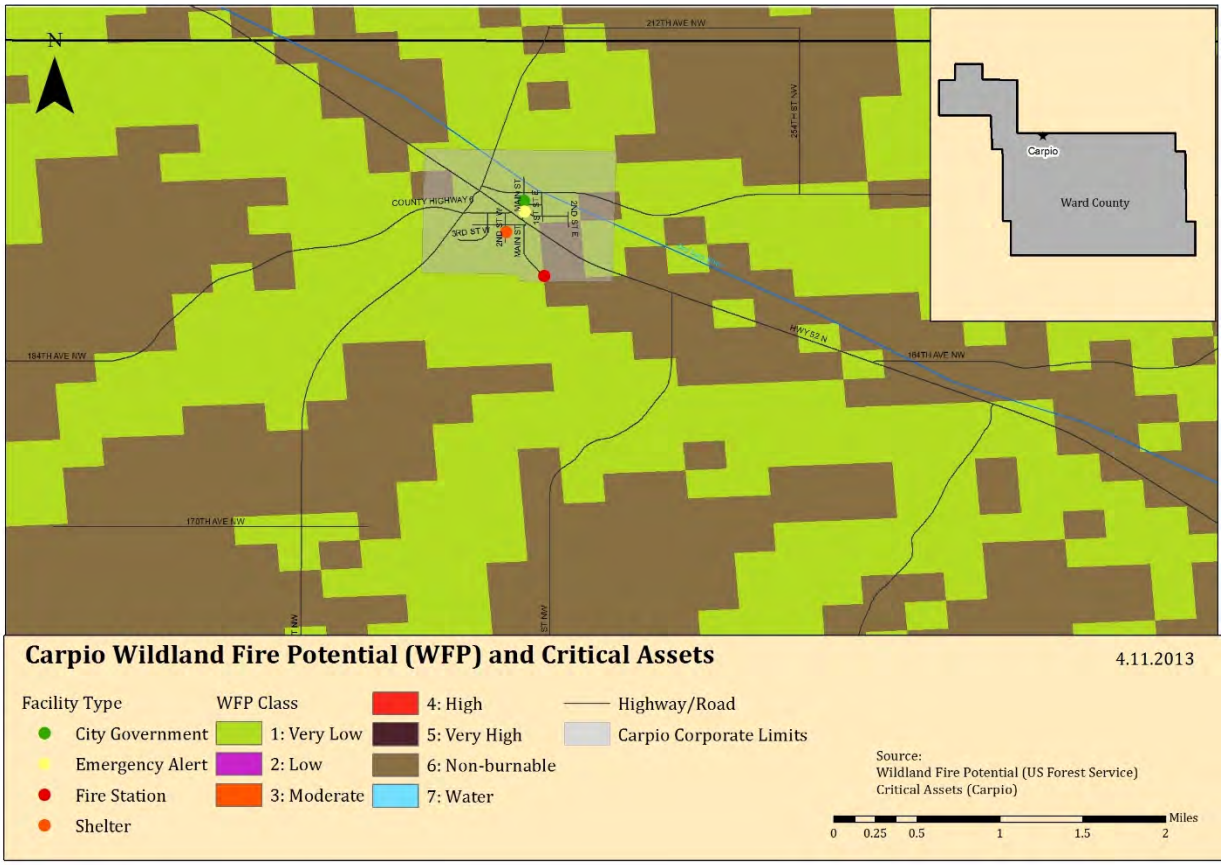
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 6.2.2.3-1 (following) illustrates the wildland fire potential for the city of Carpio, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 6.2.2.3-1
City of Carpio – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard

The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 6.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System.

Table 6.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the

destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people. In addition, some structures (such as grain elevators) require specialized teams and equipment, and so response to these events may be delayed.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Based on data obtained from the National Reporting System and from the Carpio Fire Department, the city of Carpio has experienced 12 structure fires from January 2008 through December 2012, an average of 2.4 structure fires per year. For this same time period, 29 wildland fires were responded to, an average of 5.8 per year.

In October 2012, a grain elevator exploded in Carpio, and resulted in a large fire. As a precaution, the surrounding area was evacuated, and the railroad was temporarily shut down. A crew that specialized in elevator fires was brought in from South Dakota to fight the fire.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in the city of Carpio at least once per year. Using the scale provided earlier in this section, this equates to a high probability of a future occurrence.

6.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.*

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North

Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

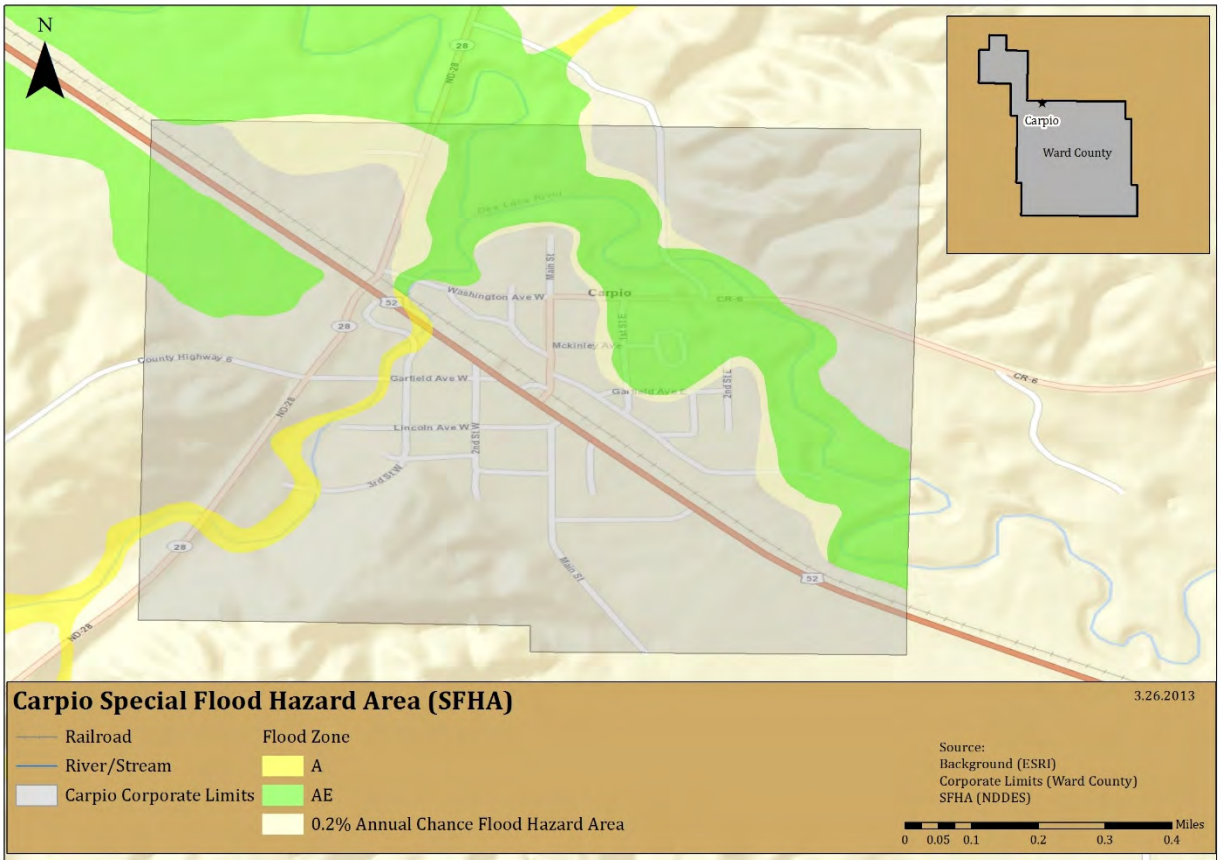
Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard

Carpio has significant areas of one percent annual chance floodplain both inside and adjacent to its corporate limits. Large portions of the city fall within the one percent annual chance floodplain, with additional areas falling in the .02% annual chance floodplain. These areas are illustrated in Figure 6.2.2.4-1 (following).

Figure 6.2.2.4-1
Special Flood Hazard Areas



Extent and Severity of the Hazard

In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 6.5.2.4-1 (below).

Table 6.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.

Zone Designation	Percent Annual Chance of Flood	Description
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 6.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 6.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

Term	Definition
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

The city of Carpio is currently a member of the NFIP, and its membership is in good standing. There are no designated Repetitive Loss or Severe Repetitive Loss properties within the city of Carpio.

Potential Impact of the Hazard
Flooding is the most frequent natural disaster in the US, and is one that occurs with regularity in the city of Carpio.

Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A major flood occurred in the Souris River Basin in 1969, which greatly impacted the region (though

not specifically the city of Carpio). More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley.

In addition, according to NCDC records, Carpio was inundated by flooding twice in 2009; these events resulted in property damages of at least $538,000.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs at less than once every five years in the city of Carpio. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is low.

6.2.2.5 Severe Summer Storms
This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

Extreme Heat
Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail
Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning
Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms
Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard
Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Carpio.

Extent and Severity of the Hazard
Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat
The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.

- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 6.2.2.5-1(following). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 6.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail

The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 6.2.2.5-1 (following) provides details of these scales.

Table 6.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33"	Pea	No damage
H1	Potentially Damaging	0.33" – 0.60"	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60" – 0.80"	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80" – 1.20"	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20" – 1.60"	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60" – 2.0"	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0" – 2.4"	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4" – 3.0"	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0" – 3.5"	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5" – 4.0"	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning
The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to

explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- **Ground-to-Cloud Lightning.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning**. Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning**. Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 6.2.2.5-2 (following) provides this severity scale.

Table 6.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to

describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 6.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 6.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Table 6.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 6.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Given that Carpio is smaller than 15 miles in diameter, it is possible for the entire jurisdiction to be impacted by the same thunderstorm at any given time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from

thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Carpio are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards.

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at

the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 6.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 6.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties

- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact

on life due to thunderstorm and associated hazards in Berthold would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard
Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least 7 occurrences of the summer storm hazard since 1994. (Note: Records prior to 1994 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 6.2.2.5-6 (below) provides details of these recorded incidents.

Table 6.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Description	Magnitude (if applicable)
September 14, 1994	Tornado/Funnel cloud	Unknown
May 17, 1998	Tornado/Funnel cloud	Unknown
August 23, 2002	Hail	.75”
July 09, 2007	Thunderstorm/Wind	52 MPH
June 26, 2010	Tornado/Funnel cloud	Unknown
June 07, 2011	Hail (2 occurrences)	1” and 1”

Probability of a Future Occurrence of the Hazard
In the 18 year period for which records are available, the summer storm hazard has occurred at least seven times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is high, as the summer storm hazard occurs at least annually.

6.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard
Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow

The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold

What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice

The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain

situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Carpio.

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold
Winter temperatures in Carpio typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 6.2.2.6-1 (following) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 6.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)

NWS Windchill Chart

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

- **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.
- **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard
Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard
According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes,

accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.

- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.
- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard

Based on the data available, winter storms occur in or otherwise impact the city of Carpio at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

6.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard

Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

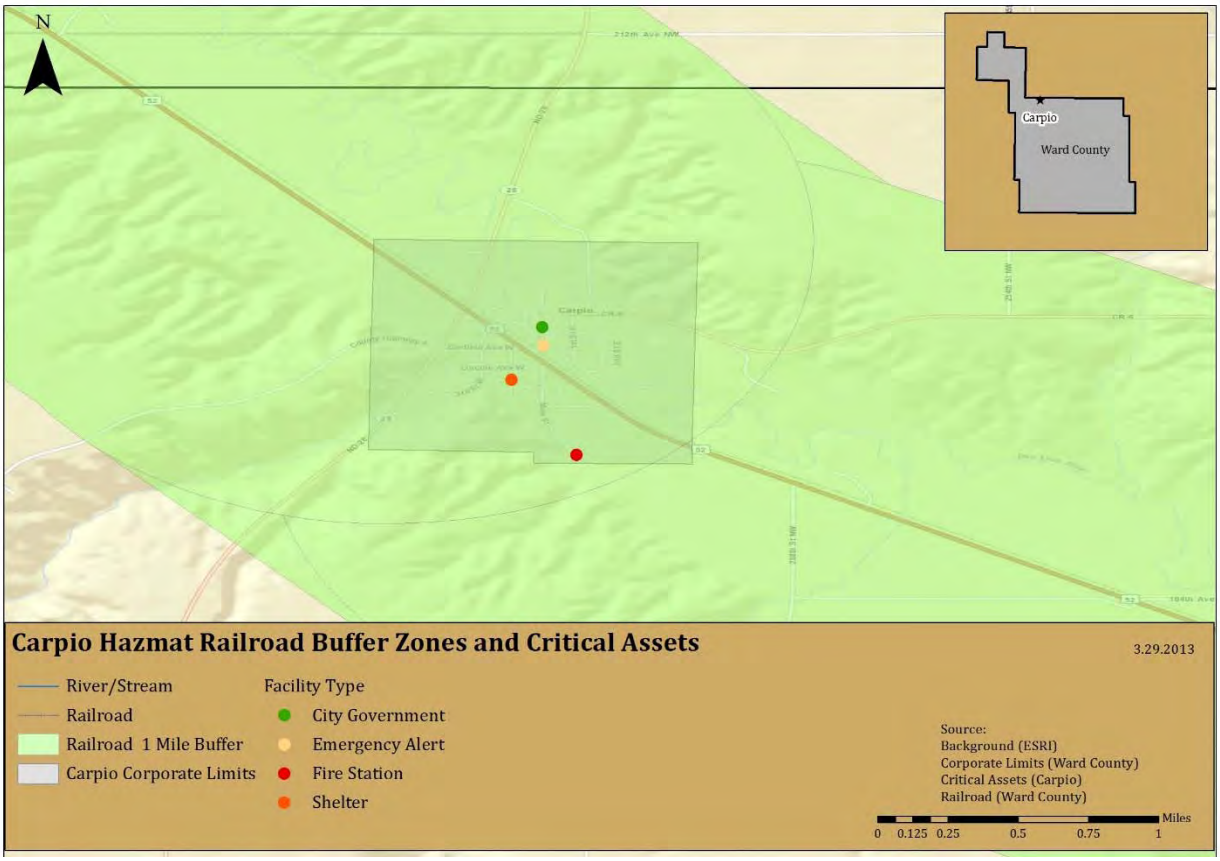
Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard

Three fixed site facilities are located in Carpio that report to Tier II. These facilities are located adjacent to the railroad.

The locations in Carpio most at risk from a hazardous materials incident are those that are in proximity to transportation routes, specifically the railroad. The following figure (6.2.2.7-1) illustrates this location in Carpio.

Figure 6.2.2.7-1
Hazardous Materials Locations – Railroad



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, no Tier II reports from the city of Carpio have been submitted to the EPA since 1987, the year that the EPA began keeping such reports.

In October 2012, a grain elevator exploded in the city of Carpio. The resulting fire could not be suppressed by traditional firefighting techniques and equipment, and the city hired a specialized firefighting team from South Dakota to address the situation.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in Ward County, though not necessarily in the city of Carpio. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

6.3 Risk Assessment (Updated)

The following table (Table 6.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Carpio.

Table 6.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

6.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Carpio from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

Impact Scale Methodology
The potential impacts of each hazard were discussed by the Steering Committee. For the purposes of this discussion, a qualitative impact scale was developed, and was used by the Steering Committee in their discussions. As a result of these discussions, each hazard was assigned a qualitative impact ranking. This scale appears in Table 6.3.1-1 (below).

Table 6.3.1-1
Hazard Impact Scale

Term	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Low	Some minor injuries possible, but no fatalities	Cosmetic damages expected to assets; Infrastructure loss of function for less than 24 hours expected	System delivery delayed or temporarily interrupted; Interruptions in service delivery of less than 24 hours expected
Moderate	Injuries expected; Fatalities possible	Some structural damages to light construction (<50 % damage); Infrastructure loss of function for 24-72 hours expected	System delivery failures expected; Interruptions in service delivery of 24-72 hours expected
High	Serious and numerous injuries expected; Fatalities expected	Some structures irreparably damaged (>50% damage); Infrastructure loss of function for 72+ hours expected	Long-term system failures/damages expected; Cancellation of services (72+ hours) expected
Not Applicable	Hazard does not have the potential to impact people or life safety	Hazard does not have the potential to impact assets or infrastructure	Hazard does not have the potential to impact service delivery

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Carpio to the identified and profiled hazards.

Critical Assets
The following table (Table 6.3.1-1) provides details of the critical assets contained within the city of Carpio.

Table 6.3.1-1
Critical Assets – City of Carpio

Asset Name	Asset Use /Function	Street Number	Street Name	Insured or Estimated Value
Carpio Fire Station	Emergency Services	10	Main Street South	$175,469
Carpio Ambulance	Emergency Services	10	Main Street South	$175,469
Carpio City Hall	Government	520	Main Street	$175,469
Carpio Lutheran Church	Shelter	200	Second Street West	$16,115
Siren	Alert and Warning	400	Main Street South	$48,995
Total estimated value of identified critical assets:				**$591,517**

Note on asset values: Valuation data for assets within the city was unavailable at the time this plan update was developed. All valuations used in the following estimates of potential losses are derived from an average of available data for the same or similar types of assets from other jurisdictions. The assessment that follows is an estimate only, and may not correlate with actual occurrences of the damage caused by the hazards described.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

6.3.2 Risk and Vulnerability Assessment

6.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 157 people residing in Carpio; the 2012 Census Estimate places the population at 153, a slight decrease from the last official Census count. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 6.3.1-1 (previous).

The representatives from the city of Carpio determined that communicable disease has the potential to cause the impacts described in Table 6.3.2.1-1 (below).

Table 6.3.2.1-1
Qualitative Hazard Impacts – Communicable Disease

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Communicable Disease	Moderate	Low	Low

Estimate of Potential Losses – Quantitative
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Carpio represents 1% of the total population of Ward County, or 157 people. While an outbreak of communicable disease in Carpio is unlikely to have significant impacts outside of Carpio, an outbreak could have significant impacts within the city.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness rate in Carpio that is similar to the illness rate across the county, the following numbers of people in Carpio could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Carpio accounts

for ~1% of the county population. This equates to 45 cases of influenza in Carpio, on average, that could potentially impact the city.

- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Carpio accounts for ~1% of the county population. This equates to 65 cases of pertussis in Carpio, on average, that could potentially impact the city.

Identified Data Limitations

There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;
- Data regarding population projections; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

6.3.2.2 Drought

Vulnerability to the Hazard

Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies depend largely on agriculture, such as the State of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result in significant societal disruption, which can worsen as the resource becomes more and more precious.

Carpio is not economically dependent on agriculture, as very few of its residents work in the industry (based on the 2010 Census). Carpio has not experienced any changes or improvements in development since the 2008 plan, and no significant changes are anticipated in the foreseeable future. Though some changes in population have been estimated, the population overall has remained relatively stable over the last decade. These factors indicate stable vulnerability regarding drought.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 6.3.1-1 (previous).

The representatives from the city of Carpio determined that drought has the potential to cause the impacts described in Table 6.3.2.2-1 (below).

Table 6.3.2.2-1
Qualitative Hazard Impacts – Drought

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Drought	Low	Low	Low

Estimate of Potential Losses – Quantitative
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no quantitative risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no quantitative risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;
- Data regarding projected/expected development;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

6.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

Carpio's structural vulnerability to fire has slightly decreased since the 2008 plan. According to the 2000 Census, there were 90 housing units in the city. The 2010 Census decreased this figure to 83, resulting in slightly fewer structures exposed to the hazard. In terms of population, the population has fluctuated slightly from 148 (2000 Census) to 157 (2010 Census) to 153 (2012 Census Estimate). The relative stability of both development and population, coupled with the lack of published plans for future development, indicate stable vulnerability to the fire hazard for now and for the foreseeable future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 6.3.1-1 (previous).

The representatives from the city of Carpio determined that fire has the potential to cause the impacts described in Table 6.3.2.3-1 (below).

Table 6.3.2.3-1
Qualitative Hazard Impacts – Fire

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Fire	Low/Moderate	Low/Moderate	Low/Moderate

Estimate of Potential Losses – Quantitative
All structures within the city of Carpio are at risk from fire. According to the 2010 Census, there are 62 housing units in the city; 53 of these units are occupied, and 93 are vacant. The majority of these structures are heated either by bottled gas or by electricity. The median value of single

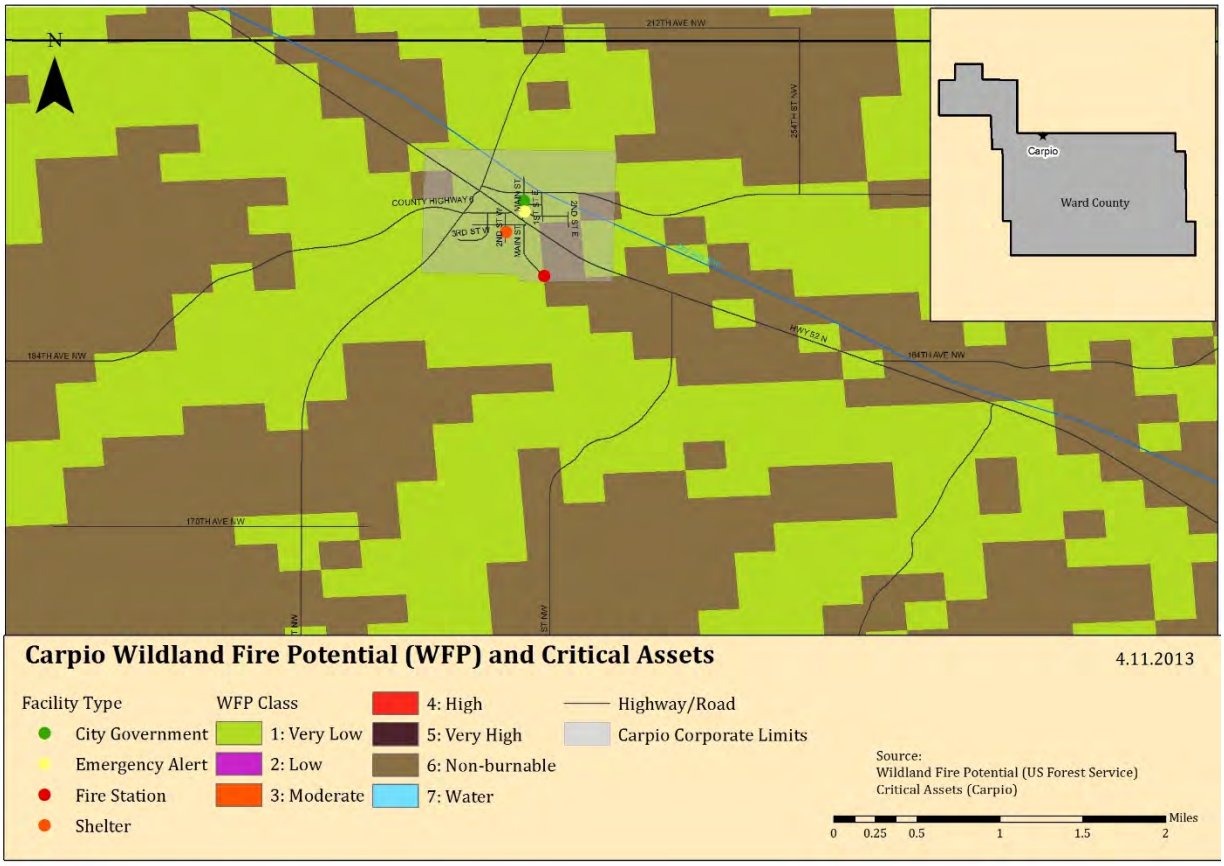
family housing in Carpio is $67,500, according to the Census. This equates to potential residential losses of $4,185,000.

In addition, all identified critical assets (identified in Table 6.3.1-1) within the city have the potential to be lost to fire. These assets have a combined estimated value of $591,517.

Using the US Forest Service's Wildland Fire Potential data, the city of Carpio and its critical assets were mapped. Based on this data set, the city of Carpio has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 6.3.2.3-1 (below) illustrates this fire potential in relation to the identified critical assets for the city.

Figure 6.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding projected/expected development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

6.3.2.4 Flood

Vulnerability to the Hazard
Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

Flood damages also take considerable time to recover from. The 2011 flooding that occurred throughout the county had far-reaching impacts, and recovery for many areas remains a work in progress as of this Plan update.

Carpio's relative stability in terms of development and population result in stable levels of vulnerability to the flood hazard. As there is no planned future development in Carpio, there is no expectation that this vulnerability will increase in the foreseeable future, but rather will remain fixed.

The city of Carpio is a member of the NFIP, and is in good standing with the program. As of February 2013, there were no NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the city of Carpio.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 6.3.1-1 (previous).

The representatives from the city of Carpio determined that flooding has the potential to cause the impacts described in Table 6.3.2.4-1 (below).

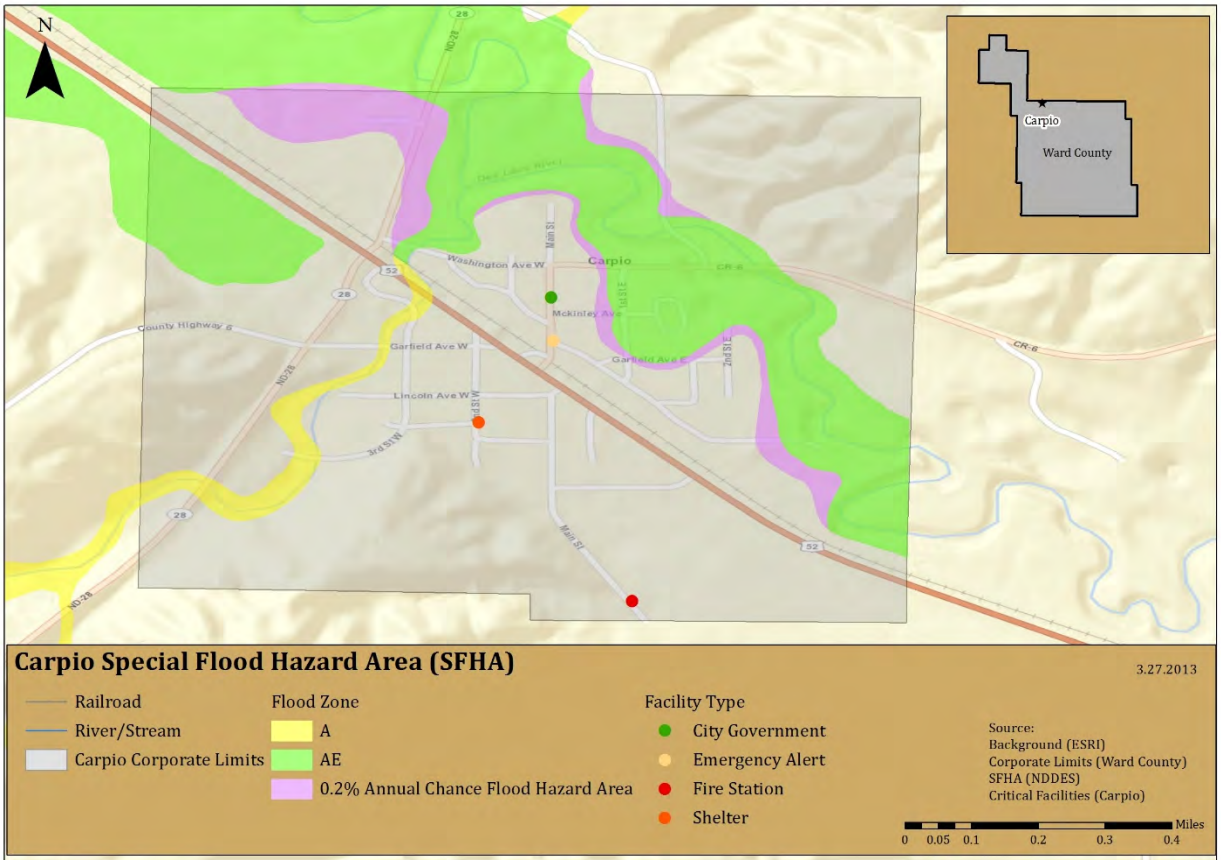
Table 6.3.2.4-1
Qualitative Hazard Impacts – Flood

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Flood	Low	Low	Low

Estimate of Potential Losses – Quantitative

Carpio has significant floodplains, both within the corporate limits and just outside of the corporate limits. Figure 6.3.2.4-1 (below) illustrates the locations and boundaries of both the one percent annual chance floodplain and the .02% annual chance floodplain. Critical assets for the city have been overlaid onto this hazard boundary map.

Figure 6.3.2.4-1
Special Flood Hazard Areas and Carpio Critical Assets



As seen in the image above, Carpio's critical assets are located outside of any identified flood hazard area, and have limited exposure to the flood hazard. However, given that the NFIP estimates that 30% of flood damages occur outside of any identified floodplain, it is reasonable to assume that at least some losses would occur to these critical assets. Using the NFIP's estimate, a loss of 30% to Carpio's critical assets would equate to at least $177,455 in damages.

The same cannot be said for the rest of the structures in the city, however, many of which are located within or adjacent to identified floodplains. If 20% of the 62 residential structures in the city are damaged by flooding, this equates to 12 flood damaged structures. Given that the median value of a single-family housing unit in Carpio is $67,500, this scenario would result in $810,000 in structural flood losses. Assuming a contents value of 50% of structure value, an additional loss of $405,000 in contents and personal property could be expected.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the city limits;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

6.3.2.5 Severe Summer Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Both development and population have remained relatively stable since the 2008 plan; there is no expectation of significant changes to either in the foreseeable future. Therefore, the vulnerability of Carpio to this hazard has not changed significantly, and is not expected to change significantly in the future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 6.3.1-1 (previous).

The representatives from the city of Carpio determined that severe summer storms have the potential to cause the impacts described in Table6.3.2.5-1 (below).

Table 6.3.2.5-1
Qualitative Hazard Impacts – Severe Summer Storm

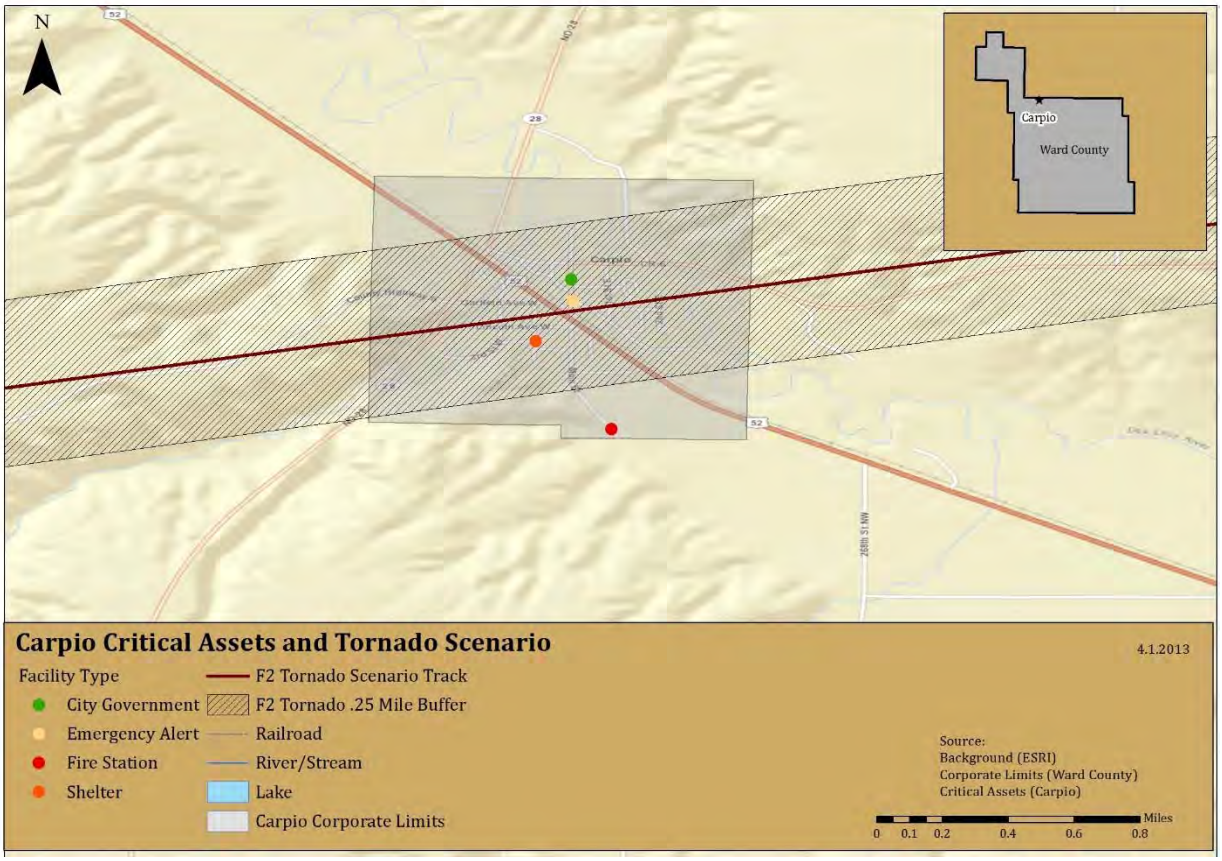
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Summer Storm	Low/Moderate	Low/Moderate	Low/Moderate

Estimate of Potential Losses – Quantitative
Severe summer storms are a non-spatial hazard that can and do affect the entire city of Carpio. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Carpio are at risk from severe summer storms. According to the 2010 Census, there are 62 housing units in the city. The median value of these structures is $67,500, according to the Census. This equates to residential assets of approximately $4,185,000. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $418,500.

In addition, all identified critical assets (identified in Table 6.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of $591,517. For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Carpio. Figure 6.3.2.5-1 (following) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 6.3.2.5-1
Tornado Scenario – City of Carpio



As seen in the above figure, in such a scenario the majority of the city of Carpio would be damaged, including critical assets (government and emergency services), and could result in at least $240,579 in damages. This scenario would result in significant damages to the city's infrastructure, and would greatly impact its ability to provide basic services, such as emergency response.

Finally, the 157 residents of Carpio are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 7.6% (children under 5) and 9.5% (those over 70) of the population of Carpio. Combined, these two groups account for more than 17% of the population, a total of 35 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);

- Building valuations for all assets within the city limit;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

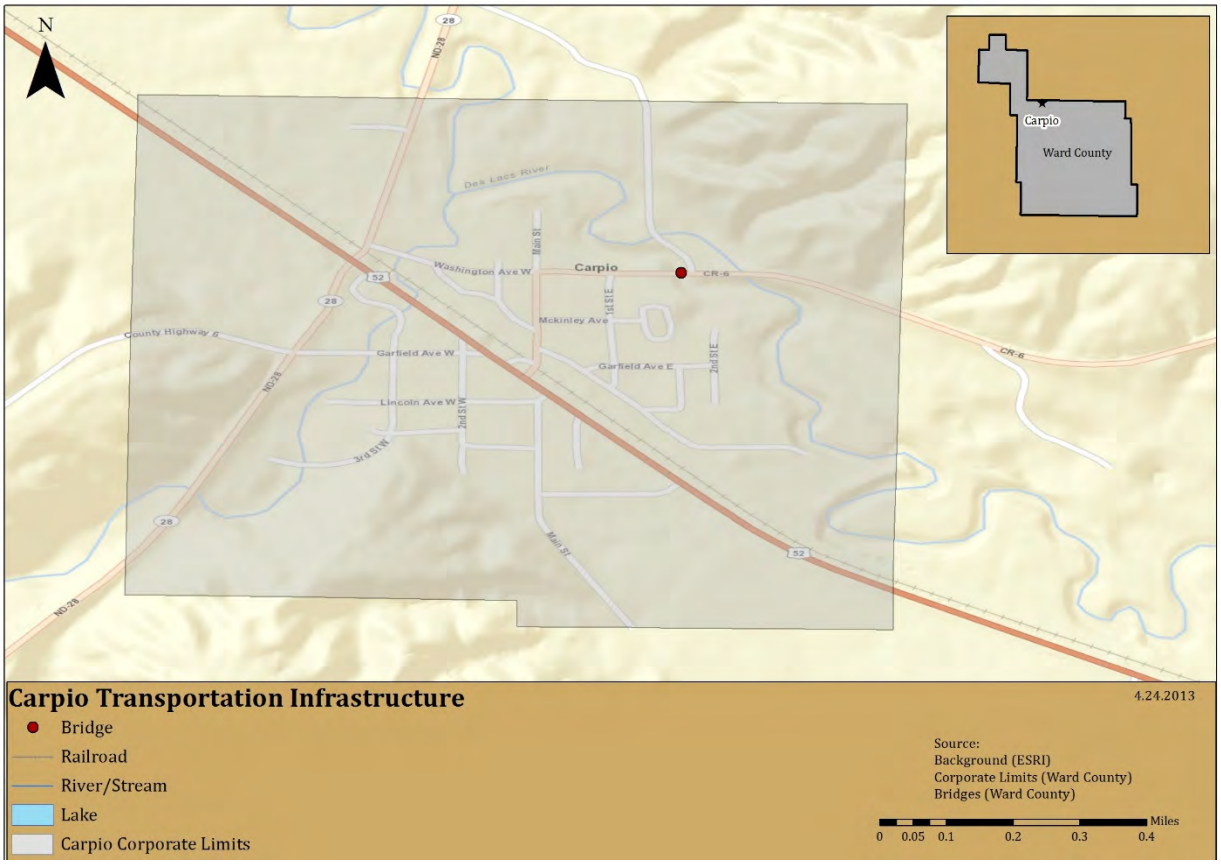
6.3.2.6 Severe Winter Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents. Figure 6.3.2.6-1 (following) provides the locations of bridges in and around the city, which typically ice over before surround roadways, making them treacherous for travel.

Figure 6.3.2.6-1
Carpio – Bridges



In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Both development and population have remained relatively stable since the 2008 plan; there is no expectation of significant changes to either in the foreseeable future. Therefore, the vulnerability of Carpio to this hazard has not changed significantly, and is not expected to change significantly in the future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 6.3.1-1 (previous).

The representatives from the city of Carpio determined that severe winter storms have the potential to cause the impacts described in Table 6.3.2.6-1 (below).

Table 6.3.2.6-1
Qualitative Hazard Impacts – Severe Winter Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Winter Storm	Low/Moderate	Low/Moderate	Low/Moderate

Estimate of Potential Losses – Quantitative
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Carpio. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Carpio are at risk from severe winter storms. According to the 2010 Census, there are 62 housing units in the city. The median value of these structures is $67,500, according to the Census. This equates to residential assets of approximately $4,185,000. If 1% of these residential assets were damaged by a severe summer storm, this would result in losses of $41,850.

In addition, all identified critical assets (identified in Table 6.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of $591,517. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $59,151.

Finally, the 157 residents of Carpio are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 7.6% (children under 5) and 9.5% (those over 70) of the population of Carpio. Combined, these two groups account for more than 17% of the population, a total of 35 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

6.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

The roadways surrounding Carpio have experienced increases in traffic in recent years, due in large part to the increase in energy activities in the state. This increase in traffic, while it may not directly impact the city of Carpio, creates an indirect increase in vulnerability, as an incident on one of the roadways in and around the city – including Highway 52, a major thoroughfare – could impact the city and its residents. The more traffic on the roadways, the greater likelihood of an incident. Any future development must take this increased vulnerability into account.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 6.3.1-1 (previous).

The representatives from the city of Carpio determined that hazardous materials incidents have the potential to cause the impacts described in Table 6.3.2.7-1 (below).

Table 6.3.2.7-1
Qualitative Hazard Impacts – Hazardous Materials Incident

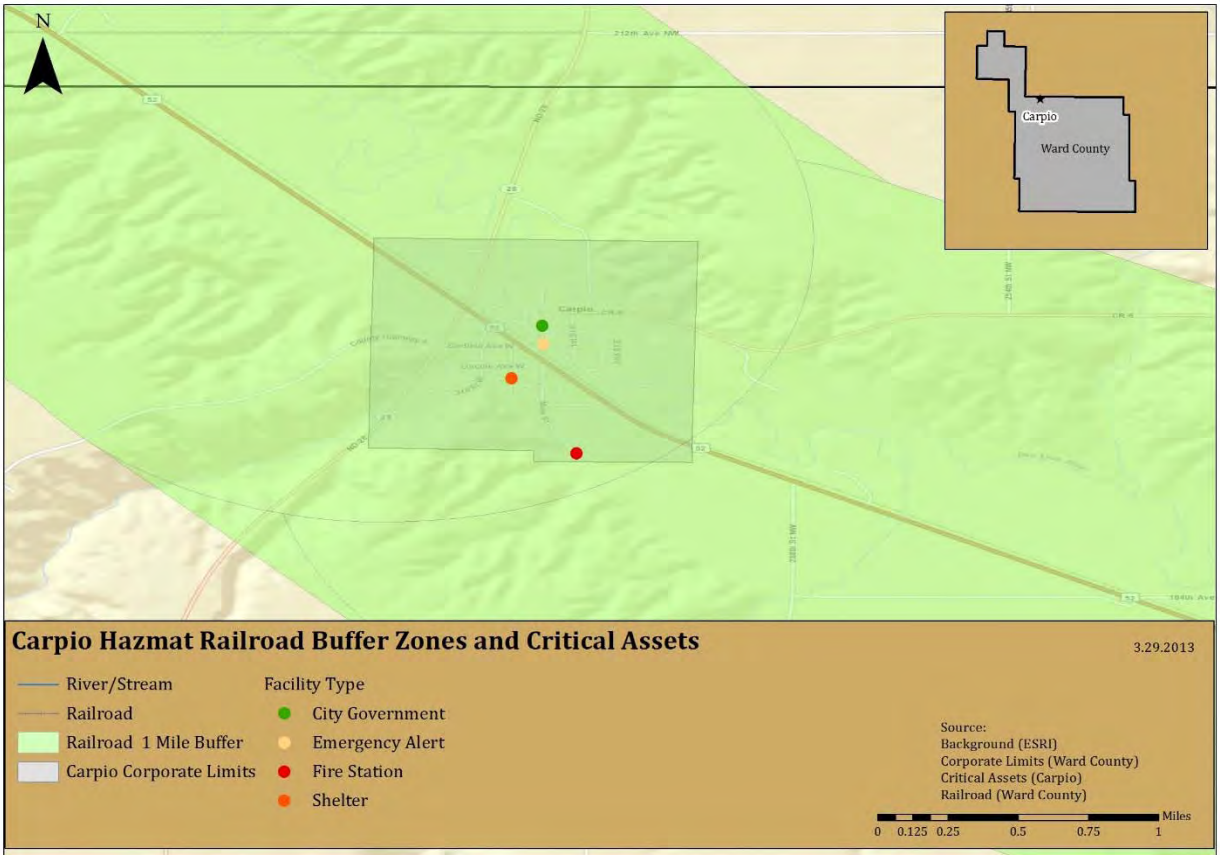
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Hazardous Materials Incident	Low	Low	Low

Estimate of Potential Losses – Quantitative

For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Carpio – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

Carpio's hazardous materials risk comes from the railroad, and from the materials that are moved along the railroad. Figure 6.3.2.7-1 (following) illustrates the location of the railroad in relation to the city of Carpio, and provides a one mile buffer zone around the railroad. For the purposes of this assessment, all assets within this buffer would be impacted to some degree.

Figure 6.3.2.7-1
Hazardous Materials Incident Scenario – Railroad



As is evident from the above image, the entire city could be impacted by an incident hazardous materials and the railroad, as could all critical assets within the city.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

6.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Carpio's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the city has some familiarity with hazard mitigation programs, and hazard mitigation does play a role in the decision-making process for the city.
- **Current/ongoing mitigation efforts** – currently, the city's mitigation efforts include participating in the development of the Ward County Hazard Mitigation Plan Update.
- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city.
- **Planning** –the city does not have a great deal of formalized planning efforts. There is no recovery plan, no evacuation plan, no COOP/COG, and no master or comprehensive plan. The city is a member of the NFIP.
- **Staff, personnel, and technical capability** – as of this Plan update, the city has a limited capability and capacity regarding hazard mitigation, and is not particularly confident in their abilities to administer hazard mitigation projects and programs. Additional experience and resources would be beneficial to building this capacity.

Like other municipalities within Ward County, Carpio depends on the framework established by the county and state government for technical assistance, and on the state and federal government for funding.

Conclusions and Recommendations
Carpio should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county towards this end.

6.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization* ***shall*** *include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there* ***must*** *be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

6.5.1 Mitigation Goals

Table 6.5.1-1 (below) provides the mitigation goals that guide the city of Carpio's mitigation strategy.

Table 6.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

6.5.2 Mitigation Actions

Potential Mitigation Actions

Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions
Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions
Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards

associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (6.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (6.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal,

Economic, and Environmental factors. This method helped the city of Carpio to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 6.5.2-2. Table 6.5.2-1 (below) describes the basic criteria considered as part of the prioritization process.

Table 6.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness

Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (6.5.2-2) provides the identified and prioritized mitigation strategy for the city of Carpio.

Table 6.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Continue to enforce floodplain management ordinance and practices	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Moderate	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Moderate	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Council	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; Ward County EMA	$500+	Low	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 03; Protect public health and safety before, during, and after hazard events.	Purchase and install emergency power generators at critical assets.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	Existing	City Council	NDDES & FEMA mitigation grant funding; general funds; in-kind contributions; Ward County EMA	$35,000+	High	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recent annexations and/or recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council	General funds; in-kind contributions; Ward County EMA	$500+	Low	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council	General fund; in-kind contributions; Ward County EMA	$500+	Low	
Goal 05: Provide long-term mitigation solutions to areas/structures that experience repetitive hazard damage or loss.	Develop and construct flood protection measure(s) for protection of repetitively flooded areas and properties.	Flood	New	Existing	City Council	NDDES & FEMA mitigation grant funding; general funds; State Water Commission; in-kind contributions; Ward County EMA	$10,000+	High	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 05: Provide long-term mitigation solutions to areas/structures that experience repetitive hazard damage or loss.	Acquire and relocate or demolish repetitively flooded properties.	Flood	New	Existing	City Council	NDDES & FEMA mitigation grant funding; general funds; State Water Commission; in-kind contributions; Ward County EMA	$75,000+	High	

Section 07
City of Des Lacs: HIRA, Capability Assessment, and Mitigation Strategy

7.1 IFR for Hazard Identification and Risk Assessment
7.2 Hazard Identification (Updated)
7.2.1 Overview of Des Lacs's History of Hazards and Potential Hazards
7.2.2 Hazard Profiles
7.3 Risk Assessment (Updated)
7.3.1 Risk Assessment Methodology
7.3.2 Risk and Vulnerability Assessment
7.4 Capability Assessment (Updated)
7.5 Mitigation Strategy (Updated)
7.5.1 Mitigation Goals
7.5.2 Mitigation Actions

7.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..*

Requirement §201.6(c)(2)(ii)(C): *[The plan* ***should*** *describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment* ***must*** *assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Des Lacs.

7.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Des Lacs. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

7.2.1 Overview of Des Lacs's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 07 weather-related hazard events have occurred in the city of Des Lacs since 2002, including the following number and types of hazard events:

- Hail – 4
- Thunderstorm – 1

- Tornado/Funnel Cloud – 1
- Heavy Rain - 1

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 7.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 7.2.1-1
Presidential Disaster Declarations – City of Des Lacs

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Des Lacs

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 7.2.1-2 (below).

Table 7.2.1-2
Preliminary Hazard Identification and Determinations – City of Des Lacs

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Des Lacs	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Des Lacs	Reason for Exclusion and other notes
Volcano	✓			✓		Low probability with sufficient advance warning
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Des Lacs	Reason for Exclusion and other notes
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to

life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

7.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

7.2.2.1 Communicable Disease

Description of the Hazard
Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard
This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard
The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk. Table 7.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 7.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Des Lacs.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table following (Table 7.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 7.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 7.2.2.1-3 (below) provides the details of pertussis outbreaks since 2007.

Table 7.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 7.2.2.1-4 (following) provides occurrence information for rabies.

Table 7.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Des Lacs did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Des Lacs, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Des Lacs, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been no occurrences of communicable disease within the city of Des Lacs. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

7.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Des Lacs are subject to the drought hazard.

Extent and Severity of the Hazard

Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.
- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

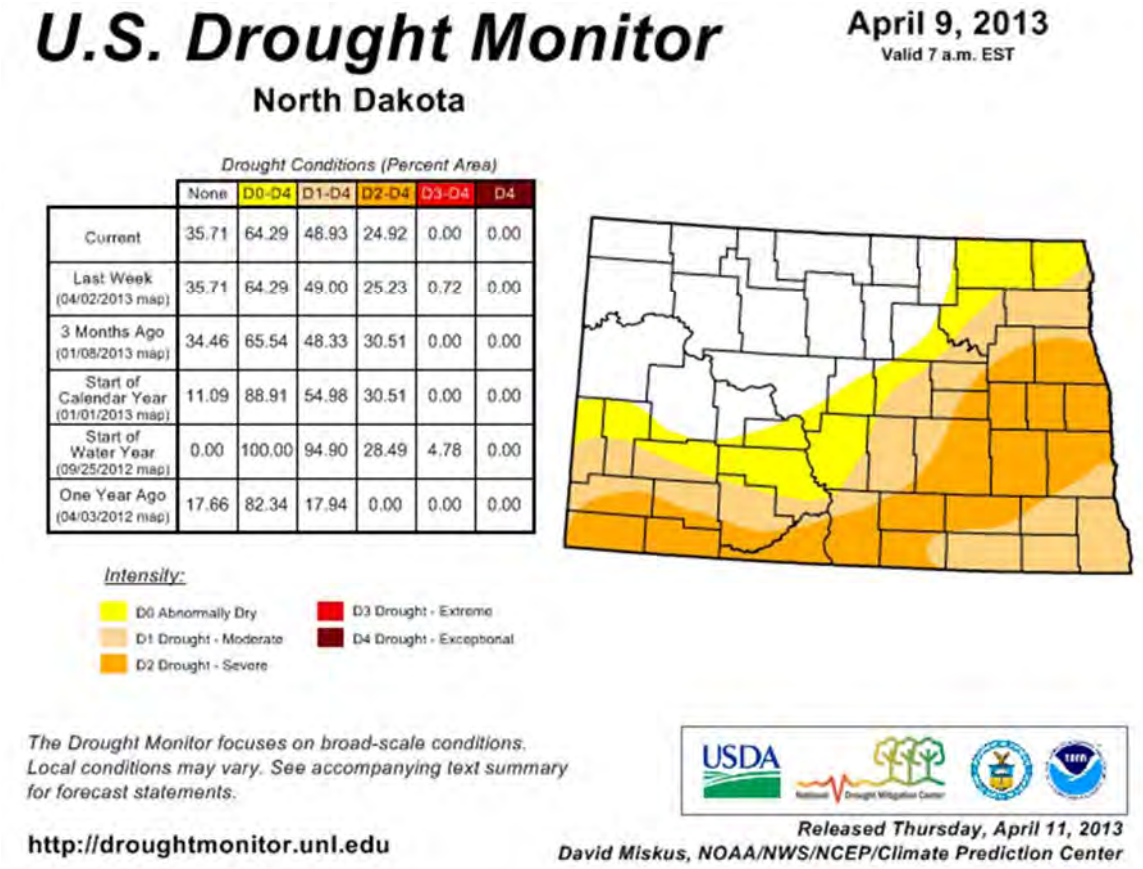
Table 7.2.2.2-1 (following) provides the PDSI classifications.

Table 7.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Des Lacs are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 7.2.2.2-1 (following).

Figure 7.2.2.2-1
US Drought Monitor – North Dakota
(source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 7.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Des Lacs – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

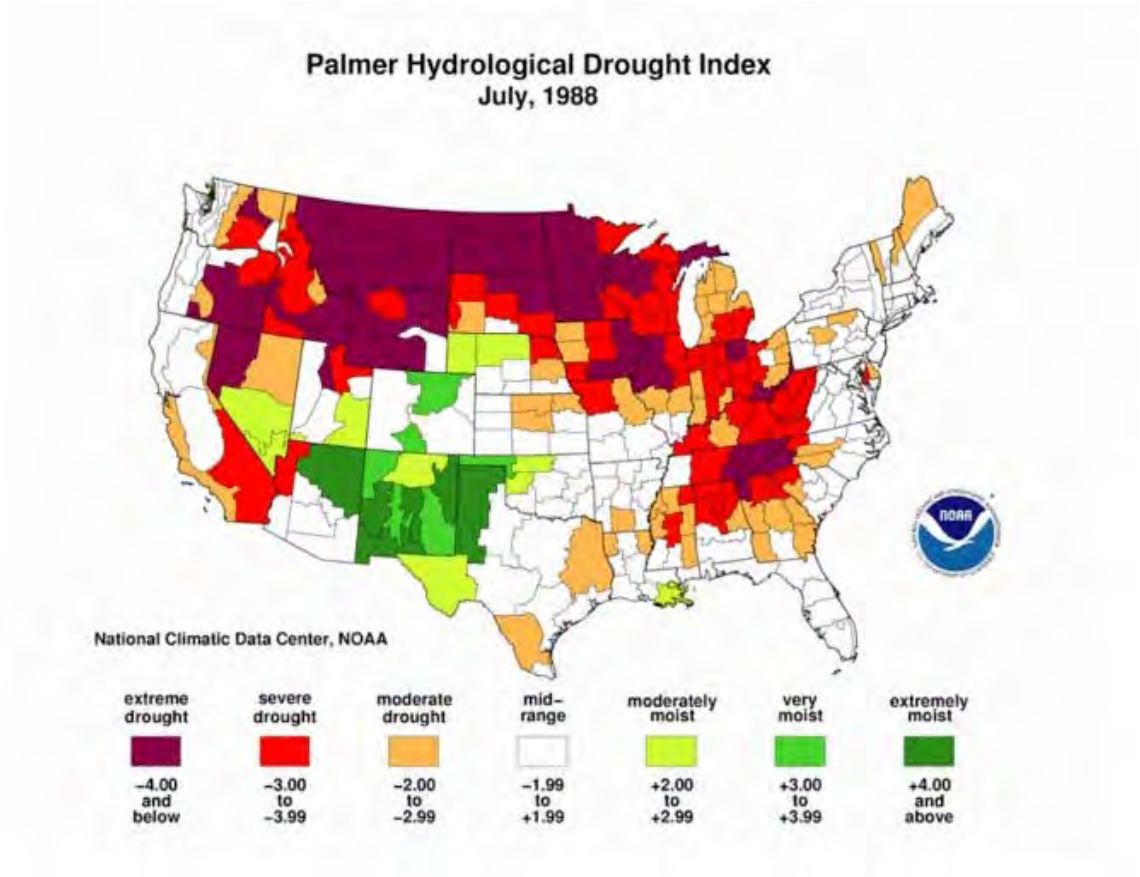
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Des Lacs. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 7.2.2.2-2 (following), the entire state – including the city of Des Lacs – was categorized as being in extreme drought during this time.

Figure 7.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Des Lacs) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years in more recent history.

7.2.2.3 Fire
This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

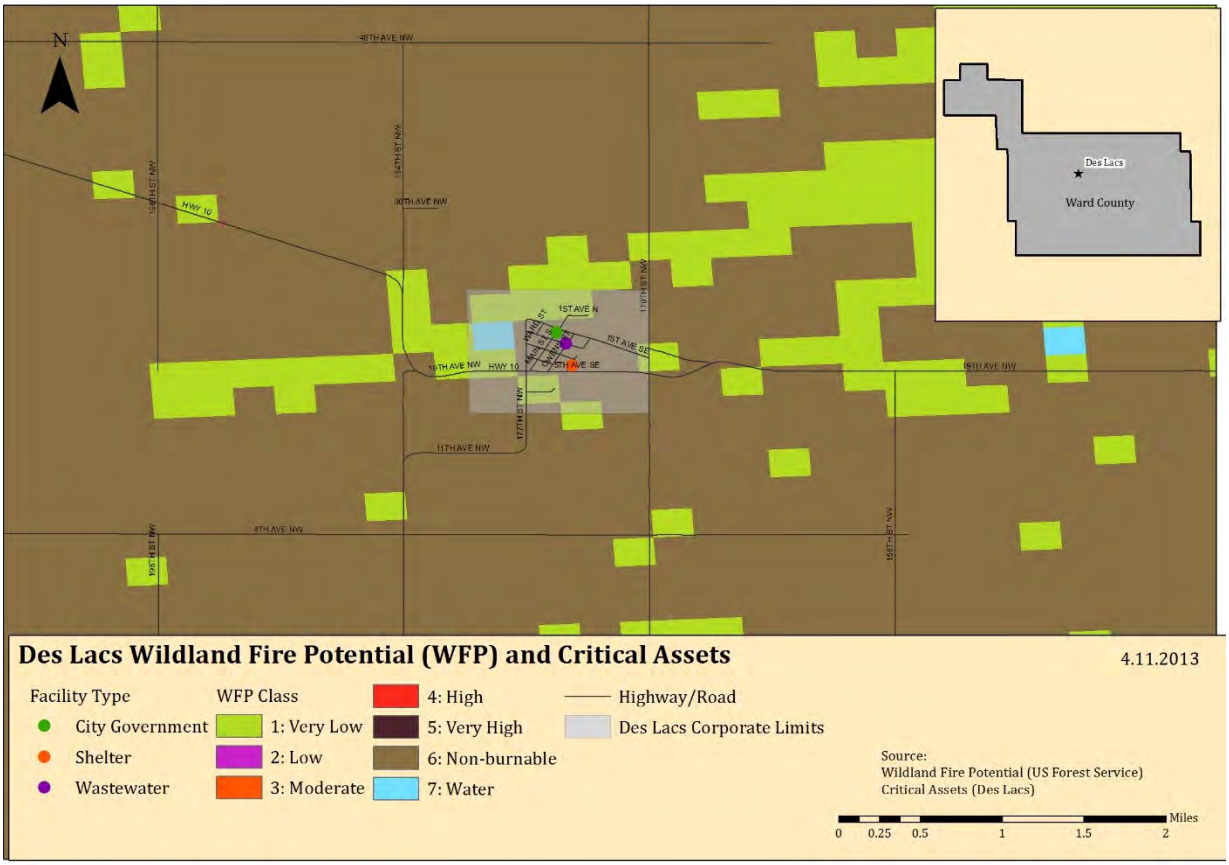
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 7.2.2.3-1 (following) illustrates the wildland fire potential for the city of Des Lacs, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 7.2.2.3-1
City of Des Lacs – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard

The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 7.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System

Table 7.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the

destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people. In addition, some structures (such as grain elevators) require specialized teams and equipment, and so response to these events may be delayed.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Based on data obtained from the city of Des Lacs, an average of 22 fires occurs in the city annually. Des Lacs does not record more specific information, so it is not possible to state how many of these fires are structure fires, and how many are wildland fires.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in the city of Des Lacs an average of 22 times a year. Using the scale provided earlier in this section, this equates to a high probability of a future occurrence.

7.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.*

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard
There are no identified or mapped floodplains within the city of Des Lacs.

Extent and Severity of the Hazard
In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 7.2.2.4-1 (below).

Table 7.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.

Zone Designation	Percent Annual Chance of Flood	Description
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 7.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 7.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

Term	Definition
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

Despite having no mapped SFHA, the city of Des Lacs is currently a member of the NFIP, and its membership is in good standing. There are no designated Repetitive Loss or Severe Repetitive Loss properties within the city of Des Lacs.

Potential Impact of the Hazard
Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A major flood occurred in the Souris River Basin in 1969, which greatly impacted the region (though not specifically the city of Des Lacs). More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley.

The city of Des Lacs reported no occurrences of flooding within the city.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs at less than once every five years in the city of Des Lacs. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is low.

7.2.2.5 Severe Summer Storms
This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

Extreme Heat
Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail
Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning
Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of

the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms
Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard
Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Des Lacs.

Extent and Severity of the Hazard
Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat
The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.
- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.

- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 7.2.2.5-1(below). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 7.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution Extreme Caution Danger Extreme Danger

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail
The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 7.2.2.5-1 (following) provides details of these scales.

Table 7.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33"	Pea	No damage
H1	Potentially Damaging	0.33" – 0.60"	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60" – 0.80"	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80" – 1.20"	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20" – 1.60"	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60" – 2.0"	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0" – 2.4"	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4" – 3.0"	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0" – 3.5"	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5" – 4.0"	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning
The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to

explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- **Ground-to-Cloud Lightning.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning**. Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning.** Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 7.2.2.5-2 (following) provides this severity scale.

Table 7.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to

describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 7.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 7.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Table 7.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 7.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Given that Des Lacs is smaller than 15 miles in diameter, it is possible for the entire jurisdiction to be impacted by the same thunderstorm at any given time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from

thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Des Lacs are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards.

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at

the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 7.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 7.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties

- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact

on life due to thunderstorm and associated hazards in Des Lacs would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard
Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least 9 occurrences of the summer storm hazard since 2002. (Note: Records prior to 2002 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 7.2.2.5-6 (below) provides details of these recorded incidents.

Table 7.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Description	Magnitude (if applicable)
July 09, 2002	Tornado/Funnel Cloud	Unknown
July 18, 2003	Hail	1.75”
July 31, 2007	Hail (2 occurrences)	1.75” and 1”
August 11, 2010	Thunderstorm Wind	65 MPH
May 10, 2011	Hail (2 occurrences)	1” (both occurrences)
June 25, 2011	Heavy Rain (2 occurrences)	NA

Probability of a Future Occurrence of the Hazard
In the 10 year period for which records are available, the summer storm hazard has occurred at least nine times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is moderate, as the summer storm hazard occurs at least once every five years.

7.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard
Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow

The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold

What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice

The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain

situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Des Lacs.

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

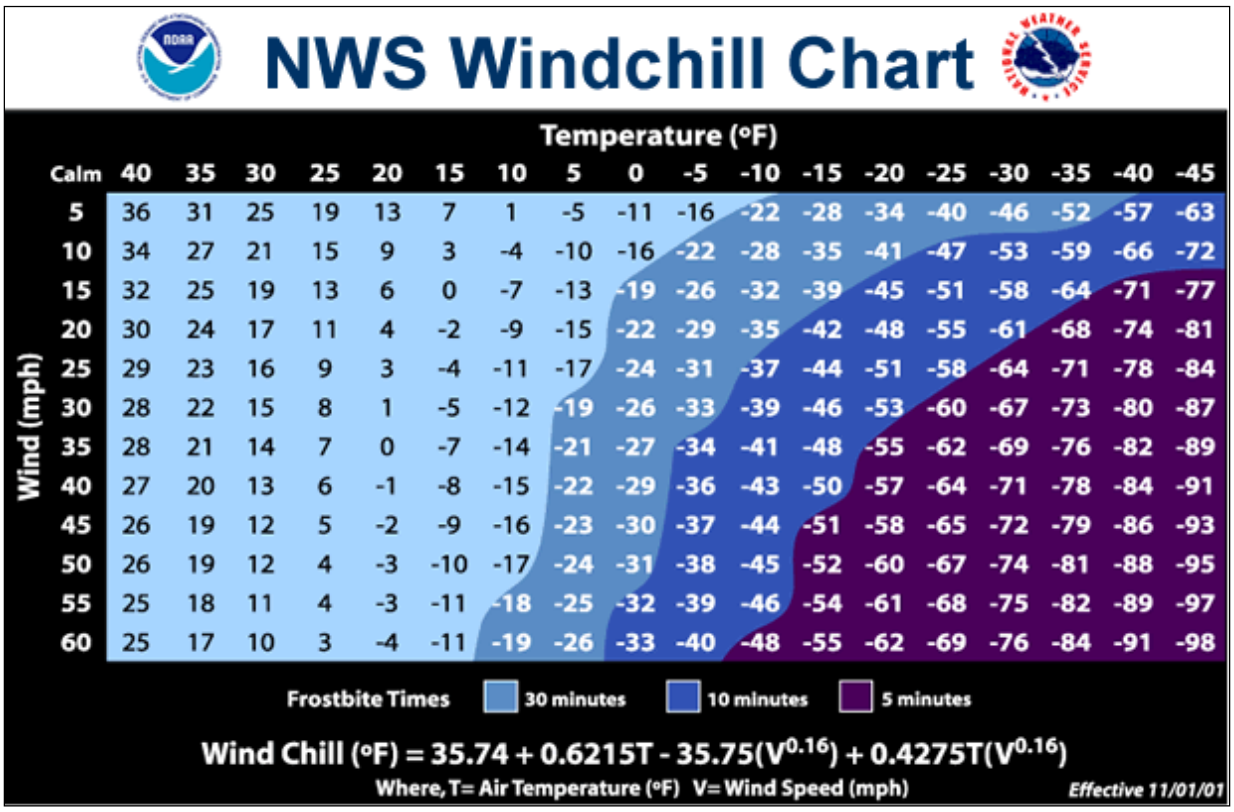
Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold
Winter temperatures in Des Lacs typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 7.2.2.6-1 depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 7.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)



NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

- **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.
- **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard
Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard
According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes,

accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.

- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.
- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard

Based on the data available, winter storms occur in or otherwise impact the city of Des Lacs at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

7.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard

Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard

The locations in Des Lacs most at risk from a hazardous materials incident are those that are in proximity to either locations that store/use hazardous materials or that are adjacent to transportation or transmission lines. The following figures (7.2.2.7-1 and 7.2.2.7-2) illustrate these locations in Des Lacs.

Figure 7.2.2.7-1
Hazardous Materials Locations – Railroads

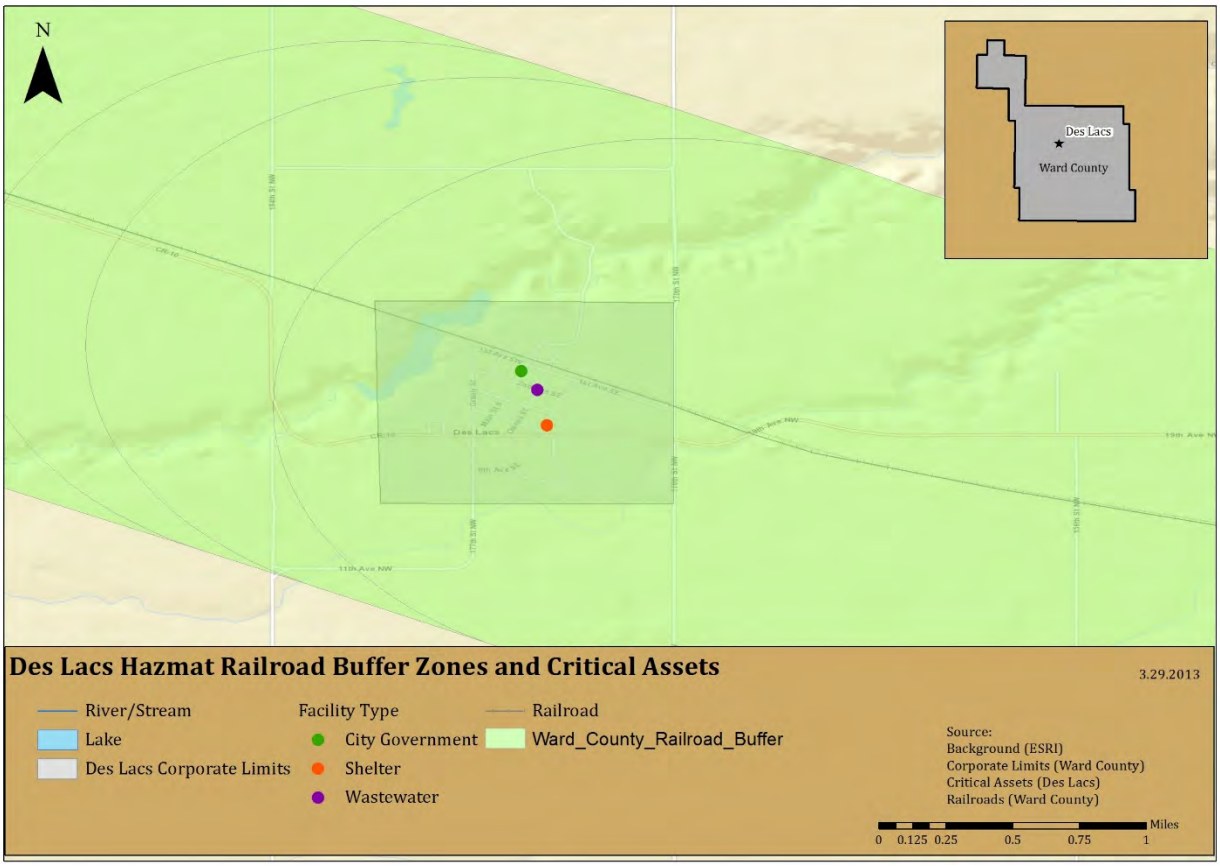
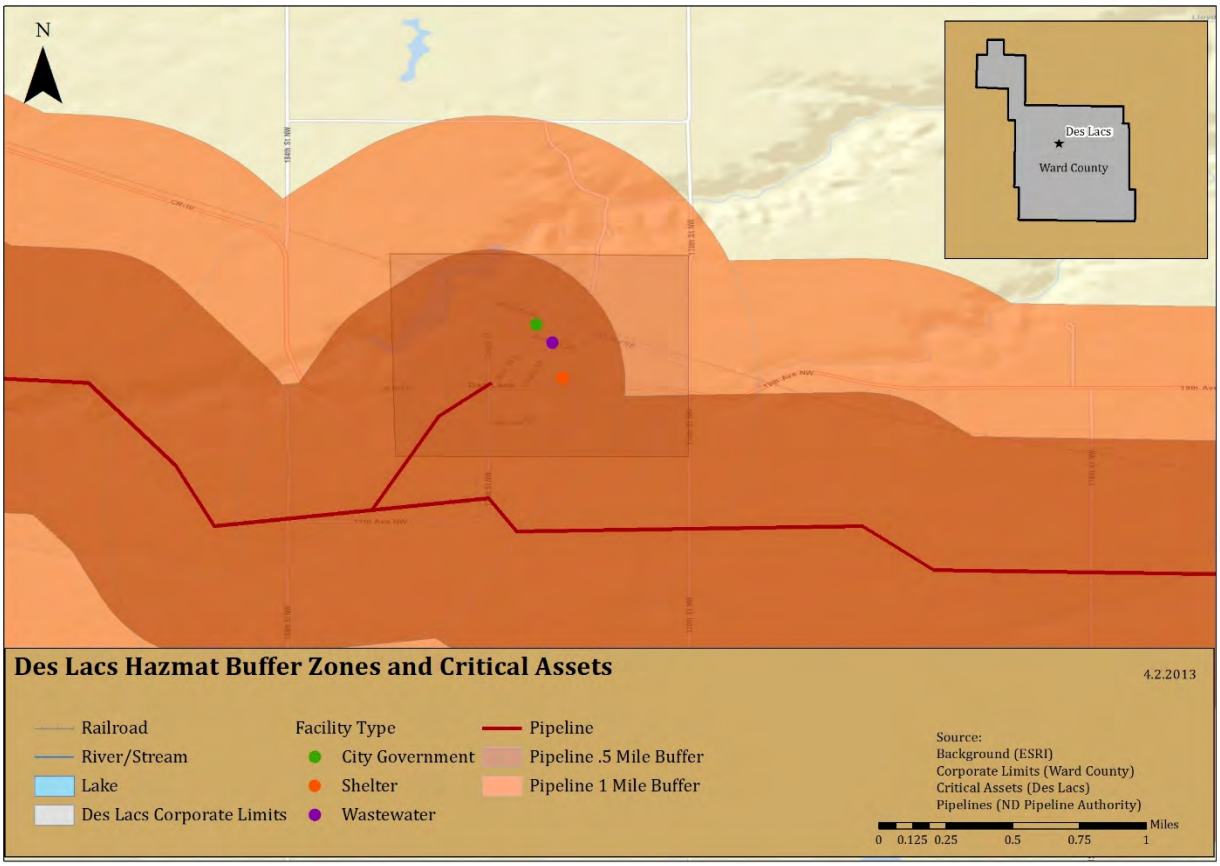


Figure 7.2.2.7-2
Hazardous Materials Locations – Pipelines



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, no Tier II reports from the city of Des Lacs have been submitted to the EPA since 1987, the year that the EPA began keeping such reports.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in Ward County, though not necessarily in the city of Des Lacs. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

7.3 Risk Assessment (Updated)

The following table (Table 7.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Des Lacs.

Table 7.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

7.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Des Lacs from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

Impact Scale Methodology
The potential impacts of each hazard were discussed by the Steering Committee. For the purposes of this discussion, a qualitative impact scale was developed, and was used by the Steering Committee in their discussions. As a result of these discussions, each hazard was assigned a qualitative impact ranking. This scale appears in Table 7.3.1-1 (below).

Table 7.3.1-1
Hazard Impact Scale

Term	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Low	Some minor injuries possible, but no fatalities	Cosmetic damages expected to assets; Infrastructure loss of function for less than 24 hours expected	System delivery delayed or temporarily interrupted; Interruptions in service delivery of less than 24 hours expected
Moderate	Injuries expected; Fatalities possible	Some structural damages to light construction (<50 % damage); Infrastructure loss of function for 24-72 hours expected	System delivery failures expected; Interruptions in service delivery of 24-72 hours expected
High	Serious and numerous injuries expected; Fatalities expected	Some structures irreparably damaged (>50% damage); Infrastructure loss of function for 72+ hours expected	Long-term system failures/damages expected; Cancellation of services (72+ hours) expected
Not Applicable	Hazard does not have the potential to impact people or life safety	Hazard does not have the potential to impact assets or infrastructure	Hazard does not have the potential to impact service delivery

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Des Lacs to the identified and profiled hazards.

Critical Assets
The table below (Table 7.3.1-1) provides details of the critical assets contained within the city of Des Lacs.

Table 7.3.1-1
Critical Assets – City of Des Lacs

Asset Name	Asset Use /Function	Street Number	Street Name	Insured or Estimated Value
Des Lacs Fire Station	Emergency Services	100	South Main Street	$175,469
Des Lacs School	Shelter	317	Roosevelt	$16,115
Des Lacs City Hall	Government	100	South Main Street	$175,469
Sanitary Lift Station	Utility	200	North Owens Street	$63,206
Siren	Emergency Alert	100	South Main Street	$48,995
Total estimated value of identified critical assets:				**$479,254**

Note on asset values: Valuation data for assets within the city was unavailable at the time this plan update was developed. All valuations used in the following estimates of potential losses are derived from an average of available data for the same or similar types of assets from other jurisdictions. The assessment that follows is an estimate only, and may not correlate with actual occurrences of the damage caused by the hazards described.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

7.3.2 Risk and Vulnerability Assessment

7.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 204 people residing in Des Lacs; the 2012 Census Estimate places the population at 206, making it relatively stable, and indicating no significant change in

vulnerability. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 7.3.1-1 (previous).

The representatives from the city of Des Lacs determined that communicable disease has the potential to cause the impacts described in Table 7.3.2.1-1 (below).

Table 7.3.2.1-1
Qualitative Hazard Impacts – Communicable Disease

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Communicable Disease	Low	Low	Low

Estimate of Potential Losses – Quantitative
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Des Lacs represents ~1% of the total population of Ward County, or 204 people. While an outbreak of communicable disease in Des Lacs is unlikely to have significant impacts outside of Des Lacs, an outbreak could have significant impacts within the city.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness rate in Des Lacs that is similar to the illness rate across the county, the following numbers of people in Des Lacs could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Des Lacs accounts for ~1% of the county population. This equates to 45 cases of influenza in Des Lacs, on average, that could potentially impact the city.

- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Des Lacs accounts for ~1% of the county population. This equates to 65 cases of pertussis in Des Lacs, on average, that could potentially impact the city.

Identified Data Limitations
There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;
- Data regarding projected population changes; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

7.3.2.2 Drought

Vulnerability to the Hazard
Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies depend largely on agriculture, such as the State of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result in significant societal disruption, which can worsen as the resource becomes more and more precious.

Des Lacs is not economically dependent on agriculture or livestock, which results in lesser vulnerability to the drought hazard. Des Lacs has not experienced any significant changes in development or population since the 2008 plan, and does not anticipate experiencing significant changes in the foreseeable future. This relative stability, both in population and in development, translates to relative stability in risk vulnerability as well.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss

to their particular jurisdiction. The explanation for these rankings appears in Table 7.3.1-1 (previous).

The representatives from the city of Des Lacs determined that drought has the potential to cause the impacts described in Table 7.3.2.2-1 (below).

Table 7.3.2.2-1
Qualitative Hazard Impacts – Drought

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Drought	Low	Moderate	Low

Estimate of Potential Losses – Quantitative
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no quantitative risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no quantitative risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;
- Data regarding projected/expected changes in development;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

7.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

Des Lacs has experienced relative stability in terms of population and development, and no significant changes to either are anticipated for the foreseeable future. This means that the municipality's vulnerability to the fire hazard has remained relatively unchanged since the 2008 plan, and is expected to remain unchanged in the near future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 7.3.1-1 (previous).

The representatives from the city of Des Lacs determined that fire has the potential to cause the impacts described in Table 7.3.2.3-1 (below).

Table 7.3.2.3-1
Qualitative Hazard Impacts – Fire

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Fire	High	High	High

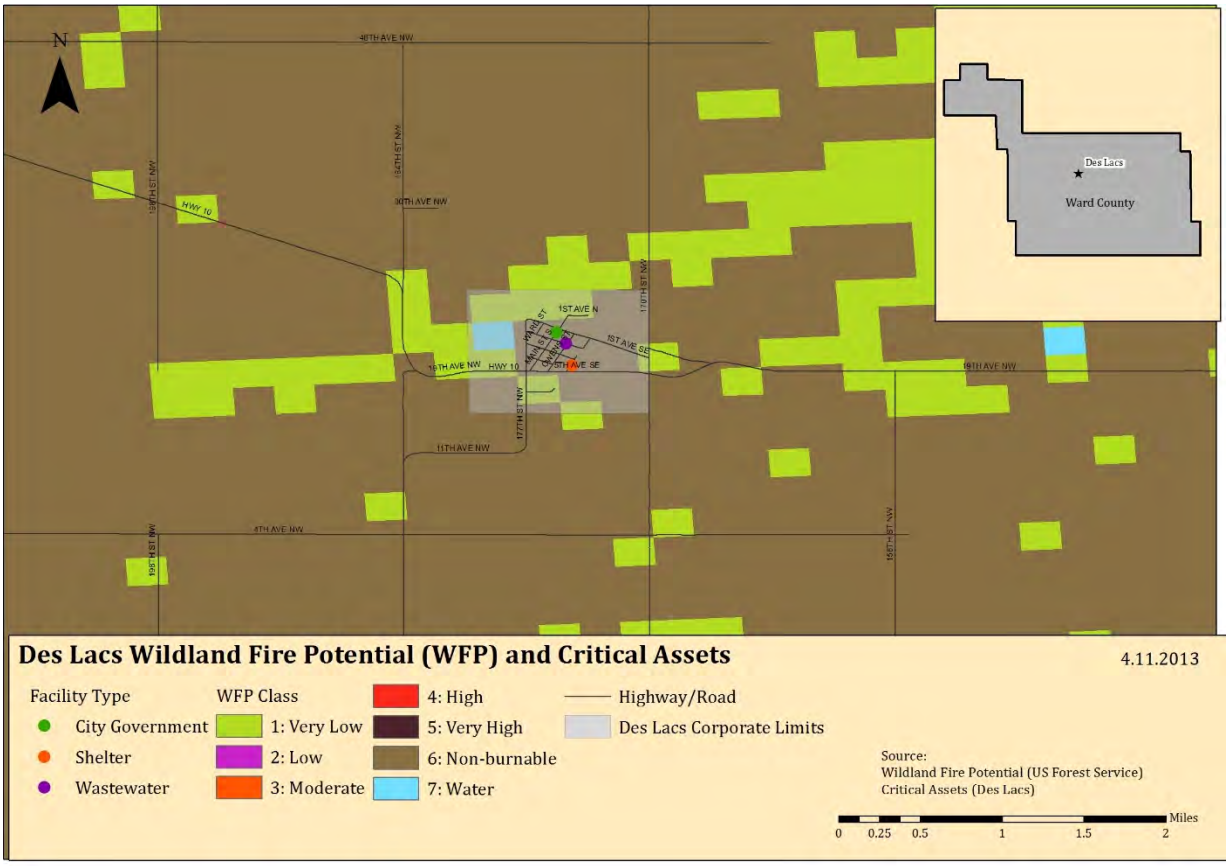
Estimate of Potential Losses – Quantitative
All structures within the city of Des Lacs are at risk from fire. According to the 2010 Census, there are 87 housing units in the city; all of these units are occupied. The majority of these structures are heated by natural gas, with the rest heated by electricity. The median value of single family housing in Des Lacs is $82,300, according to the Census. This equates to potential residential losses of $7,160,100.

In addition, all identified critical assets (identified in Table 7.3.1-1) within the city have the potential to be lost to fire. These assets have a combined estimated value of $479,254.

Using the US Forest Service's Wildland Fire Potential data, the city of Des Lacs and its critical assets were mapped. Based on this data set, the city of Des Lacs has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 7.3.2.3-1 (below) illustrates this fire potential in relation to the identified critical assets for the city.

Figure 7.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations

Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

7.3.2.4 Flood

Vulnerability to the Hazard
Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

Flood damages also take considerable time to recover from. The 2011 flooding that occurred throughout the county had far-reaching impacts, and recovery for many areas remains a work in progress as of this Plan update.

With its stable population and development and no mapped flood hazard areas, Des Lacs retains its low vulnerability to the flood hazard. As there are no projected significant changes to either the population or the development within Des Lacs, it is unlikely that this vulnerability will increase in the near future.

Despite having no mapped SHFAs, the city of Des Lacs is a member of the NFIP, and is in good standing with the program. As of February 2013, there were no NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the city of Des Lacs.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 7.3.1-1 (previous).

The representatives from the city of Des Lacs determined that flooding has the potential to cause the impacts described in Table 7.3.2.4-1 (below).

Table 7.3.2.4-1
Qualitative Hazard Impacts – Flood

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Flood	Low	Low	Low

Estimate of Potential Losses – Quantitative
It was the determination of the Steering Committee that quantitative risk assessments related to flooding should be performed for those areas within Ward County that contained a mapped or identified flood hazard area, and that all other areas should receive a qualitative assessment only.

In light of this determination, no quantitative risk assessment has been performed for this hazard for the city of Des Lacs.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed qualitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

7.3.2.5 Severe Summer Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

The relative stability of development and population since the 2008 plan translates to relative stability in the city's vulnerability to the severe storm hazard. The municipality's shelter capacity was not identified as a concern or an issue during the development of this plan update, and is unlikely to be so in the future, given the lack of projected development.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 7.3.1-1 (previous).

The representatives from the city of Des Lacs determined that severe summer storms have the potential to cause the impacts described in Table 7.3.2.5-1 (below).

Table 7.3.2.5-1
Qualitative Hazard Impacts – Severe Summer Storm

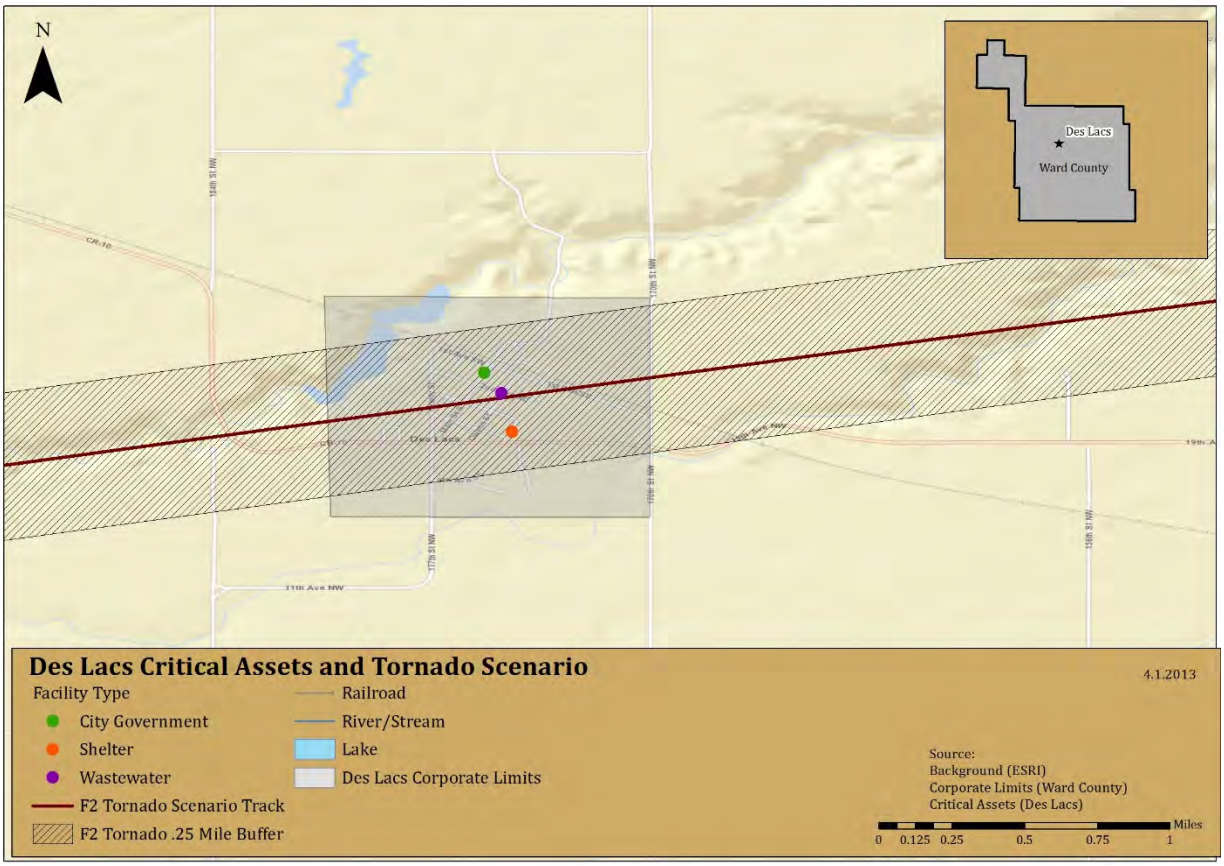
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Summer Storm	High	High	Moderate

Estimate of Potential Losses – Quantitative
Severe summer storms are a non-spatial hazard that can and do affect the entire city of Des Lacs. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Des Lacs are at risk from severe summer storms. According to the 2010 Census, there are 87 housing units in the city. The median value of these structures is $82,300, according to the Census. This equates to residential assets of approximately $7,160,100. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $716,010.

In addition, all identified critical assets (identified in Table 7.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of $479,254. For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Des Lacs. Figure 7.3.2.5-1 (following) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 7.3.2.5-1
Tornado Scenario – City of Des Lacs



As seen in the above figure, in such a scenario the majority of the city of Des Lacs would be damaged, including critical assets (government and emergency services). This scenario would result in significant damages to the city's infrastructure, and would greatly impact its ability to provide basic services, such as emergency response.

Finally, the 204 residents of Des Lacs are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 9.3% (children under 5) and 9.8% (those over 70) of the population of Des Lacs. Combined, these two groups account for more than 19% of the population, a total of 39 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limit;

- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

7.3.2.6 Severe Winter Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents.

In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

The relative stability of development and population since the 2008 plan translates to relative stability in the city's vulnerability to the winter storm hazard; this stability extends to the city's utility infrastructure, which has not increased or decreased since the 2008 plan. The municipality's shelter capacity was not identified as a concern or an issue during the development of this plan update, and is unlikely to be so in the future, given the lack of projected development.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 7.3.1-1 (previous).

The representatives from the city of Des Lacs determined that severe winter storms have the potential to cause the impacts described in Table 7.3.2.6-1 (following).

Table 7.3.2.6-1
Qualitative Hazard Impacts – Severe Winter Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Winter Storm	High	High	High

Estimate of Potential Losses – Quantitative
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Des Lacs. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Des Lacs are at risk from severe winter storms. According to the 2010 Census, there are 87 housing units in the city. The median value of these structures is $82,300, according to the Census. This equates to residential assets of approximately $7,160,100. If 1% of these residential assets were damaged by a severe winter storm, this would result in losses of $71,601.

In addition, all identified critical assets (identified in Table 7.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of $479,254. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $47,925.

Finally, the 204 residents of Des Lacs are all at risk from the severe winter storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 9.3% (children under 5) and 9.8% (those over 70) of the population of Des Lacs. Combined, these two groups account for more than 19% of the population, a total of 39 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

7.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

The roadways surrounding Des Lacs have experienced increases in traffic in recent years, due in large part to the increase in energy activities throughout the state. This increase in traffic, while not directly impacting the city, does increase the city's vulnerability, as an incident on the roadways could impact the city and its residents. Any future development in Des Lacs should take this increased vulnerability into account, and plan accordingly.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 7.3.1-1 (previous).

The representatives from the city of Des Lacs determined that hazardous materials incidents have the potential to cause the impacts described in Table 7.3.2.7-1 (below).

Table 7.3.2.7-1
Qualitative Hazard Impacts – Hazardous Materials Incident

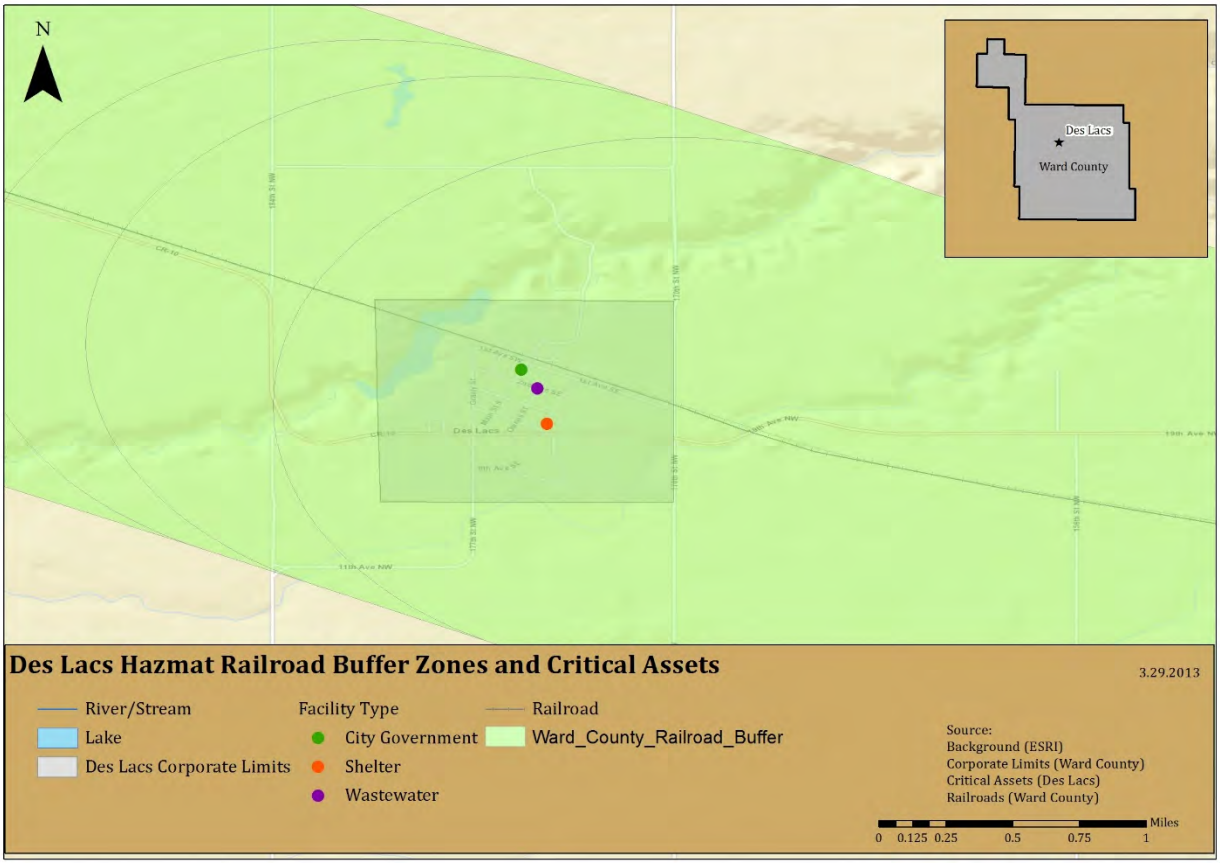
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Hazardous Materials Incident	High	High	High

Estimate of Potential Losses – Quantitative

For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Lacs – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

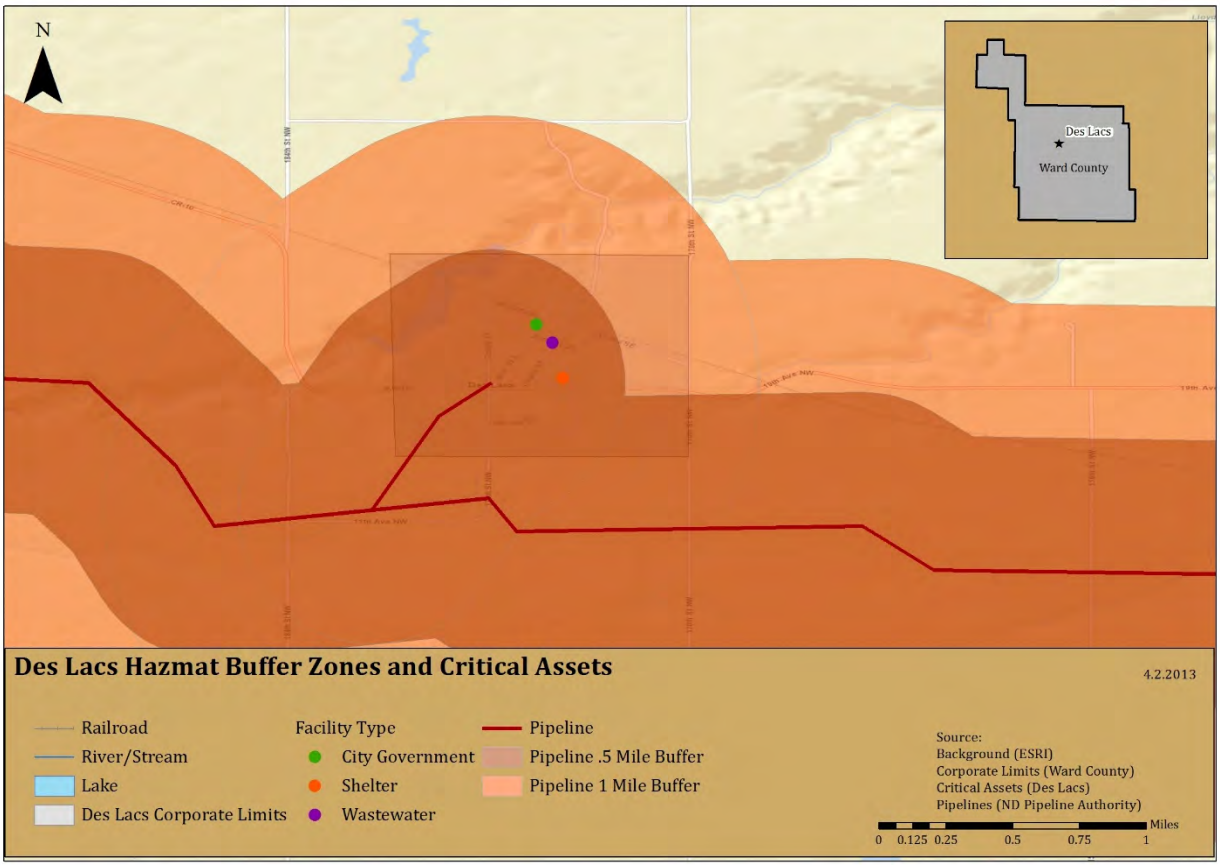
Des Lacs's hazardous materials risk comes from the railroad, and from the materials that are moved through pipelines. Figures 7.3.2.7-1 and 7.3.2.7-2 (following) illustrate the location of the railroad and pipelines in relation to the city of Des Lacs, and provides designated buffer zones around each. For the purposes of this assessment, all assets within these buffers would be impacted to some degree.

Figure 7.3.2.7-1
Hazardous Materials Incident Scenario – Railroad



As is evident from the above image, the entire city could be impacted by an incident hazardous materials and the railroad, as could all critical assets within the city.

Figure 7.3.2.7-2
Hazardous Materials Incident Scenario – Pipeline



Note that the pipeline is to the south of the city, yet is close enough in proximity that it could seriously impact the city and all assets within it.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

7.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Des Lacs's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the city has limited familiarity with hazard mitigation programs, and hazard mitigation does play some role in the decision-making process for the city.
- **Current/ongoing mitigation efforts** – currently, the city's mitigation efforts include participating in the development of the Ward County Hazard Mitigation Plan Update.
- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city.
- **Planning** –the city does not have a great deal of formalized planning efforts. There is no recovery plan, no evacuation plan, and no COOP/COG. There is no master plan, but the city does have ordinances in place, for floodplain and stormwater management. The city is a member of the NFIP.

- **Staff, personnel, and technical capability** – as of this Plan update, the city has a limited capability and capacity regarding hazard mitigation, and is not particularly confident in their abilities to administer hazard mitigation projects and programs. Additional experience and resources would be beneficial to building this capacity.

Like other municipalities within Ward County, Des Lacs depends on the framework established by the county and state government for technical assistance, and on the state and federal government for funding.

Conclusions and Recommendations
Des Lacs should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county towards this end.

7.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there **must** be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

7.5.1 Mitigation Goals

Table 7.5.1-1 (following) provides the mitigation goals that guide the city of Des Lacs's mitigation strategy.

Table 7.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

7.5.2 Mitigation Actions

Potential Mitigation Actions
Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions
Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of

special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions

Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (7.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (7.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped the city of Des Lacs to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 7.5.2-2. Table 7.5.2-1 (below) describes the basic criteria considered as part of the prioritization process.

Table 7.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.

STAPLEE	Criteria Explanation
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness

Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (7.5.2-2) provides the identified and prioritized mitigation strategy for the city of Des Lacs.

Table 7.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 01: Reduce the effects of hazards throughout the planning area.	Continue to enforce floodplain management ordinance and practices	Flood	New	New and existing	City Council; Utilities; Maintenance	General funds; Ward County EMA	$500+	Moderate	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Low	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Council; Fire Department	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; Ward County EMA	$500+	Low	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Develop SOP to ensure post-disaster continuity of operations and to secure public safety.	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council; Utilities	NDDES & FEMA grant funding; general funds; Ward County EMA	$5,000+	Low	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recent annexations and/or recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council; Utilities; Maintenance; Fire Department	NDDES & FEMA grant funding; general funds; Ward County EMA	$500+	Low	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 05: Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Develop and construct flood protection measure(s) for protection of repetitively flooded areas and properties.	Flood	New	Existing	City Council; Utilities; Maintenance	NDDES & FEMA mitigation grant funding; general funds; State Water Commission; Ward County EMA	$5,000+	High	
Goal 05: Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council; Utilities; Maintenance; Fire Department	NDDES & FEMA grant funding; general funds; Ward County EMA	$500+	Low	

Section 08
City of Donnybrook: HIRA, Capability Assessment, and Mitigation Strategy

8.1 IFR for Hazard Identification and Risk Assessment
8.2 Hazard Identification (Updated)
8.2.1 Overview of Donnybrook's History of Hazards and Potential Hazards
8.2.2 Hazard Profiles
8.3 Risk Assessment (Updated)
8.3.1 Risk Assessment Methodology
8.3.2 Risk and Vulnerability Assessment
8.4 Capability Assessment (Updated)
8.5 Mitigation Strategy (Updated)
8.5.1 Mitigation Goals
8.5.2 Mitigation Actions

8.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..*

Requirement §201.6(c)(2)(ii)(C): *[The plan* ***should*** *describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment* ***must*** *assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Donnybrook.

8.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Donnybrook. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

8.2.1 Overview of Donnybrook's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 06 weather-related hazard events have occurred in the city of Donnybrook since 1994, including the following number and types of hazard events:

- Hail – 3
- Tornado/Funnel Cloud - 3

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 8.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 8.2.1-1
Presidential Disaster Declarations – City of Donnybrook

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Donnybrook

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 8.2.1-2 (below).

Table 8.2.1-2
Preliminary Hazard Identification and Determinations – City of Donnybrook

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Donnybrook	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Donnybrook	Reason for Exclusion and other notes
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Donnybrook	Reason for Exclusion and other notes
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

8.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

8.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk. Table 8.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 8.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance

and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Donnybrook.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 8.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 8.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 8.2.2.1-3 (following) provides the details of pertussis outbreaks since 2007.

Table 8.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 8.2.2.1-4 (below) provides occurrence information for rabies.

Table 8.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Donnybrook did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Donnybrook, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Donnybrook, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been no occurrences of communicable disease within the city of Donnybrook. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

8.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Donnybrook are subject to the drought hazard.

Extent and Severity of the Hazard
Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.

- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

Table 8.2.2.2-1 (below) provides the PDSI classifications.

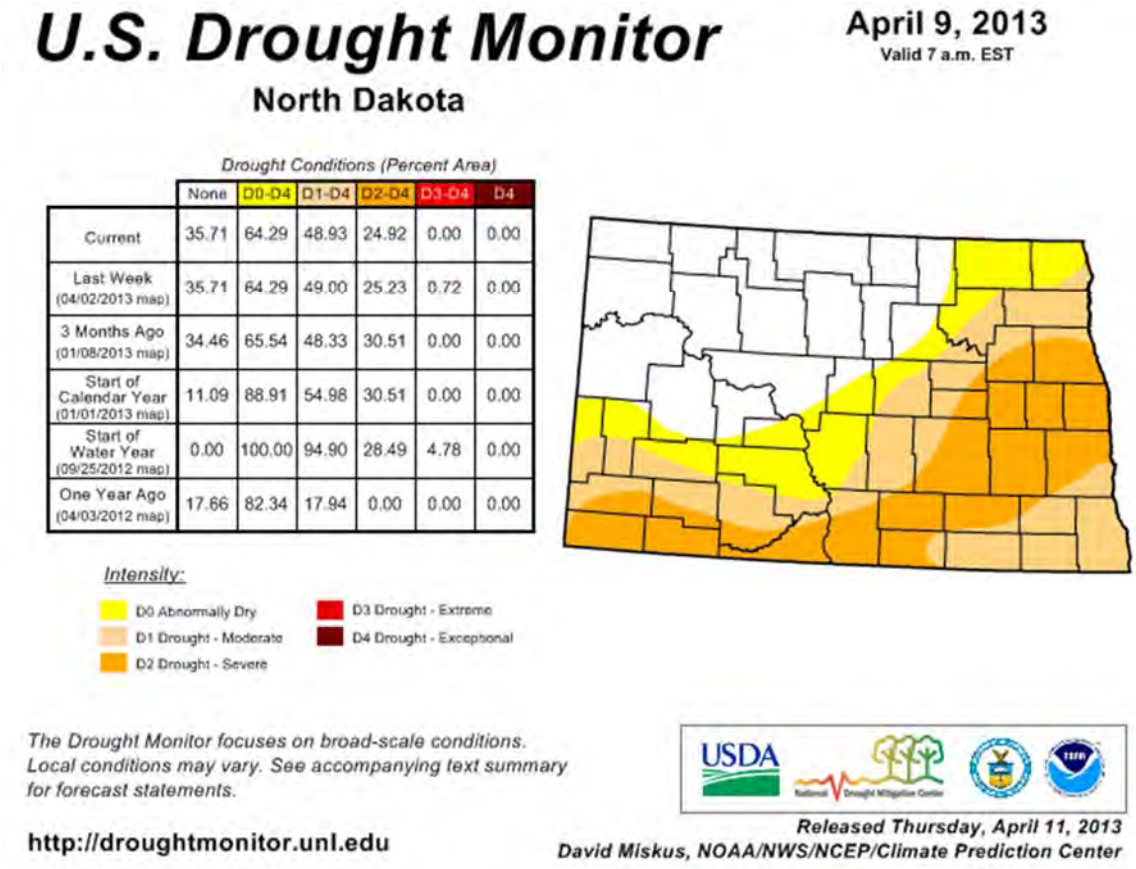
Table 8.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested

Classification	Description	Range of Possible Impacts
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Donnybrook are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 8.2.2.2-1 (following).

Figure 8.2.2.2-1
US Drought Monitor – North Dakota
(source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 8.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Donnybrook – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

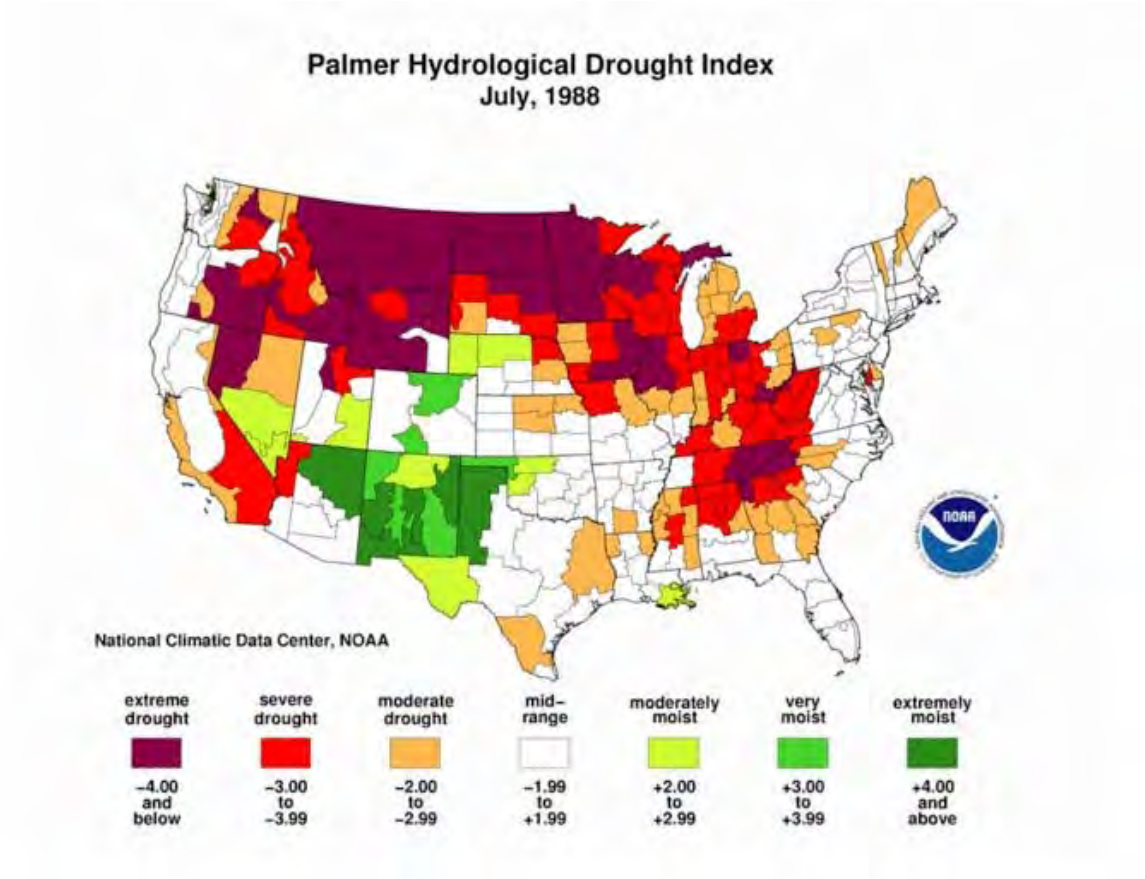
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Donnybrook. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 8.2.2.2-2 (following), the entire state – including the city of Donnybrook – was categorized as being in extreme drought during this time.

Figure 8.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Donnybrook) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years in more recent history.

8.2.2.3 Fire
This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

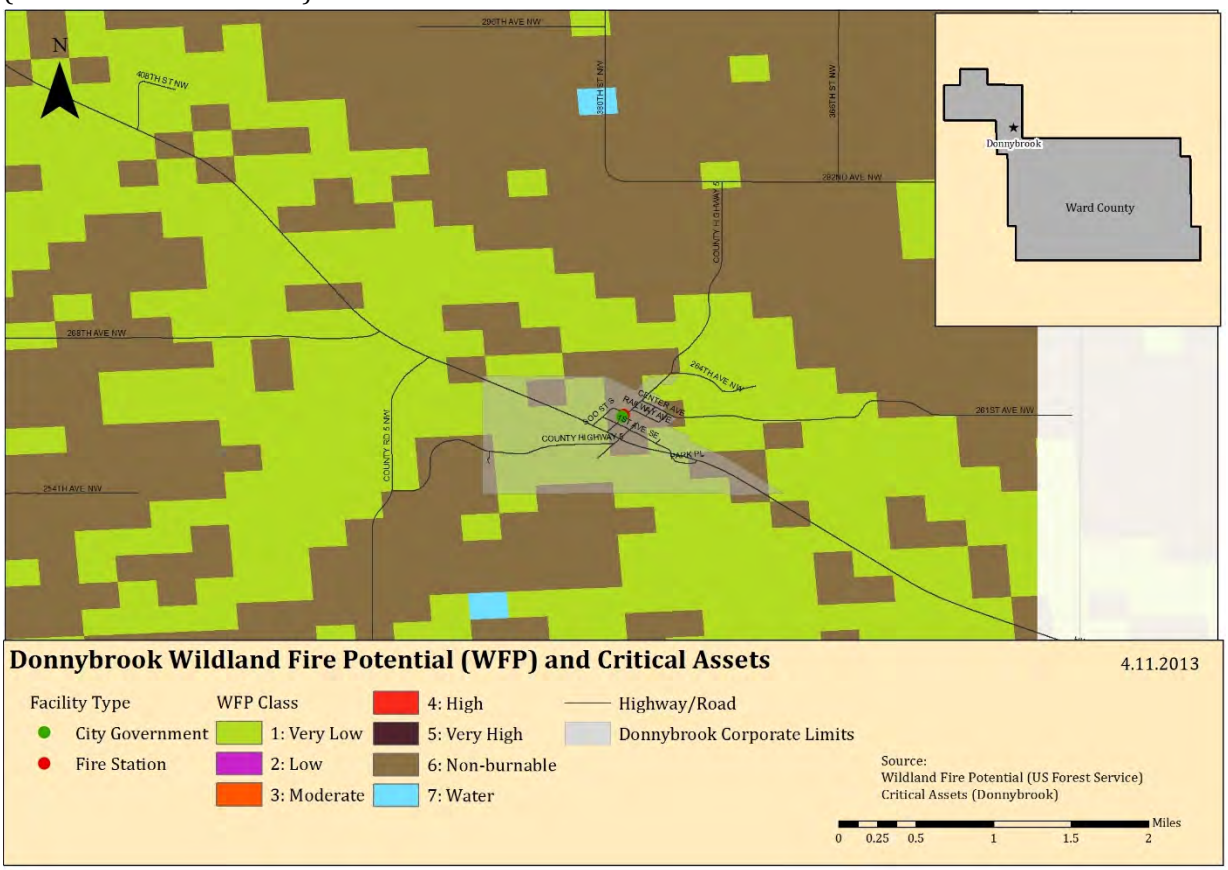
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 8.2.2.3-1 (following) illustrates the wildland fire potential for the city of Donnybrook, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 8.2.2.3-1
City of Donnybrook – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard
The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 8.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System.

Table 8.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the

destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people. In addition, some structures (such as grain elevators) require specialized teams and equipment, and so response to these events may be delayed.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Based on data obtained from the National Reporting System, the city of Donnybrook has experienced 04 structure fires from January 2008 through December 2012, an average of .80 structure fires per year. For this same time period, 03 wildland fires were responded to, an average of .60 per year.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in the city of Donnybrook less than annually but at least once every five years. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence.

8.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters,*

from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

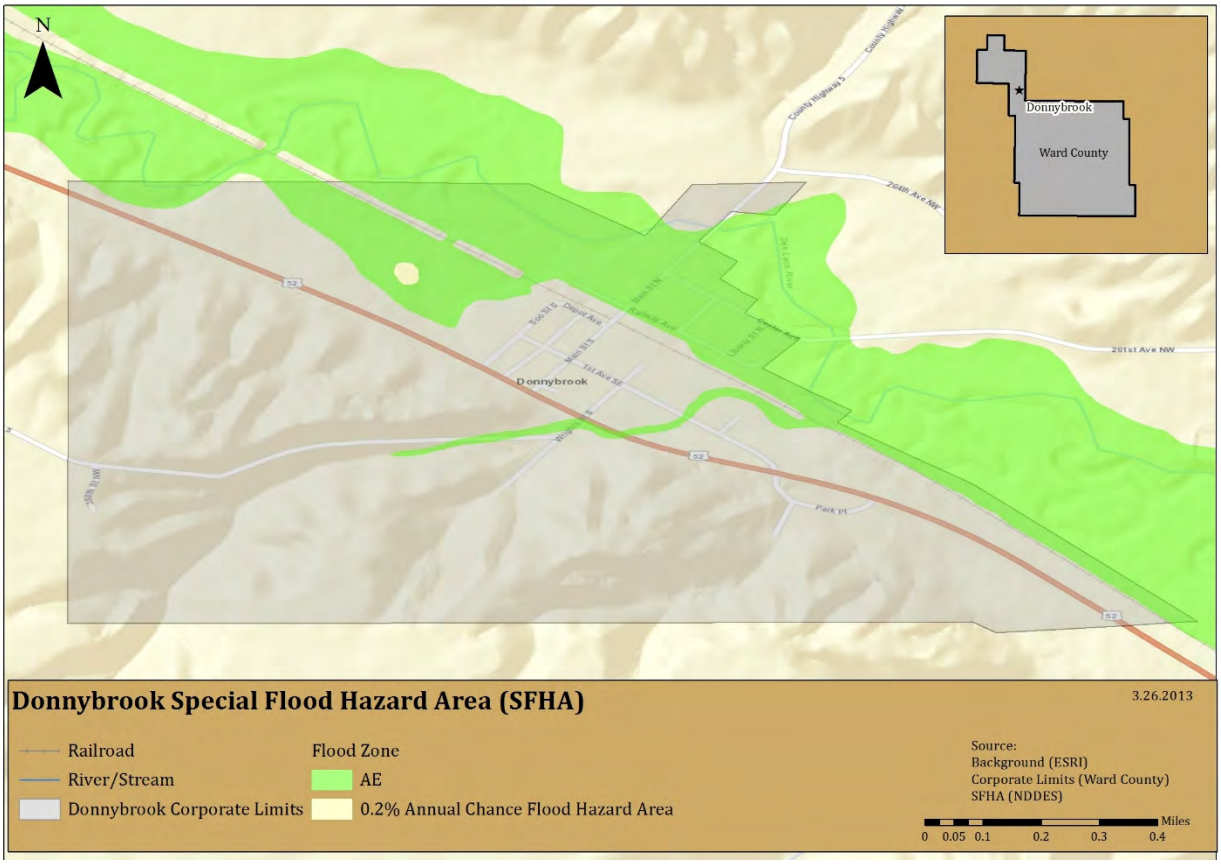
Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard

Donnybrook has significant areas of one percent annual chance floodplain both inside and adjacent to its corporate limits. Large portions of the city fall within the one percent annual chance floodplain, with additional areas falling in the .02% annual chance floodplain. These areas are illustrated in Figure 8.2.2.4-1 (following).

Figure 8.2.2.4-1
Special Flood Hazard Areas



Extent and Severity of the Hazard

In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 8.5.2.4-1 (below).

Table 8.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.

Zone Designation	Percent Annual Chance of Flood	Description
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 8.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 8.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

Term	Definition
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

The city of Donnybrook is currently a member of the NFIP, and its membership is in good standing. There are no designated Repetitive Loss or Severe Repetitive Loss properties within the city of Donnybrook.

Potential Impact of the Hazard
Flooding is the most frequent natural disaster in the US, and is one that occurs in the city of Donnybrook.

Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A major flood occurred in the Souris River Basin in 1969, which greatly impacted the region (though

not specifically the city of Donnybrook). More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley.

The city of Donnybrook reported no incidents of flooding within its corporate limits.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs at less than once every five years in the city of Donnybrook. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is low.

8.2.2.5 Severe Summer Storms
This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

Extreme Heat
Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail
Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning
Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms
Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard
Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Donnybrook.

Extent and Severity of the Hazard
Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat
The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.

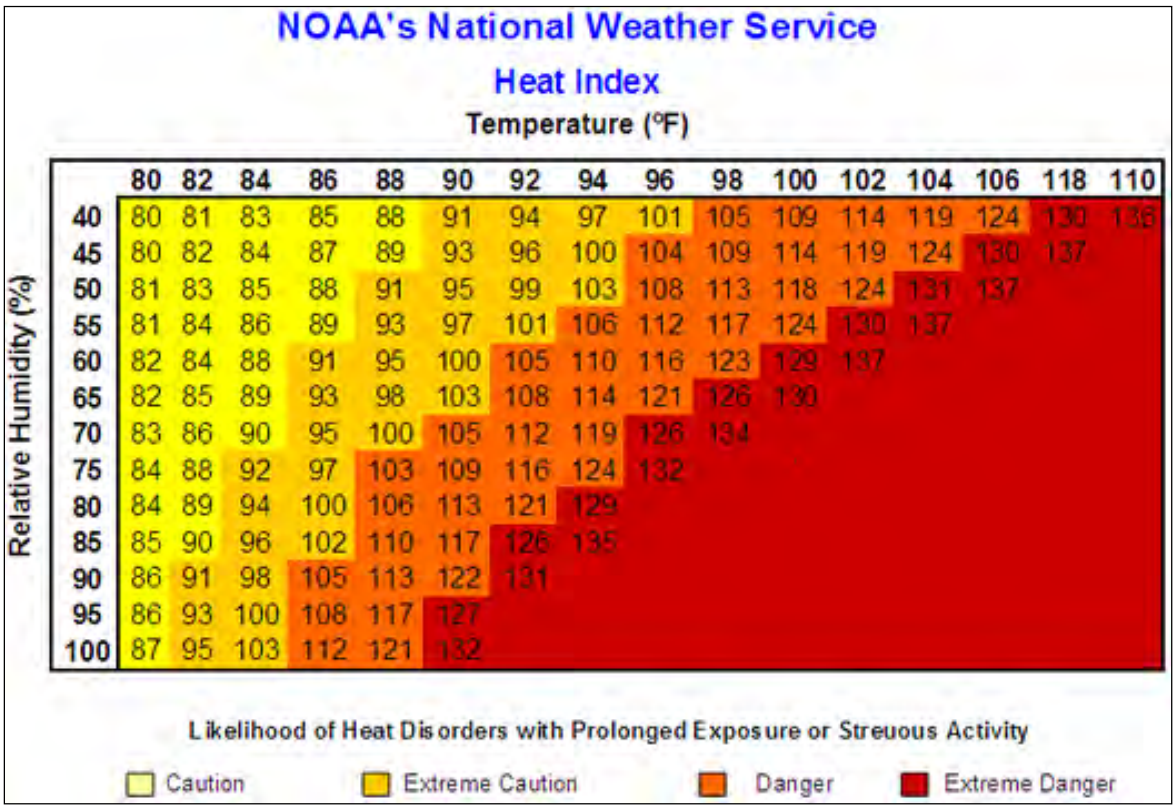
- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 8.2.2.5-1(following). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 8.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)



Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail
The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 8.2.2.5-1 (below) provides details of these scales.

Table 8.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33”	Pea	No damage
H1	Potentially Damaging	0.33” – 0.60”	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60” – 0.80”	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80” – 1.20”	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20” – 1.60”	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60” – 2.0”	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0” – 2.4”	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4” – 3.0”	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0” – 3.5”	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5” – 4.0”	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning

The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the

wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- Ground-to-Cloud Lightning**.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning**. Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning**. Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 8.2.2.5-2 (below) provides this severity scale.

Table 8.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 8.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 8.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			pattern, for it may never be identifiable through engineering studies

Table 82.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 8.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Given that Donnybrook is smaller than 15 miles in diameter, it is possible for the entire jurisdiction to be impacted by the same thunderstorm at any given time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Donnybrook are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 8.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 8.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties
- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact on life due to thunderstorm and associated hazards in Donnybrook would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard
Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least 7 occurrences of the summer storm hazard since 1994. (Note: Records prior to 1994 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 8.2.2.5-6 (below) provides details of these recorded incidents.

Table 8.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Description	Magnitude (if applicable)
July 18, 1994	Tornado/Funnel cloud	Unknown
July 19, 2001	Tornado/Funnel cloud	Unknown
June 15, 2003	Tornado/Funnel cloud	Unknown
August 08, 2003	Hail	.75”
August 02, 2008	Hail	1.75”
August 10, 2010	Hail (2 occurrences)	2”and 1”

Probability of a Future Occurrence of the Hazard
In the 18 year period for which records are available, the summer storm hazard has occurred at least seven times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is moderate, as the summer storm hazard occurs at least every five years.

8.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard
Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow
The National Weather Service defines snow as “precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes,

formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold

What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice

The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Donnybrook.

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

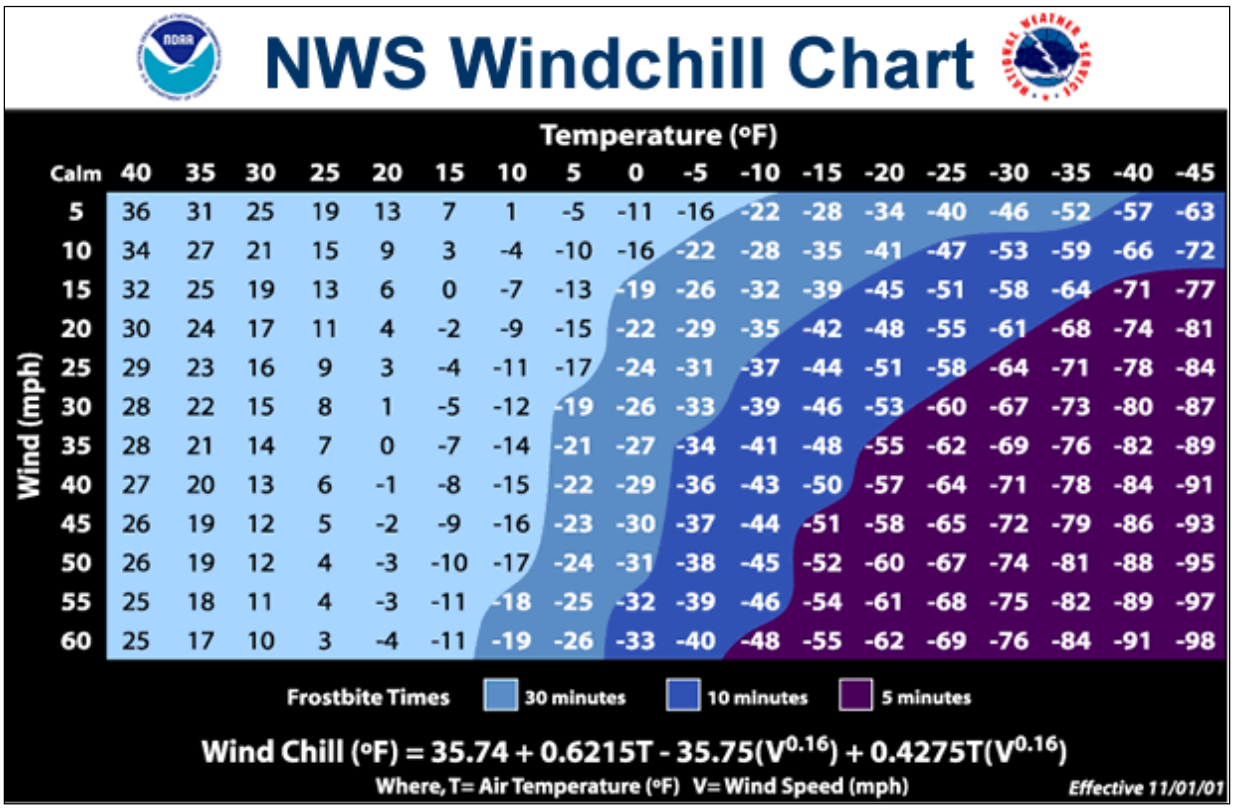
Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold
Winter temperatures in Donnybrook typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 8.2.2.6-1 (following) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 8.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)



NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice
Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

- **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.
- **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard
Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard
According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes,

accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.

- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.
- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard

Based on the data available, winter storms occur in or otherwise impact the city of Donnybrook at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

8.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard

Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard

Three fixed site facilities are located in Donnybrook that report to Tier II. These facilities are located adjacent to the railroad. One of these facilities is identified in HSIP, and appears in figure 8.2.2.7-1 (following). Additional locations in Donnybrook that are at risk from the hazardous materials incident are adjacent to the railroad and in proximity to the pipeline. These locations are depicted in Figures 8.2.2.7-2 and 8.2.2.7-3 (following).

Figure 8.2.2.7-1
Hazardous Materials Locations – Fixed Site

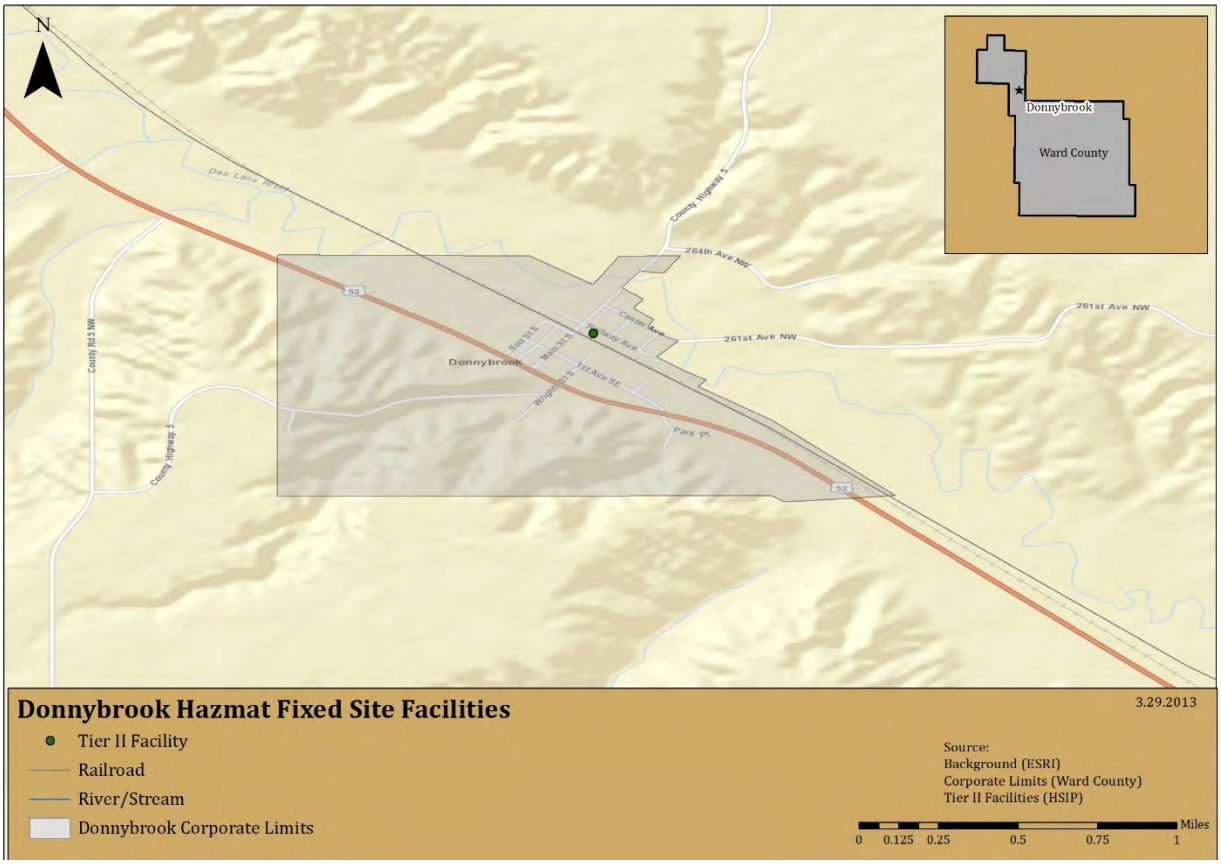


Figure 8.2.2.7-2
Hazardous Materials Locations – Railroad

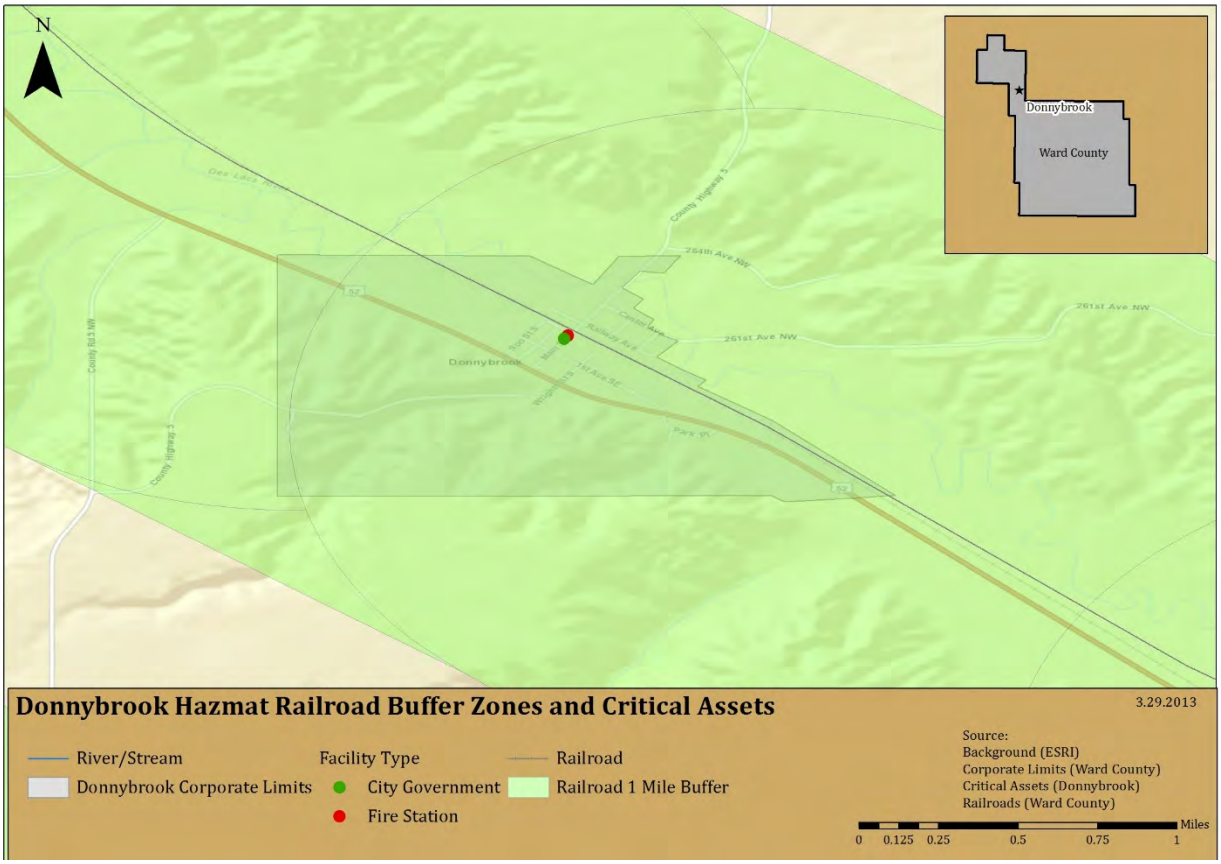
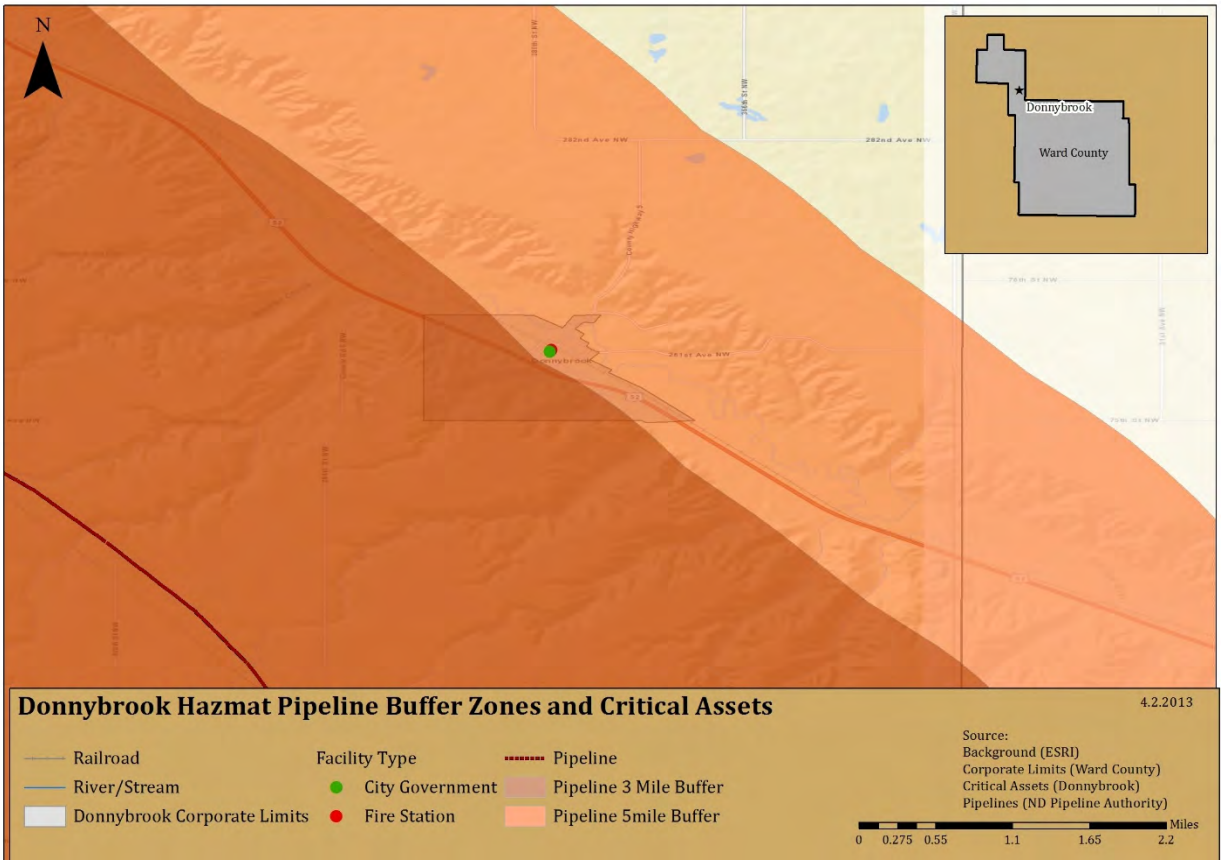


Figure 8.2.2.7-3
Hazardous Materials Locations – Pipeline



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, no Tier II reports from the city of Donnybrook have been submitted to the EPA since 1987, the year that the EPA began keeping such reports.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in Ward County, though not necessarily in the city of Donnybrook. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

8.3 Risk Assessment (Updated)

The following table (Table 8.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Donnybrook.

Table 8.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

8.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Donnybrook from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Donnybrook to the identified and profiled hazards.

Critical Assets
The table below (Table 8.3.1-1) provides details of the critical assets contained within the city of Donnybrook.

Table 8.3.1-1
Critical Assets – City of Donnybrook

Asset Name	Asset Use /Function	Street Number	Street Name	Insured or Estimated Value
Donnybrook Fire Department	Emergency Services	10	Main Street South	$175,469
Donnybrook City Hall	Government	30	Main Street South	$175,469
Total estimated value of identified critical assets:				**$350,938**

Note on asset values: Valuation data for assets within the city was unavailable at the time this plan update was developed. All valuations used in the following estimates of potential losses are derived from an average of available data for the same or similar types of assets from other jurisdictions. The assessment that follows is an estimate only, and may not correlate with actual occurrences of the damage caused by the hazards described.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

8.3.2 Risk and Vulnerability Assessment

8.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 59 people residing in Donnybrook; this is a significant reduction from the 2000 Census population of 90. In 2012, the Census Estimate was lower still, at 57. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

Estimate of Potential Losses
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Donnybrook represents ~.5% of the total population of Ward County, or 59 people. While an outbreak of communicable disease in Donnybrook is unlikely to have significant impacts outside of Donnybrook, an outbreak could have significant impacts within the city.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness rate in Donnybrook that is similar to the illness rate across the county, the following numbers of people in Donnybrook could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Donnybrook accounts for ~.5% of the county population. This equates to 23 cases of influenza in Donnybrook, on average, that could potentially impact the city.
- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Donnybrook accounts for ~.5% of the county population. This equates to 32 cases of pertussis in Donnybrook, on average, that could potentially impact the city.

Identified Data Limitations
There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy

policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;
- Data regarding projected population changes; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

8.3.2.2 Drought

Vulnerability to the Hazard
Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies depend largely on agriculture, such the State of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result in significant societal disruption, which can worsen as the resource becomes more and more precious.

Donnybrook has experienced a significant decline in both development and population since the 2008 plan; early indications are that this decline may be continuing, if the 2012 Census Estimate is a marker. This decline in people and development, however, does not necessarily translate to a decline in vulnerability to the drought hazard. People and structures remain at risk, even though there are numerically fewer of both, the exposure has not changed. Future development plans should take this vulnerability into account, and plan accordingly.

Estimate of Potential Losses
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no quantitative risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no quantitative risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

8.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

Similar to other hazards, the decrease in population and development experienced by Donnybrook does not necessarily translate to a decrease in vulnerability to the fire hazard. The vulnerability remains the same, despite the reduction in numbers. Any future development must consider this vulnerability when planning.

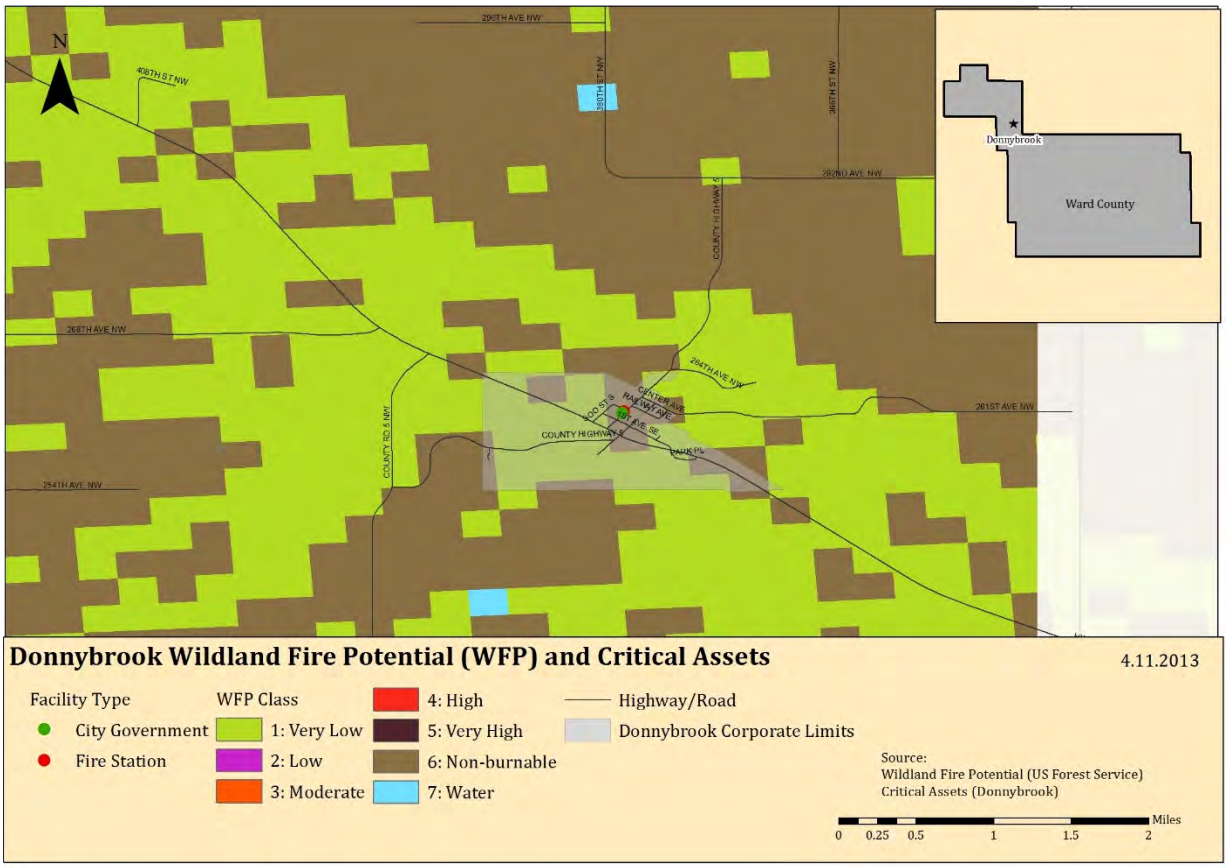
Estimate of Potential Losses
All structures within the city of Donnybrook are at risk from fire. According to the 2010 Census, there are 42 housing units in the city; 39 of these units are occupied, and 3 are vacant. The majority of these structures are heated either by bottled gas or by electricity. The median value of single family housing in Donnybrook is $41,700, according to the Census. This equates to potential residential losses of $1,751,400.

In addition, all identified critical assets (identified in Table 8.3.1-1) within the city have the potential to be lost to fire. These assets have a combined estimated value of $350,938.

Using the US Forest Service's Wildland Fire Potential data, the city of Donnybrook and its critical assets were mapped. Based on this data set, the city of Donnybrook has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 8.3.2.3-1 (following) illustrates this fire potential in relation to the identified critical assets for the city.

Figure 8.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

8.3.2.4 Flood

Vulnerability to the Hazard

Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

Flood damages also take considerable time to recover from. The 2011 flooding that occurred throughout the county had far-reaching impacts, and recovery for many areas remains a work in progress as of this Plan update.

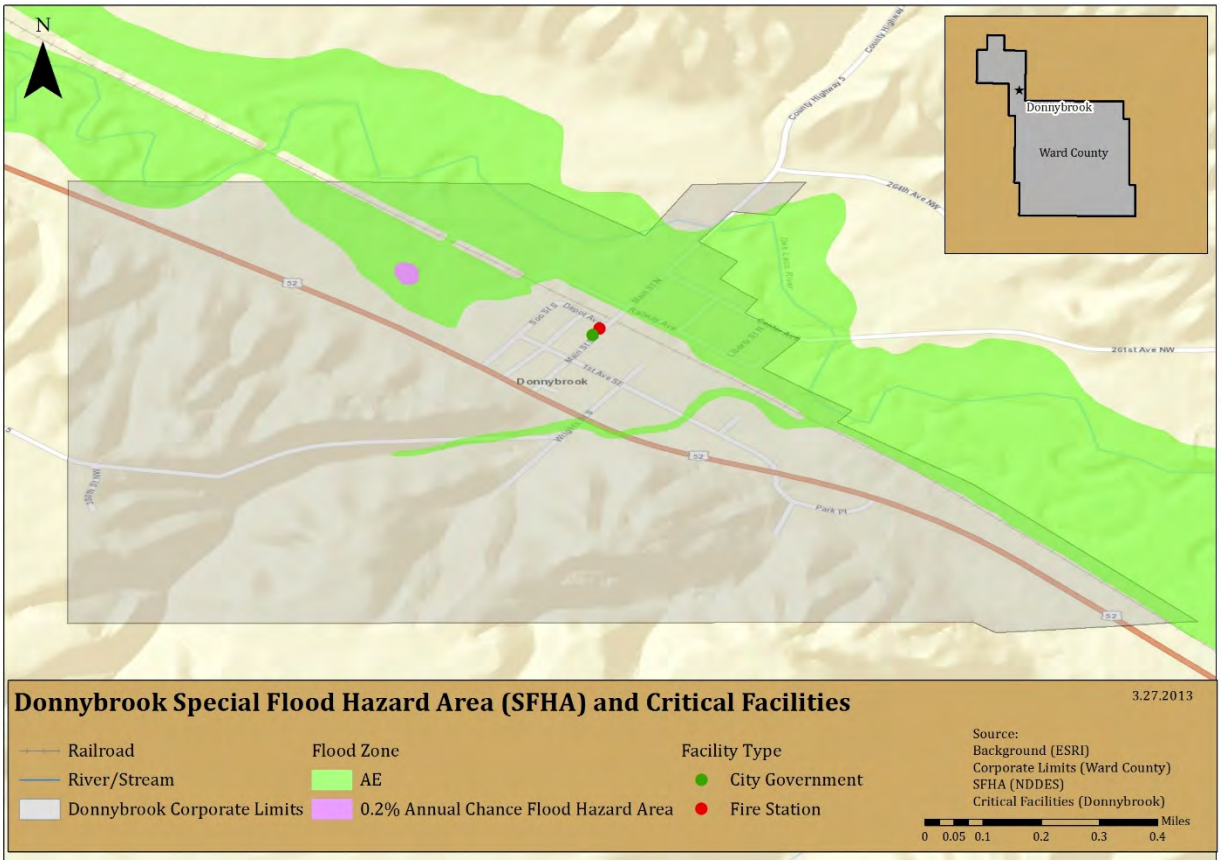
Donnybrook has experienced a significant reduction in both development and population since the 2008 plan. Indications are that this decline is continuing, based on estimates completed in 2012. There is no planned future development, and no reason to believe that there will be significant increases to population in the foreseeable future, but this does not exclude the possibility of change in the future. Donnybrook has significant flood hazard areas; these areas must be considered when any future development is being planned or considered.

The city of Donnybrook is a member of the NFIP, and is in good standing with the program. As of February 2013, there were no NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the city of Donnybrook.

Estimate of Potential Losses

Donnybrook has significant floodplains, both within the corporate limits and just outside of the corporate limits. Figure 8.3.2.4-1 (following) illustrates the locations and boundaries of both the one percent annual chance floodplain and the .02% annual chance floodplain. Critical assets for the city have been overlaid onto this hazard boundary map.

Figure 8.3.2.4-1
Special Flood Hazard Areas and Donnybrook Critical Assets



As seen in the image above, Donnybrook's critical assets are located outside of any identified flood hazard area, and have limited exposure to the flood hazard. However, given that the NFIP estimates that 30% of flood damages occur outside of any identified floodplain, it is reasonable to assume that at least some losses would occur to these critical assets. Using the NFIP's estimate, a loss of 30% to Donnybrook's critical assets would equate to at least $105,280 in damages.

The same cannot be said for the rest of the structures in the city, however, many of which are located within or adjacent to identified floodplains. If 20% of the 42 residential structures in the city are damaged by flooding, this equates to 8 flood damaged structures. Given that the median value of a single-family housing unit in Donnybrook is $41,700, this scenario would result in $333,600 in structural flood losses. Assuming a contents value of 50% of structure value, an additional loss of $166,800 in contents and personal property could be expected.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

8.3.2.5 Severe Summer Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

The decrease in population and development numbers does not translate to a reduction in vulnerability. The levels of vulnerability remain the same, regardless of the reduction in numbers. Though there are no published plans for any future development, this may change in the future. Any future development must consider this vulnerability, and plan accordingly.

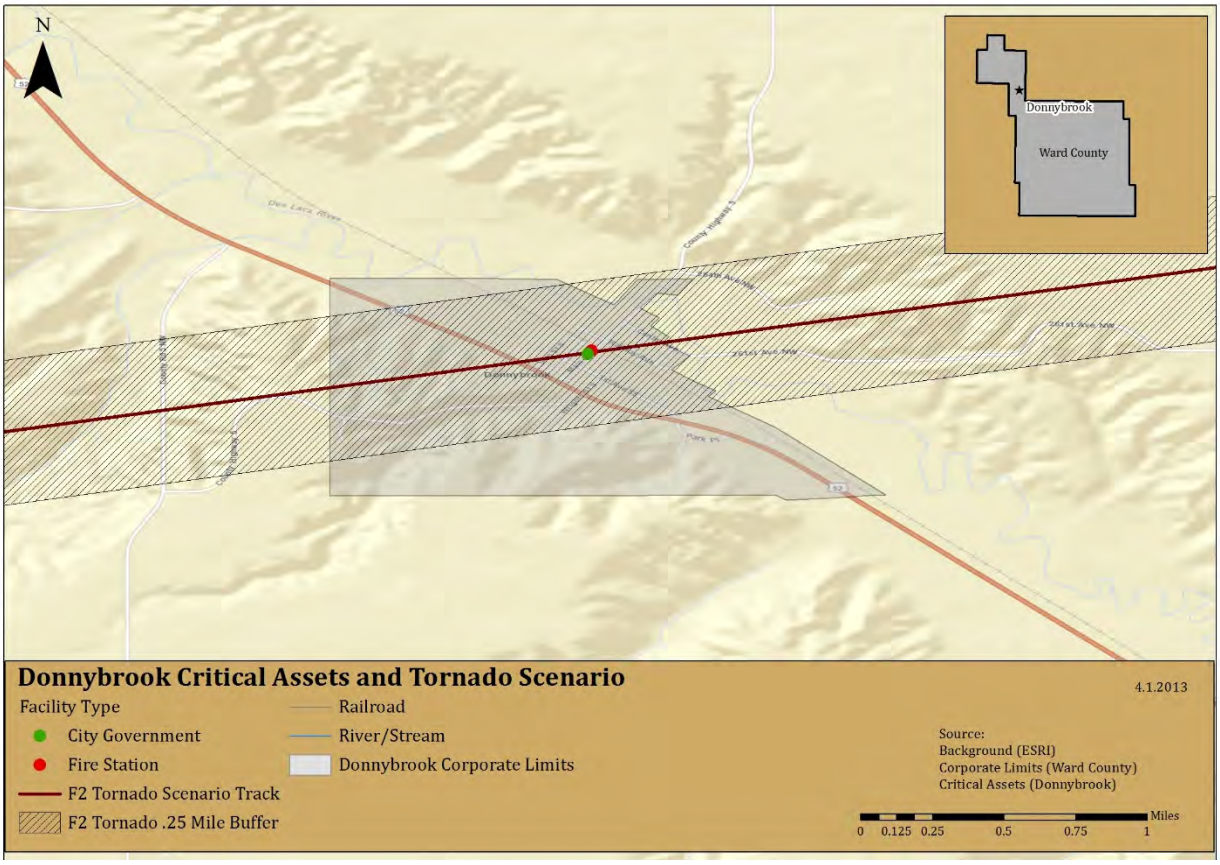
Estimate of Potential Losses
Severe summer storms are a non-spatial hazard that can and do affect the entire city of Donnybrook. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Donnybrook are at risk from severe summer storms. According to the 2010 Census, there are 42 housing units in the city. The median value of these structures is $41,700, according to the Census. This equates to residential assets of approximately $1,751,400. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $175,140.

In addition, all identified critical assets (identified in Table 8.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined

estimated value of $350,938. For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Donnybrook. Figure 8.3.2.5-1 (below) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 8.3.2.5-1
Tornado Scenario – City of Donnybrook



As seen in the above figure, in such a scenario the majority of the city of Donnybrook would be damaged, including critical assets (government and emergency services). This scenario would result in significant damages to the city's infrastructure, and would greatly impact its ability to provide basic services, such as emergency response.

Finally, the 59 residents of Donnybrook are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 1.7% (children under 5) and 15.3% (those over 70) of the population of Donnybrook. Combined, these two groups account for 17% of the population, a total of 10 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limit;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

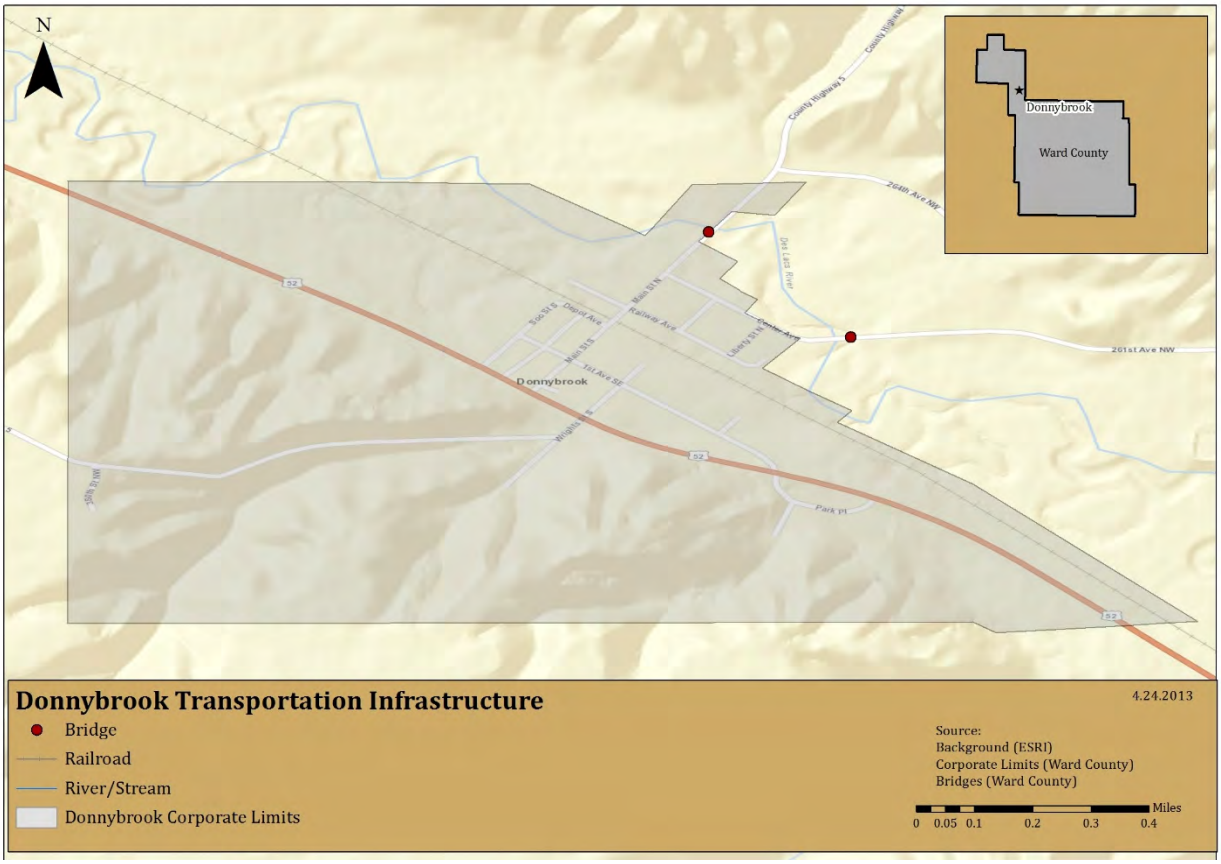
8.3.2.6 Severe Winter Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents. Figure 8.3.2.6-1 (following) provides the locations of bridges in and around the city, which typically ice over before surround roadways, making them treacherous for travel.

Figure 8.3.2.6-1
Donnybrook – Bridges



In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

The decrease in population and development numbers does not translate to a reduction in vulnerability. The levels of vulnerability remain the same, regardless of the reduction in numbers. Though there are no published plans for any future development, this may change in the future. Any future development must consider this vulnerability, and plan accordingly.

Estimate of Potential Losses
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Donnybrook. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Donnybrook are at risk from severe winter storms. According to the 2010 Census, there are 42 housing units in the city. The median value of these structures is $41,700, according to the Census. This equates to residential assets of approximately

$1,751,400. If 1% of these residential assets were damaged by a severe summer storm, this would result in losses of $17,514.

In addition, all identified critical assets (identified in Table 8.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of $350,938. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $35,093.

Finally, the 59 residents of Donnybrook are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 1.7% (children under 5) and 15.3% (those over 70) of the population of Donnybrook. Combined, these two groups account for 17% of the population, a total of 10 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

8.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

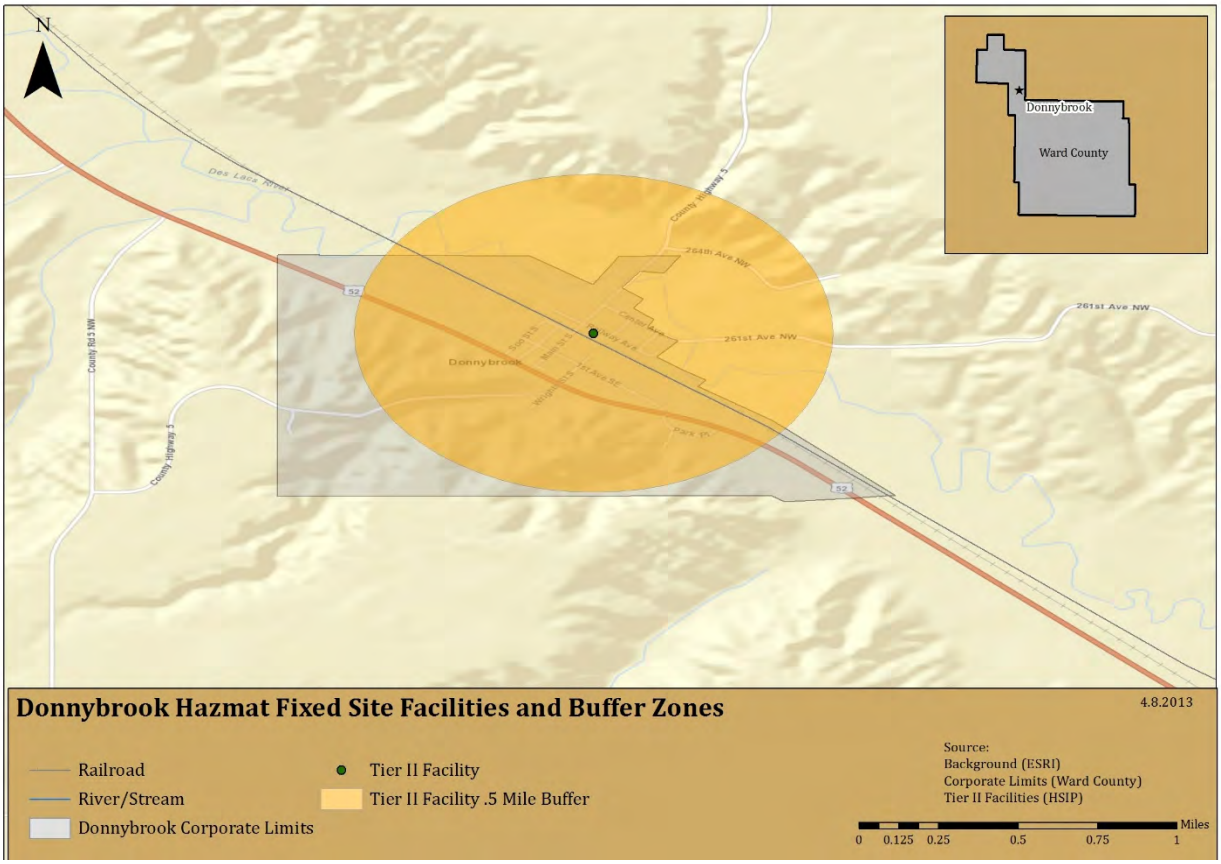
Donnybrook's surrounding roadways have experienced increases in traffic in recent years, due in part to the increase in energy activities throughout the state. This increase in traffic, while it may not directly impact the city of Donnybrook, does increase the city's vulnerability to the hazardous materials incident hazard, as an incident on the roadways could impact the city's population and development. Any planned future development must take this increased vulnerability into account.

Estimate of Potential Losses

For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Donnybrook – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

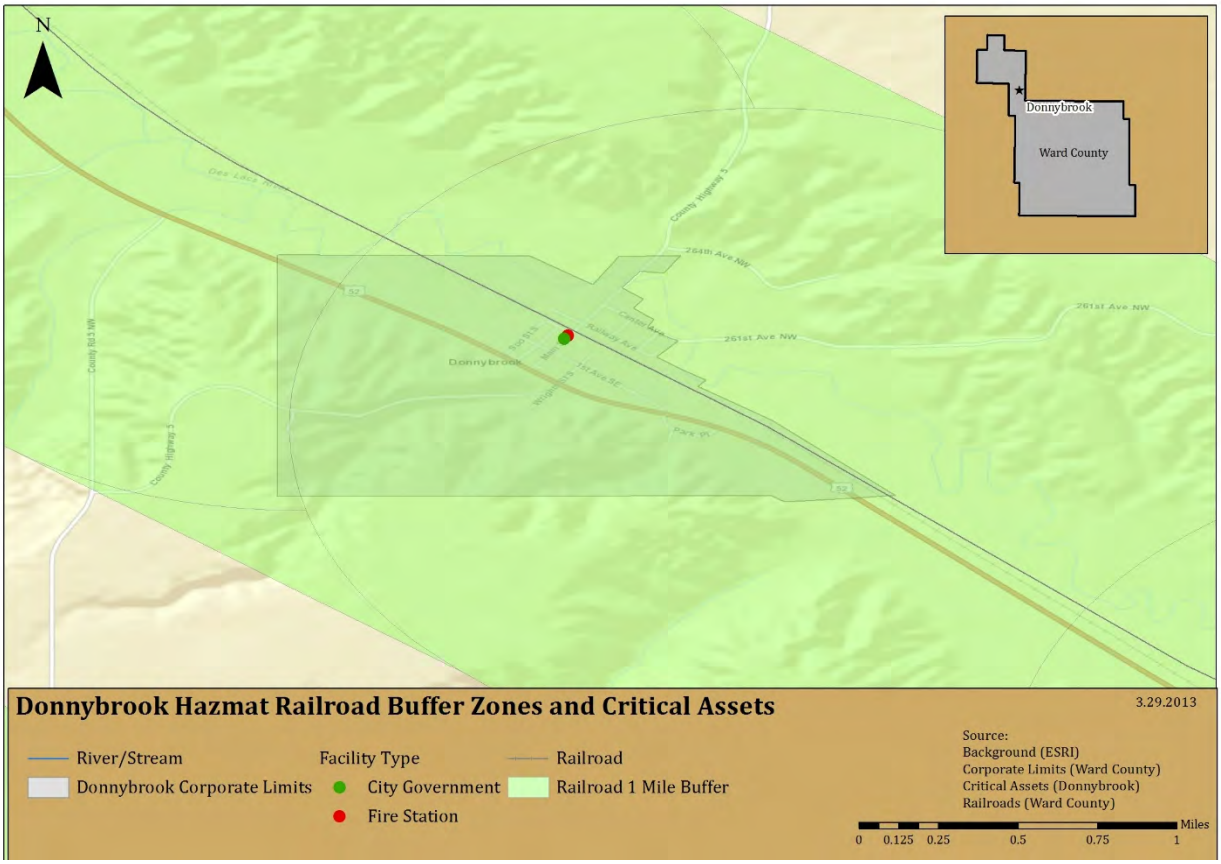
Donnybrook's hazardous materials risk comes from the fixed site facility, the railroad, and from a pipeline south of the city. Figures 8.3.2.7-1 through 8.3.2.7-3 (following) illustrate these locations A buffer zone has been applied to each of these images, indicating the area that could be impacted by an incident. For the purposes of this assessment, all assets within this buffer would be impacted to some degree.

Figure 8.3.2.7-1
Hazardous Materials Incident Scenario – Fixed Site



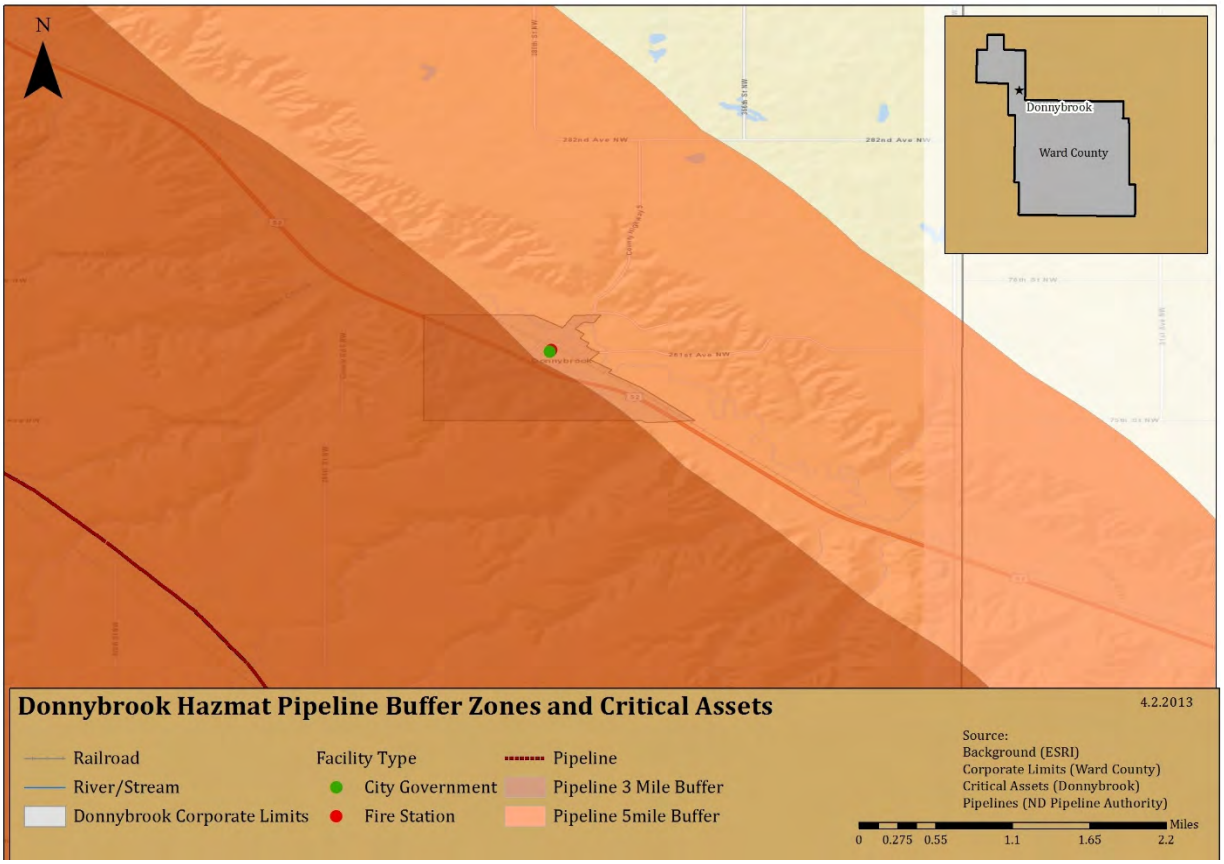
As seen in the image above, an incident at this facility could have the potential to impact the majority of the city, and could result in significant disruptions to operations.

Figure 8.3.2.7-2
Hazardous Materials Incident Scenario – Railroad



As is evident from the above image, the entire city could be impacted by a hazardous materials incident on the railroad, as could all critical assets within the city.

Figure 8.3.2.7-3
Hazardous Materials Incident Scenario – Pipeline



Though the pipeline does not actually run under the city, an incident with the pipeline could have ramifications for the city, as seen in the image above, and has the potential to impact the city's ability to respond to such an incident, whether from physical damage, from contamination, or from an evacuation for safety.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

8.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Donnybrook's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the city has some familiarity with hazard mitigation programs, and hazard mitigation does play a role in the decision-making process for the city.
- **Current/ongoing mitigation efforts** – currently, the city's mitigation efforts include participating in the development of the Ward County Hazard Mitigation Plan Update.
- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city. In addition, the fire department participates in drills and exercises.
- **Planning** –the city does not have a great deal of formalized planning efforts. There is no recovery plan, no evacuation plan, no COOP/COG, and no master or comprehensive plan. The city is a member of the NFIP.

- **Staff, personnel, and technical capability** – as of this Plan update, the city has a limited capability and capacity regarding hazard mitigation, and is not particularly confident in their abilities to administer hazard mitigation projects and programs. Additional experience and resources would be beneficial to building this capacity.

Like other municipalities within Ward County, Donnybrook depends on the framework established by the county and state government for technical assistance, and on the state and federal government for funding.

Conclusions and Recommendations
Donnybrook should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county towards this end.

8.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there **must** be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

8.5.1 Mitigation Goals

Table 8.5.1-1 (following) provides the mitigation goals that guide the city of Donnybrook's mitigation strategy.

Table 8.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

8.5.2 Mitigation Actions

Potential Mitigation Actions
Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions
Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike

wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions

Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (8.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (8.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped the city of Donnybrook to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 8.5.2-2. Table 8.5.2-1 (below) describes the basic criteria considered as part of the prioritization process.

Table 8.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.

STAPLEE	Criteria Explanation
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness

Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (8.5.2-2) provides the identified and prioritized mitigation strategy for the city of Donnybrook.

Table 8.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Continue to enforce floodplain management ordinance and practices	Flood	New	New and existing	City Council; County Code Enforcement	General funds; Ward County EMA; County Code Enforcement	$500+	Low	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Low	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Council; City Auditor	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; Ward County EMA	$500+	Moderate	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council	General fund; in-kind contributions	$500+	Low	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recent annexations and/or recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council	Ward County Highway Department; Ward County EMA	$500+	Low	
Goal 05: Provide long-term mitigation solutions to areas/structures that experience repetitive hazard damage or loss.	Develop and construct flood protection measure(s) for protection of repetitively flooded areas and properties, including public infrastructure.	Flood	New	Existing	City council;	NDDES & FEMA mitigation grant funding; general funds; State Water Commission; County EMA	$30,000+	High	

Section 09
City of Douglas: HIRA, Capability Assessment, and Mitigation Strategy

9.1 IFR for Hazard Identification and Risk Assessment
9.2 Hazard Identification (Updated)
9.2.1 Overview of Douglas's History of Hazards and Potential Hazards
9.2.2 Hazard Profiles
9.3 Risk Assessment (Updated)
9.3.1 Risk Assessment Methodology
9.3.2 Risk and Vulnerability Assessment
9.4 Capability Assessment (Updated)
9.5 Mitigation Strategy (Updated)
9.5.1 Mitigation Goals
9.5.2 Mitigation Actions

9.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan **should** describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..*

Requirement §201.6(c)(2)(ii)(C): *[The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment **must** assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Douglas.

9.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Douglas. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

9.2.1 Overview of Douglas's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 05 weather-related hazard events have occurred in the city of Douglas since 1998, including the following number and types of hazard events:

- Hail – 1
- Thunderstorm – 2

- Tornado/Funnel Cloud – 2

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 9.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 9.2.1-1
Presidential Disaster Declarations – City of Douglas

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Douglas

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 9.2.1-2 (below).

Table 9.2.1-2
Preliminary Hazard Identification and Determinations – City of Douglas

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Douglas	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Douglas	Reason for Exclusion and other notes
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Douglas	Reason for Exclusion and other notes
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

9.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

9.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk.

Table 9.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 9.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the

severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Douglas.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 9.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 9.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 9.2.2.1-3 (following) provides the details of pertussis outbreaks since 2007.

Table 9.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 9.2.2.1-4 (below) provides occurrence information for rabies.

Table 9.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Douglas did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Douglas, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Douglas, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been no occurrences of communicable disease within the city of Douglas. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

9.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Douglas are subject to the drought hazard.

Extent and Severity of the Hazard
Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.

- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

Table 9.2.2.2-1 (below) provides the PDSI classifications.

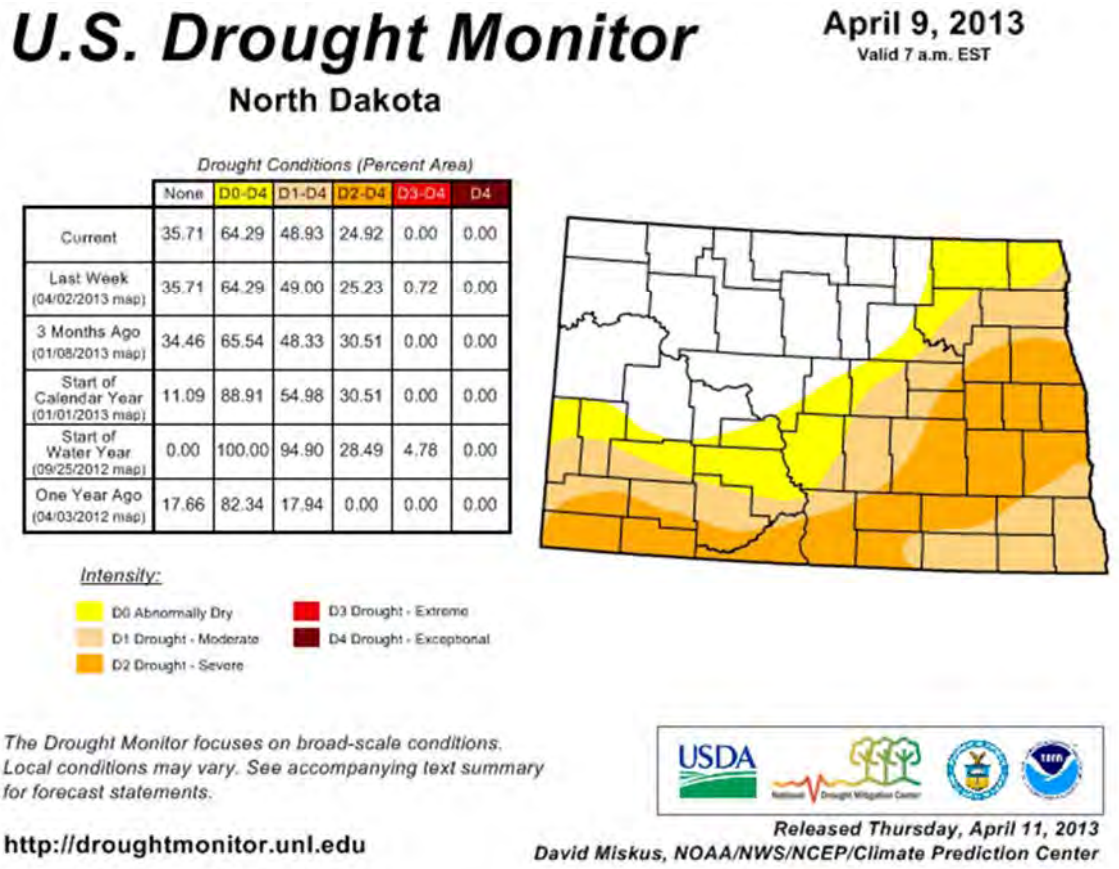
Table 9.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested

Classification	Description	Range of Possible Impacts
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Douglas are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 9.2.2.2-1 (following).

Figure 9.2.2.2-1
US Drought Monitor – North Dakota
(source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 9.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Douglas – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

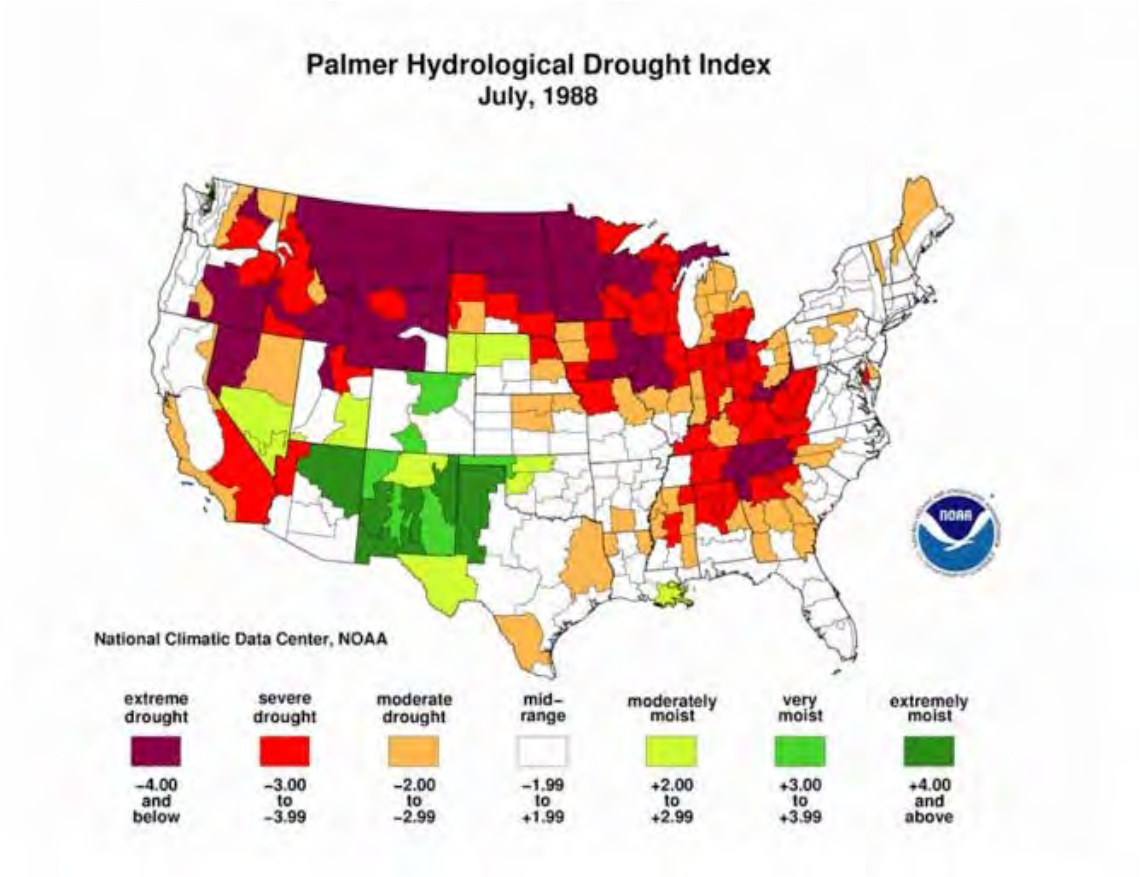
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Douglas. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 9.2.2.2-2 (following), the entire state – including the city of Douglas – was categorized as being in extreme drought during this time.

Figure 9.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Douglas) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years in more recent history.

9.2.2.3 Fire
This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

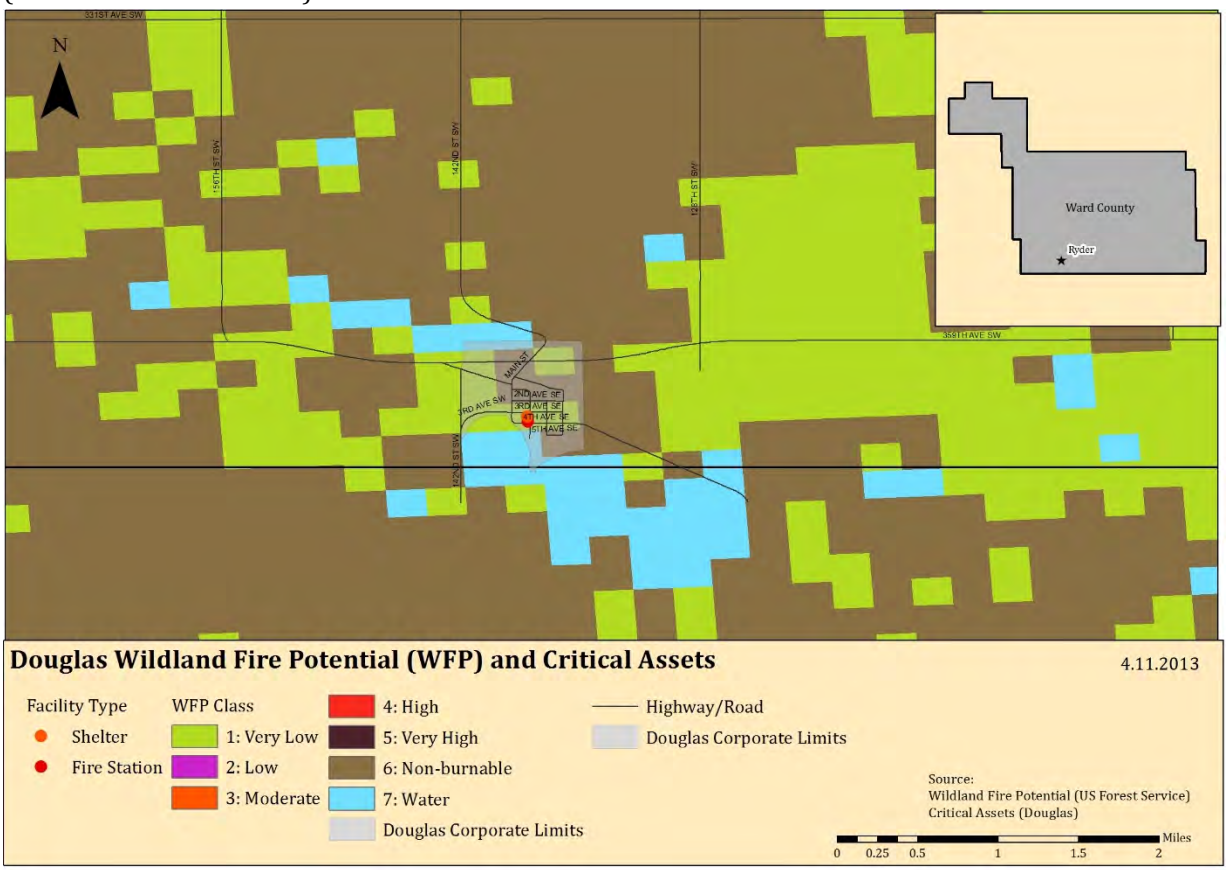
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 9.2.2.3-1 (following) illustrates the wildland fire potential for the city of Douglas, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 9.2.2.3-1
City of Douglas – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard
The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 9.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System.

Table 9.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people. In addition, some structures (such as grain elevators) require specialized teams and equipment, and so response to these events may be delayed.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Based on data obtained from the National Reporting System and from the city, the city of Douglas has experienced 6 structure fires from January 2008 through December 2012, an average of 1.2 structure fires per year. For this same time period, 11 wildland fires were responded to, an average of 2.2 per year.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in the city of Douglas annually. Using the scale provided earlier in this section, this equates to a high probability of a future occurrence.

9.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.*

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North

Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard
There are no identified or mapped floodplains within the city of Douglas.

Extent and Severity of the Hazard
In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 9.5.2.4-1 (following).

Table 9.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 9.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 9.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

)Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.

]Term	Definition
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

Because there are no mapped SFHAs, the city of Douglas is not currently a member of the NFIP, although Ward County is. There are no designated Repetitive Loss or Severe Repetitive Loss properties within the city of Douglas.

Potential Impact of the Hazard
Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A

major flood occurred in the Souris River Basin in 1969, which greatly impacted the region (though not specifically the city of Douglas). More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley.

The city of Douglas reported no occurrences of flooding within the city.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs at less than once every five years in the city of Douglas. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is low.

9.2.2.5 Severe Summer Storms
This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

Extreme Heat
Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail
Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning
Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms
Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard
Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Douglas.

Extent and Severity of the Hazard
Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat
The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.

- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 9.2.2.5-1(following). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 9.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail

The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 9.2.2.5-1 (following) provides details of these scales.

Table 9.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33"	Pea	No damage
H1	Potentially Damaging	0.33" – 0.60"	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60" – 0.80"	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80" – 1.20"	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20" – 1.60"	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60" – 2.0"	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0" – 2.4"	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4" – 3.0"	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0" – 3.5"	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5" – 4.0"	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning
The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to

explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- Ground-to-Cloud Lightning**.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning.** Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning***.* Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 9.2.2.5-2 (following) provides this severity scale.

Table 9.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to

describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 9.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 9.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Table 9.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 9.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Given that Douglas is smaller than 15 miles in diameter, it is possible for the entire jurisdiction to be impacted by the same thunderstorm at any given time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from

thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Douglas are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards.

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 9.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 9.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue

- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties
- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes

Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact on life due to thunderstorm and associated hazards in Douglas would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard
Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least 5 occurrences of the summer storm hazard since 1998. (Note: Records prior to 1998 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 9.2.2.5-6 (below) provides details of these recorded incidents.

Table 9.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Storm Hazard	Magnitude (if applicable)
July 06, 1998	Tornado/Funnel cloud	Unknown
June 06, 2004	Tornado/Funnel cloud	Unknown
July 11, 2004	Thunderstorm wind	64 MPH
May 18, 2007	Hail	1.75”
July 07, 2009	Thunderstorm wind	67 MPH

Probability of a Future Occurrence of the Hazard
In the 14 year period for which records are available, the summer storm hazard has occurred at least five times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is moderate, as the summer storm hazard occurs at least once every five years.

9.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard

Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow

The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold

What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice

The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard

Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Douglas.

Extent and Severity of the Hazard

Severe winter storms have a wide range of extent and severity markers and characteristics.

Blizzard/Excessive Snow

Various intensities of snowfall are defined differently:

- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold

Winter temperatures in Douglas typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 9.2.2.6-1 (following) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 9.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)

NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

- **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.
- **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard
Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard
According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes,

accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.

- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.
- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard

Based on the data available, winter storms occur in or otherwise impact the city of Douglas at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

9.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard

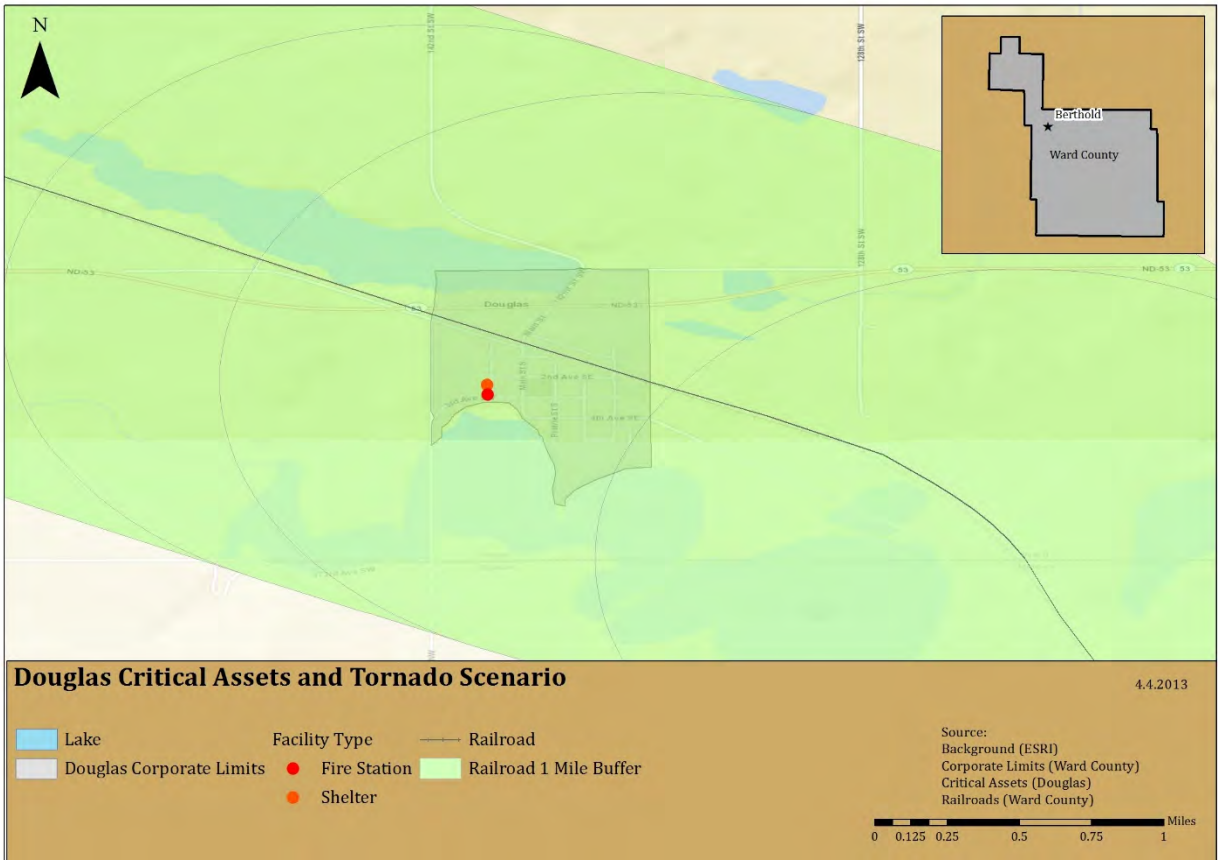
Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard

The locations in Douglas most at risk from a hazardous materials incident are those that are in proximity to o transportation or transmission lines. The following figure (9.2.2.7-1) illustrates these locations in Douglas.

Figure 9.2.2.7-1
Hazardous Materials Locations – Railroads



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, no Tier II reports from the city of Douglas have been submitted to the EPA since 1987, the year that the EPA began keeping such reports.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in Ward County, though not necessarily in the city of Douglas. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

9.3 Risk Assessment (Updated)

The following table (Table 9.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Douglas.

Table 9.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

9.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Douglas from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

Impact Scale Methodology
The potential impacts of each hazard were discussed by the Steering Committee. For the purposes of this discussion, a qualitative impact scale was developed, and was used by the Steering Committee in their discussions. As a result of these discussions, each hazard was assigned a qualitative impact ranking. This scale appears in Table 9.3.1-1 (below).

Table 9.3.1-1
Hazard Impact Scale

Term	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Low	Some minor injuries possible, but no fatalities	Cosmetic damages expected to assets; Infrastructure loss of function for less than 24 hours expected	System delivery delayed or temporarily interrupted; Interruptions in service delivery of less than 24 hours expected
Moderate	Injuries expected; Fatalities possible	Some structural damages to light construction (<50 % damage); Infrastructure loss of function for 24-72 hours expected	System delivery failures expected; Interruptions in service delivery of 24-72 hours expected
High	Serious and numerous injuries expected; Fatalities expected	Some structures irreparably damaged (>50% damage); Infrastructure loss of function for 72+ hours expected	Long-term system failures/damages expected; Cancellation of services (72+ hours) expected
Not Applicable	Hazard does not have the potential to impact people or life safety	Hazard does not have the potential to impact assets or infrastructure	Hazard does not have the potential to impact service delivery

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Douglas to the identified and profiled hazards.

Critical Assets
The table below (Table 9.3.1-1) provides details of the critical assets contained within the city of Douglas.

Table 9.3.1-1
Critical Assets – City of Douglas

Asset Name	Asset Use /Function	Street Number	Street Name	Insured or Estimated Value
Fuel Storage	Fuel	--	Main Street and Highway 13	$84,275
Fire Department	Emergency Services	--	Main Street	$175,469
Senior Center	Community Building / Shelter	--	Main Street	$16,115
Total estimated value of identified critical assets:				**$275,859**

Note on asset values: Valuation data for assets within the city was unavailable at the time this plan update was developed. All valuations used in the following estimates of potential losses are derived from an average of available data for the same or similar types of assets from other jurisdictions. The assessment that follows is an estimate only, and may not correlate with actual occurrences of the damage caused by the hazards described.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

9.3.2 Risk and Vulnerability Assessment

9.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 64 people residing in Douglas, which was unchanged from the 2000 Census. The 2012 Census Estimate placed the population slightly lower, at 62. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged

outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

No future development was identified during the Plan Update process; therefore, there is no reason to assume that the population – and its accompanying vulnerability – will change in the foreseeable future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 9.3.1-1 (previous).

The representatives from the city of Douglas determined that communicable disease has the potential to cause the impacts described in Table 9.3.2.1-1 (below).

Table 9.3.2.1-1
Qualitative Hazard Impacts – Communicable Disease

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Communicable Disease	Low	Low	Low

Estimate of Potential Losses – Quantitative
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Douglas represents ~.5% of the total population of Ward County, or 64 people. While an outbreak of communicable disease in Douglas is unlikely to have significant impacts outside of Douglas, an outbreak could have significant impacts within the city.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness rate in Douglas that is similar to the illness rate across the county, the following numbers of people in Douglas could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Douglas accounts

for ~.5% of the county population. This equates to 23 cases of influenza in Douglas, on average, that could potentially impact the city.

- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Douglas accounts for ~.5% of the county population. This equates to 32 cases of pertussis in Douglas, on average, that could potentially impact the city.

Identified Data Limitations
There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;
- Data regarding projected population changes; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

9.3.2.2 Drought

Vulnerability to the Hazard
Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies depend largely on agriculture, such as the State of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result in significant societal disruption, which can worsen as the resource becomes more and more precious.

Douglas is not economically dependent on agriculture, and so has limited vulnerability to droughts affecting agriculture. No future development was identified during the plan update process, and both the population and structure count have remained relatively stable in recent years, as has the community's vulnerability to this hazard.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating

jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 9.3.1-1 (previous).

The representatives from the city of Douglas determined that drought has the potential to cause the impacts described in Table 9.3.2.2-1 (below).

Table 9.3.2.2-1
Qualitative Hazard Impacts – Drought

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Drought	Low	Low	Low

Estimate of Potential Losses – Quantitative
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no quantitative risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no quantitative risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

9.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

The population of Douglas has remained fairly stable in the previous decade, with only a slight (estimated) decrease in recent years. There has been a slight decrease in the number of residential housing units – 44 in 2000 versus 40 in 2010. There are no published plans for significant future development in Douglas, so both population and development can be assumed to remain stable for the foreseeable future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 9.3.1-1 (previous).

The representatives from the city of Douglas determined that fire has the potential to cause the impacts described in Table 9.3.2.3-1 (below).

Table 9.3.2.3-1
Qualitative Hazard Impacts – Fire

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Fire	High	High	High

Estimate of Potential Losses – Quantitative
All structures within the city of Douglas are at risk from fire. According to the 2010 Census, there are 48 housing units in the city; 31 of these units are occupied, and 17 are vacant. The majority of these structures are heated by bottles gas, with the rest heated by electricity, natural gas, or oil. The median value of single family housing in Douglas is $61,000, according to the Census. This equates to potential residential losses of $2,928,000.

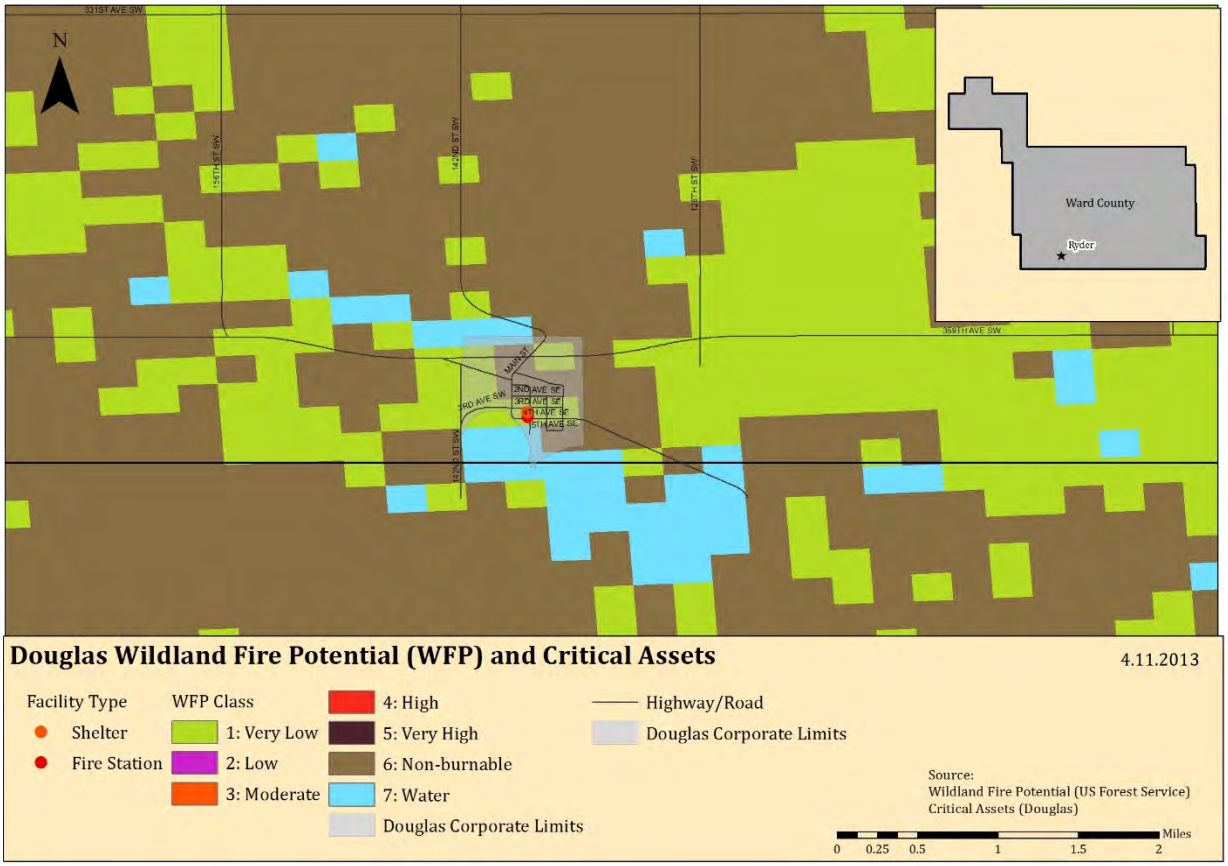
In addition, all identified critical assets (identified in Table 9.3.1-1) within the city have the potential to be lost to fire. These assets have a combined estimated value of $275,859.

Using the US Forest Service's Wildland Fire Potential data, the city of Douglas and its critical assets were mapped. Based on this data set, the city of Douglas has very low potential for

wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 9.3.2.3-1 (below) illustrates this fire potential in relation to the identified critical assets for the city.

Figure 9.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

9.3.2.4 Flood

Vulnerability to the Hazard
Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

Flood damages also take considerable time to recover from. The 2011 flooding that occurred throughout the county had far-reaching impacts, and recovery for many areas remains a work in progress as of this Plan update.

The city of Douglas has no identified or mapped floodplains and is not a member of the NFIP. As of February 2013, there were no NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the city of Douglas.

Given that there is no identified or mapped flood hazard area within the city limits, the slight decreases in population and development do not factor in to considerations of flood vulnerability. There are no identified plans for future development, so the community's vulnerability to flooding is unlikely to increase because of future development.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 9.3.1-1 (previous).

The representatives from the city of Douglas determined that flooding has the potential to cause the impacts described in Table 9.3.2.4-1 (below).

Table 9.3.2.4-1
Qualitative Hazard Impacts – Flood

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Flood	High	High	High

Estimate of Potential Losses – Quantitative
It was the determination of the Steering Committee that quantitative risk assessments related to flooding should be performed for those areas within Ward County that contained a mapped or identified flood hazard area, and that all other areas should receive a qualitative assessment only.

In light of this determination, no quantitative risk assessment has been performed for this hazard for the city of Douglas.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

9.3.2.5 Severe Summer Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Both development and population in Douglas have experienced a slight decrease since the 2008 plan (population decrease is estimated). Despite this decrease, a significant vulnerability exists in Douglas, in that there is no storm shelter within the municipality. During the plan update process, a need was identified for a storm shelter to mitigate this identified vulnerability.

There are no plans for future development in the foreseeable future; it can be assumed that this will also mean that there will not be a significant increase in population in the foreseeable future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 9.3.1-1 (previous).

The representatives from the city of Douglas determined that severe summer storms have the potential to cause the impacts described in Table 9.3.2.5-1 (below).

Table 9.3.2.5-1
Qualitative Hazard Impacts – Severe Summer Storm

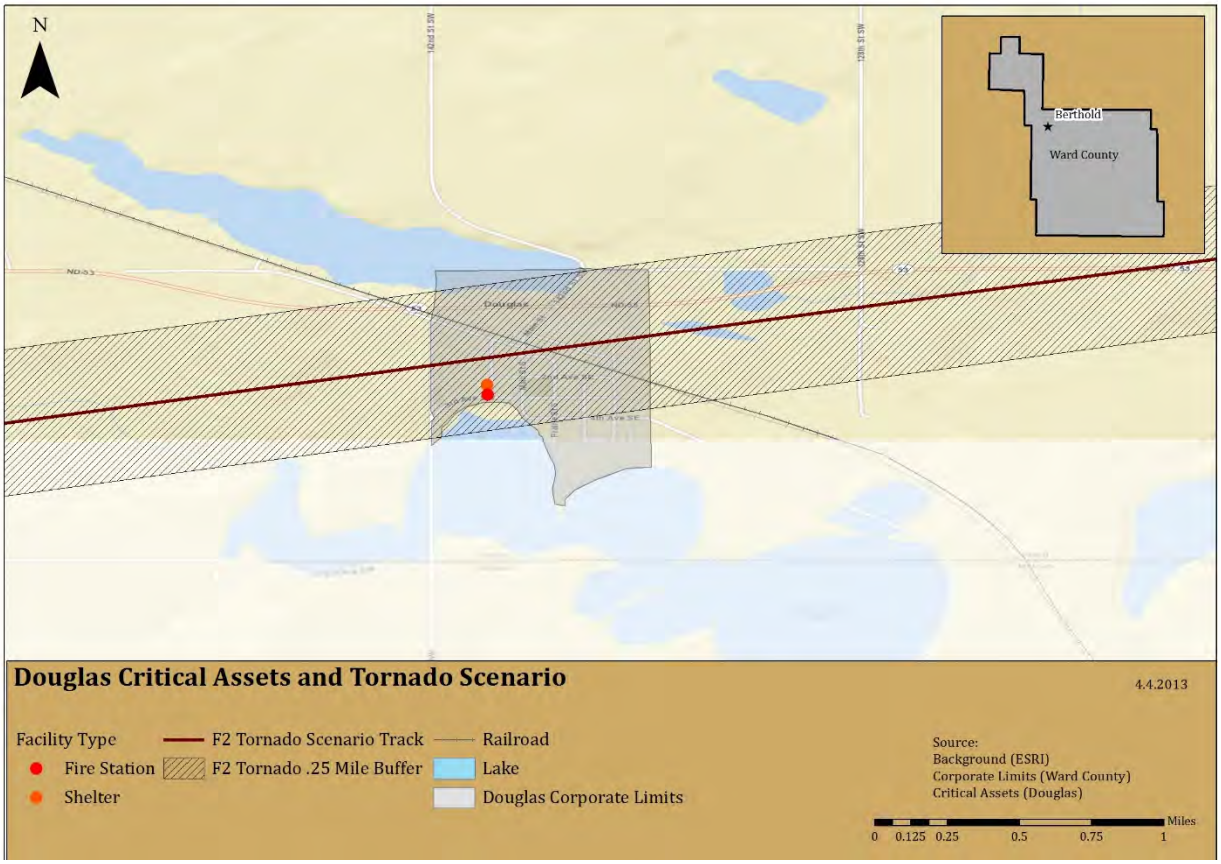
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Summer Storm	Low	Moderate	Moderate

Estimate of Potential Losses – Quantitative
Severe summer storms are a non-spatial hazard that can and do affect the entire city of Douglas. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Douglas are at risk from severe summer storms. According to the 2010 Census, there are 48 housing units in the city. The median value of these structures is $61,000, according to the Census. This equates to residential assets of approximately $2,928,000. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $292,800.

In addition, all identified critical assets (identified in Table 9.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of $275,859. For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Douglas. Figure 9.3.2.5-1 (following) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 9.3.2.5-1
Tornado Scenario – City of Douglas



As seen in the above figure, in such a scenario the majority of the city of Douglas would be damaged, including critical assets (government and emergency services). This scenario would result in significant damages to the city's infrastructure, and would greatly impact its ability to provide basic services, such as emergency response.

Finally, the 64 residents of Douglas are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 4.7% (children under 5) and 11% (those over 70) of the population of Douglas. Combined, these two groups account for more than 15% of the population, a total of 10 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limit;

- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

9.3.2.6 Severe Winter Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents.

In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Both development and population in Douglas have experienced a slight decrease since the 2008 plan (population decrease is estimated). Despite this decrease, a significant vulnerability exists in Douglas, in that there is no storm shelter within the municipality, nor any other facility that could be used to shelter the population during a storm or utility outage. During the plan update process, a need was identified for a storm shelter to mitigate this identified vulnerability, as well as a need to purchase emergency power generators for existing critical facilities.

There are no plans for future development in the foreseeable future; it can be assumed that this will also mean that there will not be a significant increase in population in the foreseeable future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 9.3.1-1 (previous).

The representatives from the city of Douglas determined that severe winter storms have the potential to cause the impacts described in Table 9.3.2.6-1 (below).

Table 9.3.2.6-1
Qualitative Hazard Impacts – Severe Winter Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Winter Storm	Low	Moderate	Moderate

Estimate of Potential Losses – Quantitative
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Douglas. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Douglas are at risk from severe winter storms. According to the 2010 Census, there are 48 housing units in the city. The median value of these structures is $61,000, according to the Census. This equates to residential assets of approximately $2,928,000. If 1% of these residential assets were damaged by a severe winter storm, this would result in losses of $29,280.

In addition, all identified critical assets (identified in Table 9.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of $275,859. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $27,585.

Finally, the 64 residents of Douglas are all at risk from the severe winter storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 4.7% (children under 5) and 11% (those over 70) of the population of Douglas. Combined, these two groups account for more than 15% of the population, a total of 10 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and

- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

9.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

The roadways around Douglas have experienced an increase in traffic in recent years, due in large part to the increase in energy activities throughout the state. This increase in traffic, while not directly impacting the city, does increase the city's vulnerability to the hazardous materials incident hazard, as an incident on the roadways around the city could impact the city and its residents.

This increase in traffic is likely to exist for the foreseeable future. While there is no planned future development as of this plan update, any future development that is considered must take this increased vulnerability into account.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 9.3.1-1 (previous).

The representatives from the city of Douglas determined that hazardous materials incidents have the potential to cause the impacts described in Table 9.3.2.7-1 (following).

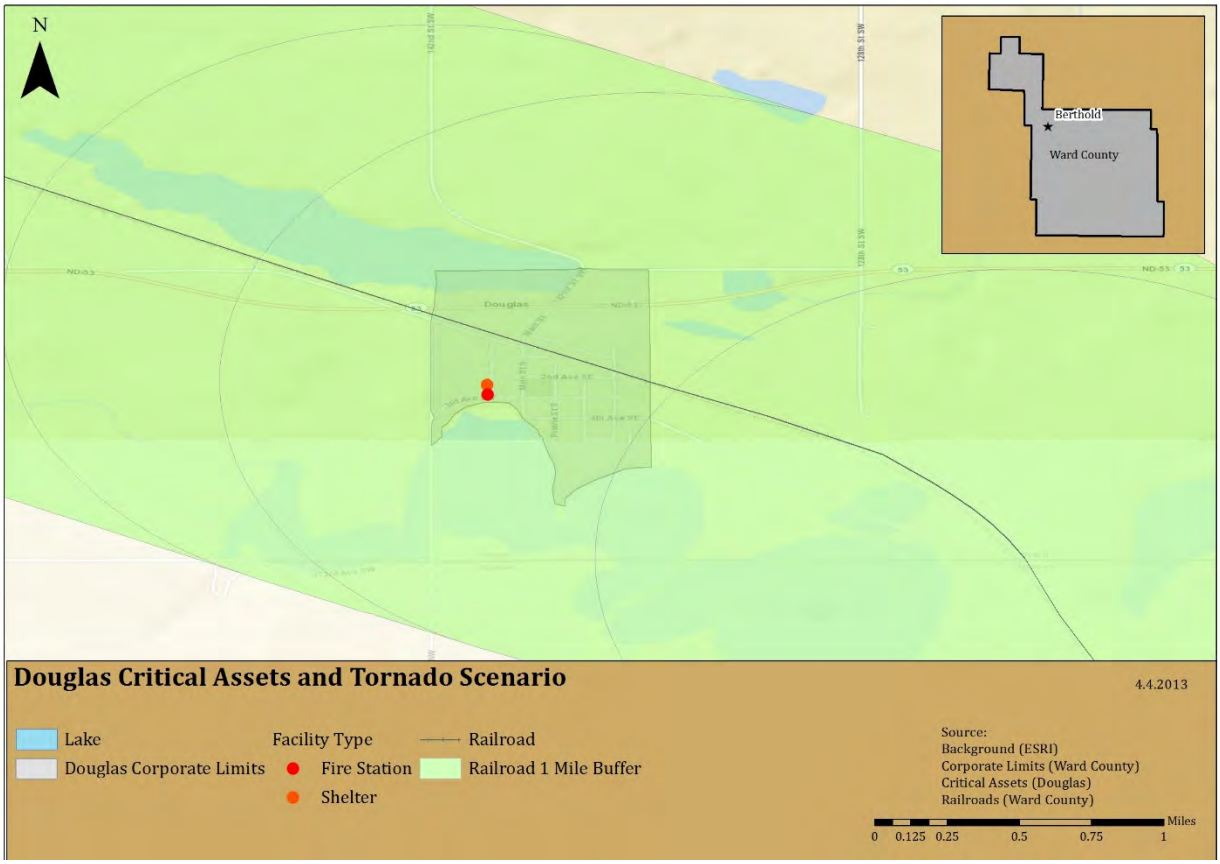
Table 9.3.2.7-1
Qualitative Hazard Impacts – Hazardous Materials Incident

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Hazardous Materials Incident	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative
For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Douglas – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

Douglas's hazardous materials risk comes from the railroad, and from the materials that are transported on it. Figure 9.3.2.7-1 (following) illustrates the location of the railroad in relation to the city of Douglas, and provides designated buffer zones around the railway. For the purposes of this assessment, all assets within these buffers would be impacted to some degree.

Figure 9.3.2.7-1
Hazardous Materials Incident Scenario – Railroad



As is evident from the above image, the entire city could be impacted by an incident hazardous materials and the railroad, as could all critical assets within the city.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

9.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Douglas's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the city has some familiarity with hazard mitigation programs, and hazard mitigation does play some role in the decision-making process for the city.
- **Current/ongoing mitigation efforts** – currently, the city's mitigation efforts include participating in the development of the Ward County Hazard Mitigation Plan Update.
- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city.
- **Planning** –the city is working with the county to develop an COP, and is also working towards completion of an evacuation plan. As of this Plan, there are no plans to develop a master plan, a disaster recovery plan, or a COOP/COG. The city is not currently a member of the NFIP, and has no mapped flood hazard areas.

- **Staff, personnel, and technical capability** – as of this Plan update, the city has moderate capability and capacity regarding hazard mitigation, and is somewhat confident in their abilities to administer hazard mitigation projects and programs. Additional experience and resources would be beneficial to building this capacity.

Like other municipalities within Ward County, Douglas depends on the framework established by the county and state government for technical assistance, and on the state and federal government for funding.

Conclusions and Recommendations
Douglas should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county towards this end.

9.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there **must** be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

9.5.1 Mitigation Goals

Table 9.5.1-1 (below) provides the mitigation goals that guide the city of Douglas's mitigation strategy.

Table 9.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

9.5.2 Mitigation Actions

Potential Mitigation Actions
Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions
Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of

special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions

Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (9.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (9.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped the city of Douglas to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 9.5.2-2. Table 9.5.2-1 (following) describes the basic criteria considered as part of the prioritization process.

Table 9.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness
Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (9.5.2-2) provides the identified and prioritized mitigation strategy for the city of Douglas.

Table 9.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes /Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Join the NFIP; enforce floodplain management ordinance and practices	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Moderate	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Moderate	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Council	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; Ward County EMA	$500+	Low	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes /Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Design and construct a facility to serve as a community storm shelter.	Fire; Flood; Severe summer storm; Severe winter storm	New	New	City Council	NDDES & FEMA mitigation grant funds; general fund; in-kind contributions; Ward County EMA	$25,000+	High	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Purchase and install emergency power generators for critical assets	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	Existing	City Council	NDDES & FEMA mitigation grant funding; general funds; Ward County EMA	$30,000+	High	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recent annexations and/or recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council	General funds; in-kind contributions; Ward County EMA	$500+	Moderate	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes /Updates
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council	General fund; in-kind contributions; Ward County EMA	$500+	Moderate	
Goal 05: Provide long-term mitigation solutions to areas/structures that experience repetitive hazard damage or loss.	Develop and construct flood protection measure(s) for protection of repetitively flooded areas and properties.	Flood	New	Existing	City Council	NDDES & FEMA mitigation grant funding; general funds; State Water Commission; Ward County EMA	$10,000+	High	

Section 10
City of Kenmare: HIRA, Capability Assessment, and Mitigation Strategy

10.1 IFR for Hazard Identification and Risk Assessment
10.2 Hazard Identification (Updated)
10.2.1 Overview of Kenmare's History of Hazards and Potential Hazards
10.2.2 Hazard Profiles
10.3 Risk Assessment (Updated)
10.3.1 Risk Assessment Methodology
10.3.2 Risk and Vulnerability Assessment
10.4 Capability Assessment (Updated)
10.5 Mitigation Strategy (Updated)
10.5.1 Mitigation Goals
10.5.2 Mitigation Actions

10.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..*

Requirement §201.6(c)(2)(ii)(C): *[The plan* ***should*** *describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment* ***must*** *assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Kenmare.

10.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Kenmare. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

10.2.1 Overview of Kenmare's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 31 weather-related hazard events have occurred in the city of Kenmare since 1994, including the following number and types of hazard events:

- Hail – 21
- Thunderstorm – 3
- Tornado/Funnel Cloud – 3

- Heavy Rain - 4

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 10.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 10.2.1-1
Presidential Disaster Declarations – City of Kenmare

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Kenmare

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 10.2.1-2 (below).

Table 10.2.1-2
Preliminary Hazard Identification and Determinations – City of Kenmare

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Kenmare	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Kenmare	Reason for Exclusion and other notes
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Kenmare	Reason for Exclusion and other notes
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

10.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

10.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk.

Table 10.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 10.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the

severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Kenmare.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 10.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 10.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 10.2.2.1-3 (following) provides the details of pertussis outbreaks since 2007.

Table 10.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 10.2.2.1-4 (below) provides occurrence information for rabies.

Table 10.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Kenmare did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Kenmare, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Kenmare, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been no occurrences of communicable disease within the city of Kenmare. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

10.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Kenmare are subject to the drought hazard.

Extent and Severity of the Hazard
Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.

- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

Table 10.2.2.2-1 (below) provides the PDSI classifications.

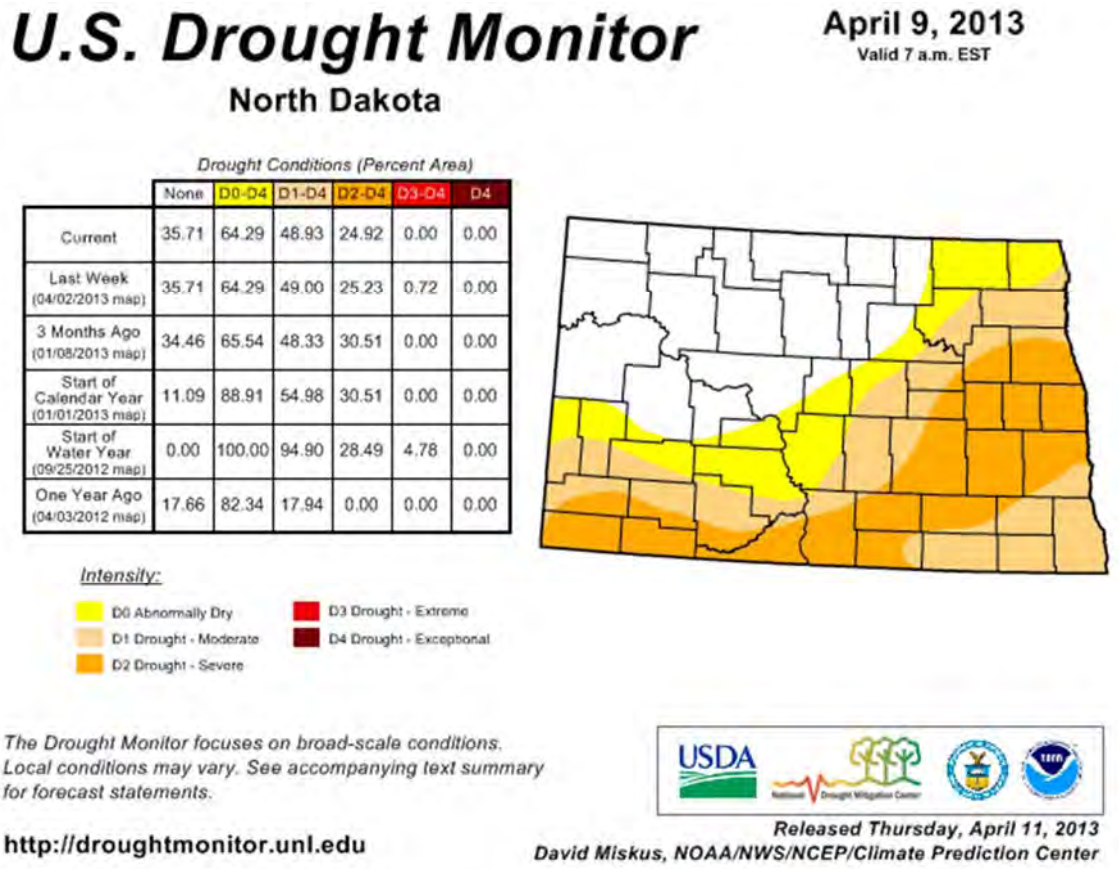
Table 10.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested

Classification	Description	Range of Possible Impacts
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Kenmare are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 10.2.2.2-1 (following).

Figure 10.2.2.2-1
US Drought Monitor – North Dakota
(source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 10.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Kenmare – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

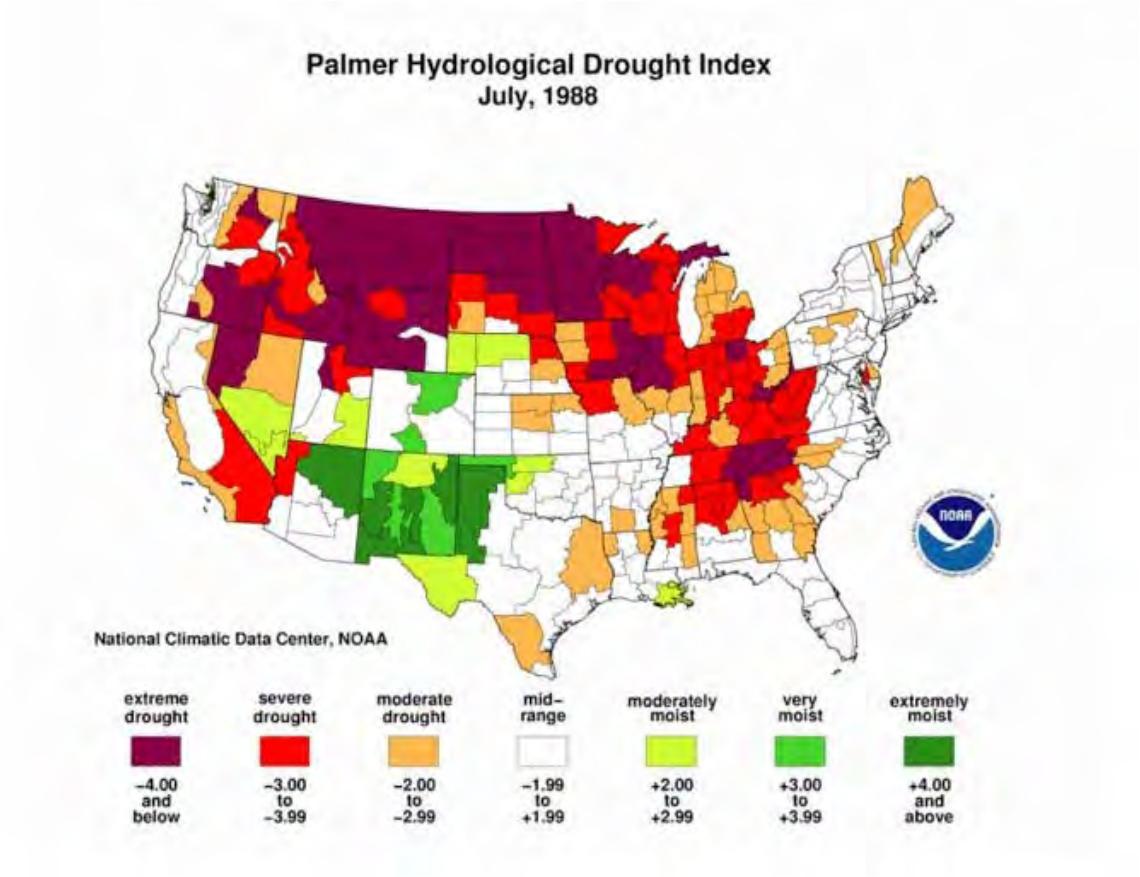
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Kenmare. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 10.2.2.2-2 (following), the entire state – including the city of Kenmare – was categorized as being in extreme drought during this time.

Figure 10.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Kenmare) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years in more recent history.

10.2.2.3 Fire

This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

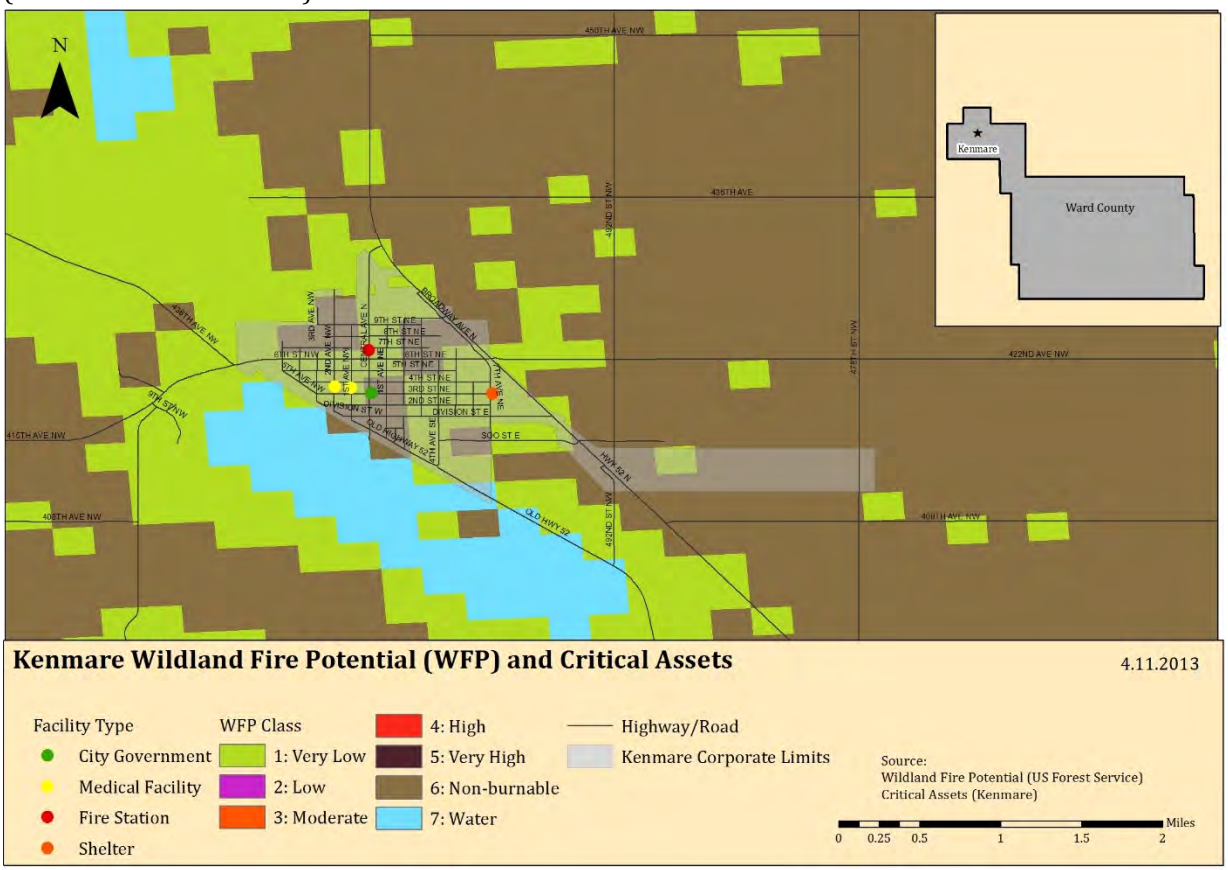
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 10.2.2.3-1 (following) illustrates the wildland fire potential for the city of Kenmare, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 10.2.2.3-1
City of Kenmare – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard

The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 10.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System.

Table 10.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people. In addition, some structures (such as grain elevators) require specialized teams and equipment, and so response to these events may be delayed.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Based on data obtained from the city, Kenmare has experienced 17 structure fires from January 2008 through December 2012, an average of 3.4 structure fires per year. For this same time period, 75 wildland fires (grass fires) were responded to, an average of 15 per year.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in the city of Kenmare at least once per year. Using the scale provided earlier in this section, this equates to a high probability of a future occurrence.

10.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters,*

from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

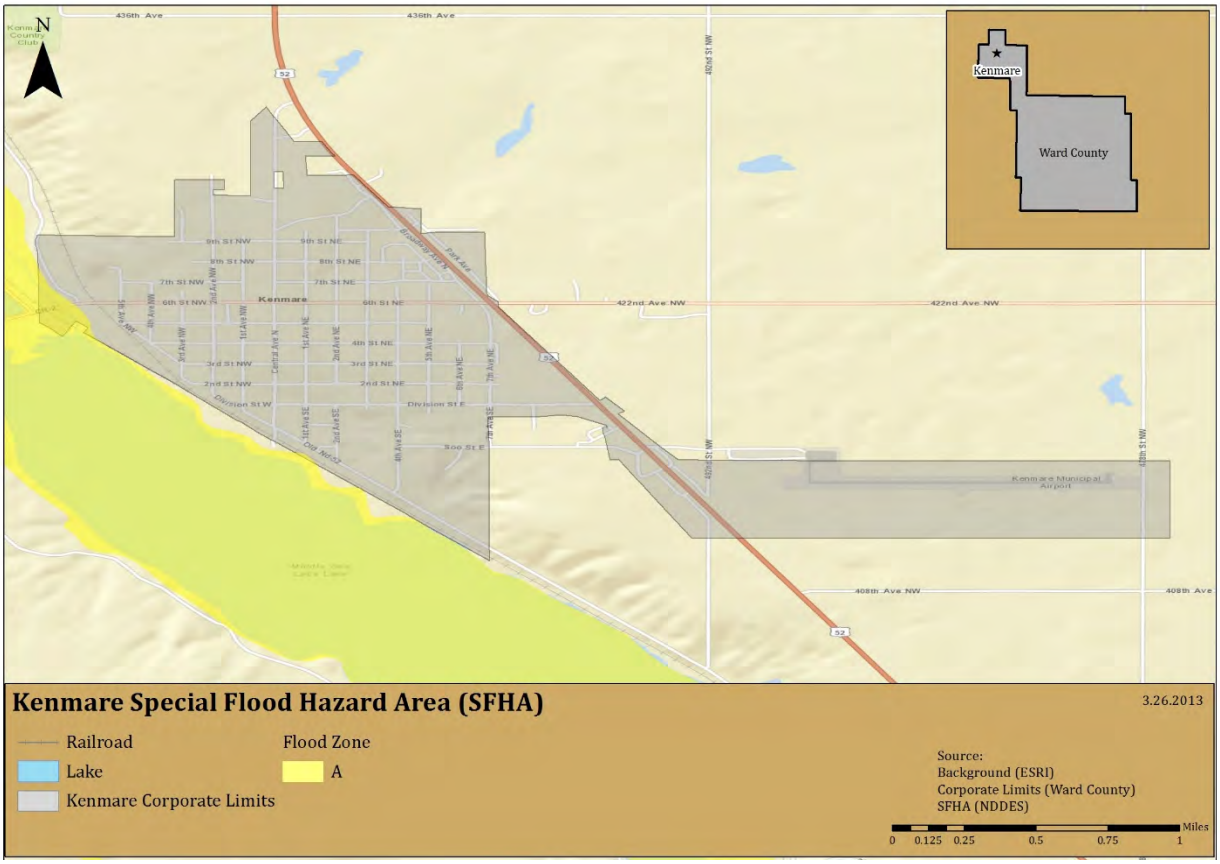
Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard

Kenmare has a small area of one percent annual chance floodplain inside of its corporate limits, but has significant areas adjacent to its boundaries. These areas are illustrated in Figure 10.2.2.4-1 (following).

Figure 10.2.2.4-1
Special Flood Hazard Areas



Extent and Severity of the Hazard

In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 10.2.2.4-1 (below).

Table 10.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.

Zone Designation	Percent Annual Chance of Flood	Description
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 10.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 10.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

Term	Definition
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

The city of Kenmare is not currently a member of the NFIP, and is currently sanctioned by the program. There are no designated Repetitive Loss or Severe Repetitive Loss properties within the city of Kenmare.

Potential Impact of the Hazard
Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A major flood occurred in the Souris River Basin in 1969, which greatly impacted the region (though not specifically the city of Kenmare). More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley.

The city of Kenmare reported no incidents of flooding in the city.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs at less than once every five years in the city of Kenmare. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is low.

10.2.2.5 Severe Summer Storms

This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

Extreme Heat
Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail
Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning
Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of

the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms
Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard
Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Kenmare.

Extent and Severity of the Hazard
Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat
The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.
- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide

enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.

- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 10.2.2.5-1(following). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 10.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail

The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 10.2.2.5-1 (below) provides details of these scales.

Table 10.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33"	Pea	No damage
H1	Potentially Damaging	0.33" – 0.60"	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60" – 0.80"	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80" – 1.20"	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20" – 1.60"	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60" – 2.0"	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0" – 2.4"	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4" – 3.0"	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0" – 3.5"	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5" – 4.0"	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning

The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the

wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- Ground-to-Cloud Lightning**.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning.** Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning**. Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 10.2.2.5-2 (following) provides this severity scale.

Table 10.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to

describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 10.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 10.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Table 10.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 10.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Given that Kenmare is smaller than 15 miles in diameter, it is possible for the entire jurisdiction to be impacted by the same thunderstorm at any given time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from

thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Kenmare are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at

the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 10.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 10.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties

- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact

on life due to thunderstorm and associated hazards in Kenmare would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard

Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least 31 occurrences of the summer storm hazard since 1994. (Note: Records prior to 1994 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 10.2.2.5-6 (below) provides details of these recorded incidents.

Table 10.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Description	Magnitude (if applicable)
August 24, 1994	Thunderstorm wind	Unknown
July 09, 1998	Hail	.75”
July 13, 1999	Tornado/Funnel cloud; Hail	Unknown; 1”
July 19, 2001	Hail (2 occurrences)	1.5”and 1.75”
August 07, 2001	Thunderstorm wind	61 MPH
August 25, 2002	Hail	.75”
August 26, 2002	Hail	1.75”
August 27	Hail (2 occurrences)	1.75 and .75”
July 03, 2003	Hail	1”
July 18, 2003	Hail	.75”
August 08, 2003	Hail	1.5”
June 06, 2004	Hail (3 occurrences	1”; 2.75” and .88”
July 11, 2004	Thunderstorm wind	61 MPH
September 09, 2004	Hail	.75”and 1”
July 01, 2005	Tornado/Funnel cloud	Unknown
June 25, 2007	Hail	2”
May 29, 2010	Hail	1”
June 25, 2010	Tornado/Funnel cloud	Unknown

Date	Description	Magnitude (if applicable)
July 03, 2010	Hail	2" and 1"
July 26, 2010	Hail	1"
June 25, 2011	Heavy Rain (4 occurrences)	--

Probability of a Future Occurrence of the Hazard
In the 18 year period for which records are available, the summer storm hazard has occurred at least 31 times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is high, as the summer storm hazard occurs at least annually.

10.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard
Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow
The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility

can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold
What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice
The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Kenmare.

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold

Winter temperatures in Kenmare typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 10.2.2.6-1 (below) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 10.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)

NWS Windchill Chart

Wind (mph) \ Temperature (°F)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

- **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.
- **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard
Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard
According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes, accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.
- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.
- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard
Based on the data available, winter storms occur in or otherwise impact the city of Kenmare at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

10.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard
Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard
The locations in Kenmare most at risk from a hazardous materials incident are those that are in proximity to transportation routes, specifically the railroad, and that are in proximity to pipelines. The following figures (10.2.2.7-1 and 10.2.2.7-2) illustrate these locations in Kenmare.

Figure 10.2.2.7-1
Hazardous Materials Locations – Railroad

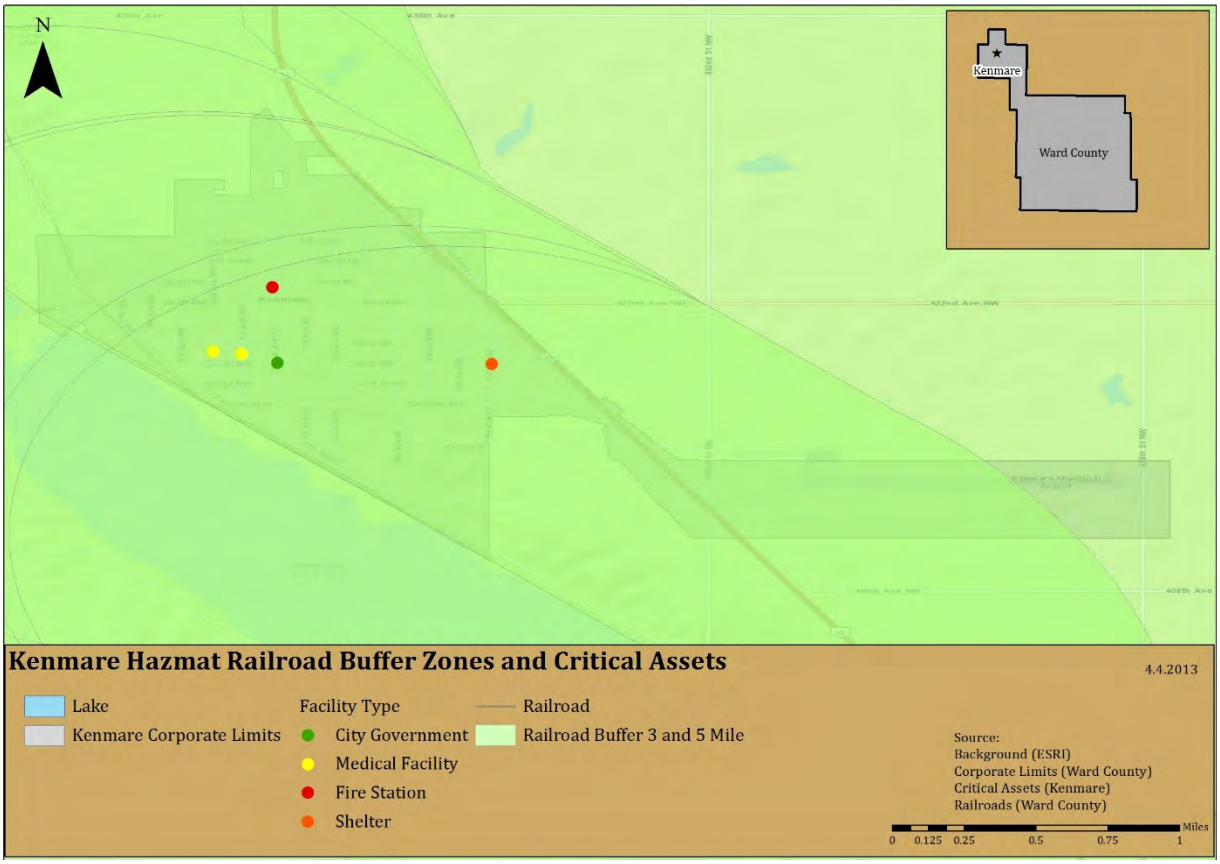
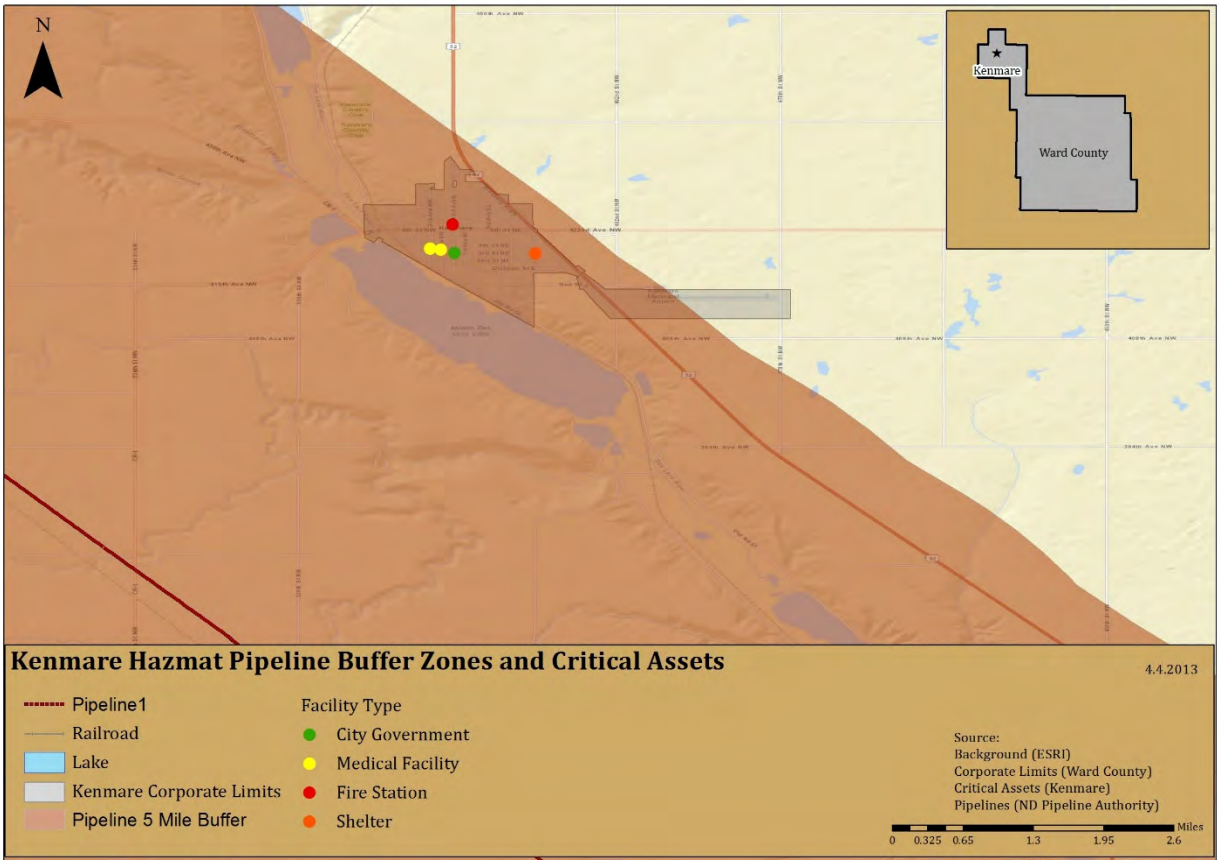


Figure 10.2.2.7-2
Hazardous Materials Locations – Pipelines



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, no Tier II reports from the city of Kenmare have been submitted to the EPA since 1987, the year that the EPA began keeping such reports.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in Ward County, though not necessarily in the city of Kenmare. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

10.3 Risk Assessment (Updated)

The following table (Table 10.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Kenmare.

Table 10.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

10.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Kenmare from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

Impact Scale Methodology
The potential impacts of each hazard were discussed by the Steering Committee. For the purposes of this discussion, a qualitative impact scale was developed, and was used by the Steering Committee in their discussions. As a result of these discussions, each hazard was assigned a qualitative impact ranking. This scale appears in Table 10.3.1-1 (below).

Table 10.3.1-1
Hazard Impact Scale

Term	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Low	Some minor injuries possible, but no fatalities	Cosmetic damages expected to assets; Infrastructure loss of function for less than 24 hours expected	System delivery delayed or temporarily interrupted; Interruptions in service delivery of less than 24 hours expected
Moderate	Injuries expected; Fatalities possible	Some structural damages to light construction (<50 % damage); Infrastructure loss of function for 24-72 hours expected	System delivery failures expected; Interruptions in service delivery of 24-72 hours expected
High	Serious and numerous injuries expected; Fatalities expected	Some structures irreparably damaged (>50% damage); Infrastructure loss of function for 72+ hours expected	Long-term system failures/damages expected; Cancellation of services (72+ hours) expected
Not Applicable	Hazard does not have the potential to impact people or life safety	Hazard does not have the potential to impact assets or infrastructure	Hazard does not have the potential to impact service delivery

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Kenmare to the identified and profiled hazards.

Critical Assets

The table below (Table 10.3.1-2) provides details of the critical assets contained within the city of Kenmare.

Table 10.3.1-2
Critical Assets – City of Kenmare

Asset Name	Asset Use /Function	Street Number	Street Name	Insured or Estimated Value
Kenmare Fire Department	Emergency Services	617	Central Avenue	$175,469
Kenmare Rural Fire Department	Emergency Services	617	Central Avenue	$175,469
Kenmare Ambulance	Emergency Services	5	3rd Street NE	$175,469
Kenmare Police Department	Emergency Services	5	3rd Street NE	$175,469
Kenmare High School	Shelter	300	7th Avenue NE	$20,586
Kenmare City Hall	Government	5	3rd Street NE	$175,469
Water Pump House Lift Station	Utility	--	4th Avenue SE	$125,369
Lift Station	Utility	--	--	$66,431
Siren	Emergency Alert	--	--	$48,995
Siren	Emergency Alert	--	--	$48,995
Airport	Transportation	--	--	$1,346,172
Kenmare Community Hospital	Medical	--	--	$1,500,000
Maple View	Medical	--	--	1,000,000
Siren	Emergency Alert	--	--	$48,995
Total estimated value of identified critical assets:				**$5,081,123**

Note on asset values: Valuation data for assets within the city was unavailable at the time this plan update was developed. All valuations used in the following estimates of potential losses are derived from an average of available data for the same or similar types of assets from other jurisdictions. The assessment that follows is an estimate only, and may not correlate with actual occurrences of the damage caused by the hazards described.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted

may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

10.3.2 Risk and Vulnerability Assessment

10.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 1,096 people residing in Kenmare; this is slightly higher than the 2012 Census Estimate of 1,062, and the 2000 Census count of 1,081. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

No future development was identified during the Plan Update process; therefore, there is no reason to assume that the population – and its accompanying vulnerability – will change in the foreseeable future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 10.3.1-1 (previous).

The representatives from the city of Kenmare determined that communicable disease has the potential to cause the impacts described in Table 10.3.2.1-1 (following).

Table 10.3.2.1-1
Qualitative Hazard Impacts – Communicable Disease

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Communicable Disease	Low	Low	Low

Estimate of Potential Losses – Quantitative
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Kenmare represents ~2% of the total population of Ward County, or 1,096 people. While an outbreak of communicable disease in Kenmare is unlikely to have significant impacts outside of Kenmare, an outbreak could have significant impacts within the city.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness rate in Kenmare that is similar to the illness rate across the county, the following numbers of people in Kenmare could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Kenmare accounts for ~2% of the county population. This equates to 90 cases of influenza in Kenmare, on average, that could potentially impact the city.
- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Kenmare accounts for ~2% of the county population. This equates to 130 cases of pertussis in Kenmare, on average, that could potentially impact the city.

Identified Data Limitations
There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;
- Data regarding projected population changes; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

10.3.2.2 Drought

Vulnerability to the Hazard
Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies depend largely on agriculture, such as the State of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result in significant societal disruption, which can worsen as the resource becomes more and more precious.

Kenmare is not economically dependent on agriculture, and so has limited vulnerability to agricultural drought. Both development and population in Kenmare have remained relatively stable in recent years, with very slight increases in both counts (according to the Census Bureau). While there are no published plans for significant future developments, the plan update process did identify a need for a booster water pump station, to mitigate the city's existing vulnerability to water pressure loss, to ensure that available water can be successfully distributed to needed areas.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 10.3.1-1 (previous).

The representatives from the city of Kenmare determined that drought has the potential to cause the impacts described in Table 10.3.2.2-1 (following).

Table 10.3.2.2-1
Qualitative Hazard Impacts – Drought

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Drought	Low	Low	Low

Estimate of Potential Losses – Quantitative
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this

cycle will end in the near future, the Steering Committee directed that no quantitative risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no quantitative risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

10.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

According to the 2010 Census, Kenmare has experienced a slight increase in both population and residential development in the previous decade. While there are no plans for significant future development as of this plan update, the city expects to grow in the future, and so has made plans to accommodate this growth. These plans include additional warning sirens, emergency generators, and a booster water pump station; these projects will ensure that the city mitigates its vulnerability to fire to the best of its ability.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss

to their particular jurisdiction. The explanation for these rankings appears in Table 10.3.1-1 (previous).

The representatives from the city of Kenmare determined that fire has the potential to cause the impacts described in Table 10.3.2.3-1 (below).

Table 10.3.2.3-1
Qualitative Hazard Impacts – Fire

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Fire	High	High	High

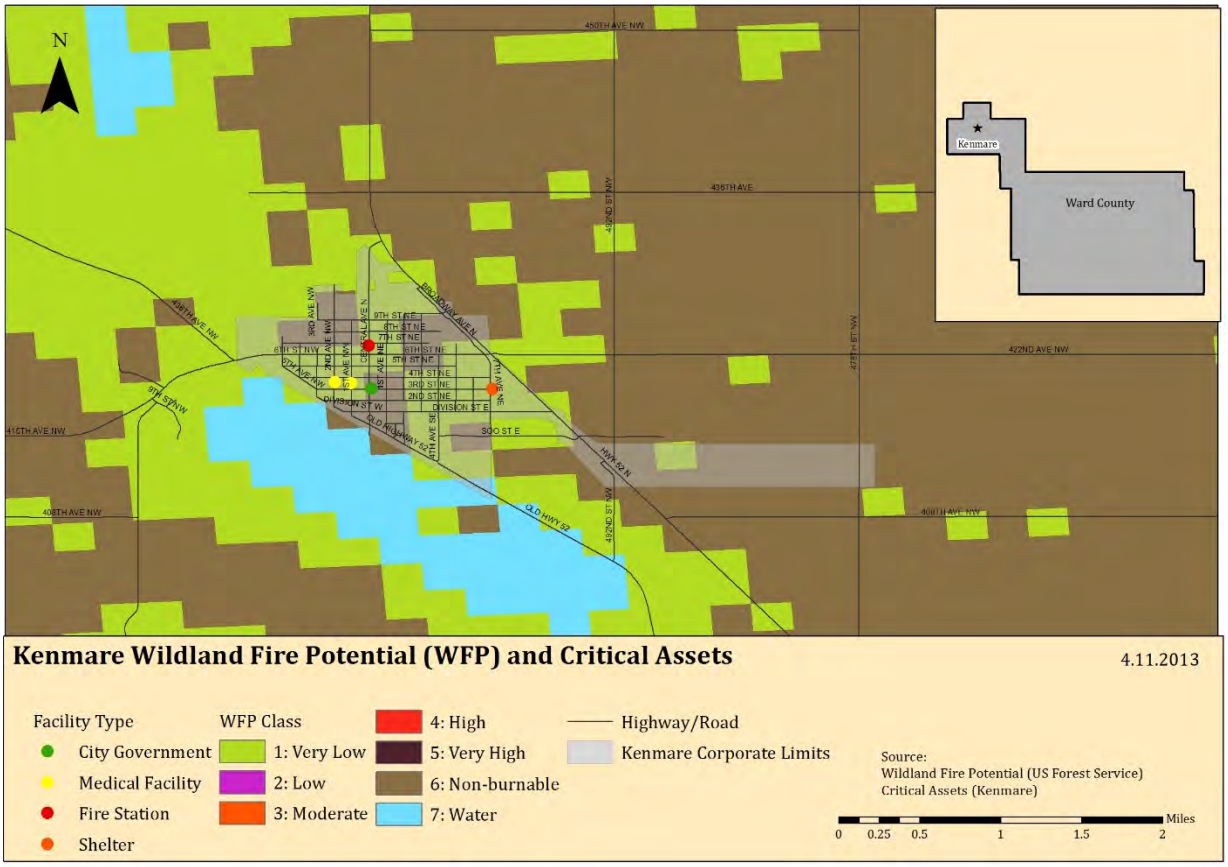
Estimate of Potential Losses – Quantitative
All structures within the city of Kenmare are at risk from fire. According to the 2010 Census, there are 558 housing units in the city; 439 of these units are occupied, and 119 are vacant. The majority of these structures are heated either by bottled gas or by electricity. The median value of single family housing in Kenmare is $72,000, according to the Census. This equates to potential residential losses of $40,176,000.

In addition, all identified critical assets (identified in Table 10.3.1-1) within the city have the potential to be lost to fire. These assets have a combined estimated value of $5,081,123.

Using the US Forest Service's Wildland Fire Potential data, the city of Kenmare and its critical assets were mapped. Based on this data set, the city of Kenmare has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 10.3.2.3-1 (following) illustrates this fire potential in relation to the identified critical assets for the city.

Figure 10.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

10.3.2.4 Flood

Vulnerability to the Hazard
Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

Flood damages also take considerable time to recover from. The 2011 flooding that occurred throughout the county had far-reaching impacts, and recovery for many areas remains a work in progress as of this Plan update.

While there are no identified plans for significant future development as of this plan update, this may change in the future. Any plans for future development should consider Kenmare's flood hazard, and the vulnerability of planned developments – and their subsequent occupying populations.

The city of Kenmare is not a member of the NFIP, and is sanctioned by the program. As of February 2013, there were no NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the city of Kenmare.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 10.3.1-1 (previous).

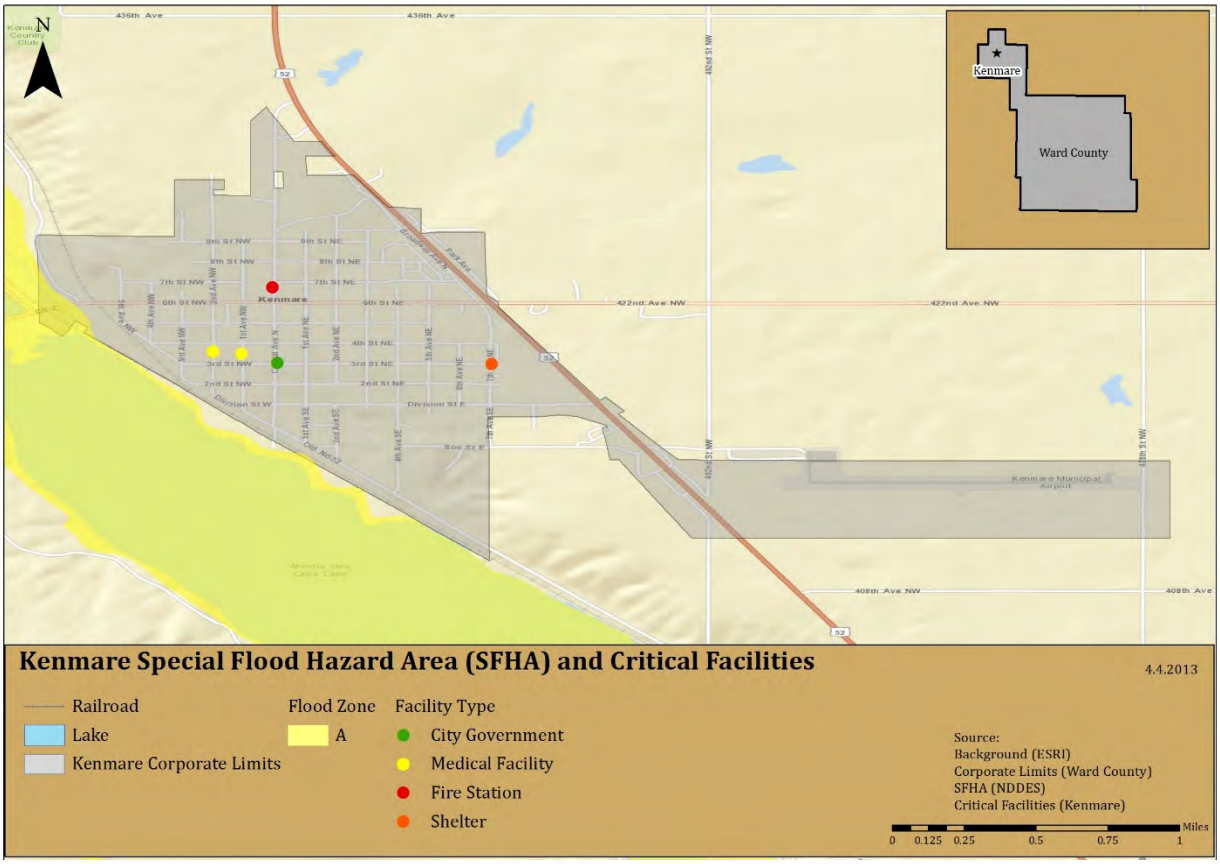
The representatives from the city of Kenmare determined that flooding has the potential to cause the impacts described in Table 10.3.2.4-1 (below).

Table 10.3.2.4-1
Qualitative Hazard Impacts – Flood

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Flood	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative
Kenmare has identified and mapped floodplains, both within the corporate limits and just outside of the corporate limits. Figure 10.3.2.4-1 (following) illustrates the locations and boundaries of the one percent annual chance floodplain. Critical assets for the city have been overlaid onto this hazard boundary map.

Figure 10.3.2.4-1
Special Flood Hazard Areas and Kenmare Critical Assets



As seen in the image above, Kenmare's critical assets are located outside of any identified flood hazard area, and have limited exposure to the flood hazard. However, given that the NFIP estimates that 30% of flood damages occur outside of any identified floodplain, it is reasonable to assume that at least some losses would occur to these critical assets. Using the NFIP's estimate, a loss of 30% to Kenmare's critical assets would equate to at least $1,524,337 in damages.

The same cannot be said for the rest of the structures in the city, however, some of which are located within or adjacent to identified floodplains. If 10% of the 558 residential structures in the city are damaged by flooding, this equates to 56 flood damaged structures. Given that the median value of a single-family housing unit in Kenmare is $72,000, this scenario would result in $4,032,000 in structural flood losses. Assuming a contents value of 50% of structure value, an additional loss of $2,016,000 in contents and personal property could be expected.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

10.3.2.5 Severe Summer Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

During the plan update process, Kenmare identified a vulnerability in their ability to provide warning of storm events to residents. It was determined that additional warning sirens should be acquired to mitigate this vulnerability. While there are no published plans for significant future development as of this plan update, additional warning sirens may be considered in the future, in the event that this changes, as additional development will mean additional population.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 10.3.1-1 (previous).

The representatives from the city of Kenmare determined that severe summer storms have the potential to cause the impacts described in Table 10.3.2.5-1 (following).

Table 10.3.2.5-1
Qualitative Hazard Impacts – Severe Summer Storm

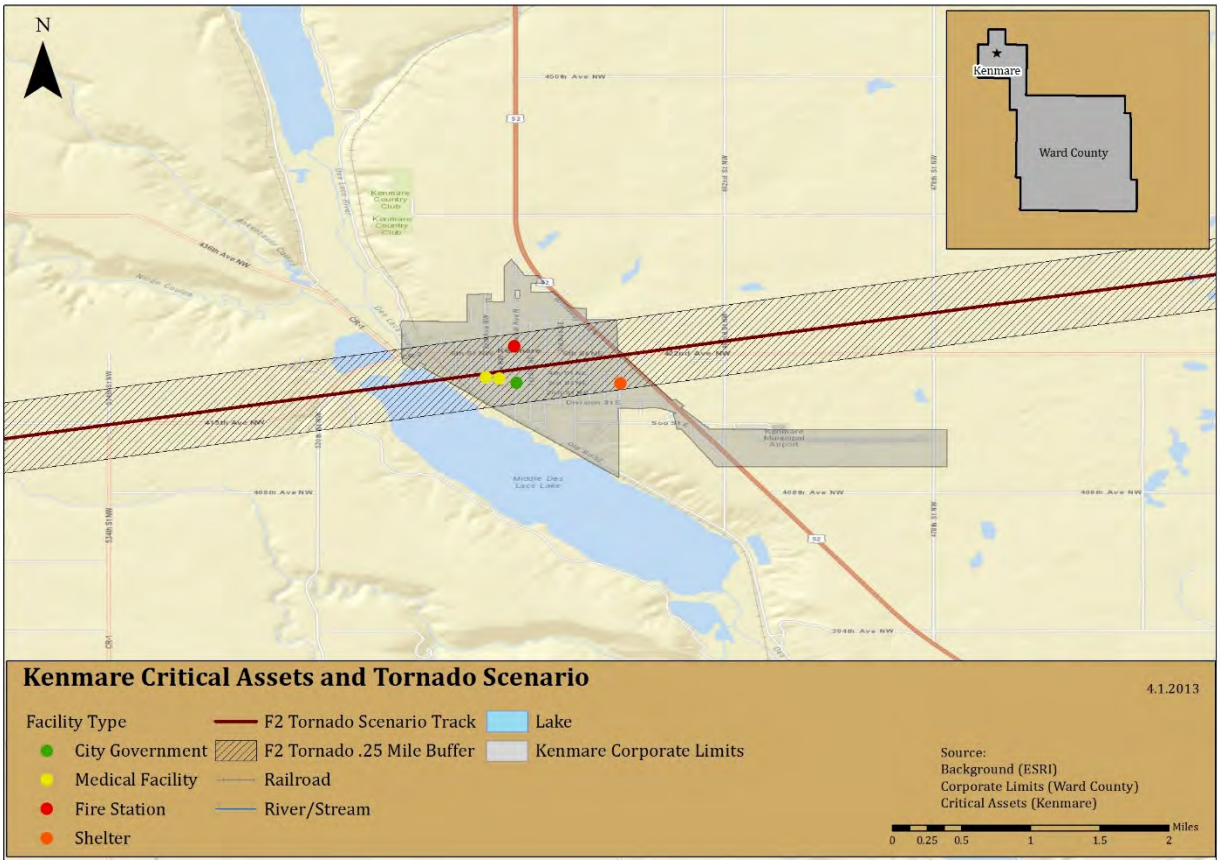
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Summer Storm	High	High	High

Estimate of Potential Losses – Quantitative
Severe summer storms are a non-spatial hazard that can and do affect the entire city of Kenmare. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Kenmare are at risk from severe summer storms. According to the 2010 Census, there are 558 housing units in the city. The median value of these structures is $72,000, according to the Census. This equates to residential assets of approximately $48,176,000. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $4,017,600.

In addition, all identified critical assets (identified in Table 10.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of $5,081,123. For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Kenmare. Figure 10.3.2.5-1 (following) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 10.3.2.5-1
Tornado Scenario – City of Kenmare



As seen in the above figure, in such a scenario the majority of the city of Kenmare would be damaged, including critical assets (government and emergency services). This scenario would result in significant damages to the city's infrastructure, and would greatly impact its ability to provide basic services, such as emergency response.

Finally, the 1,096 residents of Kenmare are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 12% (children under 5) and 5.8% (those over 75) of the population of Kenmare. Combined, these two groups account for more than 17% of the population, a total of 199 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limit;

- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

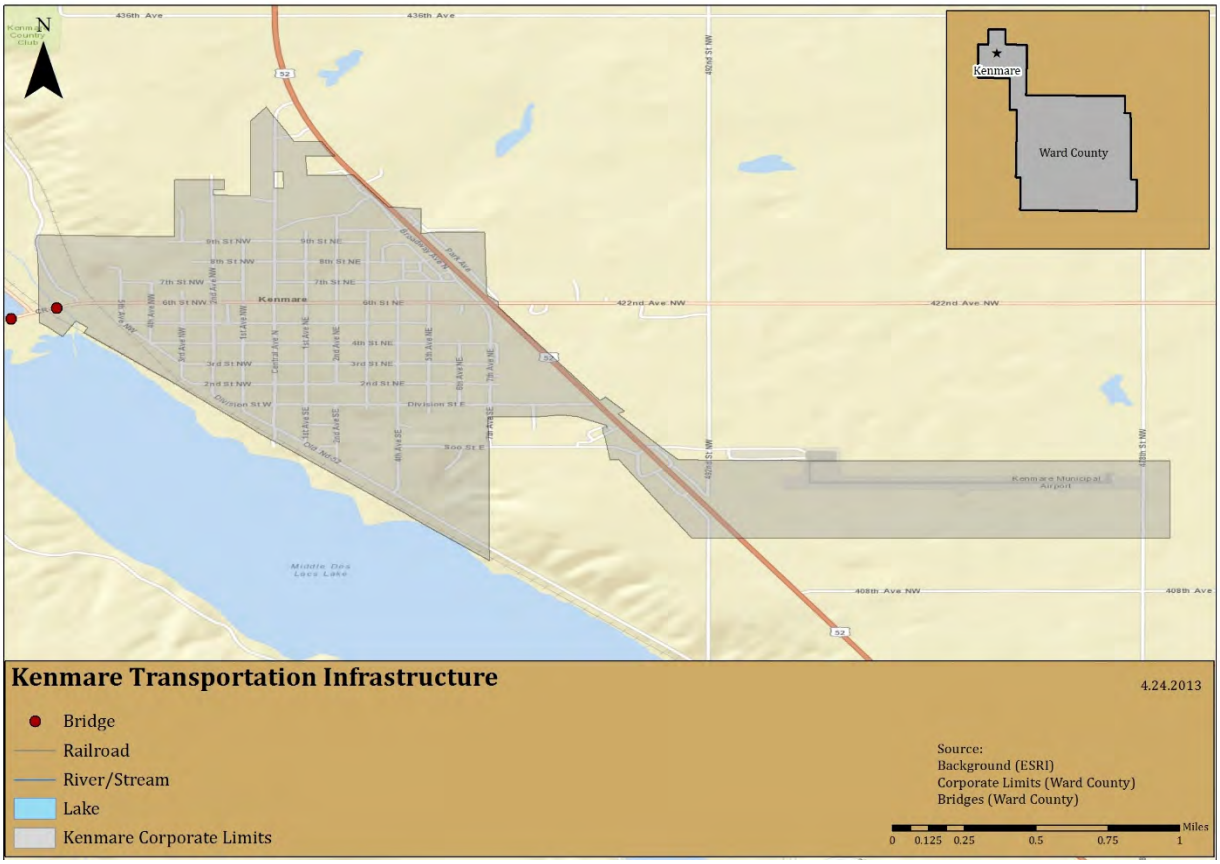
10.3.2.6 Severe Winter Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents. Figure 10.3.2.6-1 (following) provides the locations of bridges in and around the city, which typically ice over before surround roadways, making them treacherous for travel.

Figure 10.3.2.6-1
Kenmare – Bridges



In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

During the plan update process, Kenmare identified a vulnerability in their ability to provide warning of storm events to residents. It was determined that additional warning sirens should be acquired to mitigate this vulnerability. Also, it was determined that vulnerabilities to utility outage could be mitigated through the acquisition of emergency power generators. While there are no published plans for significant future development as of this plan update, additional warning sirens and generators may be considered in the future, in the event that this changes, as additional development will mean additional population.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss

to their particular jurisdiction. The explanation for these rankings appears in Table 10.3.1-1 (previous).

The representatives from the city of Kenmare determined that severe winter storms have the potential to cause the impacts described in Table 10.3.2.6-1 (below).

Table 10.3.2.6-1
Qualitative Hazard Impacts – Severe Winter Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Winter Storm	Moderate/High	Low	Moderate

Estimate of Potential Losses – Quantitative
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Kenmare. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Kenmare are at risk from severe winter storms. According to the 2010 Census, there are 558 housing units in the city. The median value of these structures is $72,000, according to the Census. This equates to residential assets of approximately $40,176,000. If 1% of these residential assets were damaged by a severe summer storm, this would result in losses of $401,760.

In addition, all identified critical assets (identified in Table 10.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of $5,081,123. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $508,112.

Finally, the 1,096 residents of Kenmare are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 12% (children under 5) and 5.8% (those over 75) of the population of Kenmare. Combined, these two groups account for more than 17% of the population, a total of 199 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;

- Data regarding projected changes in population; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

10.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

The surrounding roadways around Kenmare have experienced increases in traffic in recent years, due in large part to the increase in energy activities throughout the state. While this increase in traffic does not necessarily translate into a direct increase in vulnerability to Kenmare, it does result in increased indirect vulnerability, as an incident on the roadways surrounding Kenmare would certainly impact the city and its residents. This increased activity resulted in an identified need for additional warning sirens, to ensure that all residents can be warned of an incident in a timely manner. Any future development, while not currently planned, must consider this increased exposure, and plan accordingly.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 10.3.1-1 (previous).

The representatives from the city of Kenmare determined that hazardous materials incidents have the potential to cause the impacts described in Table 10.3.2.7-1 (following).

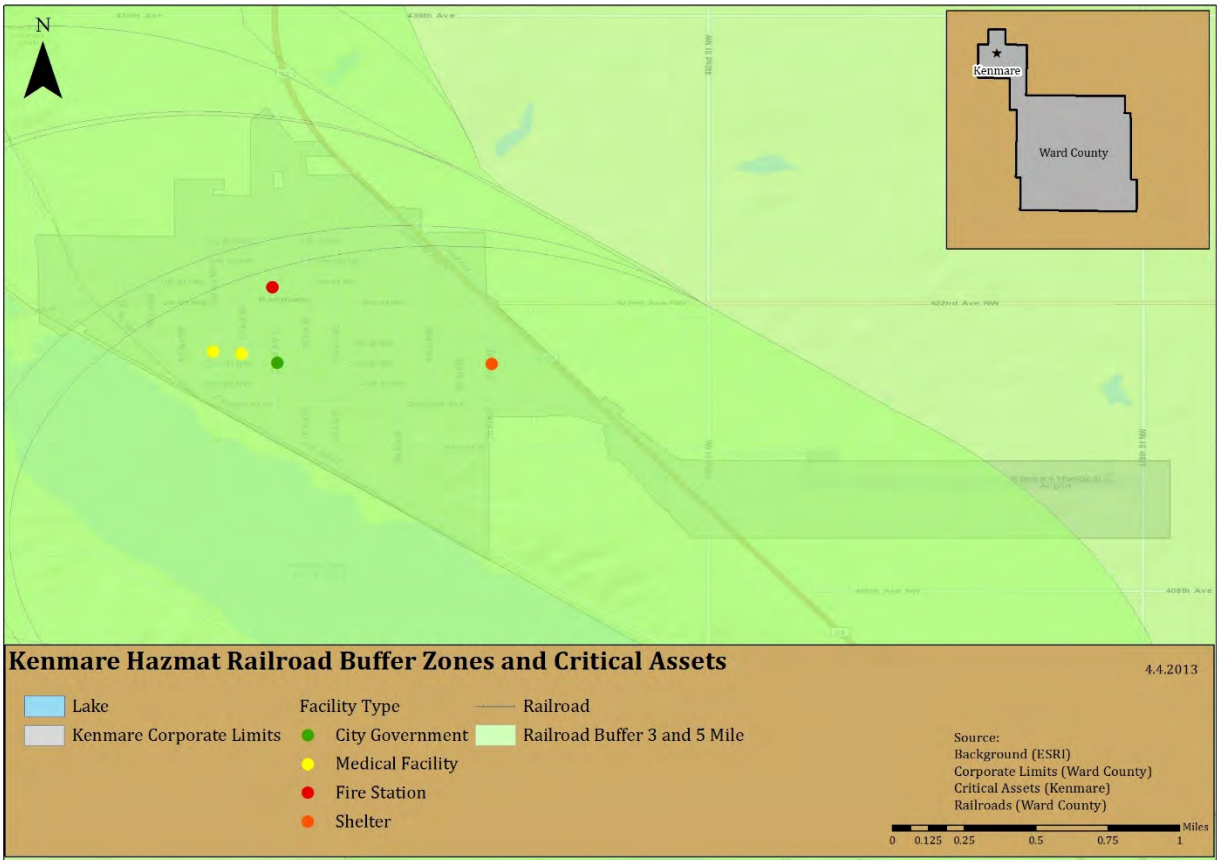
Table 10.3.2.7-1
Qualitative Hazard Impacts – Hazardous Materials Incident

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Hazardous Materials Incident	High	Low	Low

Estimate of Potential Losses – Quantitative
For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Kenmare – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

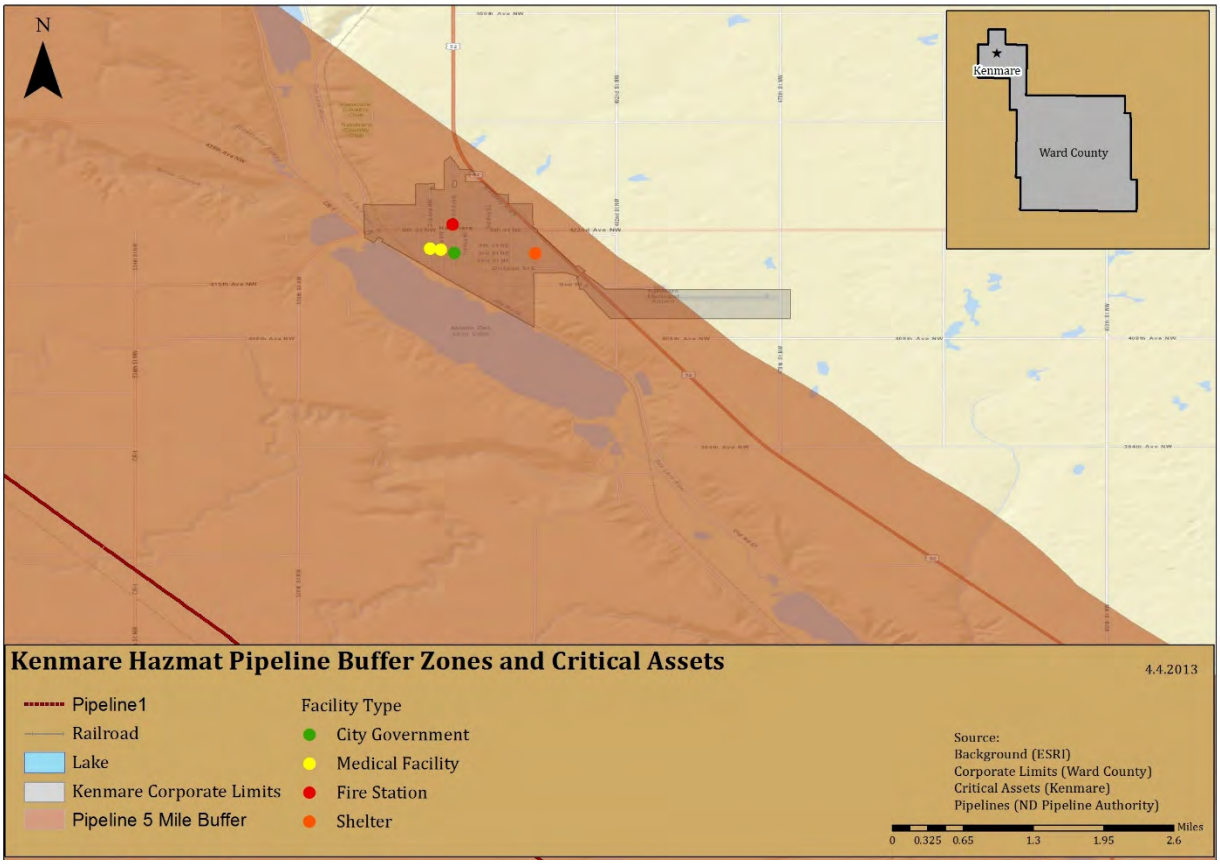
Kenmare's hazardous materials risk comes from the railroad, and from the materials that are moved through pipelines. Figures 10.3.2.7-1 and 10.3.2.7-2 (below and following) illustrate the locations of the railroad and pipelines in relation to the city of Kenmare, a buffer zone has been added to illustrate the potential area of impact from an event, given the right conditions and circumstances For the purposes of this assessment, all assets within this buffer would be impacted to some degree.

Figure 10.3.2.7-1
Hazardous Materials Incident Scenario – Railroad



As is evident from the above image, the entire city could be impacted by an incident hazardous materials and the railroad, as could all critical assets within the city.

Figure 10.3.2.7-2
Hazardous Materials Incident Scenario – Pipelines



Though there are no pipelines within the city limits, a pipeline is located within ½ mile of the city, and has the potential to cause impacts or damage in the event of an accident.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

10.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Kenmare's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the city has some familiarity with hazard mitigation programs, and hazard mitigation does play a role in the decision-making process for the city.
- **Current/ongoing mitigation efforts** – currently, the city's mitigation efforts include participating in the development of the Ward County Hazard Mitigation Plan Update.
- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city.
- **Planning** –the city does not have a great deal of formalized planning efforts. There is no recovery plan, no evacuation plan, no COOP/COG, and no master or comprehensive plan. The city is a not member of the NFIP.
- **Staff, personnel, and technical capability** – as of this Plan update, the city has a limited capability and capacity regarding hazard mitigation, and is somewhat confident in their

abilities to administer hazard mitigation projects and programs. Additional experience and resources would be beneficial to building this capacity.

Like other municipalities within Ward County, Kenmare depends on the framework established by the county and state government for technical assistance, and on the state and federal government for funding.

Conclusions and Recommendations
Kenmare should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county towards this end.

6.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv)*: For multi-jurisdictional plans, there **must** be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

10.5.1 Mitigation Goals

Table 10.5.1-1 (following) provides the mitigation goals that guide the city of Kenmare's mitigation strategy.

Table 10.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

10.5.2 Mitigation Actions

Potential Mitigation Actions
Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions
Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike

wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions

Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (10.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (10.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped the city of Kenmare to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 10.5.2-2. Table 10.5.2-1 (below) describes the basic criteria considered as part of the prioritization process.

Table 10.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.

STAPLEE	Criteria Explanation
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness

Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (10.5.2-2) provides the identified and prioritized mitigation strategy for the city of Kenmare.

Table 10.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes / Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Join the National Flood Insurance Program	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Low	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Low	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Council	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; Ward County EMA	$500+	Moderate	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes / Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Purchase and install additional warning sirens	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council	NDDES & FEMA mitigation grant funding ; General funds; Ward County EMA	$30,000+	High	
Goal 03: Protect public health and safety before, during, and after hazard events.	Purchase and install emergency power generators at critical assets	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council	NDDES & FEMA mitigation grant funding ; General funds; Ward County EMA	$30,000+	High	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Design and construct a booster station for water, to ensure availability and operation of delivery system.	Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council	NDDES & FEMA mitigation grant funding ; General funds; in-kind donations; Ward County EMA	$30,000+	High	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes / Updates
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recent annexations and/or recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council	General fund; in-kind contributions; Ward County EMA	$500+	Low	
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council	General fund; in-kind contributions; Ward County EMA	$500+	Low	

Section 11
City of Makoti: HIRA, Capability Assessment, and Mitigation Strategy

11.1 IFR for Hazard Identification and Risk Assessment
11.2 Hazard Identification (Updated)
11.2.1 Overview of Makoti's History of Hazards and Potential Hazards
11.2.2 Hazard Profiles
11.3 Risk Assessment (Updated)
11.3.1 Risk Assessment Methodology
11.3.2 Risk and Vulnerability Assessment
11.4 Capability Assessment (Updated)
11.5 Mitigation Strategy (Updated)
11.5.1 Mitigation Goals
11.5.2 Mitigation Actions

11.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of*

the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..

Requirement §201.6(c)(2)(ii)(C): *[The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment **must** assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Makoti.

11.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Makoti. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

11.2.1 Overview of Makoti's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 10 weather-related hazard events have occurred in the city of Makoti since 1998, including the following number and types of hazard events:

- Hail – 8
- Tornado/Funnel Cloud – 2

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 11.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 11.2.1-1
Presidential Disaster Declarations – City of Makoti

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Makoti

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 11.2.1-2 (below).

Table 11.2.1-2
Preliminary Hazard Identification and Determinations – City of Makoti

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Makoti	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Makoti	Reason for Exclusion and other notes
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Makoti	Reason for Exclusion and other notes
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

11.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

11.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk. Table 11.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 11.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance

and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Makoti.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 11.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 11.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 11.2.2.1-3 (following) provides the details of pertussis outbreaks since 2007.

Table 11.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 11.2.2.1-4 (below) provides occurrence information for rabies.

Table 11.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Makoti did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Makoti, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Makoti, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been no occurrences of communicable disease within the city of Makoti. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

11.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Makoti are subject to the drought hazard.

Extent and Severity of the Hazard
Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.

- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

Table 11.2.2.2-1 (below) provides the PDSI classifications.

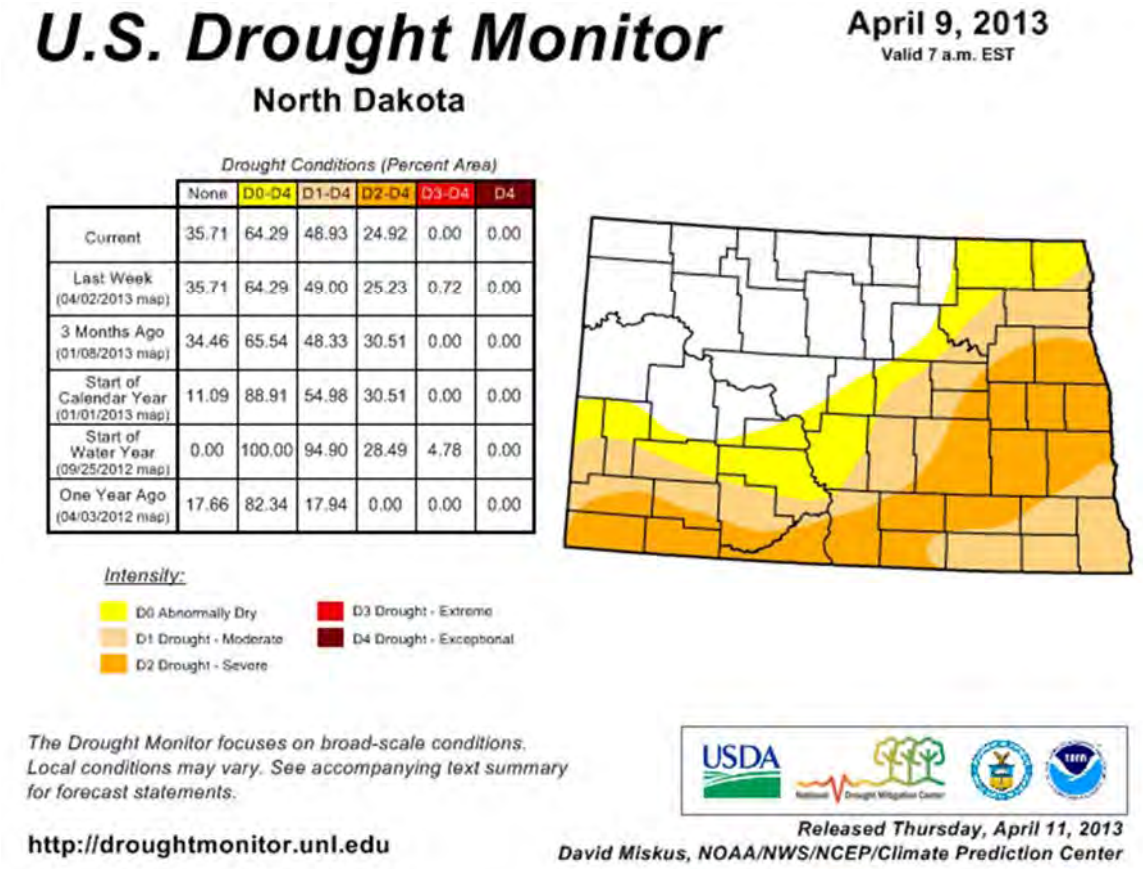
Table 11.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested

Classification	Description	Range of Possible Impacts
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Makoti are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 11.2.2.2-1 (following).

Figure 11.2.2.2-1
US Drought Monitor – North Dakota
(source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 11.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Makoti – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

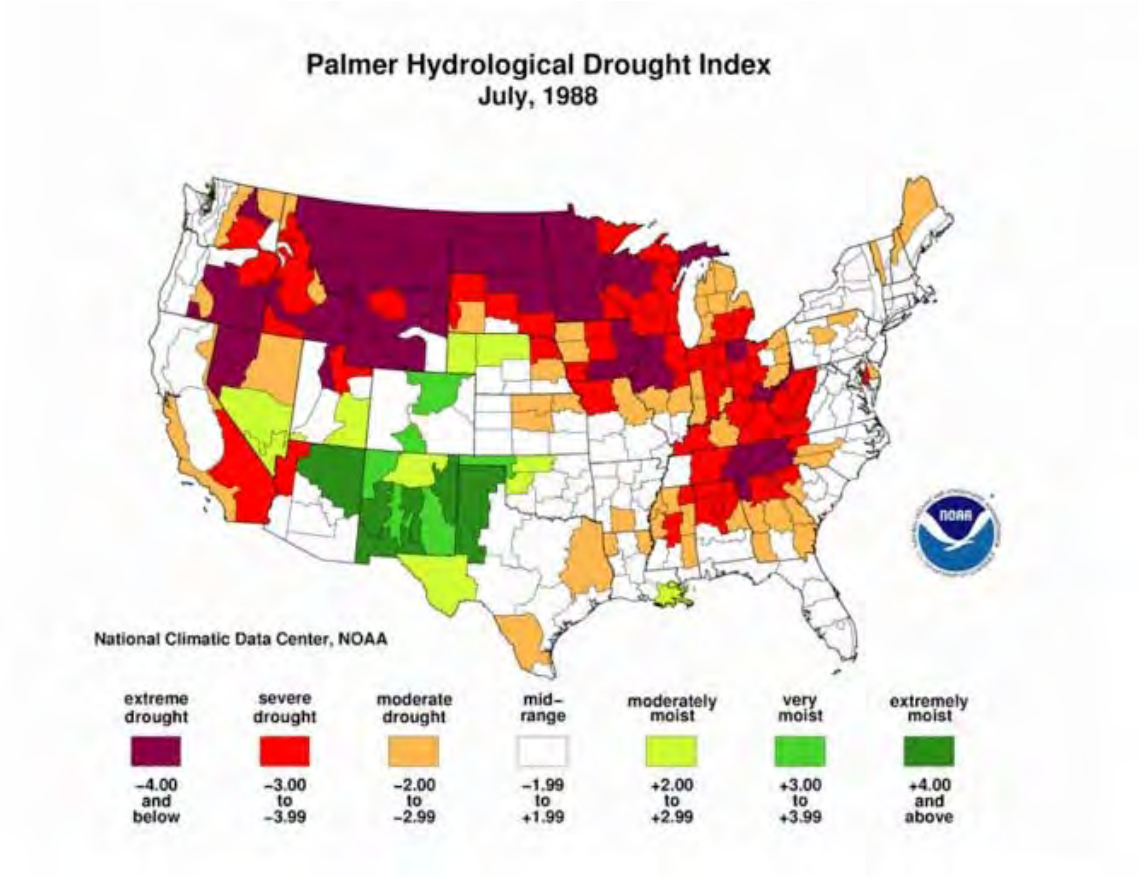
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Makoti. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 11.2.2.2-2 (following), the entire state – including the city of Makoti – was categorized as being in extreme drought during this time.

Figure 11.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Makoti) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years in more recent history.

11.2.2.3 Fire

This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

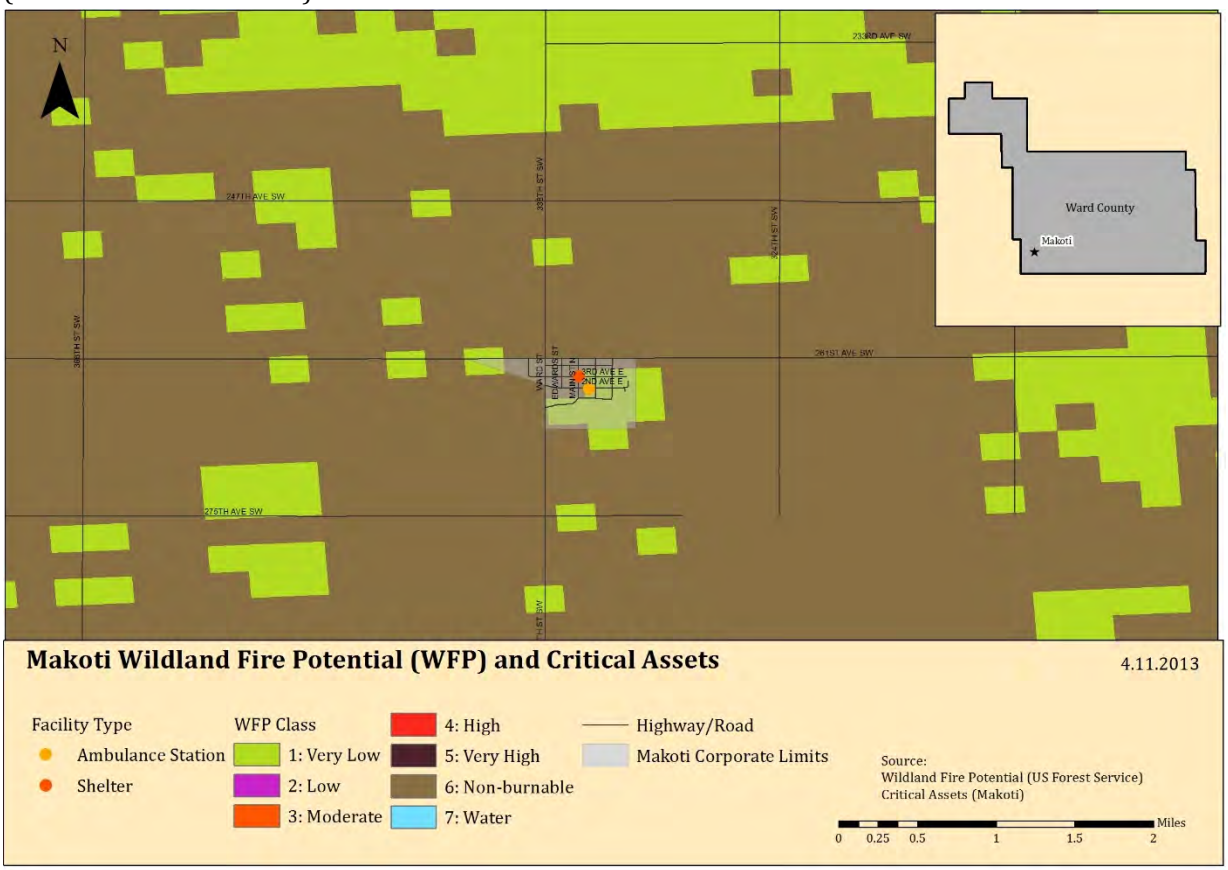
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 11.2.2.3-1 (following) illustrates the wildland fire potential for the city of Makoti, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 11.2.2.3-1
City of Makoti – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard
The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 11.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System

Table 11.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the

destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people. In addition, some structures (such as grain elevators) require specialized teams and equipment, and so response to these events may be delayed.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Note: Makoti's Fire Department works in conjunction with the city of Ryder, and all statistics are combined for both cities. Therefore, the statistics below assume that 50% of the reported fires occurred in each city.

Based on data obtained from the National Reporting System and from the Makoti/Ryder Fire Department, the city of Makoti has experienced 3.5 structure fires from January 2008 through December 2012, an average of .70 structure fires per year. For this same time period, 23 wildland fires were responded to, an average of 4.6 per year.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in the city of Makoti annually. Using the scale provided earlier in this section, this equates to a high probability of a future occurrence.

11.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.*

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North

Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard
There are no identified or mapped floodplains within the city of Makoti.

Extent and Severity of the Hazard
In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 11.2.2.4-1 (following).

Table 11.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 11.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 11.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.

Term	Definition
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

Makoti has no mapped or identified floodplains, and is not a member of the NFIP, nor are they sanctioned by the NFIP. There are no designated Repetitive Loss or Severe Repetitive Loss properties within the city of Makoti.

Potential Impact of the Hazard
Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A

major flood occurred in the Souris River Basin in 1969, which greatly impacted the region (though not specifically the city of Makoti). More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley.

The city of Makoti reported no occurrences of flooding within the city.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs at less than once every five years in the city of Makoti. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is low.

11.2.2.5 Severe Summer Storms

This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

Extreme Heat
Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail
Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning
Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms
Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard
Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Makoti.

Extent and Severity of the Hazard
Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat
The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.

- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 11.2.2.5-1(following). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 11.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution Extreme Caution Danger Extreme Danger

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail

The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 11.2.2.5-1 (following) provides details of these scales.

Table 11.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33"	Pea	No damage
H1	Potentially Damaging	0.33" – 0.60"	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60" – 0.80"	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80" – 1.20"	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20" – 1.60"	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60" – 2.0"	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0" – 2.4"	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4" – 3.0"	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0" – 3.5"	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5" – 4.0"	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning
The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to

explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- **Ground-to-Cloud Lightning.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning**. Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning.** Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 11.2.2.5-2 (following) provides this severity scale.

Table 11.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to

describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 11.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 11.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Table 11.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 11.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Given that Makoti is smaller than 15 miles in diameter, it is possible for the entire jurisdiction to be impacted by the same thunderstorm at any given time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from

thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Makoti are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards.

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at

the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 11.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 11.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties

- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact

on life due to thunderstorm and associated hazards in Makoti would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard
Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least10 occurrences of the summer storm hazard since 1998. (Note: Records prior to 1998 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 11.2.2.5-6 (below) provides details of these recorded incidents.

Table 11.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Description	Magnitude (if applicable)
July 06, 1998	Tornado/Funnel cloud	Unknown
August 21, 2001	Hail	1.75”
June 06, 2004	Tornado/Funnel Cloud	Unknown
July 20, 2004	Hail	.75”
July 21, 2005	Hail	.88”
May 21, 2007	Hail (3 occurrences)	1.75”; .88” and 1.25”
August 01, 2008	Hail	1.5”
July 20, 2010	Hail	1”

Probability of a Future Occurrence of the Hazard
In the 18 year period for which records are available, the summer storm hazard has occurred at least nine times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is moderate, as the summer storm hazard occurs at least once every five years.

11.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard

Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow

The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold

What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice

The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations

of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Makoti.

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold
Winter temperatures in Makoti typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 11.2.2.6-1 (following) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 11.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)

NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

- **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.
- **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard
Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard
According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes,

accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.

- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.
- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard

Based on the data available, winter storms occur in or otherwise impact the city of Makoti at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

11.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard

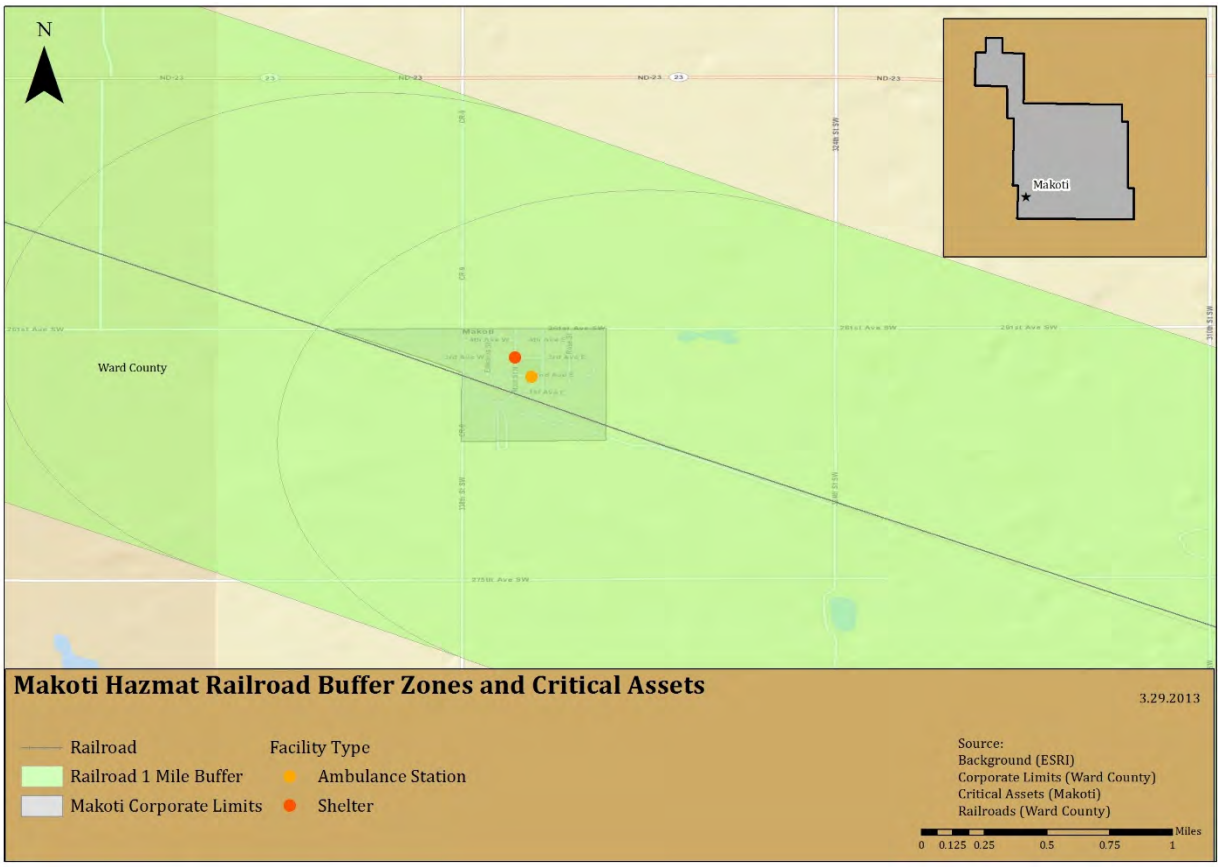
Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard

The locations in Makoti most at risk from a hazardous materials incident are those that are in proximity to either locations that store/use hazardous materials or that are adjacent to transportation lines. The following figure (11.2.2.7-1) illustrates these locations in Makoti.

Figure 11.2.2.7-1
Hazardous Materials Locations – Railroads



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, no Tier II reports from the city of Makoti have been submitted to the EPA since 1987, the year that the EPA began keeping such reports.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in Ward County, though not necessarily in the city of Makoti. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

11.3 Risk Assessment (Updated)

The following table (Table 11.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Makoti.

Table 11.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

11.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Makoti from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

Impact Scale Methodology
The potential impacts of each hazard were discussed by the Steering Committee. For the purposes of this discussion, a qualitative impact scale was developed, and was used by the Steering Committee in their discussions. As a result of these discussions, each hazard was assigned a qualitative impact ranking. This scale appears in Table 11.3.1-1 (below).

Table 11.3.1-1
Hazard Impact Scale

Term	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Low	Some minor injuries possible, but no fatalities	Cosmetic damages expected to assets; Infrastructure loss of function for less than 24 hours expected	System delivery delayed or temporarily interrupted; Interruptions in service delivery of less than 24 hours expected
Moderate	Injuries expected; Fatalities possible	Some structural damages to light construction (<50 % damage); Infrastructure loss of function for 24-72 hours expected	System delivery failures expected; Interruptions in service delivery of 24-72 hours expected
High	Serious and numerous injuries expected; Fatalities expected	Some structures irreparably damaged (>50% damage); Infrastructure loss of function for 72+ hours expected	Long-term system failures/damages expected; Cancellation of services (72+ hours) expected
Not Applicable	Hazard does not have the potential to impact people or life safety	Hazard does not have the potential to impact assets or infrastructure	Hazard does not have the potential to impact service delivery

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Makoti to the identified and profiled hazards.

Critical Assets
The table below (Table 11.3.1-1) provides details of the critical assets contained within the city of Makoti.

Table 11.3.1-1
Critical Assets – City of Makoti

Asset Name	Asset Use /Function	Street Number	Street Name	Insured or Estimated Value
Ryder/Makoti Fire Protection District – Makoti Fire Hall	Emergency Services	61	2nd Avenue East	$175,469
Makoti School	Shelter	--	3rd Avenue East	$16,115
Total estimated value of identified critical assets:				**$191,584**

Note on asset values: Valuation data for assets within the city was unavailable at the time this plan update was developed. All valuations used in the following estimates of potential losses are derived from an average of available data for the same or similar types of assets from other jurisdictions. The assessment that follows is an estimate only, and may not correlate with actual occurrences of the damage caused by the hazards described.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

11.3.2 Risk and Vulnerability Assessment

11.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 154 people residing in Makoti; this is slightly higher than the 2012 Census estimated population of 152, but much higher than the 2000 Census count of 145. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists.

Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

This increase in population, combined with the expected increase in traffic around Makoti (due to the nearby oil refinery, which was under construction as of this plan update) serves to increase the vulnerability of the residents of Makoti to the communicable disease hazard. More people means more carriers, and increase interactions will increase the chances of a disease or illness spreading through the community.

Estimate of Potential Losses
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Makoti represents ~1% of the total population of Ward County, or 154 people. While an outbreak of communicable disease in Makoti is unlikely to have significant impacts outside of Makoti, an outbreak could have significant impacts within the city.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness rate in Makoti that is similar to the illness rate across the county, the following numbers of people in Makoti could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Makoti accounts for ~1% of the county population. This equates to 45 cases of influenza in Makoti, on average, that could potentially impact the city.
- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Makoti accounts for ~1% of the county population. This equates to 65 cases of pertussis in Makoti, on average, that could potentially impact the city.

Identified Data Limitations
There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;

- Data regarding projected population changes; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

11.3.2.2 Drought

Vulnerability to the Hazard
Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies depend largely on agriculture, such the State of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result in significant societal disruption, which can worsen as the resource becomes more and more precious.

As with much of the planning area, Makoti has not experienced any significant changes in either population or development since the 2008 plan. While no significant development is planned within the jurisdiction of Makoti, the oil refinery under construction near Makoti will likely have some impact on the city, and may increase its vulnerability, at least temporarily. The increase in traffic, utility usage, and people in the area will require the use of resources, which may result in increased vulnerabilities throughout the area. However, any increase in vulnerability should be temporary, as there are no published plans for permanent developments within the jurisdiction.

Estimate of Potential Losses
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;

- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

11.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

As with much of the planning area, Makoti has not experienced any significant changes in either population or development since the 2008 plan. While no significant development is planned within the jurisdiction of Makoti, the oil refinery under construction near Makoti will likely have some impact on the city, and may increase its vulnerability, at least temporarily. The increase in traffic, utility usage, and people in the area will require the use of resources, which may result in increased vulnerabilities throughout the area. However, any increase in vulnerability should be temporary, as there are no published plans for permanent developments within the jurisdiction.

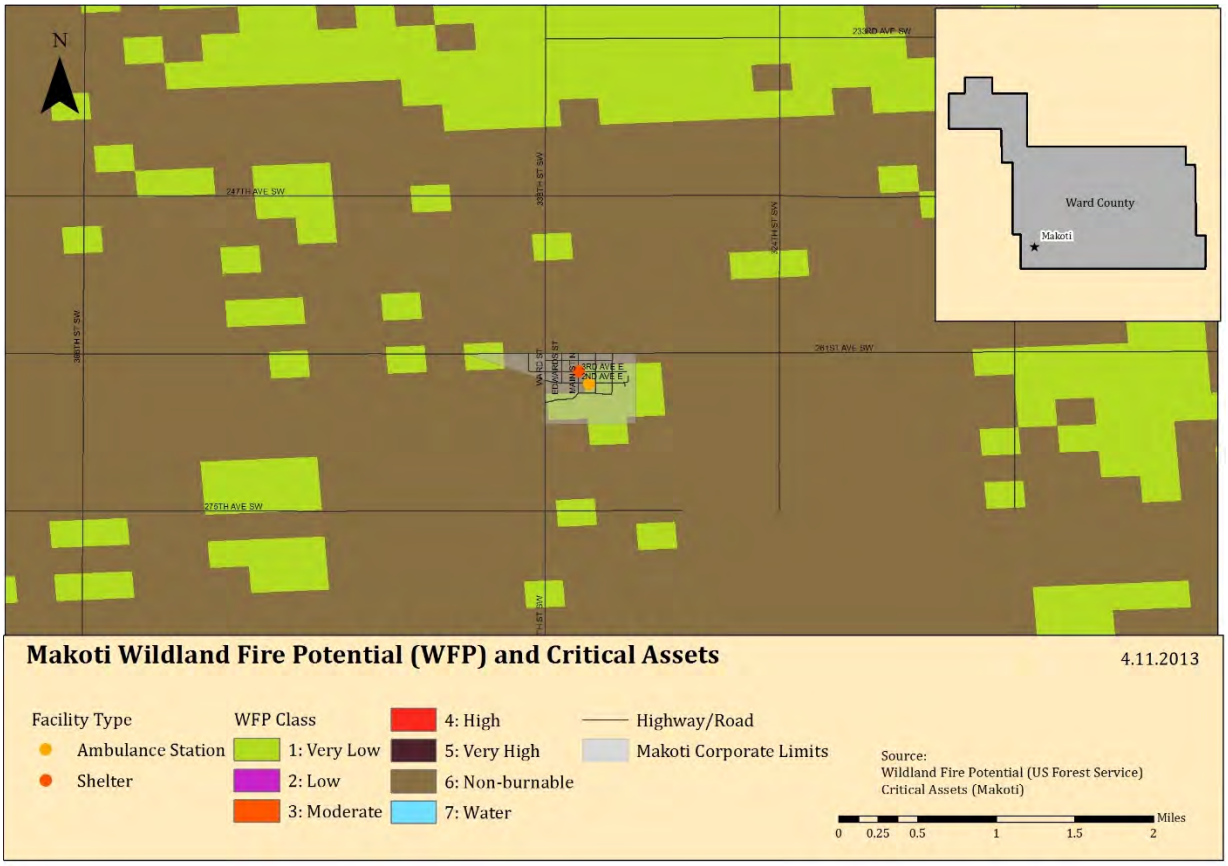
Estimate of Potential Losses
All structures within the city of Makoti are at risk from fire. According to the 2010 Census, there are 102 housing units in the city; 92 of these units are occupied, and 10 are vacant. The majority of these structures are heated by bottled gas or electricity. The median value of single family housing in Makoti is $72,200, according to the Census. This equates to potential residential losses of $7,364,400.

In addition, all identified critical assets (identified in Table 11.3.1-1) within the city have the potential to be lost to fire. These assets have a combined estimated value of $191,584.

Using the US Forest Service's Wildland Fire Potential data, the city of Makoti and its critical assets were mapped. Based on this data set, the city of Makoti has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 11.3.2.3-1 (below) illustrates this fire potential in relation to the identified critical assets for the city.

Figure 11.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations

Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

11.3.2.4 Flood

Vulnerability to the Hazard
Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

Flood damages also take considerable time to recover from. The 2011 flooding that occurred throughout the county had far-reaching impacts, and recovery for many areas remains a work in progress as of this Plan update.

As with much of the planning area, Makoti has not experienced any significant changes in either population or development since the 2008 plan. While no significant development is planned within the jurisdiction of Makoti, the oil refinery under construction near Makoti will likely have some impact on the city, and may increase its vulnerability, at least temporarily. The increase in traffic, utility usage, and people in the area will require the use of resources, which may result in increased vulnerabilities throughout the area. However, any increase in vulnerability should be temporary, as there are no published plans for permanent developments within the jurisdiction.

The city of Makoti has no mapped or identified SFHAs, and is not a member of the NFIP. As of February 2013, there were no NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the city of Makoti.

Estimate of Potential Losses
It was the determination of the Steering Committee that risk assessments related to flooding should be performed for those areas within Ward County that contained a mapped or identified flood hazard area.

In light of this determination, no risk assessment has been performed for this hazard for the city of Makoti.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

11.3.2.5 Severe Summer Storms

Vulnerability to the Hazard

People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Makoti has remained relatively stable in terms of population and development since the 2000 Census. During the plan update process, a vulnerability was identified regarding the city's ability to warn residents of impending storms. A need for warning sirens was identified, and was included in the city's updated mitigation strategy.

As with much of the planning area, Makoti has not experienced any significant changes in either population or development since the 2008 plan. While no significant development is planned within the jurisdiction of Makoti, the oil refinery under construction near Makoti will likely have some impact on the city, and may increase its vulnerability, at least temporarily. The increase in traffic, utility usage, and people in the area will require the use of resources, which may result in increased vulnerabilities throughout the area. However, any increase in vulnerability should be temporary, as there are no published plans for permanent developments within the jurisdiction.

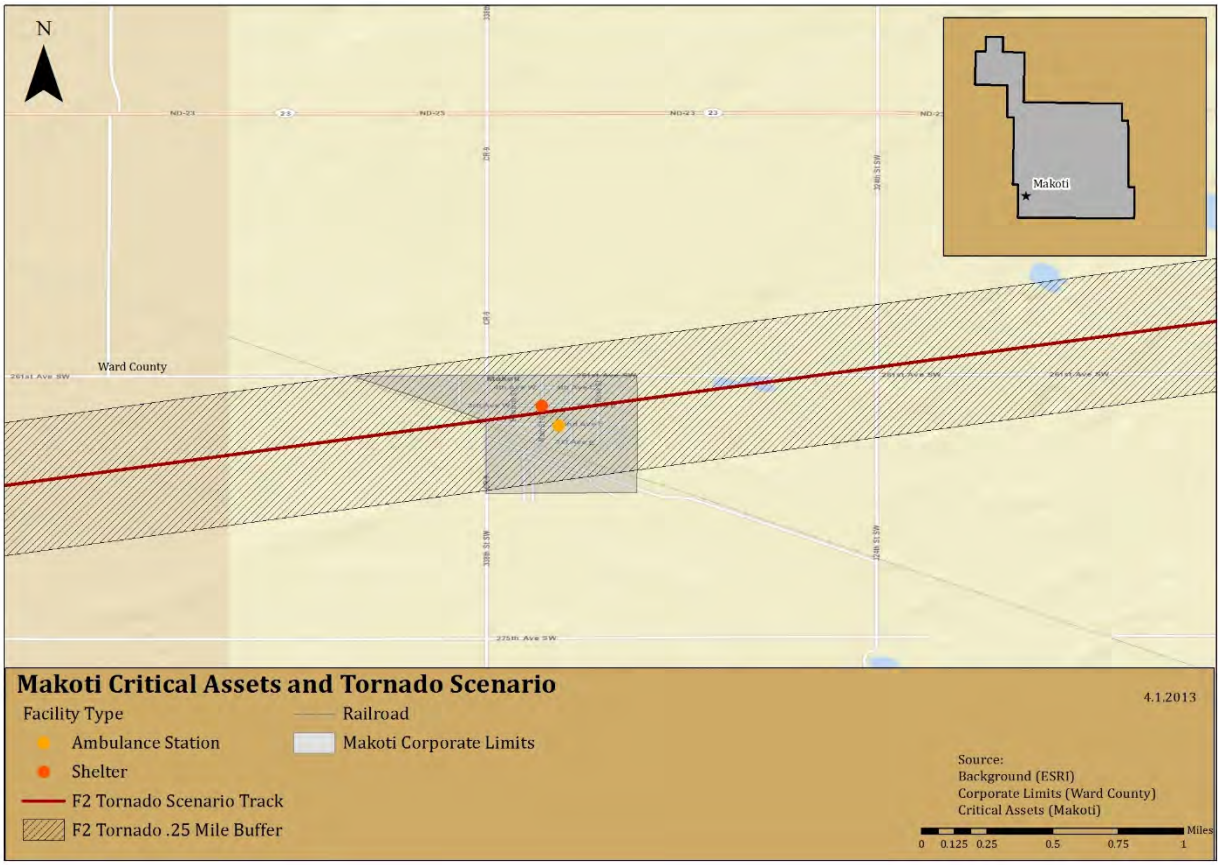
Estimate of Potential Losses

Severe summer storms are a non-spatial hazard that can and do affect the entire city of Makoti. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Makoti are at risk from severe summer storms. According to the 2010 Census, there are 102 housing units in the city. The median value of these structures is $72,200, according to the Census. This equates to residential assets of approximately $7,364,400. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $736,440.

In addition, all identified critical assets (identified in Table 11.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of $191,584. For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Makoti. Figure 11.3.2.5-1 (below) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 11.3.2.5-1
Tornado Scenario – City of Makoti



As seen in the above figure, in such a scenario the majority of the city of Makoti would be damaged, including critical assets (government and emergency services). This scenario would result in significant damages to the city's infrastructure, and would greatly impact its ability to provide basic services, such as emergency response.

Finally, the 154 residents of Makoti are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 6.5% (children under 5) and 17.5% (those over 70) of the population of Makoti. Combined, these two groups account for 24% of the population, a total of 37 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limit;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

11.3.2.6 Severe Winter Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents.

In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Makoti has remained relatively stable in terms of population and development since the 2000 Census. During the plan update process, a vulnerability was identified regarding the city's ability to maintain emergency power during outages. A need for emergency generators was identified, and was included in the city's updated mitigation strategy.

As with much of the planning area, Makoti has not experienced any significant changes in either population or development since the 2008 plan. While no significant development is planned within the jurisdiction of Makoti, the oil refinery under construction near Makoti will likely have some impact on the city, and may increase its vulnerability, at least temporarily. The increase in traffic, utility usage, and people in the area will require the use of resources, which

may result in increased vulnerabilities throughout the area. However, any increase in vulnerability should be temporary, as there are no published plans for permanent developments within the jurisdiction.

Estimate of Potential Losses
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Makoti. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Makoti are at risk from severe winter storms. According to the 2010 Census, there are 102 housing units in the city. The median value of these structures is $72,200, according to the Census. This equates to residential assets of approximately $7,364,000. If 1% of these residential assets were damaged by a severe winter storm, this would result in losses of $73,644.

In addition, all identified critical assets (identified in Table 11.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of $191,584. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $19,158.

Finally, the 154 residents of Makoti are all at risk from the severe winter storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 6.5% (children under 5) and 17.5% (those over 70) of the population of Makoti. Combined, these two groups account for 25% of the population, a total of 37 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

11.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have

little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

The roadways surrounding Makoti have experienced an increase in traffic in recent years; this increase will continue in Makoti, with the construction of the oil refinery near Makoti that is underway. While an incident on the roadways may not directly impact the city, it could have indirect impacts on the city and its residents. As a result of this increased vulnerability resulting from the increased activity in the area, a need was identified for warning sirens in Makoti, to help reduce the vulnerability of the city and its residents.

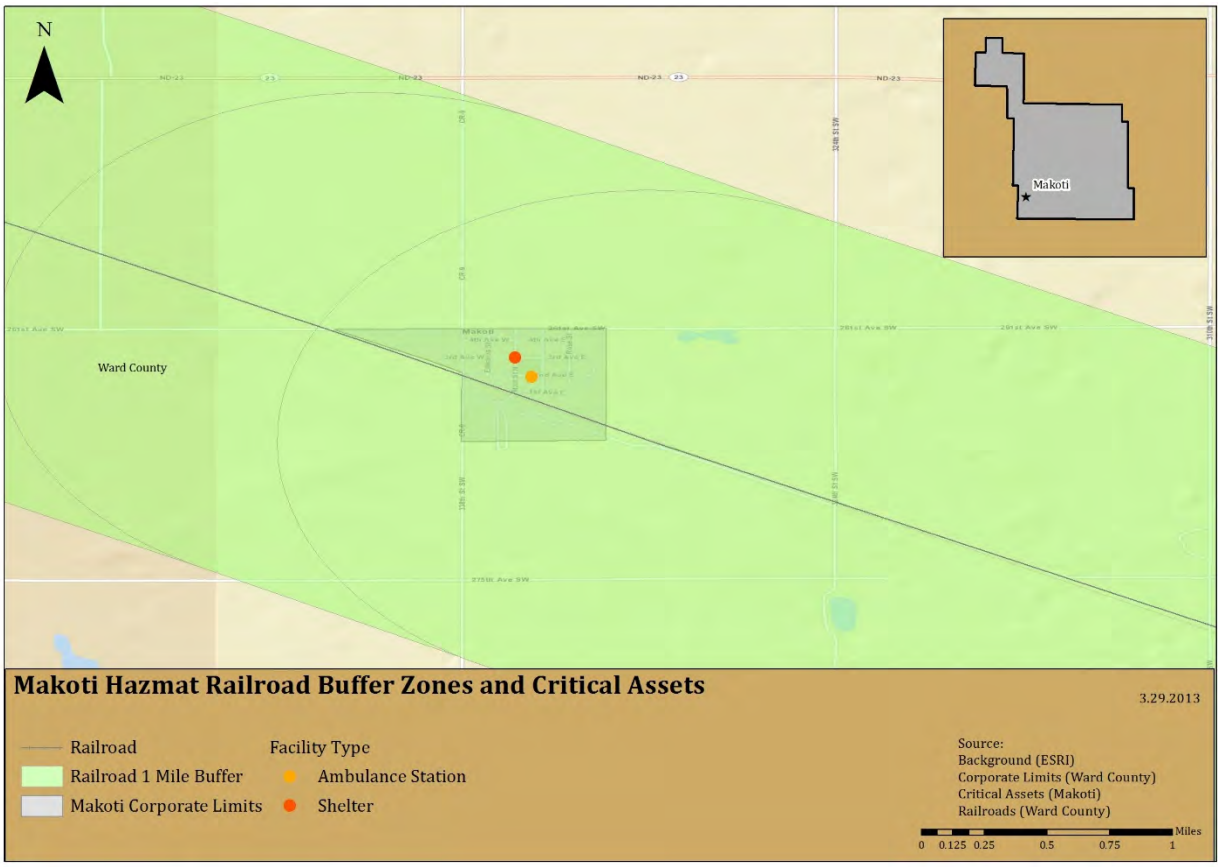
As with much of the planning area, Makoti has not experienced any significant changes in either population or development since the 2008 plan. While no significant development is planned within the jurisdiction of Makoti, the oil refinery under construction near Makoti will likely have some impact on the city, and may increase its vulnerability, at least temporarily. The increase in traffic, utility usage, and people in the area will require the use of resources, which may result in increased vulnerabilities throughout the area. However, any increase in vulnerability should be temporary, as there are no published plans for permanent developments within the jurisdiction.

Estimate of Potential Losses

For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Makoti – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

Makoti's hazardous materials risk comes from the railroad, and from the materials that are moved on the railroad. Figure 1.3.2.7-1 (following) illustrates the location of the railroad in relation to the city of Makoti, and provides designated buffer zones around it. For the purposes of this assessment, all assets within these buffers would be impacted to some degree.

Figure 11.3.2.7-1
Hazardous Materials Incident Scenario – Railroad



As is evident from the above image, the entire city could be impacted by an incident hazardous materials and the railroad, as could all critical assets within the city.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

11.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Makoti's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the city has limited familiarity with hazard mitigation programs, and hazard mitigation does not currently play a role in the decision-making process for the city.
- **Current/ongoing mitigation efforts** – currently, the city's mitigation efforts include participating in the development of the Ward County Hazard Mitigation Plan Update.
- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city.
- **Planning** –the city does not have a great deal of formalized planning efforts. There is no recovery plan, no evacuation plan, and no COOP/COG. There is no master plan, but the city does a land use plan, and is moving towards additional planning efforts. The city is not a member of the NFIP.

- **Staff, personnel, and technical capability** – as of this Plan update, the city has a limited capability and capacity regarding hazard mitigation, and has limited confidence in their abilities to administer hazard mitigation projects and programs. Additional experience and resources would be beneficial to building this capacity.

Like other municipalities within Ward County, Makoti depends on the framework established by the county and state government for technical assistance, and on the state and federal government for funding.

Conclusions and Recommendations
Makoti should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county towards this end.

11.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there **must** be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

11.5.1 Mitigation Goals

Table 11.5.1-1 (following) provides the mitigation goals that guide the city of Makoti's mitigation strategy.

Table 11.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

11.5.2 Mitigation Actions

Potential Mitigation Actions
Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions
Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of

special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions

Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (11.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (11.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped the city of Makoti to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 11.5.2-2. Table 11.5.2-1 (below) describes the basic criteria considered as part of the prioritization process.

Table 11.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.

STAPLEE	Criteria Explanation
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness

Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (11.5.2-2) provides the identified and prioritized mitigation strategy for the city of Makoti.

Table 11.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Join the NFIP; enforce floodplain management ordinance and practices	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Low	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Low	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Council	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; Ward County EMA	$500+	Low	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Purchase and install emergency power generators for critical assets	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	Existing	City Council	NDDES & FEMA mitigation grants; general funds; in-kind contributions; Ward County EMA	$25,000+	Moderate	
Goal 03: Protect public health and safety before, during, and after hazard events.	Purchase and install additional warning sirens	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	Existing	City Council	NDDES & FEMA mitigation grants; general funds; in-kind contributions; Ward County EMA	$25,000+	Moderate	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recent annexations and/or recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council	Ward County EMA	$500+	Low	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council	General fund; in-kind contributions; Ward County EMA	$500+	Low	

Section 12
City of Minot: HIRA, Capability Assessment, and Mitigation Strategy

12.1 IFR for Hazard Identification and Risk Assessment
12.2 Hazard Identification (Updated)
12.2.1 Overview of Minot's History of Hazards and Potential Hazards
12.2.2 Hazard Profiles
12.3 Risk Assessment (Updated)
12.3.1 Risk Assessment Methodology
12.3.2 Risk and Vulnerability Assessment
12.4 Capability Assessment (Updated)
12.5 Mitigation Strategy (Updated)
12.5.1 Mitigation Goals
12.5.2 Mitigation Actions

12.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of*

the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ...

Requirement §201.6(c)(2)(ii)(C): *[The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment **must** assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Minot.

12.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Minot. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

12.2.1 Overview of Minot's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 94 weather-related hazard events have occurred in the city of Minot since 1993, including the following number and types of hazard events:

- Flood/Flash Flood – 8
- Hail – 46
- Lightning - 5
- Tornado/Funnel Cloud - 8

- Thunderstorm/Wind - 24
- Rain/Heavy Rain - 3

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 12.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 12.2.1-1
Presidential Disaster Declarations – City of Minot

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Minot

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 12.2.1-2 (below).

Table 12.2.1-2
Preliminary Hazard Identification and Determinations – City of Minot

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Minot	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Minot	Reason for Exclusion and other notes
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Minot	Reason for Exclusion and other notes
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

12.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

12.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk.

Table 12.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 12.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the

severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Minot.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 12.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 12.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 12.2.2.1-3 (following) provides the details of pertussis outbreaks since 2007.

Table 12.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 12.2.2.1-4 (below) provides occurrence information for rabies.

Table 12.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Minot did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Minot, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Minot, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been no documented occurrences of communicable disease within the city of Minot. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

12.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Minot are subject to the drought hazard.

Extent and Severity of the Hazard
Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.

- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

Table 12.2.2.2-1 (below) provides the PDSI classifications.

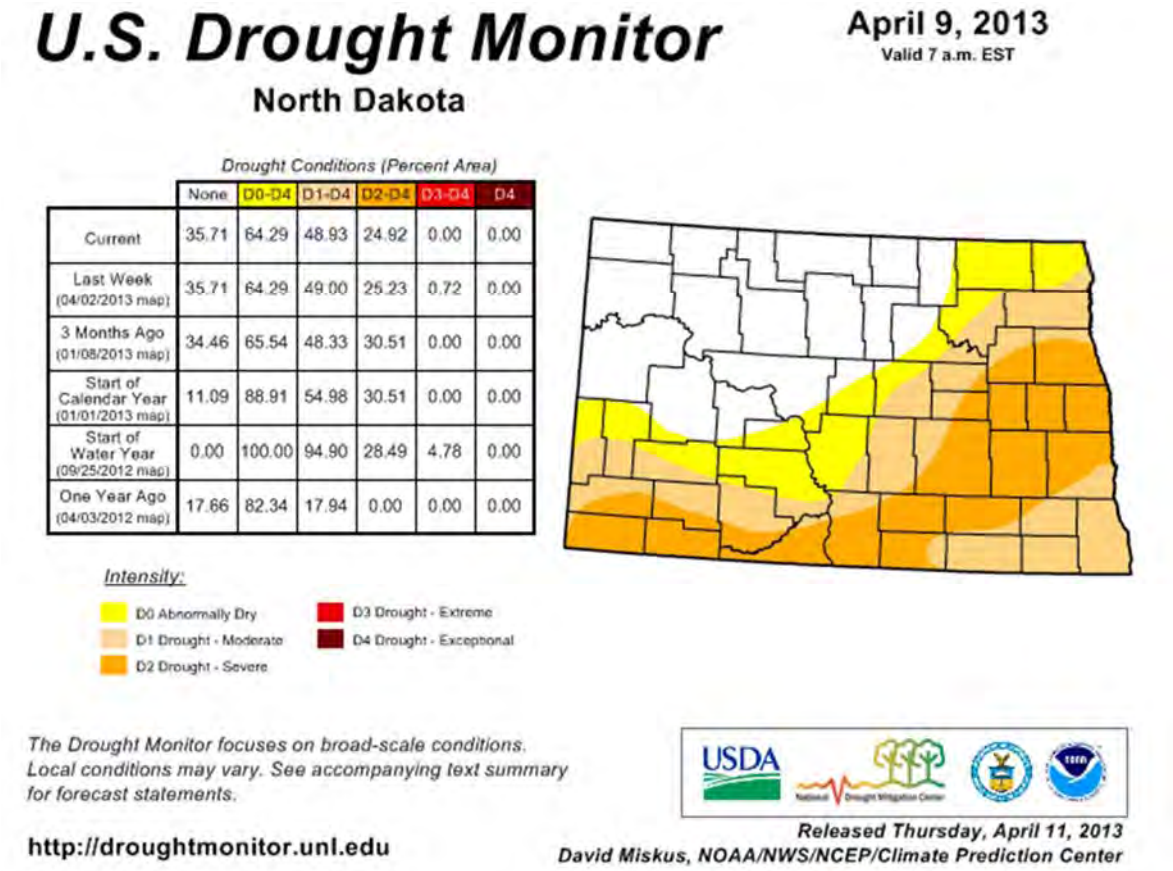
Table 12.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested

Classification	Description	Range of Possible Impacts
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Minot are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 12.2.2.2-1 (following).

Figure 12.2.2.2-1
US Drought Monitor – North Dakota
(Source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 12.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Minot – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

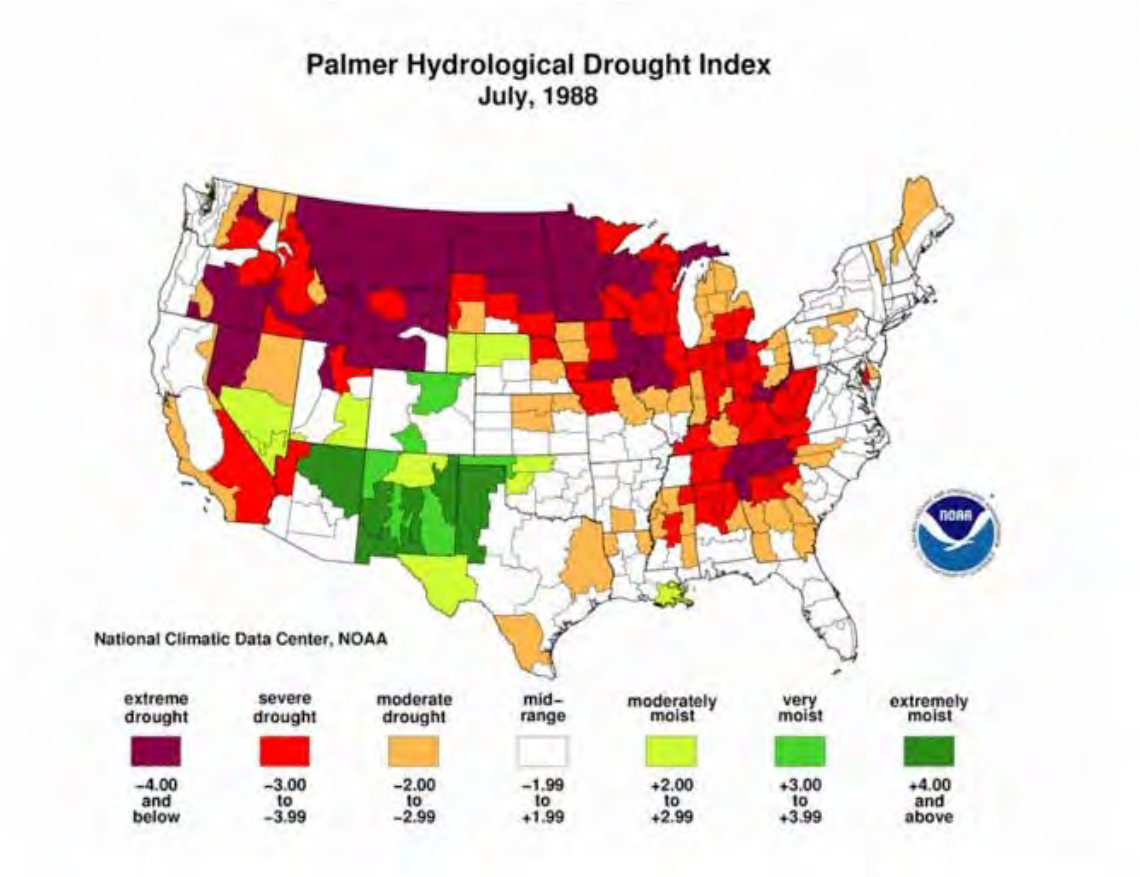
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Minot. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 5.2.2.2-2 (following), the entire state – including the city of Minot – was categorized as being in extreme drought during this time.

Figure 12.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(Source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Minot) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years.

12.2.2.3 Fire

This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

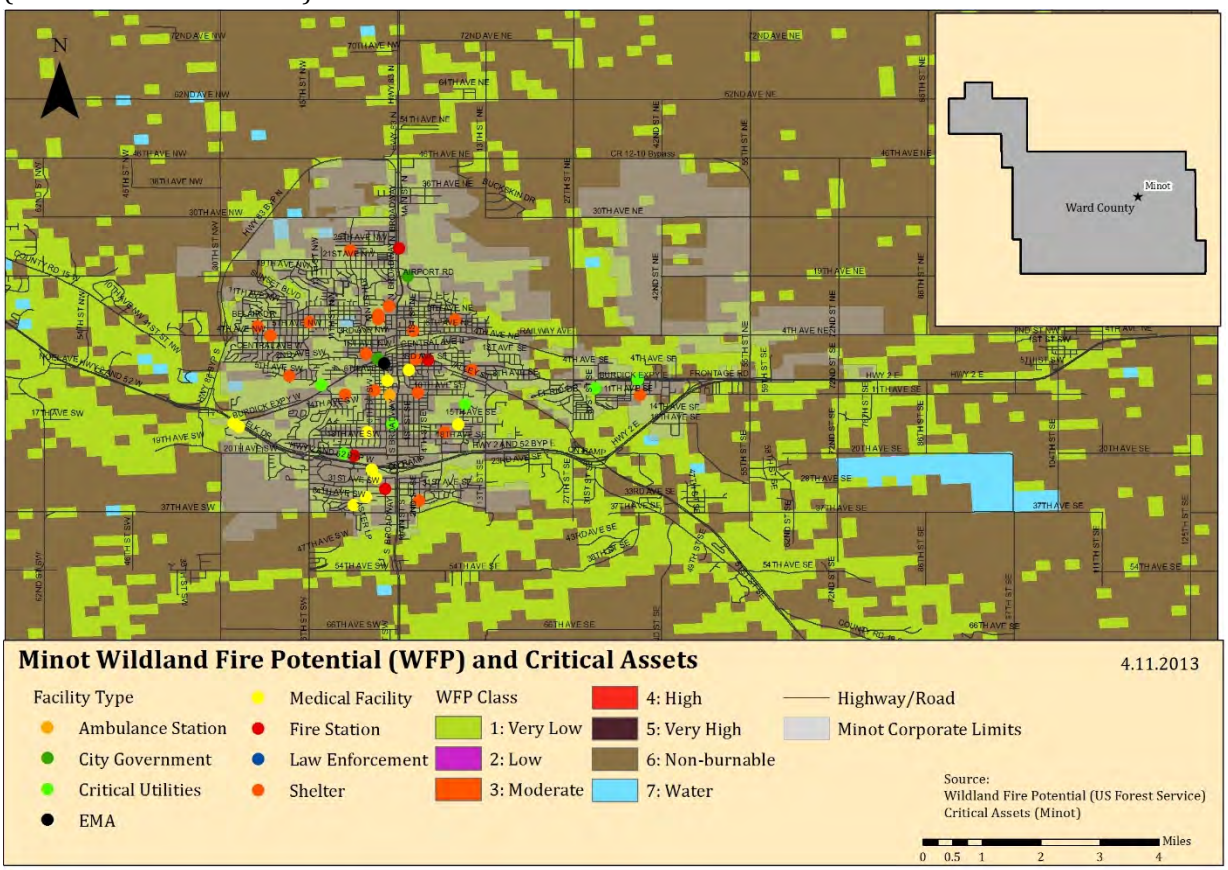
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 12.2.2.3-1 (following) illustrates the wildland fire potential for the city of Minot, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 12.2.2.3-1
City of Minot – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard

The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 12.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System.

Table 12.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the

destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Based on data obtained from the National Reporting System, the city of Minot has experienced 277 structure fires from January 2008 and December 2012, an average of 55.4 structure fires per year. For this same time period, 310 wildland fires were responded to, an average of 62 per year.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in the city of Minot at least once per year. Using the scale provided earlier in this section, this equates to a high probability of a future occurrence.

12.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.*

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise

sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

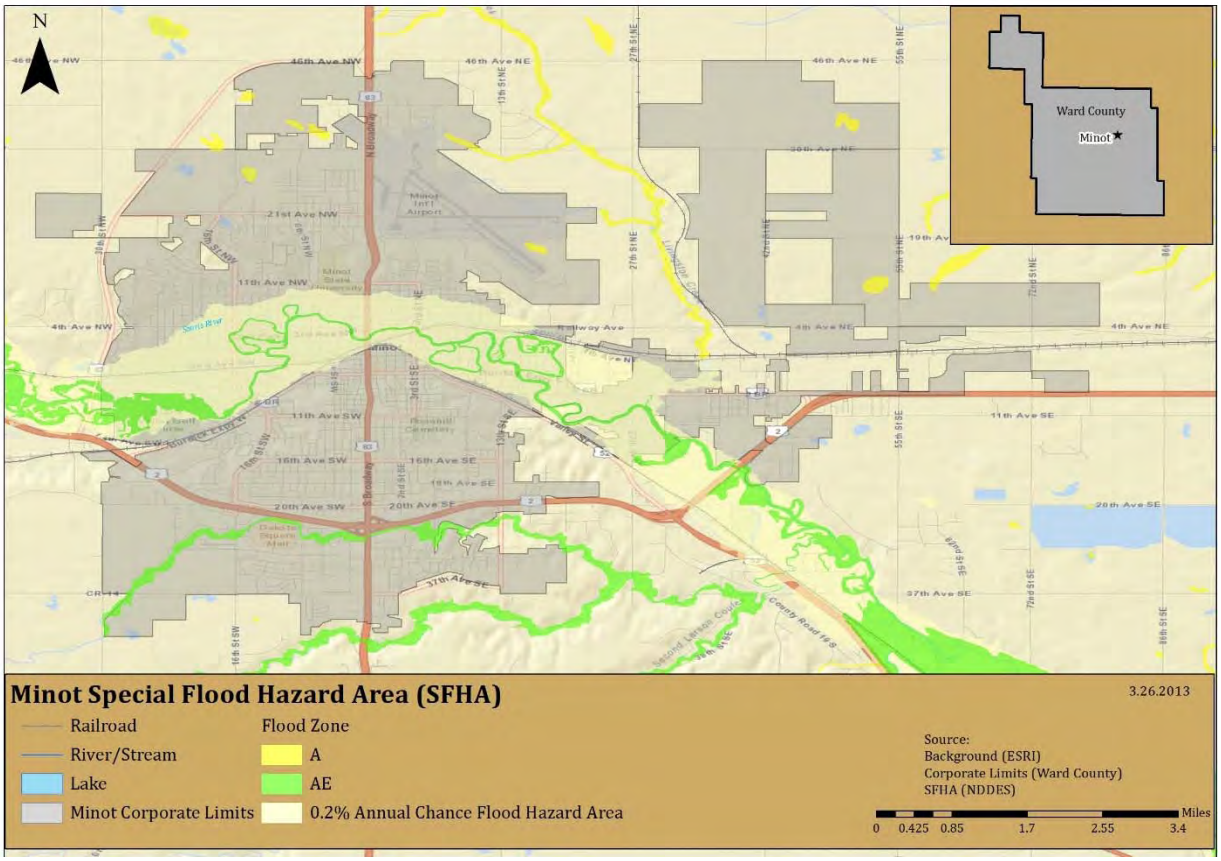
Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard

Minot has significant areas of one percent annual chance floodplain adjacent to its corporate limits, as well as areas within its limits. Large portions of the city fall within the .02% annual chance floodplain. These areas are illustrated in Figure 12.2.2.4-1 (following).

Figure 12.2.2.4-1
Special Flood Hazard Areas



Extent and Severity of the Hazard

In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 12.5.2.4-1 (below).

Table 12.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.

Zone Designation	Percent Annual Chance of Flood	Description
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 12.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 12.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

Term	Definition
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

The city of Minot is currently a member of the NFIP, and its membership is in good standing. There are 06 designated Repetitive Loss or Severe Repetitive Loss properties within the city of Minot, as of February 2013.

Potential Impact of the Hazard
Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A major flood occurred in the Souris River Basin in 1969, which greatly impacted the region – including the city of Minot.

More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley. The stage was set for flooding in the summer of 2010, with above normal precipitation levels and saturated soil conditions. In the fall of 2010, the National Weather Service began issuing flood predictions for the following late winter/spring.

The first flood warning on the Souris (Mouse) Rive was issued on February 17, 2011, in response to high releases at Lake Darling, which were needed to create more storage space. In March 2011, forecasts were issued for significant runoff above the Canadian Rafferty and Alameda dams (in the Mouse River Basin). Eventually so much water entered these dams that they began an "inflows must match outflows" period, to prevent the reservoirs from overflowing. This led to extensive flooding along the Souris (Mouse) River, including in the city of Minot. By the time floodwaters in Minot receded in July 2011, the Souris (Mouse) River in Minot crested more than 3 feet above the previous record, 4,100 structures were inundated, and more than 12,000 people had been evacuated.

As of April 2013, FEMA has approved almost $96 M in grant assistance to individuals and families affected by the flooding, and more than $246 M in assistance for repairs to public buildings and infrastructure. The vast majority of this assistance was obligated to Minot and Ward County.

In addition, according to NCDC records, Minot experienced flash flood incidents in 2005 and 2010. These incidents caused at least $35,000 in damages.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs less than once every five years in the city of Minot. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is low.

12.2.2.5 Severe Summer Storms

This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

> *Extreme Heat*
> Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail

Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning

Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes

The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms

Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard

Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Minot.

Extent and Severity of the Hazard

Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat

The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.
- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 12.2.2.5-1(following). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 12.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail

The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 12.2.2.5-1 (following) provides details of these scales.

Table 12.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33"	Pea	No damage
H1	Potentially Damaging	0.33" – 0.60"	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60" – 0.80"	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80" – 1.20"	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20" – 1.60"	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60" – 2.0"	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0" – 2.4"	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4" – 3.0"	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0" – 3.5"	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5" – 4.0"	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning

The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to

explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- Ground-to-Cloud Lightning**.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning.** Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning***.* Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 12.2.2.5-2 (following) provides this severity scale.

Table 12.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to

describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 12.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 12.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Table 12.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 12.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Minot is slightly less than 17.4 mi^2 in area, so it is possible for the majority – or all – of the city to be impacted by a thunderstorm at the same time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from

thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Minot are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at

the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 12.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 12.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties

- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact

on life due to thunderstorm and associated hazards in Minot would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard

Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least 86 occurrences of the summer storm hazard since 1993. (Note: Records prior to 1993 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 12.2.2.5-6 (below) provides details of these recorded incidents.

Table 12.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Description	Magnitude (if applicable)	Damages (if known)
May 06, 1993	Thunderstorm wind	59 MPH	--
June 23, 1994	Thunderstorm wind	Unknown	--
July 12, 1995	Tornado/funnel cloud	Unknown	--
August 18, 1995	Hail	1.50”	$50 M (property and crop)
August 27, 1995	Tornado/funnel cloud	Unknown	--
June 25, 1996	Hail	1”	--
September 04, 1996	Hail	.75”	--
July 10, 1997	Tornado/funnel cloud	Unknown	--
July 25, 1997	Tornado/funnel cloud (2 occurrences)	Unknown	--
August 22, 1997	Lightning	--	$65,000
May 17, 1998	Hail (2 occurrences)	.75” (both)	--
July 05, 1998	Lightning	--	--
July 06, 1998	Hail (3 occurrences)	1.75” (all occurrences)	--
July 11, 1998	Lightning	--	--
July 13, 1999	Hail Tornado/funnel cloud Thunderstorm wind	2.75” -- 65 MPH	$1.1 M (property and crop)
July 22, 1999	Thunderstorm wind (2 occurrences)	73 and 57 MPH	--
June 11, 2000	Tornado/funnel cloud Hail (3 occurrences)	-- 1.25”;1” and 2”	--

Date	Description	Magnitude (if applicable)	Damages (if known)
August 05, 2000	Thunderstorm wind	70 MPH	--
August 28, 2000	Hail	.75"	--
July 16, 2001	Hail (2 occurrences)	1.75"(both occurrences)	--
July 22, 2001	Thunderstorm wind	57 MPH	--
August 21, 2001	Hail	75 MPH	--
June 08, 2002	Thunderstorm wind	61 MPH	--
June 16, 2002	Thunderstorm wind	50 MPH	--
June 22, 2002	Hail	.75"	--
July 31, 2002	Thunderstorm wind (2 occurrences)	52 MPH (both)	--
August 25, 2002	Thunderstorm wind	52 MPH	--
July 03, 2003	Thunderstorm wind	59 MPH	--
July 18, 2003	Hail	.75"	--
August 27, 2003	Hail	.75"	--
June 06, 2004	Hail (4 occurrences)	1"; 1"; 1.75"; and 2"	--
August 25, 2004	Hail Tornado/funnel cloud	.75" Unknown	--
June 19, 2005	Hail (2 occurrences)	1.75" and 1"	--
July 07, 2005	Hail (2 occurrences)	1" and .75"	--
September 16, 2005	Hail	.88"	--
May 28, 2006	Hail	1"	--
June 03, 2006	Hail Heavy Rain Thunderstorm wind	.88" Unknown 50 MPH	--
June 24, 2006	Lightning	--	$125,000 (property)
July 12, 2006	Thunderstorm wind	52 MPH	--
May 18, 2007	Hail (2 occurrences)	.88" and 1"	--
May 21, 2007	Hail	.88"	--
June 12, 2007	Thunderstorm wind	52 MPH	--
June 22, 2007	Hail	1.75"	--
June 26, 2007	Thunderstorm wind	50 MPH	--
July 03, 2007	Thunderstorm wind	52 MPH	$2,000 (property)
June 13, 2008	Thunderstorm wind	60 MPH	$6,000 (property)
June 14, 2008	Thunderstorm wind	59 MPH	--
June 18, 2008	Hail (3 occurrences)	1.75"; .88"; and 1"	--
August 01, 2008	Hail	1"	--

Date	Description	Magnitude (if applicable)	Damages (if known)
August 02, 2008	Hail (2 occurrences)	1.75" and 1.25"	--
September 08, 2009	Lightning	--	$40,000 (property)
April 13, 2010	Hail	2"	--
May 22, 2010	Hail	1"	--
May 27, 2010	Hail	1"	--
August 11, 2010	Thunderstorm wind (2 occurrences)	56 MPH and 50 MPH	--
May 30, 2011	Heavy rain (2 occurrences)	--	--
June 25, 2011	Thunderstorm wind (2 occurrences)	55 MPH (both)	--
July 30, 2011	Hail (2 occurrences)	1" (both)	--

Probability of a Future Occurrence of the Hazard
In the 19 year period for which records are available, the summer storm hazard has occurred at least 86 times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is moderate, as the summer storm hazard occurs at least once every five years.

12.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard
Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow
The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold
What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice
The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Minot.

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

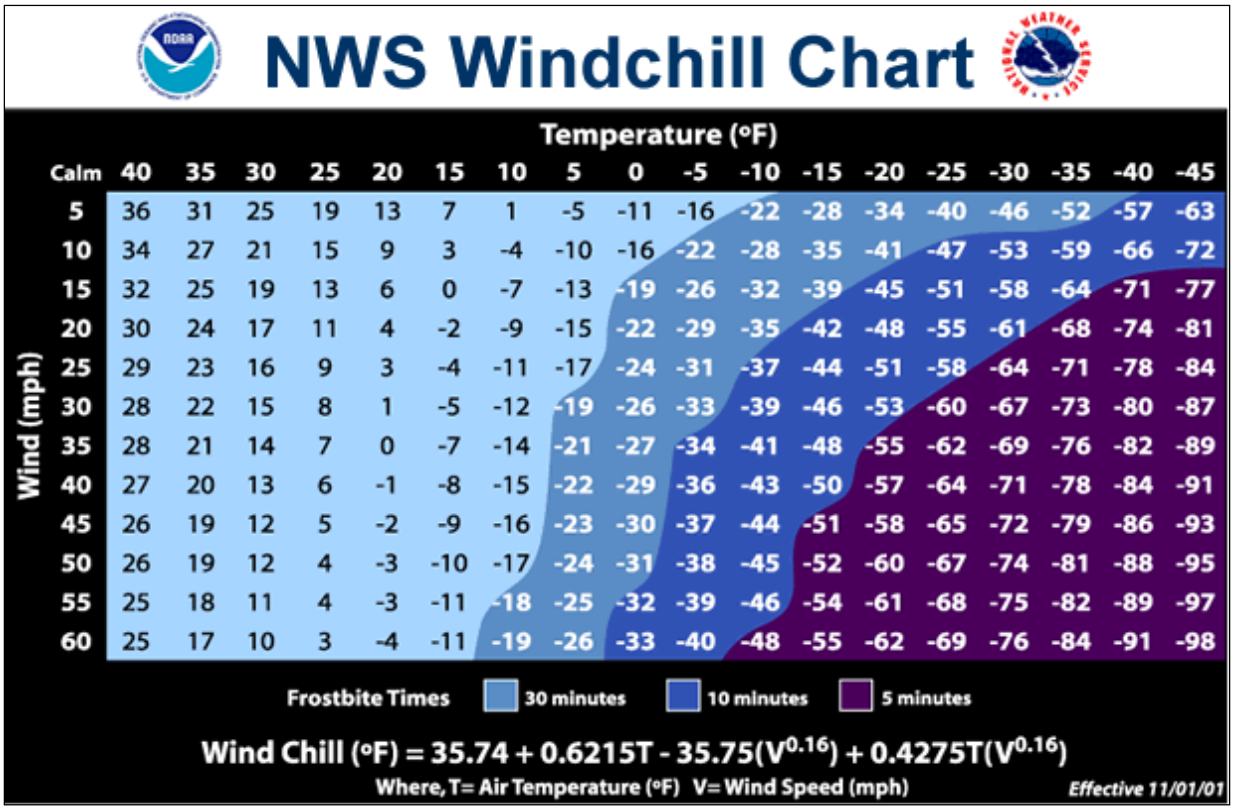
- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold

Winter temperatures in Minot typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 12.2.2.6-1 (below) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 12.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)



NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

> **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous. **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard

Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate

stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard

According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes, accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.
- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.

- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard
Based on the data available, winter storms occur in or otherwise impact the city of Minot at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

12.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard
Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard
The locations in Minot most at risk from a hazardous materials incident are those that are in proximity to either locations that store/use hazardous materials or that are adjacent to transportation or transmission lines. The following figures (12.2.2.7-1 through 12.2.2.7-3) illustrate these locations in Minot.

Figure 12.2.2.7-1
Hazardous Materials Locations – Fixed Sites

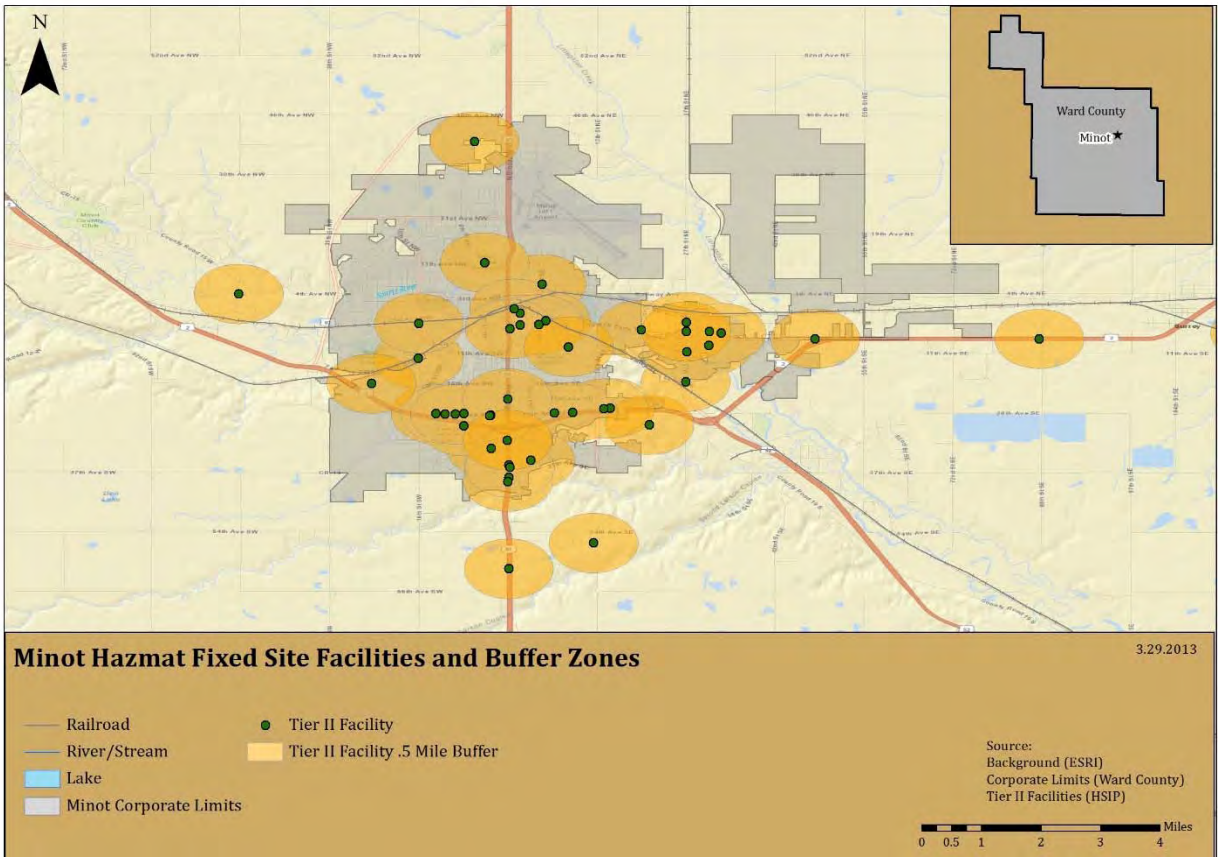


Figure 12.2.2.7-2
Hazardous Materials Locations – Railroads

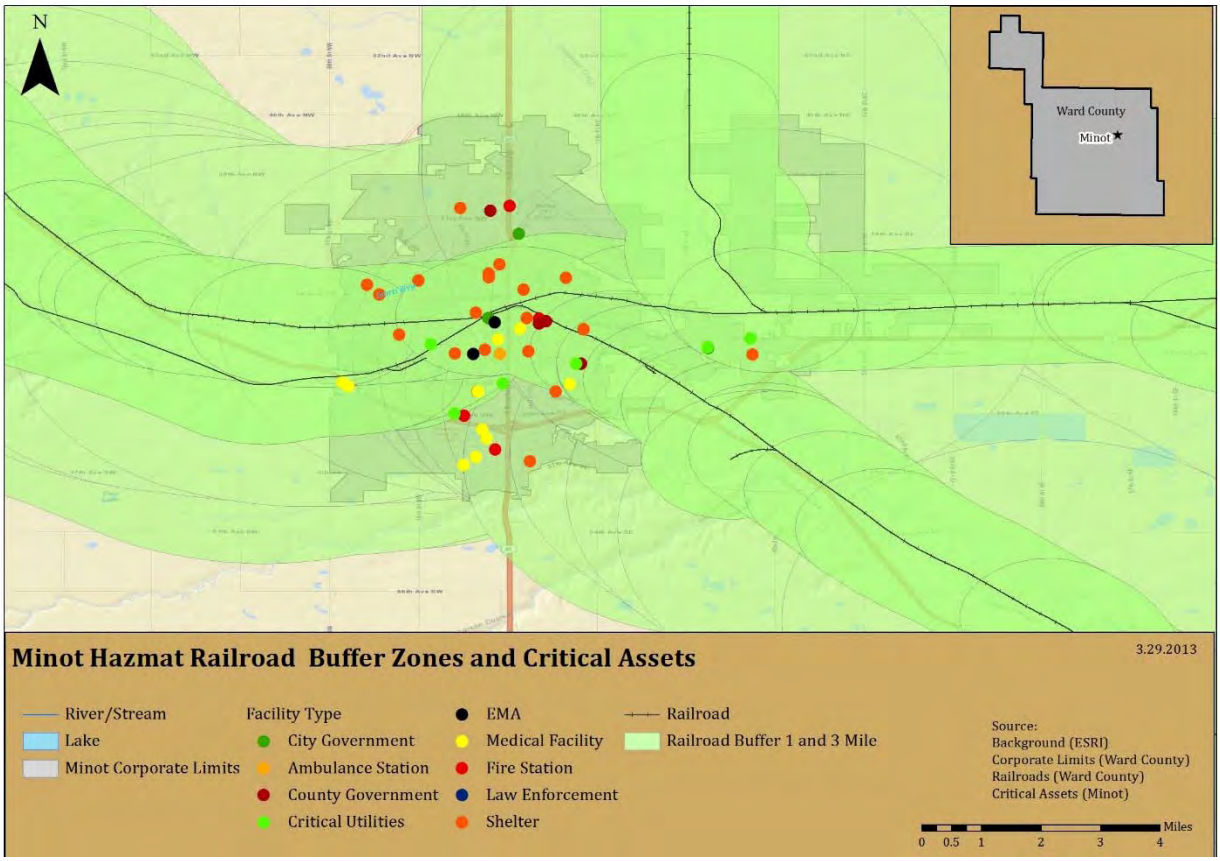
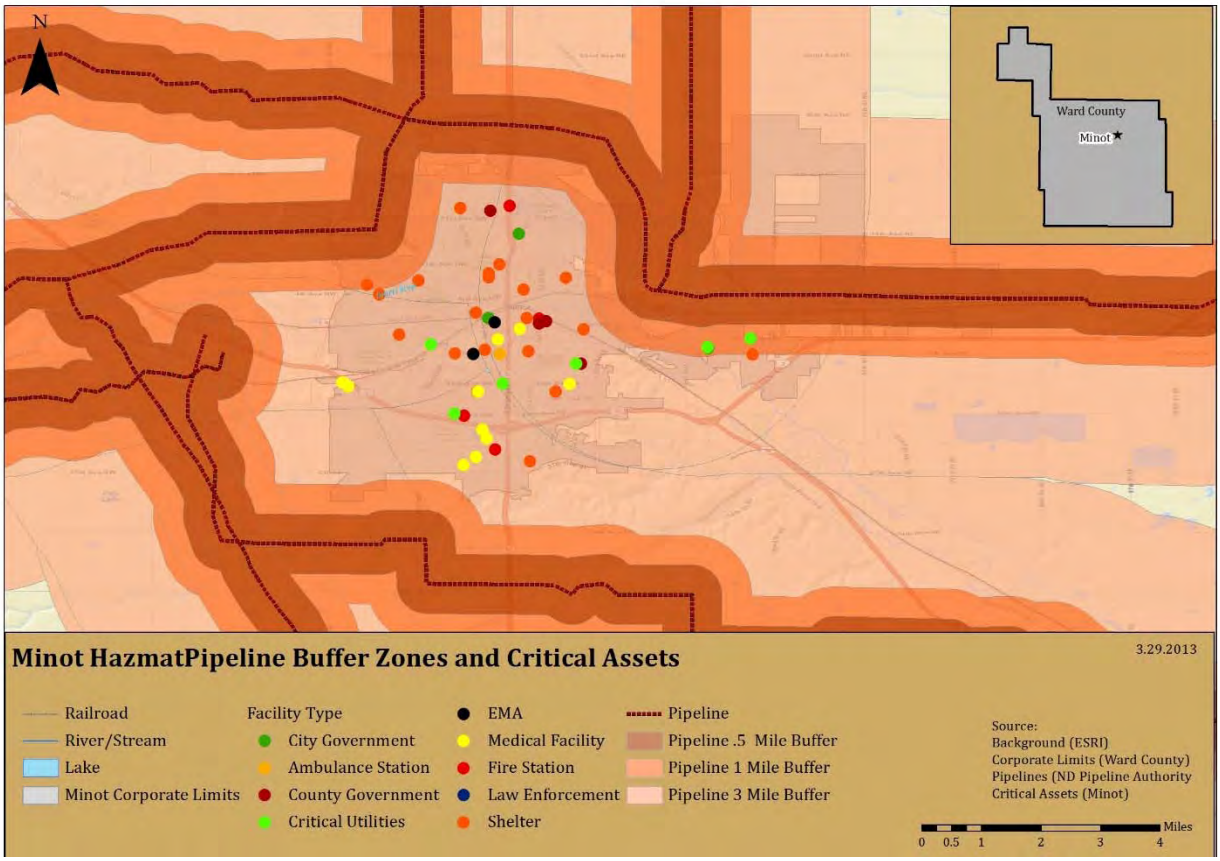


Figure 12.2.2.7-3
Hazardous Materials Locations – Pipelines



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, 18 Tier II reports from the city of Minot have been submitted to the EPA since 1987, the year that the EPA began keeping such reports. Two of these reports (submitted in 1987 and 1988) are from a facility within the corporate limits of Minot. The remaining 16 reports (from 2004 through 2011) are from Minot Air Force Base, which is near Minot but is not within the city limits.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in both Ward County, though not necessarily in the city of Minot. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

12.3 Risk Assessment (Updated)

The following table (Table 12.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Minot.

Table 12.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

12.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Minot from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

Impact Scale Methodology
The potential impacts of each hazard were discussed by the Steering Committee. For the purposes of this discussion, a qualitative impact scale was developed, and was used by the Steering Committee in their discussions. As a result of these discussions, each hazard was assigned a qualitative impact ranking. This scale appears in Table 12.3.1-1 (below).

Table 12.3.1-1
Hazard Impact Scale

Term	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Low	Some minor injuries possible, but no fatalities	Cosmetic damages expected to assets; Infrastructure loss of function for less than 24 hours expected	System delivery delayed or temporarily interrupted; Interruptions in service delivery of less than 24 hours expected
Moderate	Injuries expected; Fatalities possible	Some structural damages to light construction (<50 % damage); Infrastructure loss of function for 24-72 hours expected	System delivery failures expected; Interruptions in service delivery of 24-72 hours expected
High	Serious and numerous injuries expected; Fatalities expected	Some structures irreparably damaged (>50% damage); Infrastructure loss of function for 72+ hours expected	Long-term system failures/damages expected; Cancellation of services (72+ hours) expected
Not Applicable	Hazard does not have the potential to impact people or life safety	Hazard does not have the potential to impact assets or infrastructure	Hazard does not have the potential to impact service delivery

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Minot to the identified and profiled hazards.

Critical Assets
The following table (Table 12.3.1-1) provides details of select critical assets contained within the city of Minot.

Table 12.3.1-1
Select Critical Assets – City of Minot

Asset Name	Asset Use /Function	Insured or Estimated Value
Airport Fire Station	Emergency Services	$139,769
Airport Terminal	Transportation	$7,588,350
Civic Center/City Hall/Police Department (includes addition)	Government / Emergency Services	$5,291,111
Fire Station #2	Emergency Services	$1,170,514
Fire Station #1	Emergency Services	$1,998,528
Fire Station #3	Emergency Services	$1,033,961
Public Works Building	Government	$9,078,872
Auditorium	Community	$450,200
Water Treatment Plant	Utility	$6,419,077

Note on asset values: Asset values provided by the city of Minot.

Insurance information provided by the city of Minot indicates that city-owned property is valued (for insurance purposes) at a minimum of $34,571,383. This figure represents insured values only, and may not reflect actual damages from an actual event. However, it is a reasonable estimate to use for the purposes of this Plan.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

12.3.2 Risk and Vulnerability Assessment

12.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 40,888 people residing in Minot. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

Minot is undergoing significant fluctuations regarding population. In 2012, the Census Bureau estimated the population to be 43,736 – an increase of almost 3,000 residents in two years, and this figure does not account for all of the temporary residents and workers in the area who would not have been counted as part of the official Census or Census estimate. This increase in population, combined with the influx of temporary residents and workers – for both energy and flood recovery – increases the vulnerability of the area to the communicable disease hazard, as new people from other areas may bring new illnesses and diseases with them, and potentially infect a population unaccustomed population.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 12.3.1-1 (previous).

The representatives from the city of Minot determined that communicable disease has the potential to cause the impacts described in Table 12.3.2.1-1 (below).

Table 12.3.2.1-1
Qualitative Hazard Impacts – Communicable Disease

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Communicable Disease	Moderate	Low	Moderate

Estimate of Potential Losses – Quantitative
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Minot represents almost 64% of the total population of Ward County, or 40,888 people. An outbreak within the city of Minot could have devastating and far-reaching impacts throughout the region, as Minot serves as the regional hub for a variety of services.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness rate in Minot that is similar to the illness rate across the county, the following numbers of people in Minot could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Minot accounts for approximately 64% of the county population. This equates to 2,967 cases of influenza in Minot, on average, that could potentially impact the city.
- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Minot accounts for approximately 64% of the county population. This equates to 4,147 cases of pertussis in Minot, on average, that could potentially impact the city.

Identified Data Limitations

There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;
- Data regarding projected population changes; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

12.3.2.2 Drought

Vulnerability to the Hazard

Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies are connected to agriculture, such as Minot and Ward County as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result in significant societal disruption, which can worsen as the resource becomes more and more precious.

Minot's economy is not reliant on agriculture – less than 3% of the workforce is employed in the agriculture sector. Thus, Minot is not as vulnerable to agricultural drought as other areas of the state.

Minot has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. There are significant plans to increase the utility infrastructure in Minot, to accommodate this increase in demand and need. These increases in population and development, coupled with the projected future increases in both, increase the vulnerability of the community to drought, as the community will require more and more water in the future, just to meet normal demands.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 12.3.1-1 (previous).

The representatives from the city of Minot determined that drought has the potential to cause the impacts described in Table 12.3.2.2-1 (below).

Table 12.3.2.2-1
Qualitative Hazard Impacts – Drought

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Drought	Low	Low	Low

Estimate of Potential Losses – Quantitative
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no quantitative risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no quantitative risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;
- Data regarding expected/planned changes in development;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

12.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

Minot has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. There are significant plans to increase the utility infrastructure in Minot, to accommodate this increase in demand and need. These increases in population and development, coupled with the projected future increases in both, increase the vulnerability of the community to fire, as more structures and more people will be exposed to the risk of fire.

In addition, as of this plan update, many Minot residents are still living in temporary housing as a result of the 2011 flood. These temporary residences are generally more vulnerable to hazards than traditional structures, as they are not as well constructed and cannot withstand hazards as well.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 12.3.1-1 (previous).

The representatives from the city of Minot determined that fire has the potential to cause the impacts described in Table 12.3.2.3-1 (following).

Table 12.3.2.3-1
Qualitative Hazard Impacts – Fire

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Fire	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative
All structures within the city of Minot are at some risk from fire. According to the 2010 Census, there are 18,299 housing units in the city; 17,275 of these units are occupied, and 1,024 are vacant.[1] The majority of these structures are heated by natural gas or electricity. The average value of single family housing in Minot is $124,800, according to the Census. This equates to potential residential losses of $2,283,715,200. If 1% of structures in the city are damaged by fire, this would result in $22,837,152 in potential structural losses.

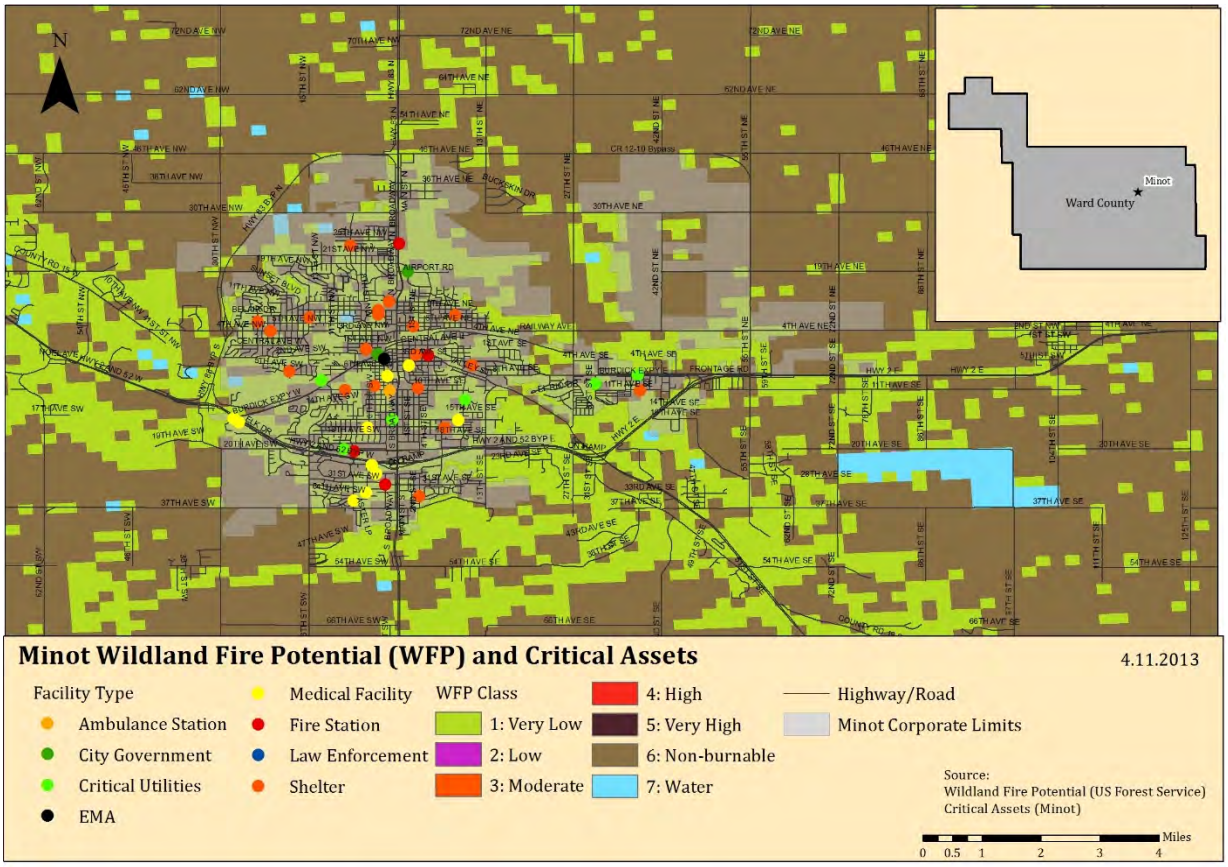
In addition, all identified critical assets (identified in Table 12.3.1-1) within the city have the potential to be lost to fire. These assets have a combine estimated value of at least $34,571,383. If 1% of these assets are lost to or damaged by fire, this would result in $345,714 in potential asset damages.

Using the US Forest Service's Wildland Fire Potential data, the city of Minot and its critical assets were mapped. Based on this data set, the city of Minot has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 12.3.2.3-1 (following) illustrates this fire potential in relation to the identified critical assets for the city.

[1] The figures for housing are from the 2010 Census, which was completed prior to the 2011 flood which devastated the housing stock in the city of Minot. However, the 2010 Census figures remain the best available data for housing estimates within the city, and so are used here to perform estimates of potential losses.

Figure 12.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding expected/project changes in development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

12.3.2.4 Flood

Vulnerability to the Hazard
Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

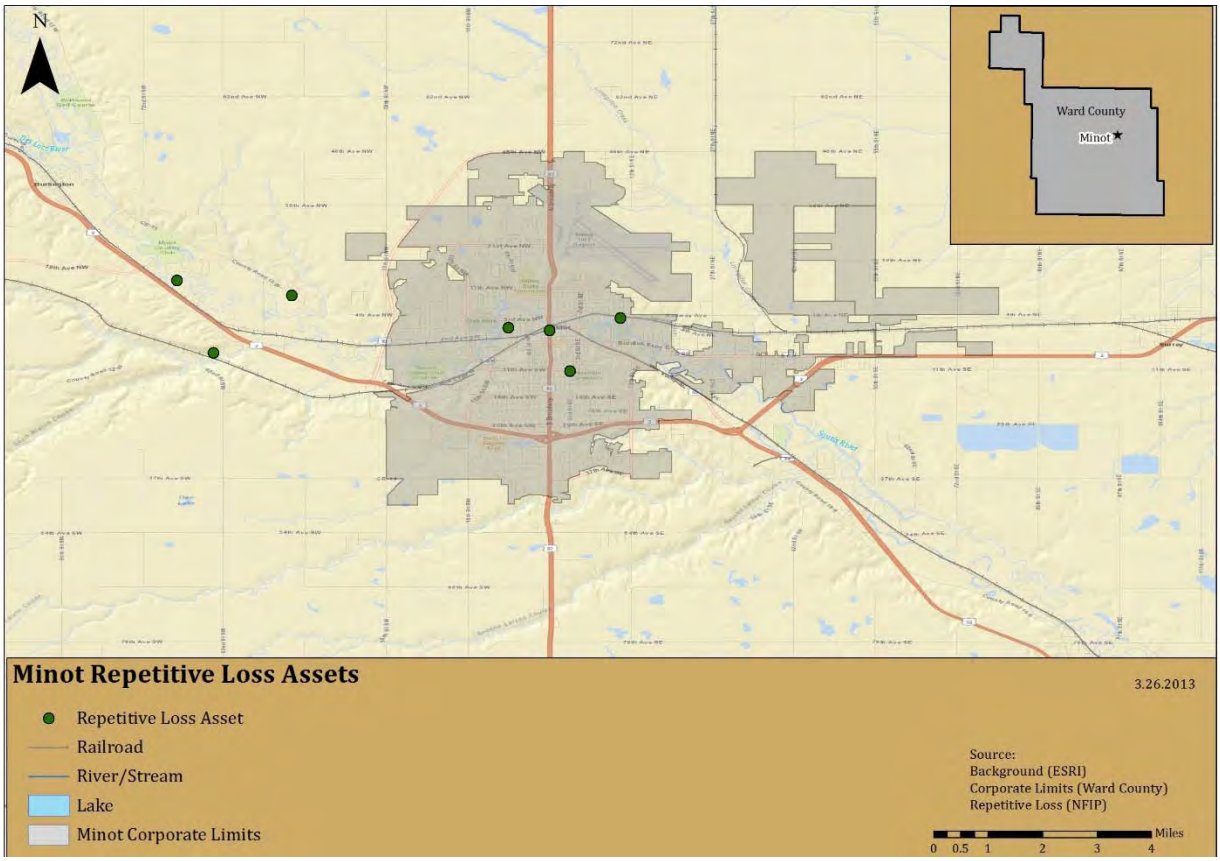
Flood damages also take considerable time to recover from. For example, as of the development of this Plan update, Minot continues to work towards full recovery from the 2011 Souris (Mouse) River flooding.

Minot has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. A large swath of the city lies within an identified floodplain; in addition, much of the city that was flooded in 2011 was outside of these identified and mapped areas. The flood risk in Minot is significant, and the vulnerability to this hazard must be considered when any future development is planned.

In addition, as of this plan update, many Minot residents are still living in temporary housing as a result of the 2011 flood. These temporary residences are generally more vulnerable to hazards than traditional structures, as they are not as well constructed and cannot withstand hazards as well.

The city of Minot is a member of the NFIP, and is in good standing with the program. As of February 2013, there were four NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the city of Minot. The location of these properties is represented in Figure 12.3.2.4-1 (following).

Figure 12.3.2.4-1
Repetitive Loss/Severe Repetitive Loss Properties – Minot



Combined, these four properties account for nine flood insurance claims, with payments totaling more than $69,000.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 12.3.1-1 (previous).

The representatives from the city of Minot determined that flooding has the potential to cause the impacts described in Table 12.3.2.4-1 (below).

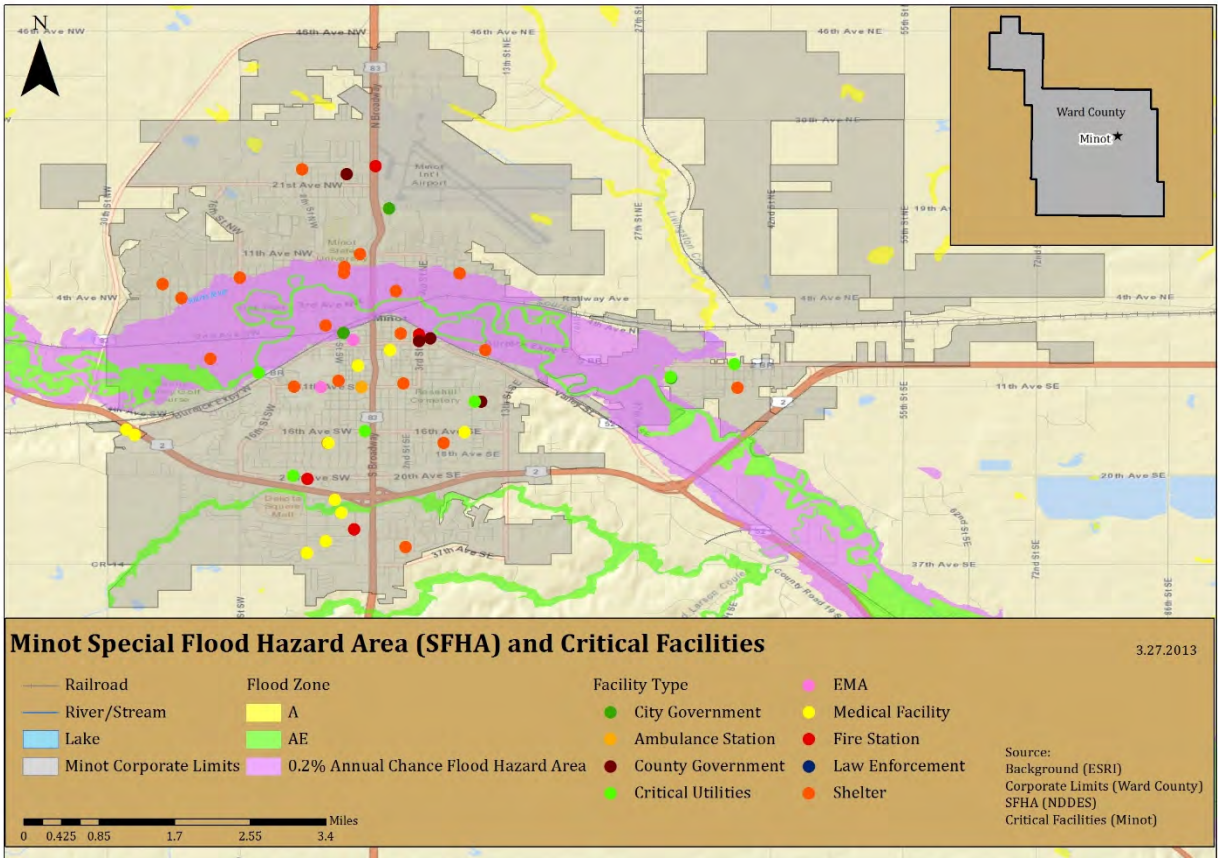
Table 12.3.2.4-1
Qualitative Hazard Impacts – Flood

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Flood	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative

Minot has significant floodplains, both within the corporate limits and outside of the corporate limits. Figure 12.3.2.4-1 (below) illustrates the locations and boundaries of both the one percent annual chance floodplain and the .02% annual chance floodplain. Critical assets for the city have been overlaid onto this hazard boundary map.

Figure 12.3.2.4-1
Special Flood Hazard Areas and Minot Critical Assets



While the majority of Minot's critical assets fall outside of any mapped flood hazard area, it is notable that the majority of critical assets that lie within this hazard area are shelters or medical facilities.

Residential structures, and the people that live in them, are also at significant risk from flooding in Minot. More than 1,300 people (2010 Census) reside within an identified flood hazard area, in more than 640 structures. Using the median value of $124,800, this indicates potential losses of at least $79 M.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

12.3.2.5 Severe Summer Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Minot has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. There are significant plans to increase the utility infrastructure in Minot, to accommodate this increase in demand and need. These increases in population and development, coupled with the projected future increases in both, increase the vulnerability of the community to storm damage, as more structures and more people will be exposed to the risk of summer storms. To mitigate this vulnerability, a need for additional warning sirens and emergency generators was identified during the plan update process; these needs were included in the mitigation strategy for Minot.

In addition, as of this plan update, many Minot residents are still living in temporary housing as a result of the 2011 flood. These temporary residences are generally more vulnerable to hazards than traditional structures, as they are not as well constructed and cannot withstand hazards as well.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table12.3.1-1 (previous).

The representatives from the city of Minot determined that severe summer storms have the potential to cause the impacts described in Table 12.3.2.5-1 (below).

Table 12.3.2.5-1
Qualitative Hazard Impacts – Severe Summer Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Summer Storm	Moderate	Moderate	Moderate

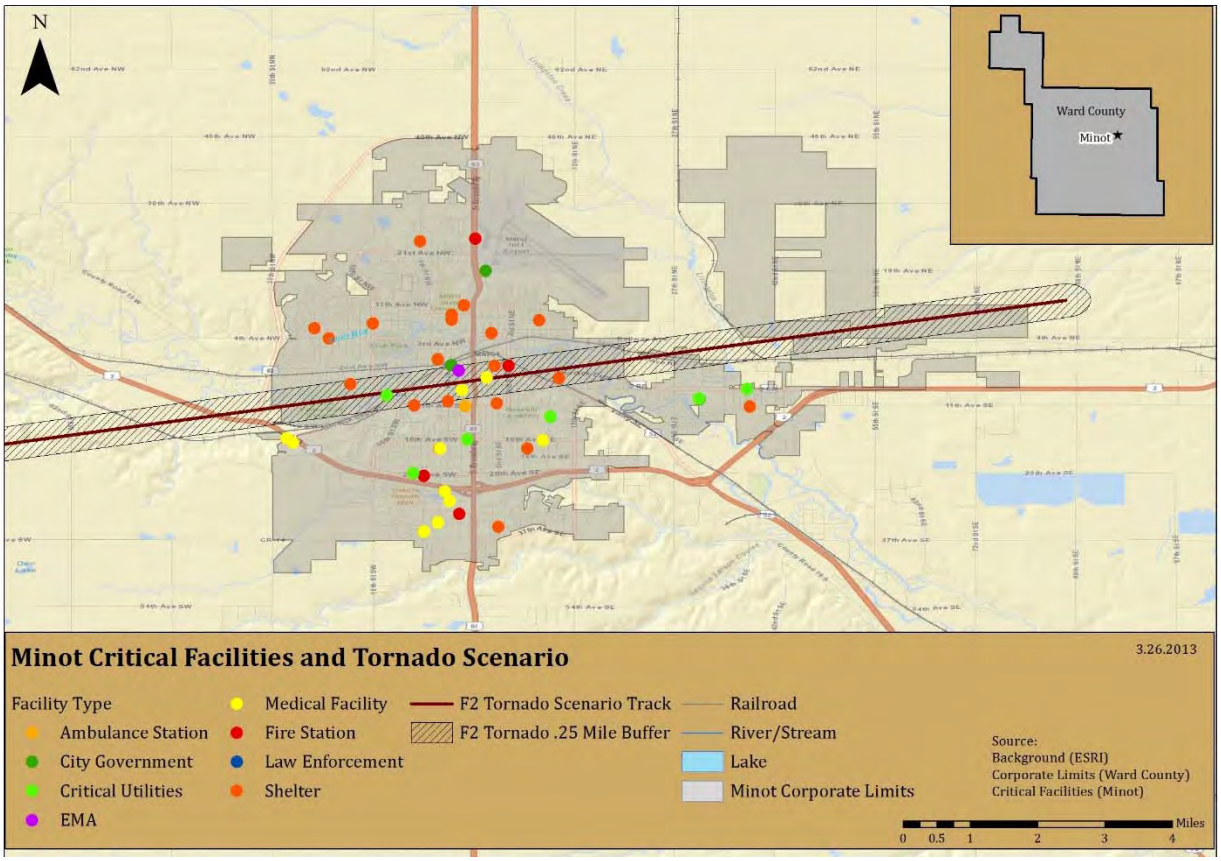
Estimate of Potential Losses – Quantitative
Severe summer storms are a non-spatial hazard that can and do affect the entire city of Minot. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Minot are at risk from severe summer storms. According to the 2010 Census, there are 18,299 housing units in the city. The median value of these structures is $124,800, according to the Census. This equates to residential assets of approximately $2,283,715,200. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $228,371,520.

In addition, all identified critical assets (identified in Table 12.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of at least $34,571,383.

For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Minot. Figure 12.3.2.5-1 (following) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 12.3.2.5-1
Tornado Scenario – City of Minot



In the scenario depicted above, 2,165 residential structures would have potential losses, for a value of more than $270 M. More than 2,600 people would be at risk to injury. 10 critical assets would likely be damaged or destroyed, resulting in additional potential losses of more than $21 M.

As seen in the scenario figure, in such a scenario the majority of the city of Minot would be damaged, including critical assets (government and emergency services). This scenario would result in significant damages to the city's infrastructure, and would greatly impact its ability to provide basic services, such as sewer and water.

Finally, the 40,888 residents of Minot are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 7.1% (children under 5) and 11.5% (those over 70) of the population of Minot. Combined, these two groups account for more than 18% of the population, a total of 7,585 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limit;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

12.3.2.6 Severe Winter Storms

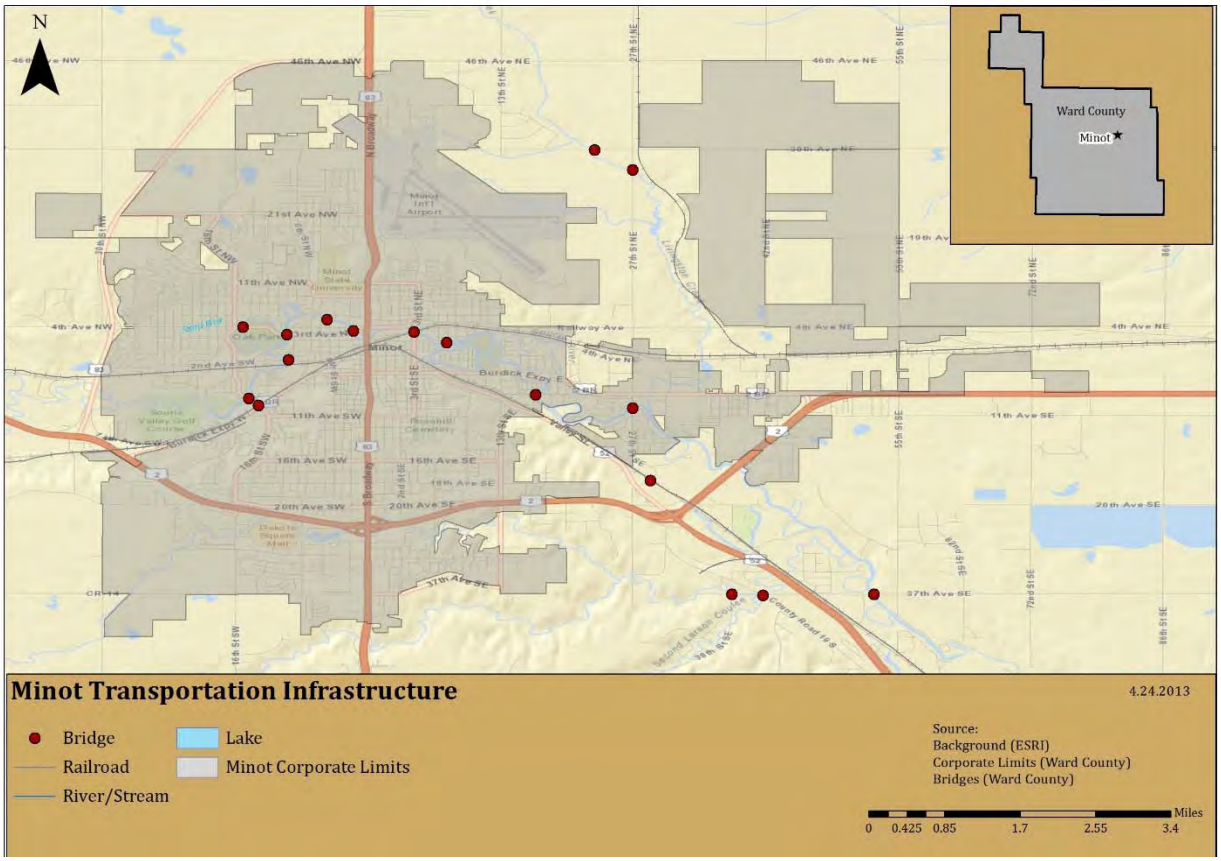
Vulnerability to the Hazard

People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents. Figure 12.3.2.6-1 (following) provides the locations of bridges in and around the city, which typically ice over before surround roadways, making them treacherous for travel.

Figure 12.3.2.6-1
Minot – Bridges



In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Minot has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. There are significant plans to increase the utility infrastructure in Minot, to accommodate this increase in demand and need. These increases in population and development, coupled with the projected future increases in both, increase the vulnerability of the community to storm damage and utility loss, as more structures and more people will be exposed to the risk of winter storms. To mitigate this vulnerability, a need for additional warning sirens and emergency generators was identified during the plan update process; these needs were included in the mitigation strategy for Minot.

In addition, as of this plan update, many Minot residents are still living in temporary housing as a result of the 2011 flood. These temporary residences are generally more vulnerable to hazards than traditional structures, as they are not as well constructed and cannot withstand hazards as well.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 12.3.1-1 (previous).

The representatives from the city of Minot determined that severe winter storms have the potential to cause the impacts described in Table 12.3.2.6-1 (below).

Table 12.3.2.6-1
Qualitative Hazard Impacts – Severe Winter Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Winter Storm	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Minot. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Minot are at risk from severe winter storms. According to the 2010 Census, there are 18,299 housing units in the city. The median value of these structures is $124,800, according to the Census. This equates to residential assets of approximately $2,283,715,200. If 1% of these residential assets were damaged by a severe summer storm, this would result in losses of $22,837,152.

In addition, all identified critical assets (identified in Table 12.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of at least $34,571,383. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $3.4 M.

Finally, the 40,888 residents of Minot are all at risk from the severe winter storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 7.1% (children under 5) and almost 11.5% (those over 70) of the population of Minot. Combined, these two groups account for more than 18% of the population, a total of 7,585 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

12.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard

Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

Minot has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. There are significant plans to increase the utility infrastructure in Minot, to accommodate this increase in demand and need. These increases in population and development, coupled with the projected future increases in both, increase the vulnerability of the community, as more structures and more people will be exposed to the risk of hazardous materials incidents. To mitigate this vulnerability, a need for additional warning sirens and emergency generators was identified during the plan update process; these needs were included in the mitigation strategy for Minot.

In addition, as of this plan update, many Minot residents are still living in temporary housing as a result of the 2011 flood. These temporary residences are generally more vulnerable to hazards than traditional structures, as they are not as well constructed and cannot withstand hazards as well.

The roadways in and around Minot have also seen a significant increase in traffic in recent years, due to the combination of energy activities and disaster recovery, as well as the increased development in the area. This increased traffic increases the chances of a hazardous materials incident occurring. Even if an incident occurred outside of the city it could still impact the city and its residents.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 12.3.1-1 (previous).

The representatives from the city of Minot determined that hazardous materials incidents have the potential to cause the impacts described in Table 12.3.2.7-1 (below).

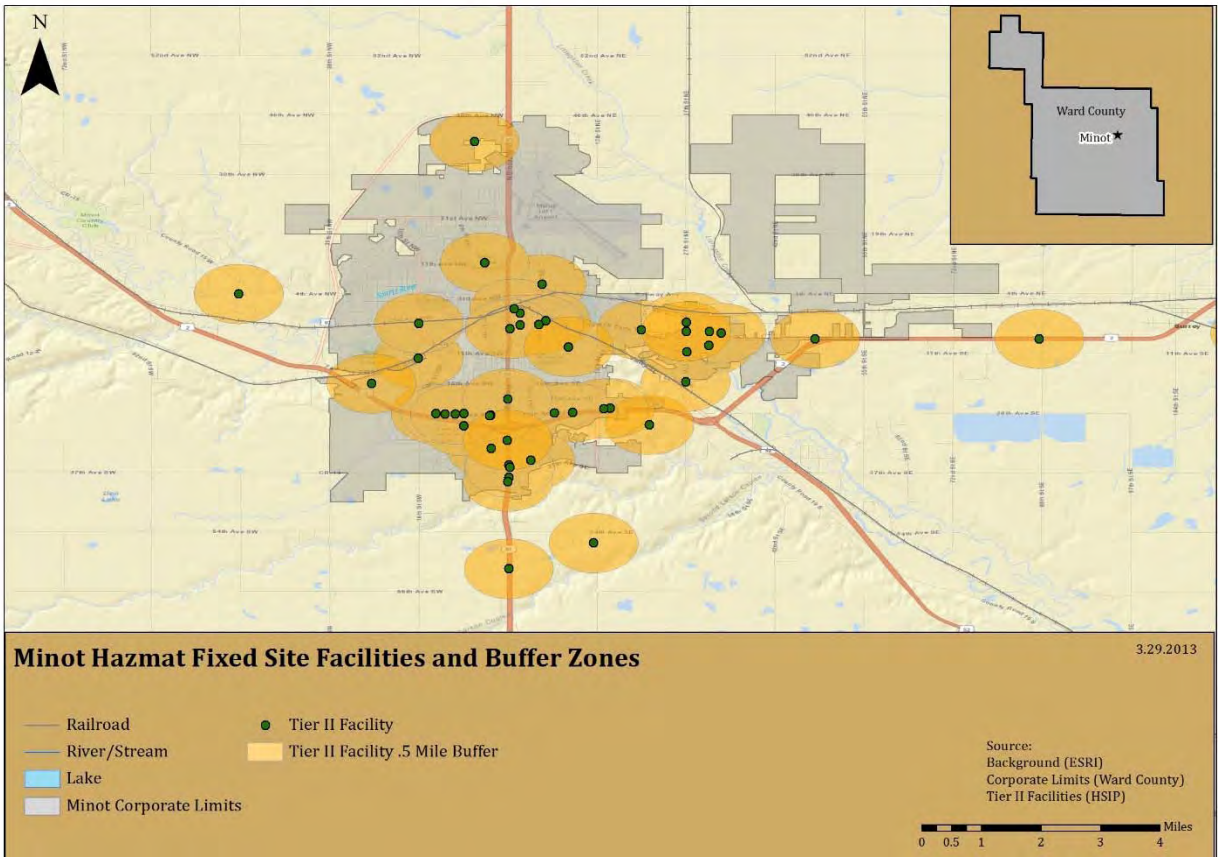
Table 12.3.2.7-1
Qualitative Hazard Impacts – Hazardous Materials Incident

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Hazardous Materials Incident	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative
For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Moderate – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

Minot has at least 45 fixed site facilities that are required to report to Tier II. Figure 12.3.2.7-1 (following) illustrates the locations of these facilities in relation to the city of Minot, and provides a ½ mile buffer zone around each facility. For the purposes of this assessment, all assets within this buffer would be impacted to some degree.

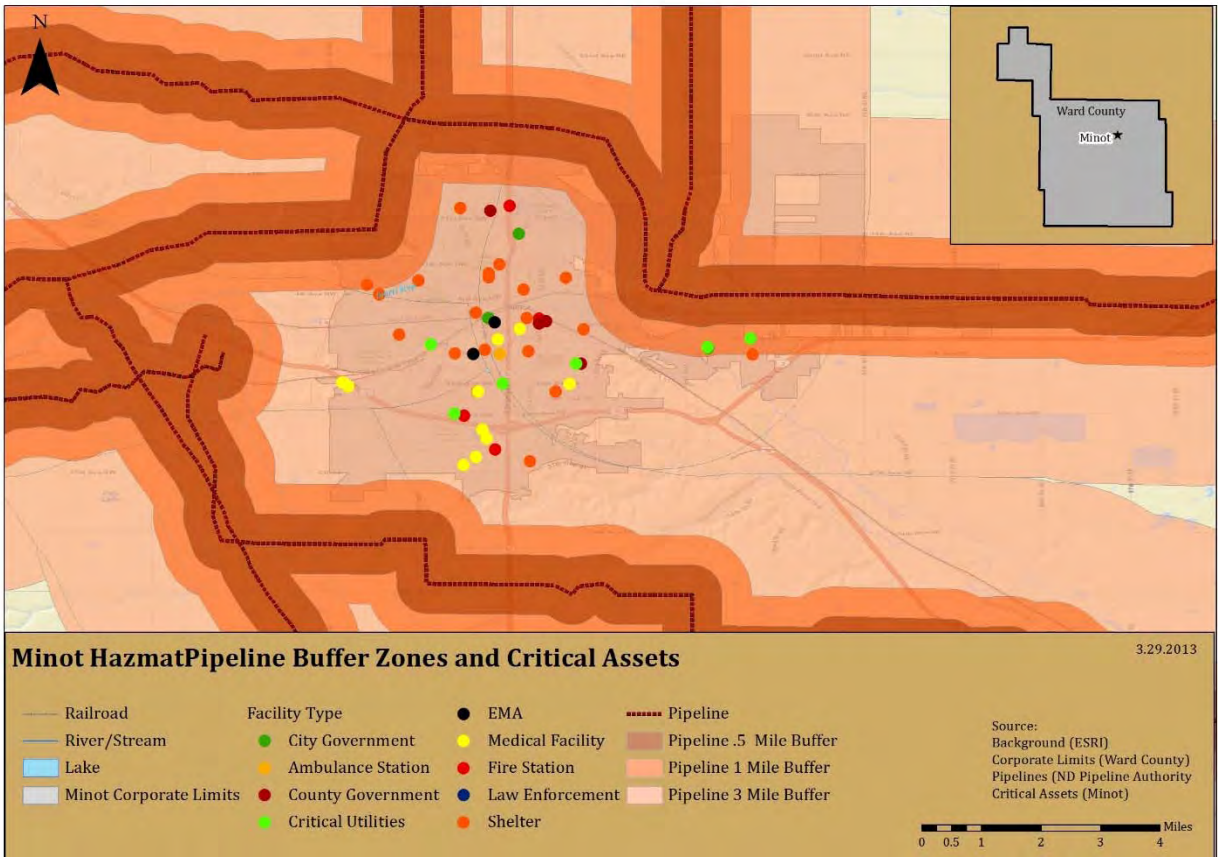
Figure 12.3.2.7-1
Hazardous Materials Incident Scenario – Fixed Site Facilities



The majority of critical assets within the city of Minot fall within one of these buffer zones. In addition, 31,672 people live within these zones, in more than 14,000 structures. As seen in the image above, an incident at any one of these facilities would have the potential to impact a significant portion of the city of Minot, depending on conditions and circumstances.

Pipelines also have the potential to cause significant impacts within the city of Minot. Figure 12.3.2.7-2 (following) illustrates the location of identified pipelines under the city), and provides a ½ mile, one mile, and three mile buffer zone around these pipelines. As seen in this image, all critical assets in the city of Minot could be impacted by an incident with the pipelines. These losses could be structural or physical damage, or could be a loss of function due to contamination or inaccessibility.

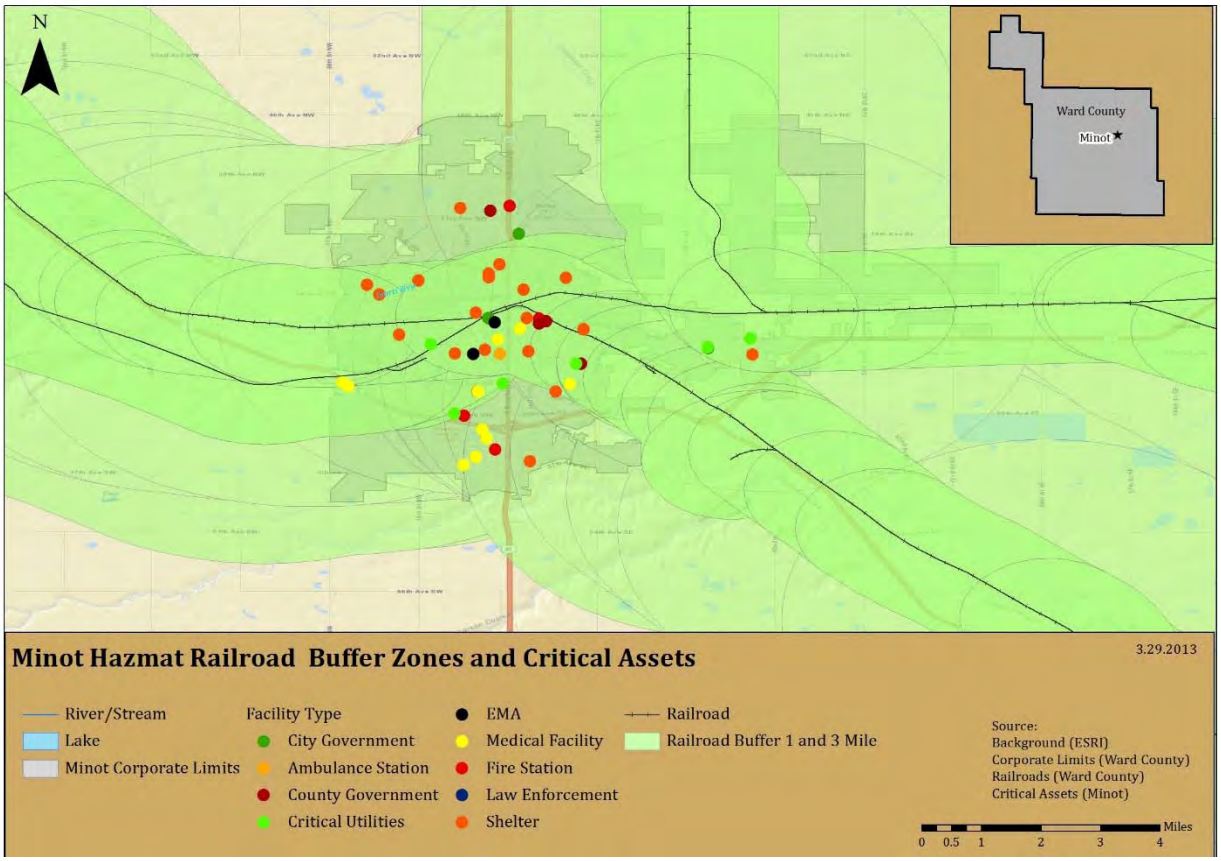
Figure 12.3.2.7-2
Hazardous Materials Incident Scenario – Pipelines



As is evident from the above image, the entire city could be impacted by an incident involving pipelines, depending on the substance involved, the location of the incident, and the specifics of the incident. The entire population of Minot resides within a three mile buffer zone of a pipeline, and more than 27,000 people live within one mile.

Finally, railroads also pose a significant hazardous materials threat to the city of Minot, as railroads are routinely used to transport hazardous materials. Figure 12.3.2.7-3 (following) illustrates the location of the railroad, and provides the one mile buffer zone around this railroad. As seen in this image, all critical assets in the city of Minot could be impacted by an incident with the railroad. These losses could be structural or physical damage, or could be a loss of function due to contamination or inaccessibility.

Figure 12.3.2.7-3
Hazardous Materials Incident Scenario – Railroads



As is evident from the above image, the entire city could be impacted by an incident hazardous materials and the railroad. All critical assets in the city lay within three miles of a railroad, as does the entire population. More than 6,000 people reside within 1 mile, and more than a thousand live within ½ mile.

In addition, an incident with the railways could have transportation ramifications, as trains and other modes of transportation were forced to come to a stop until the incident scene is cleared and cleaned.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and

- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

12.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Minot's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the city has significant familiarity with hazard mitigation programs, and has implemented hazard mitigation projects in the wake of the 2011 Souris (Mouse) River flooding. In addition, the city is currently seeking funding for the Mouse River Flood Protection Plan, which will be a significant hazard mitigation effort, relying on the resources of multiple local, state, and federal partners.
- **Current/ongoing mitigation efforts** – the city is currently working on property acquisition projects and other hazard mitigation grants as a result of the 2011 flooding. In addition, the city maintains a listing of residents who will need additional assistance with evacuations, so that proper planning and timing can be ensured.

- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city. In addition, the city participates in mutual aid agreements.
- **Planning** – The city does not currently have either a COOP/COG or a disaster recovery plan. However, the city does have a comprehensive plan as well as an evacuation plan. The city practices stormwater management, and is a member of the NFIP.
- **Staff, personnel, and technical capability** – as of this Plan update, the city has a high capability and capacity regarding hazard mitigation, and is moderately confident in their abilities to administer hazard mitigation projects and programs. Like most capabilities, it could be improved with experience and additional resources.

Like other municipalities within Ward County, Minot utilizes the framework established by the county and state government for technical assistance, and relies on the state and federal governments for funding.

Conclusions and Recommendations
Minot should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county and the state towards this end.

12.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there* ***must*** *be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

12.5.1 Mitigation Goals

Table 12.5.1-1 (below) provides the mitigation goals that guide the city of Minot's mitigation strategy.

Table 12.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

12.5.2 Mitigation Actions

Potential Mitigation Actions

Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions

Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions

Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (12.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (12.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped the city of Minot to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 12.5.2-2.

Table 12.5.2-1 (below) describes the basic criteria considered as part of the prioritization process.

Table 12.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness
Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (12.5.2-2) provides the identified and prioritized mitigation strategy for the city of Minot.

Table 12.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Continue to enforce floodplain management ordinance and practices	Flood	New	New and existing	Minot Public Works; Minot Floodplain Manager	General funds	$500+	High	
Goal 01: Reduce the effect of hazards throughout the planning area.	Strengthen floodplain ordinance to require additional elevations for new development	Flood	New	New	Minot Public Works; Minot Floodplain Manager	General funds; Ward County EMA	$500+	High	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	Minot Public Works; Minot Floodplain Manager	General funds; Ward County EMA	$500+	High	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Finance Department	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions	$1,000+	Moderate	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Work with state and federal partners to determine additional structural flood protection needs, and to design and construct those measures	Flood	New	New and existing	Minot Public Works	FEMA & NDDES hazard mitigation grant funds	$25,000+	High	
Goal 03: Protect public health and safety before, during, and after hazard events.	Purchase and install additional emergency power generators	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	Minot Public Works	FEMA & NDDES hazard mitigation grant funds; general funds	$60,000+	Moderate / High	
Goal 03: Protect public health and safety before, during, and after hazard events.	Purchase and install additional warning sirens	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and Existing	Minot Public Works	FEMA & NDDES hazard mitigation grant funds; general funds	$60,000+	Moderate / High	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Study and develop mitigation solutions to existing stormwater and drainage issues that currently result in periodic flooding	Flood	New	Existing	Minot Public Works	FEMA & NDDES hazard mitigation grant funds; general funds	$25,000+	High	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recent annexations and/or recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	Minot Public Works	General funds; Ward County EMA	$1,000+	Moderate	
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	Minot Public Works; City Finance Department	General fund; in-kind contributions; Ward County EMA	$500+	Moderate	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Identify and acquire floodprone properties throughout the City	Flood	New	Existing	Minot Public Works; Minot Finance Department	FEMA & NDDES hazard mitigation grant funding; general funds; Community Development Block Grants; other federal / state funding sources, as available	$50,000+	High	

Section 13
City of Ryder: HIRA, Capability Assessment, and Mitigation Strategy

13.1 IFR for Hazard Identification and Risk Assessment
13.2 Hazard Identification (Updated)
13.2.1 Overview of Ryder's History of Hazards and Potential Hazards
13.2.2 Hazard Profiles
13.3 Risk Assessment (Updated)
13.3.1 Risk Assessment Methodology
13.3.2 Risk and Vulnerability Assessment
13.4 Capability Assessment (Updated)
13.5 Mitigation Strategy (Updated)
13.5.1 Mitigation Goals
13.5.2 Mitigation Actions

13.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of*

the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..

Requirement §201.6(c)(2)(ii)(C): *[The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment **must** assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Ryder.

13.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Ryder. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

13.2.1 Overview of Ryder's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 9 weather-related hazard events have occurred in the city of Ryder since 1995, including the following number and types of hazard events:

- Hail – 6
- Thunderstorm wind - 3

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 13.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 13.2.1-1
Presidential Disaster Declarations – City of Ryder

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Ryder

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 13.2.1-2 (below).

Table 13.2.1-2
Preliminary Hazard Identification and Determinations – City of Ryder

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Ryder	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Ryder	Reason for Exclusion and other notes
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Ryder	Reason for Exclusion and other notes
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

13.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

13.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk. Table 13.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 13.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance

and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Ryder.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 13.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 13.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 13.2.2.1-3 (following) provides the details of pertussis outbreaks since 2007.

Table 13.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 13.2.2.1-4 (below) provides occurrence information for rabies.

Table 13.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Ryder did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Ryder, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Ryder, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been no occurrences of communicable disease within the city of Ryder. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

13.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Ryder are subject to the drought hazard.

Extent and Severity of the Hazard
Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.

- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

Table 13.2.2.2-1 (below) provides the PDSI classifications.

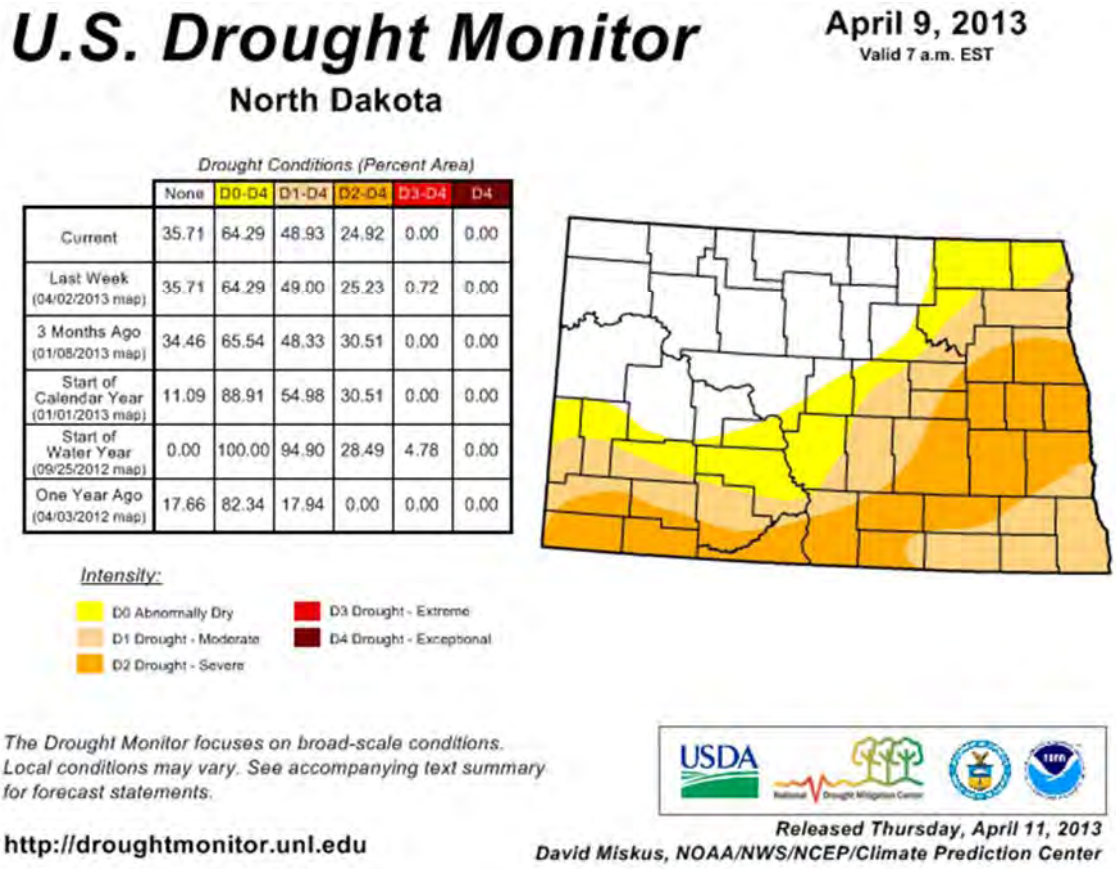
Table 13.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested

Classification	Description	Range of Possible Impacts
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Ryder are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 13.2.2.2-1 (following).

Figure 13.2.2.2-1
US Drought Monitor – North Dakota
(source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 13.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Ryder – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

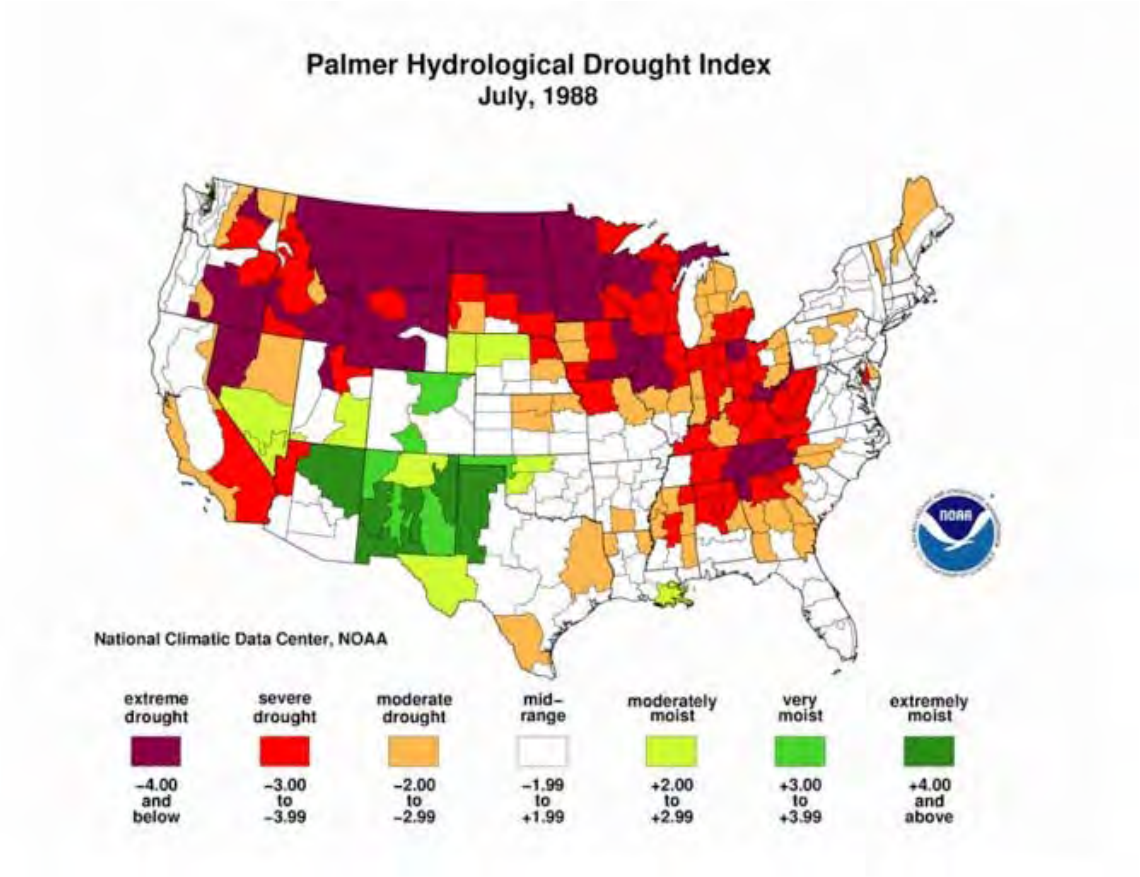
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Ryder. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 11.2.2.2-2 (following), the entire state – including the city of Ryder – was categorized as being in extreme drought during this time.

Figure 13.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Ryder) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years in more recent history.

13.2.2.3 Fire

This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

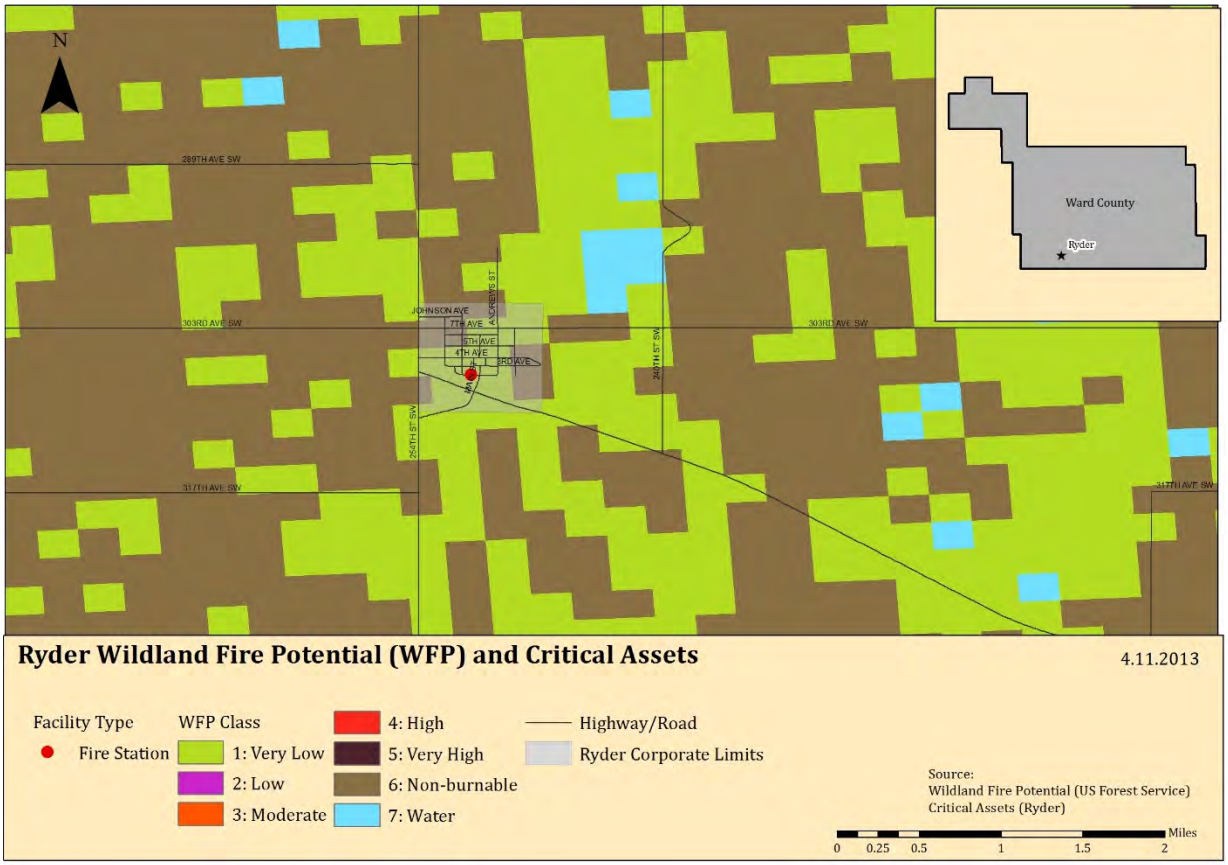
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 13.2.2.3-1 (following) illustrates the wildland fire potential for the city of Ryder, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 13.2.2.3-1
City of Ryder – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard

The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 13.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System

Table 13.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the

destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people. In addition, some structures (such as grain elevators) require specialized teams and equipment, and so response to these events may be delayed.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Note: Ryder's Fire Department works in conjunction with the city of Makoti, and all statistics are combined for both cities. Therefore, the statistics below assume that 50% of the reported fires occurred in each city.

Based on data obtained from the National Reporting System and from the Makoti/Ryder Fire Department, the city of Ryder has experienced 3.5 structure fires from January 2008 through December 2012, an average of .70 structure fires per year. For this same time period, 23 wildland fires were responded to, an average of 4.6 per year.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in the city of Ryder annually. Using the scale provided earlier in this section, this equates to a high probability of a future occurrence.

13.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.*

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North

Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard
There are no identified or mapped floodplains within the city of Ryder.

Extent and Severity of the Hazard
In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 13.2.2.4-1 (following).

Table 13.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 13.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 13.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.

Term	Definition
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

Ryder has no mapped or identified floodplains, and is not a member of the NFIP, nor are they sanctioned by the NFIP. There are no designated Repetitive Loss or Severe Repetitive Loss properties within the city of Ryder.

Potential Impact of the Hazard
Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A

major flood occurred in the Souris River Basin in 1969, which greatly impacted the region (though not specifically the city of Ryder). More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley.

The city of Ryder reported no occurrences of flooding within the city.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs at less than once every five years in the city of Ryder. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is low.

13.2.2.5 Severe Summer Storms

This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

Extreme Heat
Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail
Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning
Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms
Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard
Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Ryder.

Extent and Severity of the Hazard
Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat
The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.

- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 13.2.2.5-1(following). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 13.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail

The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 13.2.2.5-1 (following) provides details of these scales.

Table 13.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33"	Pea	No damage
H1	Potentially Damaging	0.33" – 0.60"	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60" – 0.80"	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80" – 1.20"	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20" – 1.60"	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60" – 2.0"	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0" – 2.4"	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4" – 3.0"	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0" – 3.5"	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5" – 4.0"	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning

The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to

explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- **Ground-to-Cloud Lightning.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning**. Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning.** Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 13.2.2.5-2 (following) provides this severity scale.

Table 13.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to

describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 13.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 13.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Table 13.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 13.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms
Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Given that Ryder is smaller than 15 miles in diameter, it is possible for the entire jurisdiction to be impacted by the same thunderstorm at any given time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from

thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Ryder are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards.

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at

the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 13.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 13.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties

- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact

on life due to thunderstorm and associated hazards in Ryder would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard
Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least10 occurrences of the summer storm hazard since 1998. (Note: Records prior to 1998 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 13.2.2.5-6 (below) provides details of these recorded incidents.

Table 13.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Description	Magnitude (if applicable)
July 06, 1998	Tornado/Funnel cloud	Unknown
August 21, 2001	Hail	1.75”
June 06, 2004	Tornado/Funnel Cloud	Unknown
July 20, 2004	Hail	.75”
July 21, 2005	Hail	.88”
May 21, 2007	Hail (3 occurrences)	1.75”; .88” and 1.25”
August 01, 2008	Hail	1.5”
July 20, 2010	Hail	1”

Probability of a Future Occurrence of the Hazard
In the 17 year period for which records are available, the summer storm hazard has occurred at least nine times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is moderate, as the summer storm hazard occurs at least once every five years.

13.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard

Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow

The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold

What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice

The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations

of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Ryder.

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold
Winter temperatures in Ryder typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 13.2.2.6-1 (following) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 13.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)

NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

- **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.
- **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard
Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard
According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes,

accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.

- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.
- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard

Based on the data available, winter storms occur in or otherwise impact the city of Ryder at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

13.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard

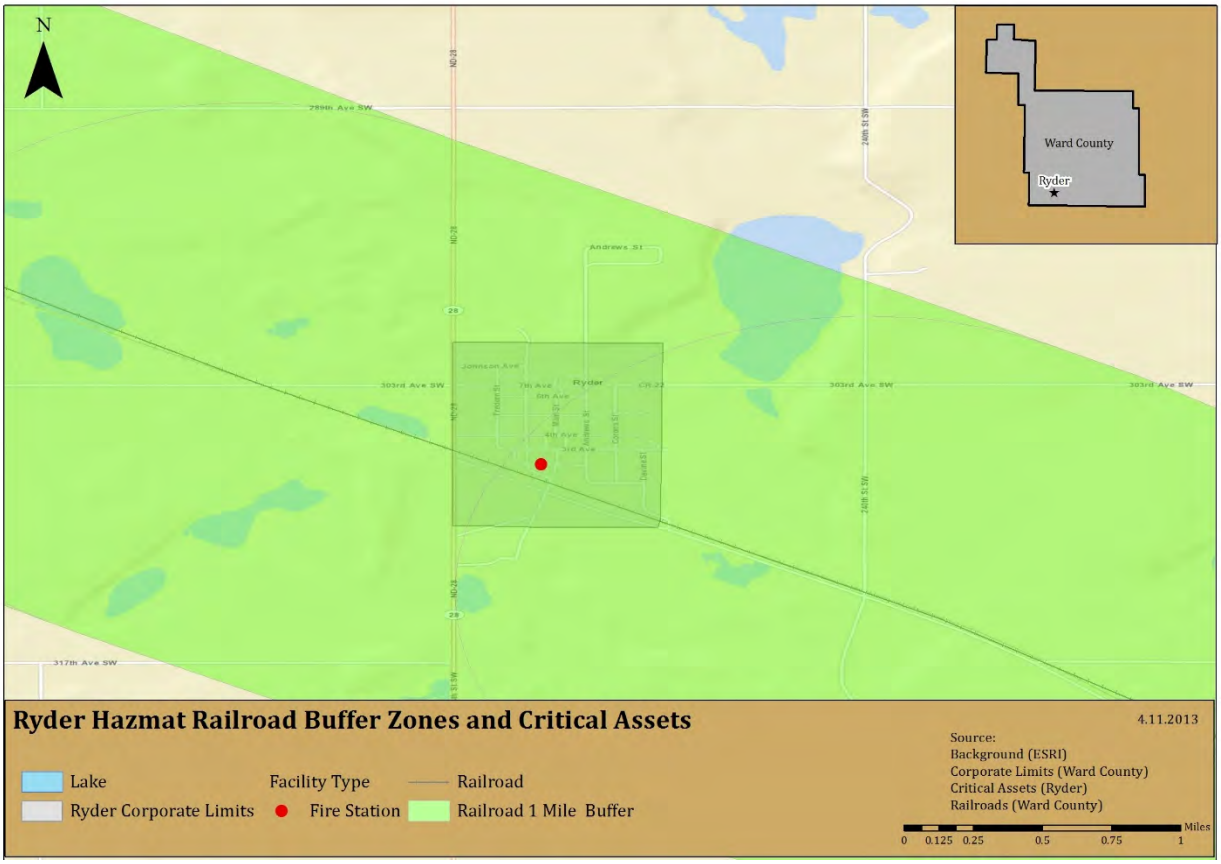
Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard

The locations in Ryder most at risk from a hazardous materials incident are those that are in proximity to either locations that store/use hazardous materials or that are adjacent to transportation lines. The following figure (13.2.2.7-1) illustrates these locations in Ryder.

Figure 13.2.2.7-1
Hazardous Materials Locations – Railroads



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, no Tier II reports from the city of Ryder have been submitted to the EPA since 1987, the year that the EPA began keeping such reports.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in Ward County, though not necessarily in the city of Ryder. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

13.3 Risk Assessment (Updated)

The table below (Table 13.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Ryder.

Table 13.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

13.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Ryder from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city

- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Ryder to the identified and profiled hazards.

Critical Assets
The table below (Table 13.3.1-1) provides details of the critical assets contained within the city of Ryder.

Table 13.3.1-1
Critical Assets – City of Ryder

Asset Name	Asset Use /Function	Street Number	Street Name	Insured or Estimated Value
Ryder/Makoti Fire Protection District – Ryder Fire Hall	Emergency Services	50	2nd Avenue West	$175,469
Ryder/Makoti Ambulance	Emergency Services	61	2nd Avenue West	175,469
North Shore School	Shelter	2	6th Avenue West	$16,115
Cenex Building	Shelter	151	North Main Street	$16,115
Sewer Lift Station	Utility	--	5th Avenue and Devine Street	$63,206
Cenex	Fuel	151	North Main Street	$84,275
Total estimated value of identified critical assets:				**$530,649**

Note on asset values: Valuation data for assets within the city was unavailable at the time this plan update was developed. All valuations used in the following estimates of potential losses are derived from an average of available data for the same or similar types of assets from other jurisdictions. The assessment that follows is an estimate only, and may not correlate with actual occurrences of the damage caused by the hazards described.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

13.3.2 Risk and Vulnerability Assessment

13.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 85 people residing in Ryder; this is a decrease from the 2000 Census (92 people), and is in line with the 2012 Census Estimate (84 people). Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

The stability in Ryder's population indicates stability in the community's vulnerability; with no projected increases in the population in the foreseeable future, it can be reasonably assumed that the community's vulnerability will remain stable in the near future.

Estimate of Potential Losses
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Ryder represents ~.5% of the total population of Ward County, or 85 people. While an outbreak of communicable disease in Ryder is unlikely to have significant impacts outside of Ryder, an outbreak could have significant impacts within the city.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness rate in Ryder that is similar to the illness rate across the county, the following numbers of people in Ryder could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Ryder accounts for ~.5% of the county population. This equates to 23 cases of influenza in Ryder, on average, that could potentially impact the city.
- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Ryder accounts for ~.5% of the county population. This equates to 32 cases of pertussis in Ryder, on average, that could potentially impact the city.

Identified Data Limitations
There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;
- Data regarding projected population changes; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

13.3.2.2 Drought

Vulnerability to the Hazard
Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies depend largely on agriculture, such as the State of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result in significant societal disruption, which can worsen as the resource becomes more and more precious.

While agriculture is not a critical sector of Ryder's economy, it does account for approximately 16% of its employment (based on the 2010 Census), thereby making the community's economy at least somewhat vulnerable to agriculture drought.

Ryder's population and development has remained relatively stable since the 2000 Census. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no changes to the city's vulnerability to this hazard in the near future.

Estimate of Potential Losses
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this

hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

13.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

Ryder's population and development has remained relatively stable since the 2000 Census. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no changes to the city's vulnerability to this hazard in the near future.

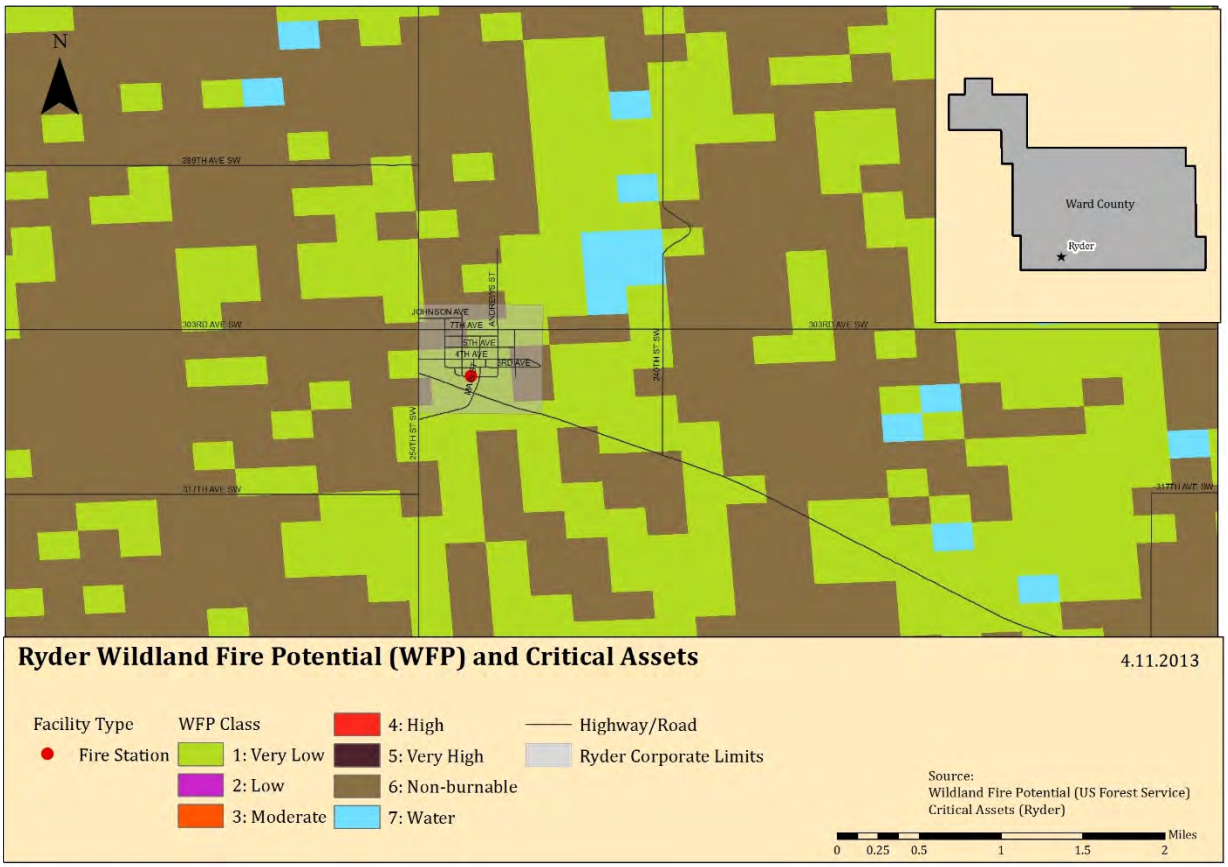
Estimate of Potential Losses
All structures within the city of Ryder are at risk from fire. According to the 2010 Census, there are 51 housing units in the city; 33 of these units are occupied, and 18 are vacant. The majority of these structures are heated by bottled gas or fuel oil. The median value of single family housing in Ryder is $22,500, according to the Census. This equates to potential residential losses of $1,147,500.

In addition, all identified critical assets (identified in Table 13.3.1-1) within the city have the potential to be lost to fire. These assets have a combined estimated value of $530,649.

Using the US Forest Service's Wildland Fire Potential data, the city of Ryder and its critical assets were mapped. Based on this data set, the city of Ryder has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 13.3.2.3-1 (below) illustrates this fire potential in relation to the identified critical assets for the city.

Figure 13.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and

- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

13.3.2.4 Flood

Vulnerability to the Hazard
Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

Flood damages also take considerable time to recover from. The 2011 flooding that occurred throughout the county had far-reaching impacts, and recovery for many areas remains a work in progress as of this Plan update.

Ryder's population and development has remained relatively stable since the 2000 Census. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no changes to the city's vulnerability to this hazard in the near future.

The city of Ryder has no mapped or identified SFHAs, and is not a member of the NFIP. As of February 2013, there were no NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the city of Ryder.

Estimate of Potential Losses
It was the determination of the Steering Committee that risk assessments related to flooding should be performed for those areas within Ward County that contained a mapped or identified flood hazard area.

In light of this determination, no risk assessment has been performed for this hazard for the city of Ryder.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

13.3.2.5 Severe Summer Storms

Vulnerability to the Hazard

People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Ryder's population and development has remained relatively stable since the 2000 Census. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no changes to the city's vulnerability to this hazard in the near future.

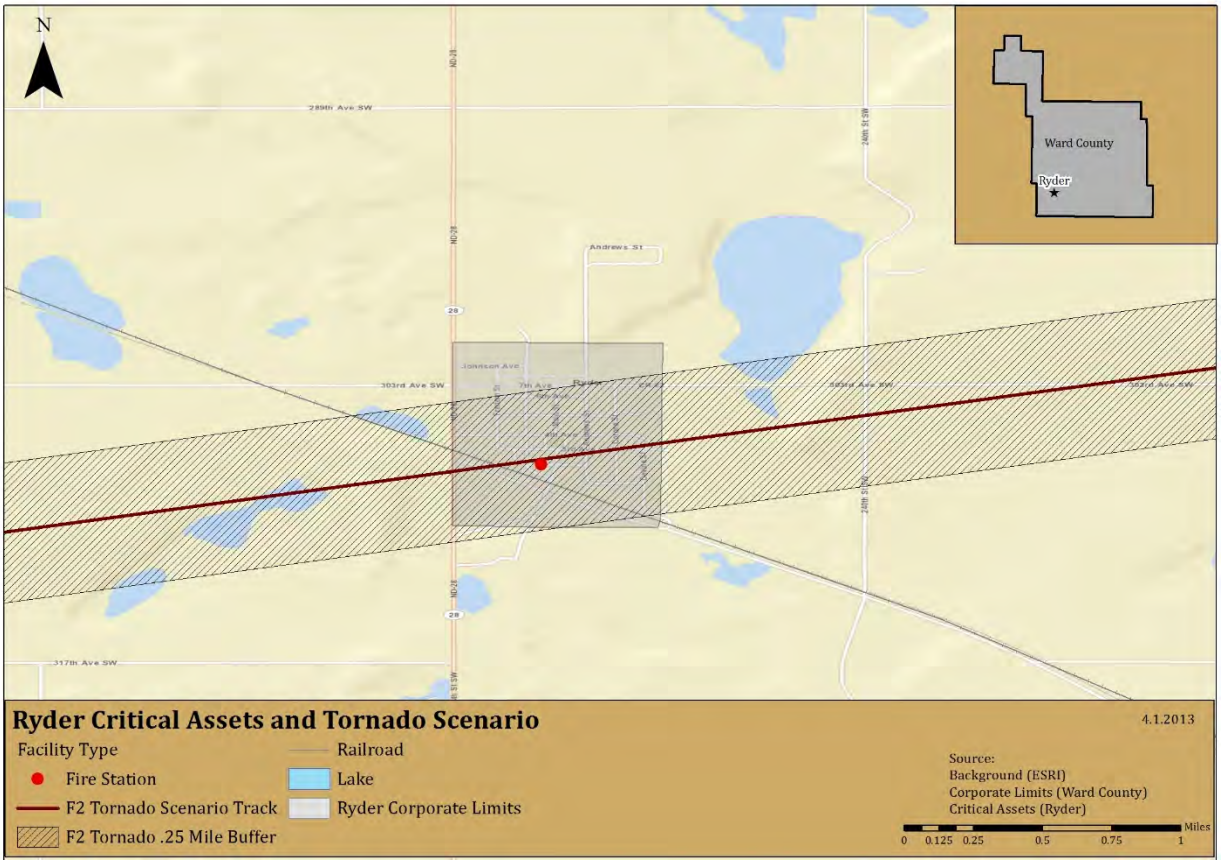
Estimate of Potential Losses

Severe summer storms are a non-spatial hazard that can and do affect the entire city of Ryder. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Ryder are at risk from severe summer storms. According to the 2010 Census, there are 51 housing units in the city. The median value of these structures is $22,500, according to the Census. This equates to residential assets of approximately $1,147,500. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $114,750.

In addition, all identified critical assets (identified in Table 13.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of $530,649. For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Ryder. Figure 13.3.2.5-1 (following) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 13.3.2.5-1
Tornado Scenario – City of Ryder



As seen in the above figure, in such a scenario the majority of the city of Ryder would be damaged, including critical assets (government and emergency services). This scenario would result in $175,469 in potential losses to the city, and would greatly impact its ability to provide basic services, such as emergency response.

Finally, the 85 residents of Ryder are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 7.1% (children under 5) and 18.8% (those over 70) of the population of Ryder. Combined, these two groups account for almost 26% of the population, a total of 22 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limit;

- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

13.3.2.6 Severe Winter Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents.

In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Ryder's population and development has remained relatively stable since the 2000 Census. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no changes to the city's vulnerability to this hazard in the near future.

Estimate of Potential Losses
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Ryder. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Ryder are at risk from severe winter storms. According to the 2010 Census, there are 51 housing units in the city. The median value of these structures is $22,500, according to the Census. This equates to residential assets of approximately $1,147,500. If 1% of these residential assets were damaged by a severe winter storm, this would result in losses of $11,475.

In addition, all identified critical assets (identified in Table 13.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of $530,649. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $53,065.

Finally, the 85 residents of Ryder are all at risk from the severe winter storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 7.1% (children under 5) and 18.8% (those over 70) of the population of Ryder. Combined, these two groups account for almost 26% of the population, a total of 22 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

13.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

Ryder's population and development has remained relatively stable since the 2000 Census. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future.

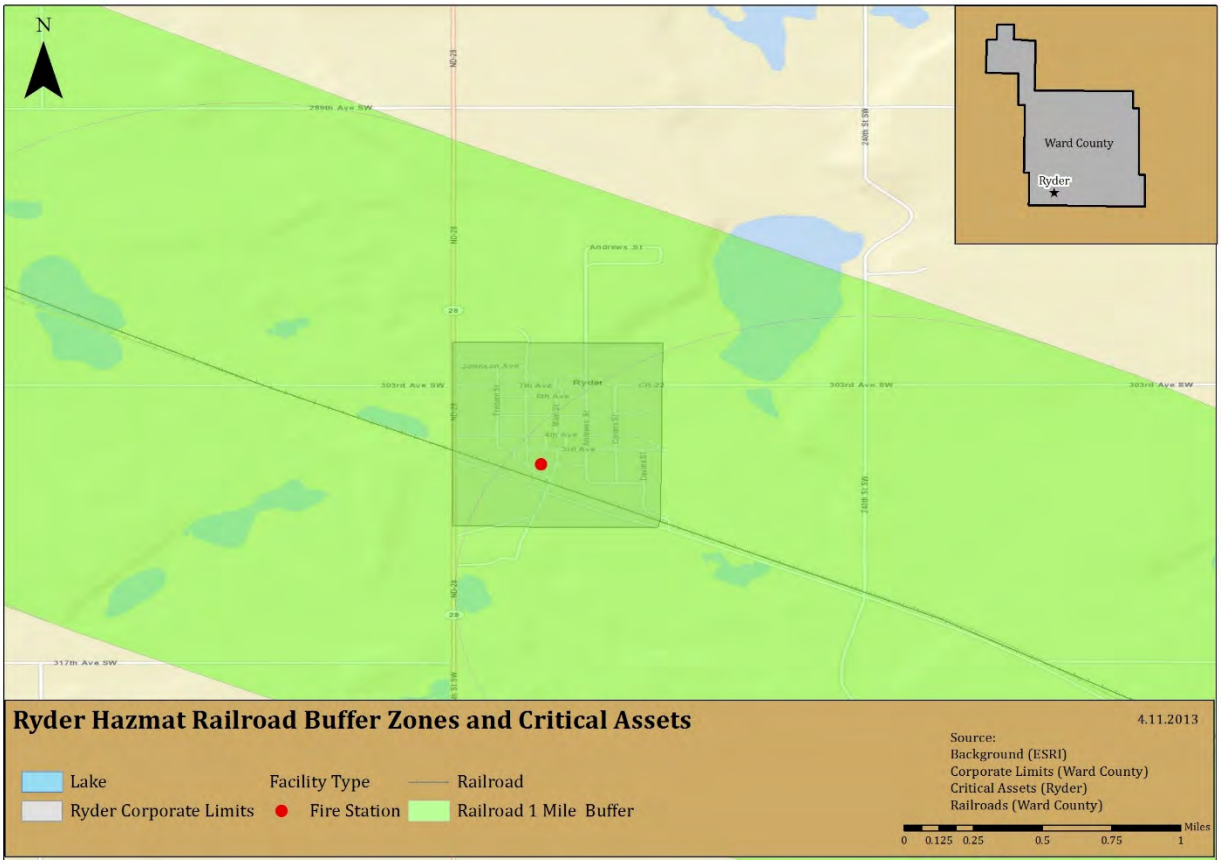
The roadways around Ryder have seen an increase in traffic in recent years, due in large part to the increase in energy activities throughout the state. An incident on the roadways could impact the city and its residents, even if it did not occur within the city limits. This increase traffic has led to at least some increase in vulnerability to this hazard.

Estimate of Potential Losses

For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Ryder – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

Ryder's hazardous materials risk comes from the railroad, and from the materials that are moved on the railroad. Figure 13.3.2.7-1 (following) illustrates the location of the railroad in relation to the city of Ryder, and provides designated buffer zones around it. For the purposes of this assessment, all assets within these buffers would be impacted to some degree.

Figure 13.3.2.7-1
Hazardous Materials Incident Scenario – Railroad



As is evident from the above image, the entire city could be impacted by an incident hazardous materials and the railroad, as could all critical assets within the city. This equals potential losses of $1,678,149 (critical asset and residential structures).

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

13.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Ryder's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the city has moderate familiarity with hazard mitigation programs, and hazard mitigation does not currently play a role in the decision-making process for the city.
- **Current/ongoing mitigation efforts** – currently, the city's mitigation efforts include participating in the development of the Ward County Hazard Mitigation Plan Update. The Fire Department informally keeps track of vulnerable populations.
- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city.
- **Planning** –the city has adopted and enforced building codes, and has an informal COOP/COG plan. There is no disaster recovery, evacuation, or master plan. The city is not a member of the NFIP.

- **Staff, personnel, and technical capability** – as of this Plan update, the city has a limited capability and capacity regarding hazard mitigation, and has limited confidence in their abilities to administer hazard mitigation projects and programs. Additional experience and resources would be beneficial to building this capacity.

Like other municipalities within Ward County, Ryder depends on the framework established by the county and state government for technical assistance, and on the state and federal government for funding.

Conclusions and Recommendations
Ryder should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county towards this end.

13.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there **must** be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

13.5.1 Mitigation Goals

Table 13.5.1-1 (following) provides the mitigation goals that guide the city of Ryder's mitigation strategy.

Table 13.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

13.5.2 Mitigation Actions

Potential Mitigation Actions
Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions
Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of

special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions

Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (13.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (13.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped the city of Ryder to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 13.5.2-2. Table 13.5.2-1 (below) describes the basic criteria considered as part of the prioritization process.

Table 13.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.

STAPLEE	Criteria Explanation
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness

Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (13.5.2-2) provides the identified and prioritized mitigation strategy for the city of Ryder.

Table 13.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Join the NFIP; enforce floodplain management ordinance and practices	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Low	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	City Council	General funds; Ward County EMA	$500+	Low	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Council	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; Ward County EMA	$500+	High	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recent annexations and/or recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council	Ward County EMA	$500+	Low	
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council; City Auditor	General fund; in-kind contributions; Ward County EMA; State Fire Marshal	$500+	Low	

Section 14
City of Sawyer: HIRA, Capability Assessment, and Mitigation Strategy

14.1 IFR for Hazard Identification and Risk Assessment
14.2 Hazard Identification (Updated)
14.2.1 Overview of Sawyer's History of Hazards and Potential Hazards
14.2.2 Hazard Profiles
14.3 Risk Assessment (Updated)
14.3.1 Risk Assessment Methodology
14.3.2 Risk and Vulnerability Assessment
14.4 Capability Assessment (Updated)
14.5 Mitigation Strategy (Updated)
14.5.1 Mitigation Goals
14.5.2 Mitigation Actions

14.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of*

the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..

Requirement §201.6(c)(2)(ii)(C): *[The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment **must** assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Sawyer.

14.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Sawyer. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

14.2.1 Overview of Sawyer's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 20 weather-related hazard events have occurred in the city of Sawyer since 1994, including the following number and types of hazard events:

- Hail – 13
- Thunderstorm – 6
- Tornado/Funnel Cloud - 1

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 14.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 14.2.1-1
Presidential Disaster Declarations – City of Sawyer

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Sawyer

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 14.2.1-2 (below).

Table 14.2.1-2
Preliminary Hazard Identification and Determinations – City of Sawyer

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Sawyer	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Sawyer	Reason for Exclusion and other notes
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Sawyer	Reason for Exclusion and other notes
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

14.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

14.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk. Table 14.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 14.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance

and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Sawyer.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 14.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 14.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 14.2.2.1-3 (following) provides the details of pertussis outbreaks since 2007.

Table 14.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 14.2.2.1-4 (below) provides occurrence information for rabies.

Table 14.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Sawyer did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Sawyer, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Sawyer, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been no occurrences of communicable disease within the city of Sawyer. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

14.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Sawyer are subject to the drought hazard.

Extent and Severity of the Hazard
Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.

- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

Table 14.2.2.2-1 (below) provides the PDSI classifications.

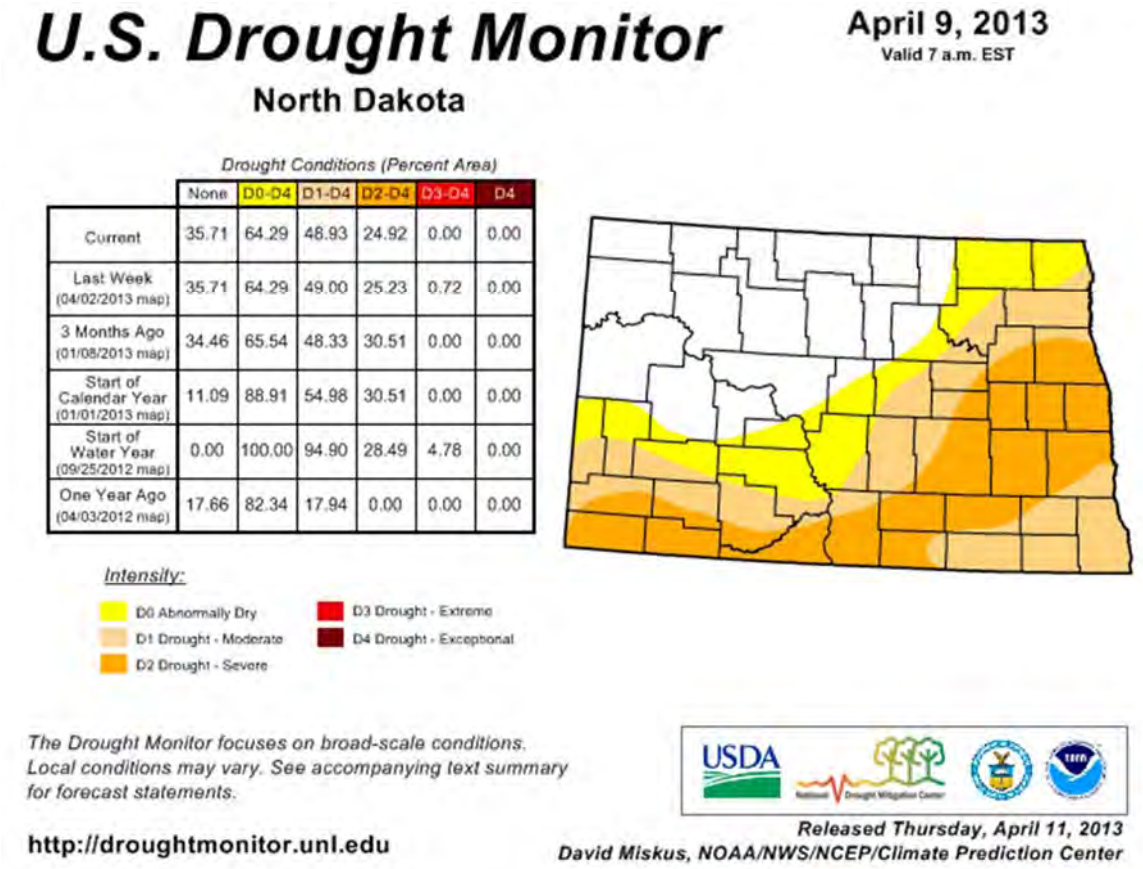
Table 14.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested

Classification	Description	Range of Possible Impacts
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Sawyer are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 14.2.2.2-1 (following).

Figure 14.2.2.2-1
US Drought Monitor – North Dakota
(source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 14.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Sawyer – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

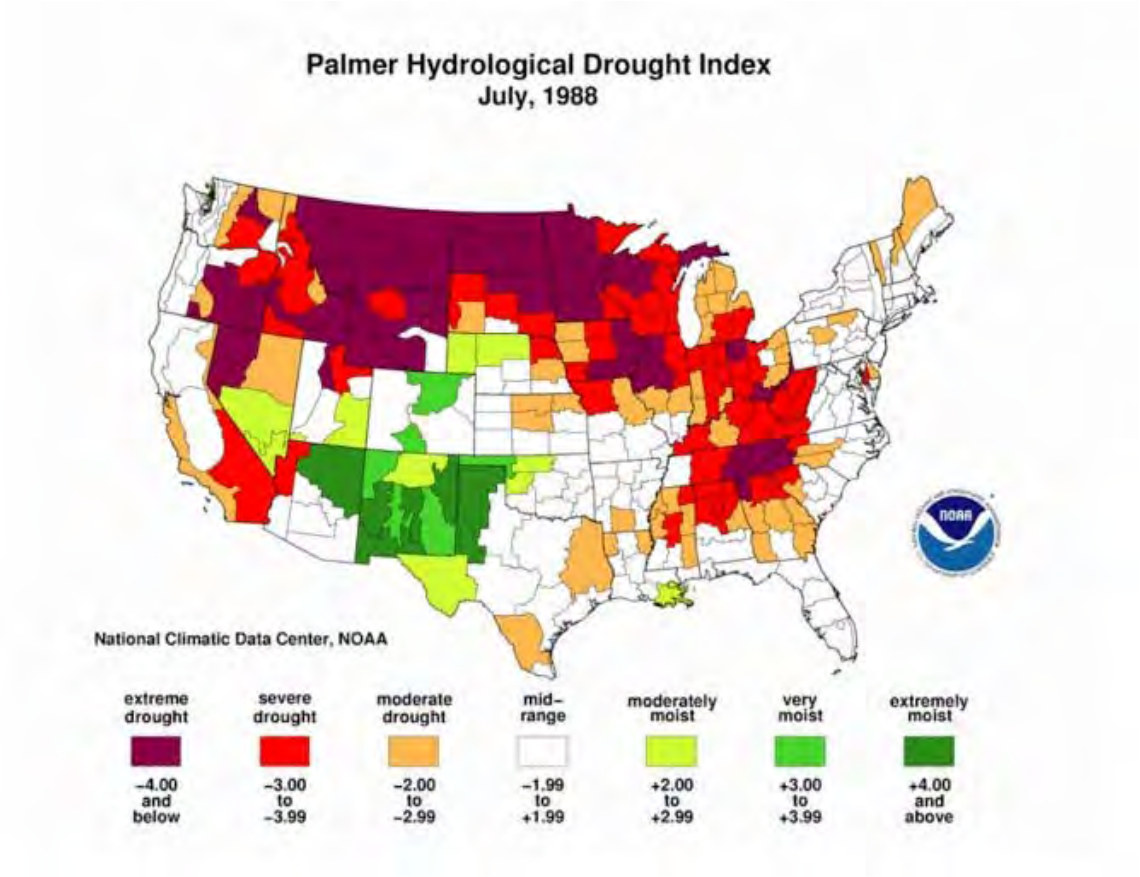
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Sawyer. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 14.2.2.2-2 (following), the entire state – including the city of Sawyer – was categorized as being in extreme drought during this time.

Figure 14.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Sawyer) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years in more recent history.

14.2.2.3 Fire

This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

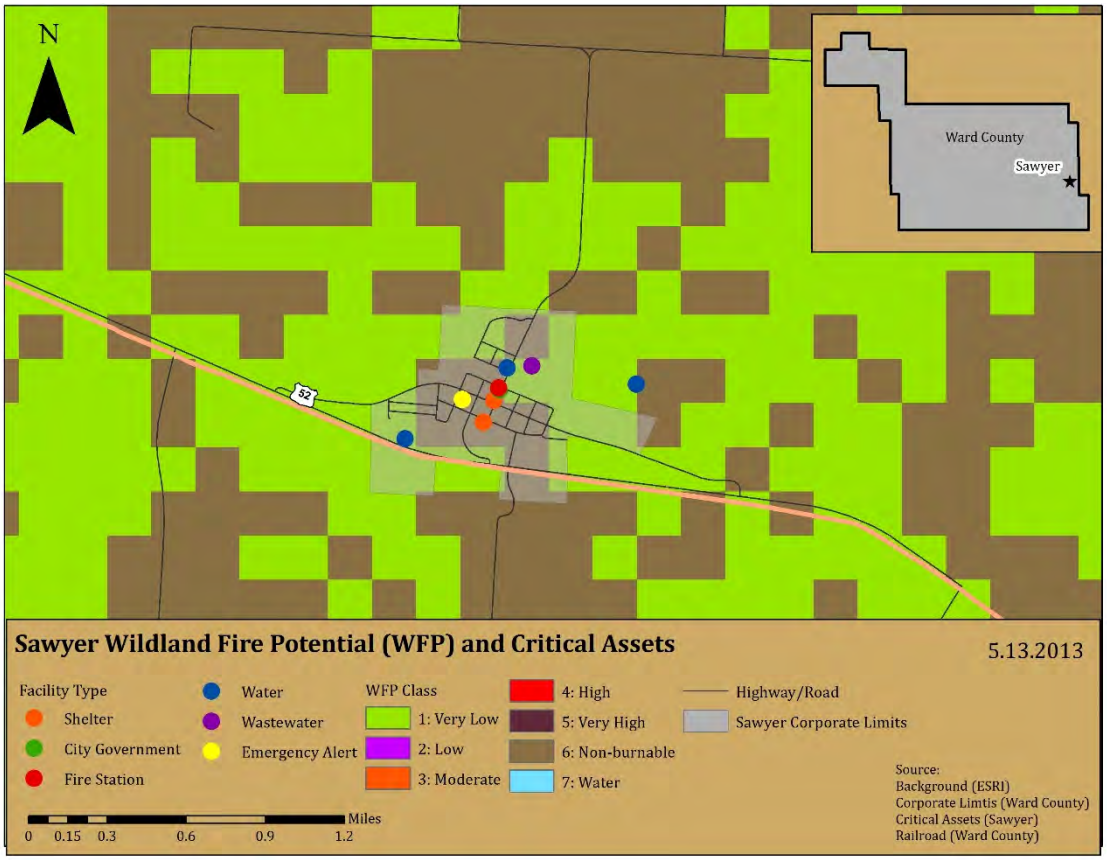
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 14.2.2.3-1 (following) illustrates the wildland fire potential for the city of Sawyer, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 14.2.2.3-1
City of Sawyer – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard

The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 14.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System.

Table 14.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the

destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people. In addition, some structures (such as grain elevators) require specialized teams and equipment, and so response to these events may be delayed.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
The city of Sawyer did not report any prior incidents of fire, either structure or wildland, and has not reported any incidents to the National Reporting System in the previous decade..

Probability of a Future Occurrence of the Hazard
Based on the available data, it is not possible to determine the probability of a future occurrence of the fire hazard specific to the city of Sawyer. However, as all other jurisdictions in the county have a moderate or high probability of a future occurrence, it is reasonable to assume that Sawyer has at least this same probability. Based on this assumption, the probability of a future occurrence of fire in Sawyer is moderate.

14.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters,*

from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

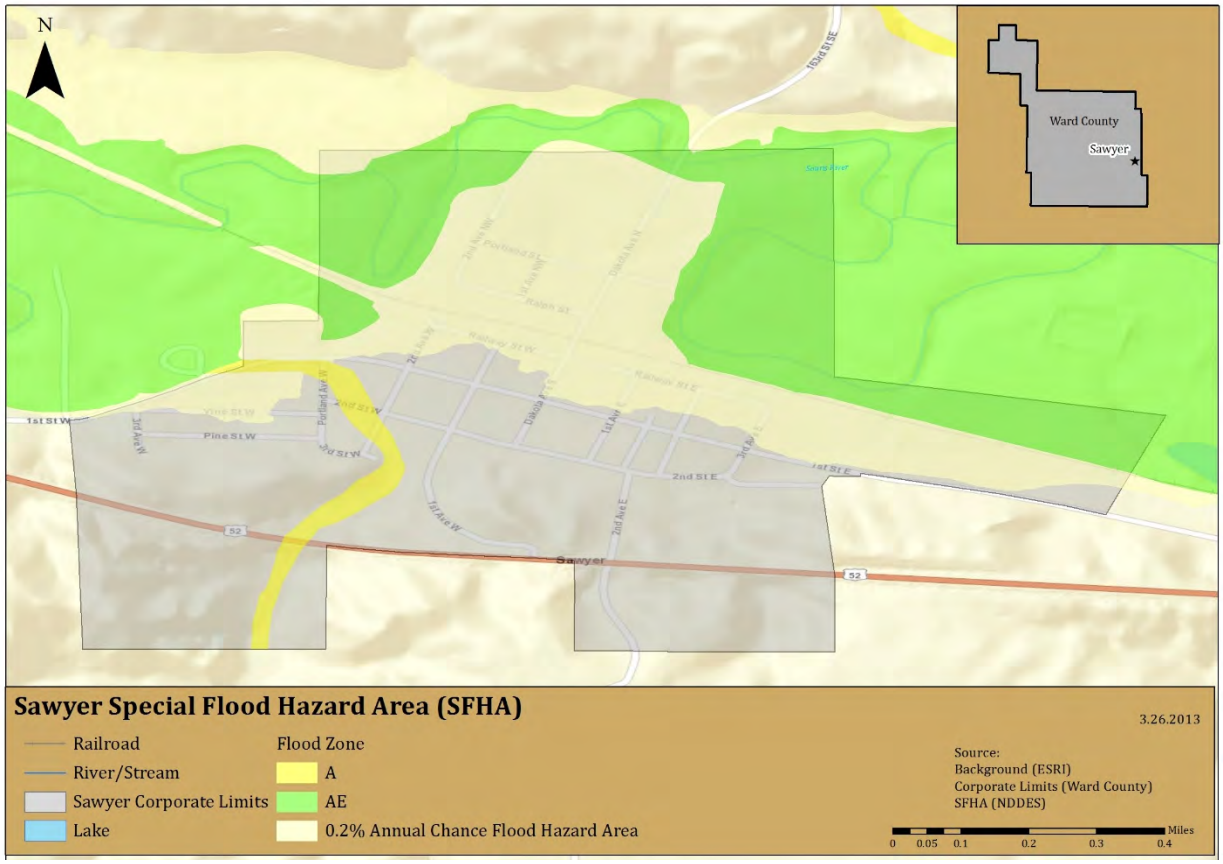
Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard

Sawyer has significant areas of one percent annual chance floodplain both inside and adjacent to its corporate limits. Large portions of the city fall within the one percent annual chance floodplain, with additional areas falling in the .02% annual chance floodplain. These areas are illustrated in Figure 14.2.2.4-1 (following).

Figure 14.2.2.4-1
Special Flood Hazard Areas



Extent and Severity of the Hazard

In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 14.5.2.4-1 (below).

Table 14.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.

Zone Designation	Percent Annual Chance of Flood	Description
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 14.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 14.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

Term	Definition
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

The city of Sawyer is currently a member of the NFIP (under Ward County), and its membership is in good standing. There are no designated Repetitive Loss or Severe Repetitive Loss properties within the city of Sawyer.

Potential Impact of the Hazard
Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A major flood occurred in the Souris River Basin in 1969, which greatly impacted the region (though not specifically the city of Sawyer). More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley.

No incidents of flooding were reported specifically for the city of Sawyer.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs less than once every five years in the city of Sawyer. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is low.

14.2.2.5 Severe Summer Storms

This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

Extreme Heat
Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail
Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning
Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of

the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms
Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard
Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Sawyer.

Extent and Severity of the Hazard
Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat
The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.
- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.

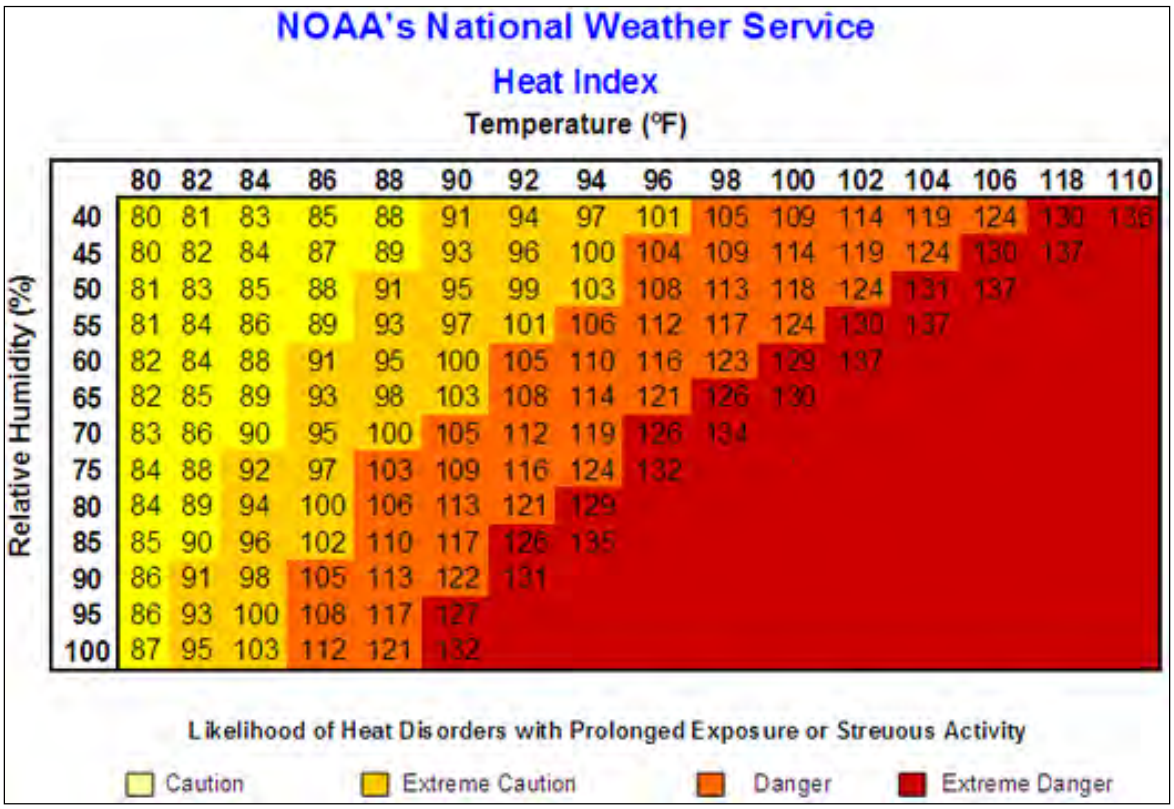
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 14.2.2.5-1(following). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 14.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)



Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail
The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 14.2.2.5-1 (following) provides details of these scales.

Table 14.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33"	Pea	No damage
H1	Potentially Damaging	0.33" – 0.60"	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60" – 0.80"	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80" – 1.20"	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20" – 1.60"	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60" – 2.0"	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0" – 2.4"	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4" – 3.0"	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0" – 3.5"	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5" – 4.0"	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning
The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to

explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- Ground-to-Cloud Lightning**.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning.** Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning***.* Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 14.2.2.5-2 (following) provides this severity scale.

Table 14.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to

describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 14.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 14.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Table 14.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 14.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Given that Sawyer is smaller than 15 miles in diameter, it is possible for the entire jurisdiction to be impacted by the same thunderstorm at any given time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from

thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Sawyer are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards.

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at

the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 14.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 14.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties

- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact

on life due to thunderstorm and associated hazards in Berthold would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard

Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least 20 occurrences of the summer storm hazard since 1994. (Note: Records prior to 1994 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 14.2.2.5-6 (below) provides details of these recorded incidents.

Table 14.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Description	Magnitude (if applicable)
May 21, 1994	Hail	.75”
July 18, 1994	Hail	.75”
June 20, 1995	Thunderstorm wind	52 MPH
July 13, 1999	Hail	1.75”
July 20, 2001	Thunderstorm wind	61 MPH
August 21, 2001	Hail (2 occurrences)	.88” and .75”
June 10, 2002	Hail	.75”
June 06, 2004	Hail	1”
July 12, 2006	Thunderstorm wind	56 MPH
May 18, 2007	Hail	1.75”
June 12, 2007	Tornado/funnel cloud	Unknown
June 18, 2008	Hail	1”
June 17, 2010	Thunderstorm wind	65 MPH
July 26, 2010	Hail (2 occurrences)	3” and 2”
July 17, 2011	Hail (2 occurrences) Thunderstorm wind (2 occurrences)	3” (both) 56 MPH (both

Probability of a Future Occurrence of the Hazard
In the 18 year period for which records are available, the summer storm hazard has occurred at least seven times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is high, as the summer storm hazard occurs at least annually.

14.2.2.6 Severe Winter Storms

This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard
Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow
The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold
What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice
The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Sawyer.

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

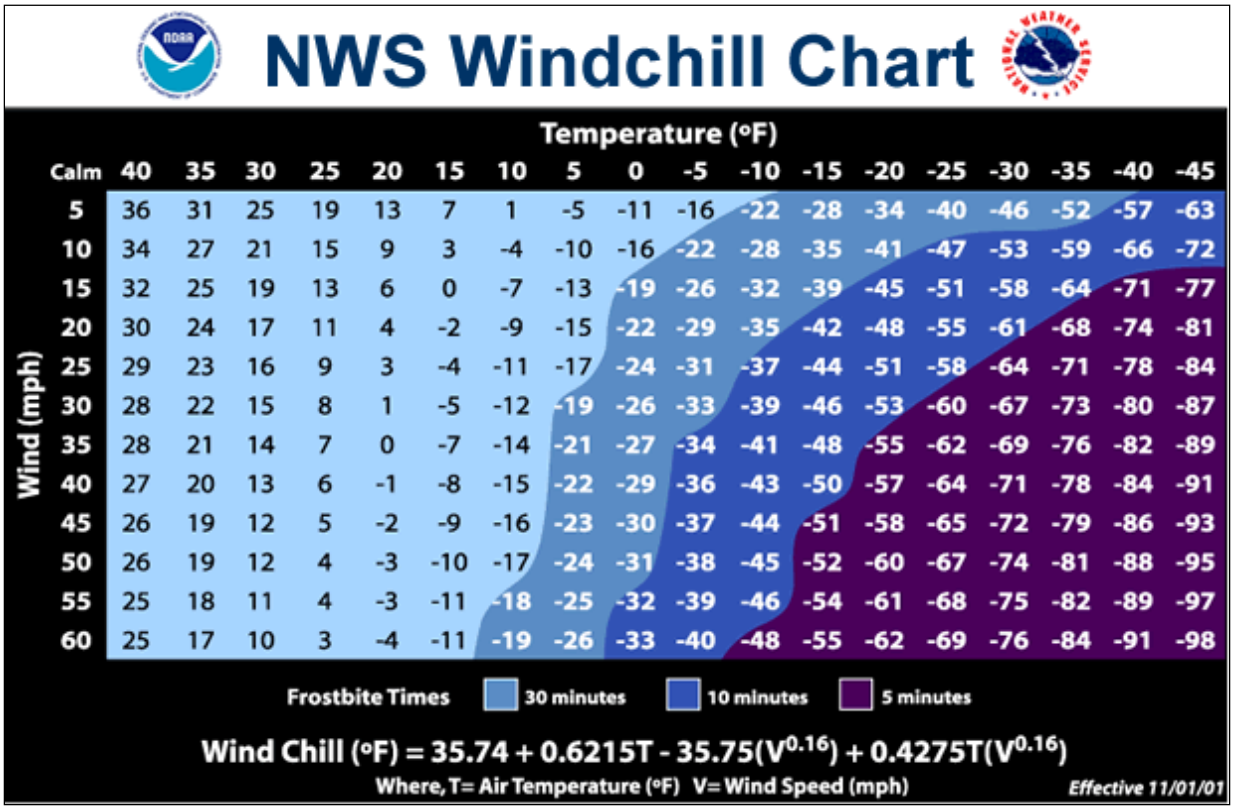
Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold
Winter temperatures in Sawyer typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 14.2.2.6-1 (following) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 14.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)



NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63	
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72	
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77	
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81	
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84	
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87	
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89	
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91	
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93	
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95	
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97	
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98	

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

- **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.

- **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard
Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard
According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes, accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.
- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.
- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard
Based on the data available, winter storms occur in or otherwise impact the city of Sawyer at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

14.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard
Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard
The locations in Sawyer most at risk from a hazardous materials incident are those that are in proximity to transportation routes, specifically the railroad, and those along transmission lines, specifically pipelines. The following figures (14.2.2.7-1 and 14.2.2.7-2) illustrate these locations in Sawyer.

Figure 14.2.2.7-1
Hazardous Materials Locations – Railroad

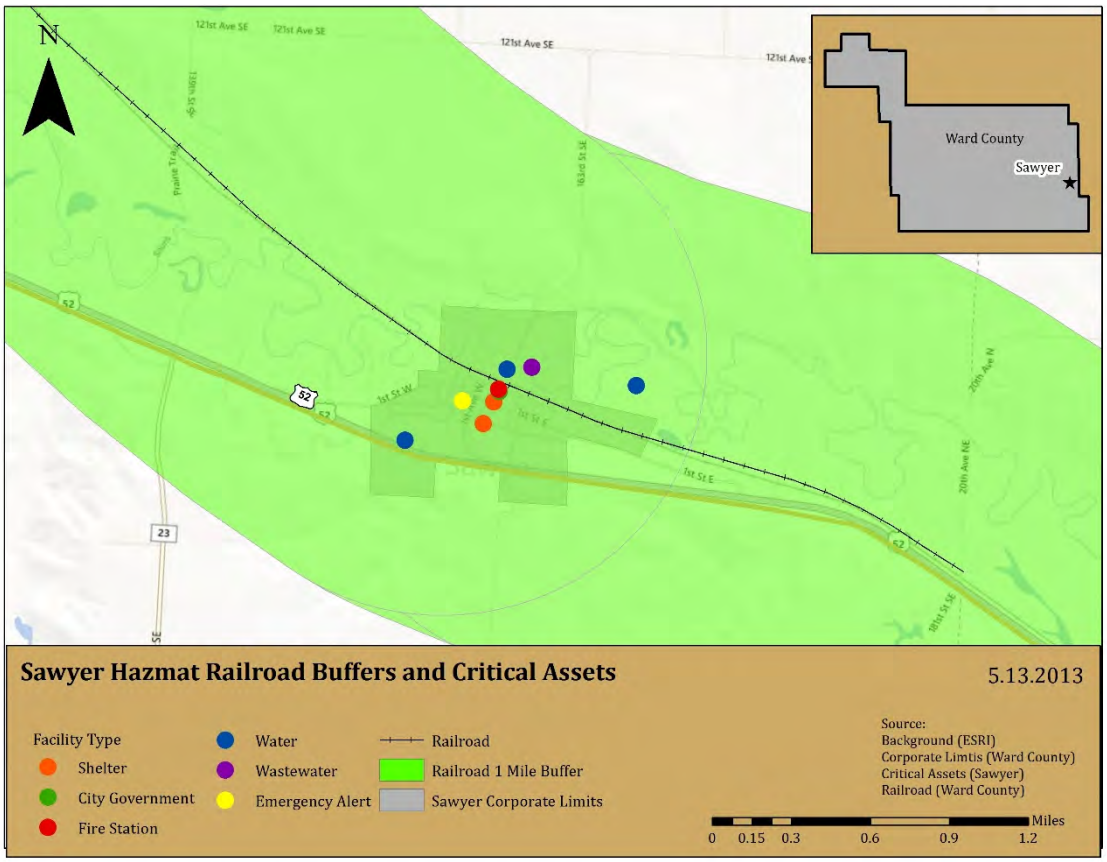
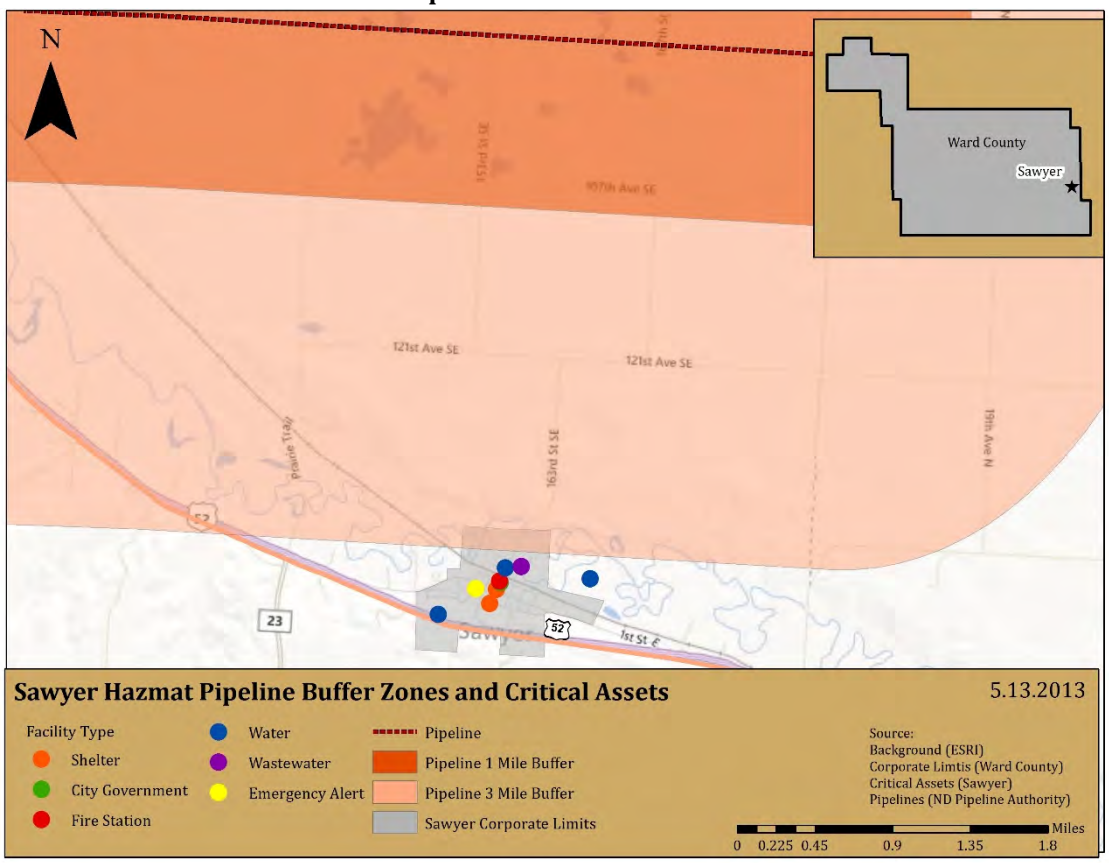


Figure 14.2.2.7-2
Hazardous Materials Locations – Pipeline



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, no Tier II reports from the city of Sawyer have been submitted to the EPA since 1987, the year that the EPA began keeping such reports.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in Ward County, though not necessarily in the city of Sawyer. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

14.3 Risk Assessment (Updated)

The following table (Table 14.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Sawyer.

Table 14.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

14.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Sawyer from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

Impact Scale Methodology
The potential impacts of each hazard were discussed by the Steering Committee. For the purposes of this discussion, a qualitative impact scale was developed, and was used by the Steering Committee in their discussions. As a result of these discussions, each hazard was assigned a qualitative impact ranking. This scale appears in Table 14.3.1-1 (below).

Table 14.3.1-1
Hazard Impact Scale

Term	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Low	Some minor injuries possible, but no fatalities	Cosmetic damages expected to assets; Infrastructure loss of function for less than 24 hours expected	System delivery delayed or temporarily interrupted; Interruptions in service delivery of less than 24 hours expected
Moderate	Injuries expected; Fatalities possible	Some structural damages to light construction (<50 % damage); Infrastructure loss of function for 24-72 hours expected	System delivery failures expected; Interruptions in service delivery of 24-72 hours expected
High	Serious and numerous injuries expected; Fatalities expected	Some structures irreparably damaged (>50% damage); Infrastructure loss of function for 72+ hours expected	Long-term system failures/damages expected; Cancellation of services (72+ hours) expected
Not Applicable	Hazard does not have the potential to impact people or life safety	Hazard does not have the potential to impact assets or infrastructure	Hazard does not have the potential to impact service delivery

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Sawyer to the identified and profiled hazards.

Critical Assets
The following table (Table 14.3.1-1) provides details of the critical assets contained within the city of Sawyer.

Table 14.3.1-1
Critical Assets – City of Sawyer

Asset Name	Asset Use /Function	Street Number	Street Name	Insured or Estimated Value
Sawyer Fire Department	Emergency Services	103	Railway Avenue West	$175,469
Sawyer City Hall	Government	104	Dakota Avenue South	$175,469
Sawyer School	Shelter	101	2nd Street West	$16,115
Pump Station	Utility	301	Dakota Avenue South	$10,717
Lift Station	Utility	201	Portland Street East	$63,206
Well House	Utility	102	Ralph Street	$30,971
Senior Center	Community	--	--	$0
Water Tower	Utility	--	--	$396,353
Siren	Alert and Warning	--	--	$48,995
Total estimated value of identified critical assets:				**$917,295**

Note on asset values: Valuation data for assets within the city was unavailable at the time this plan update was developed. All valuations used in the following estimates of potential losses are derived from an average of available data for the same or similar types of assets from other jurisdictions. The assessment that follows is an estimate only, and may not correlate with actual occurrences of the damage caused by the hazards described.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

14.3.2 Risk and Vulnerability Assessment

14.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 357 people residing in Sawyer; this is a decline since the 2000 Census. The 2012 Census Estimate lowered the population further, to 353 people. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

The relative stability in Sawyer's population indicates stability in the community's vulnerability; with no projected increases in the population in the foreseeable future, it can be reasonably assumed that the community's vulnerability will remain stable in the near future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 14.3.1-1 (previous).

The representatives from the city of Sawyer determined that communicable disease has the potential to cause the impacts described in Table 14.3.2.1-1 (below).

Table 14.3.2.1-1
Qualitative Hazard Impacts – Communicable Disease

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Communicable Disease	Low	Low	Low

Estimate of Potential Losses – Quantitative
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Sawyer represents ~.5% of the total population of Ward County, or 357 people. While an outbreak of communicable disease in Sawyer is unlikely to have significant impacts outside of Sawyer, an outbreak could have significant impacts within the city.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness

rate in Sawyer that is similar to the illness rate across the county, the following numbers of people in Sawyer could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Sawyer accounts for ~.5% of the county population. This equates to 22 cases of influenza in Sawyer, on average, that could potentially impact the city.
- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Sawyer accounts for ~.5% of the county population. This equates to 33 cases of pertussis in Sawyer, on average, that could potentially impact the city.

Identified Data Limitations
There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;
- Data regarding projected population changes; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

14.3.2.2 Drought

Vulnerability to the Hazard
Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies depend largely on agriculture, such the State of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result in significant societal disruption, which can worsen as the resource becomes more and more precious.

Sawyer is not economically dependent on agriculture, making it less vulnerable to the economic ramifications of an agricultural drought.

Sawyer's population and development decreased since the 2000 Census, as have the number of housing units in the community. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no changes to the city's vulnerability to this hazard in the near future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 14.3.1-1 (previous).

The representatives from the city of Sawyer determined that drought has the potential to cause the impacts described in Table 14.3.2.2-1 (below).

Table 14.3.2.2-1
Qualitative Hazard Impacts – Drought

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Drought	Low	Low/Moderate	Low/Moderate

Estimate of Potential Losses – Quantitative
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no quantitative risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no quantitative risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and

- Estimates of potential increases in operating costs that would result from a lack of water.

14.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

Sawyer's population and development decreased since the 2000 Census, as have the number of housing units in the community. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no changes to the city's vulnerability to this hazard in the near future.

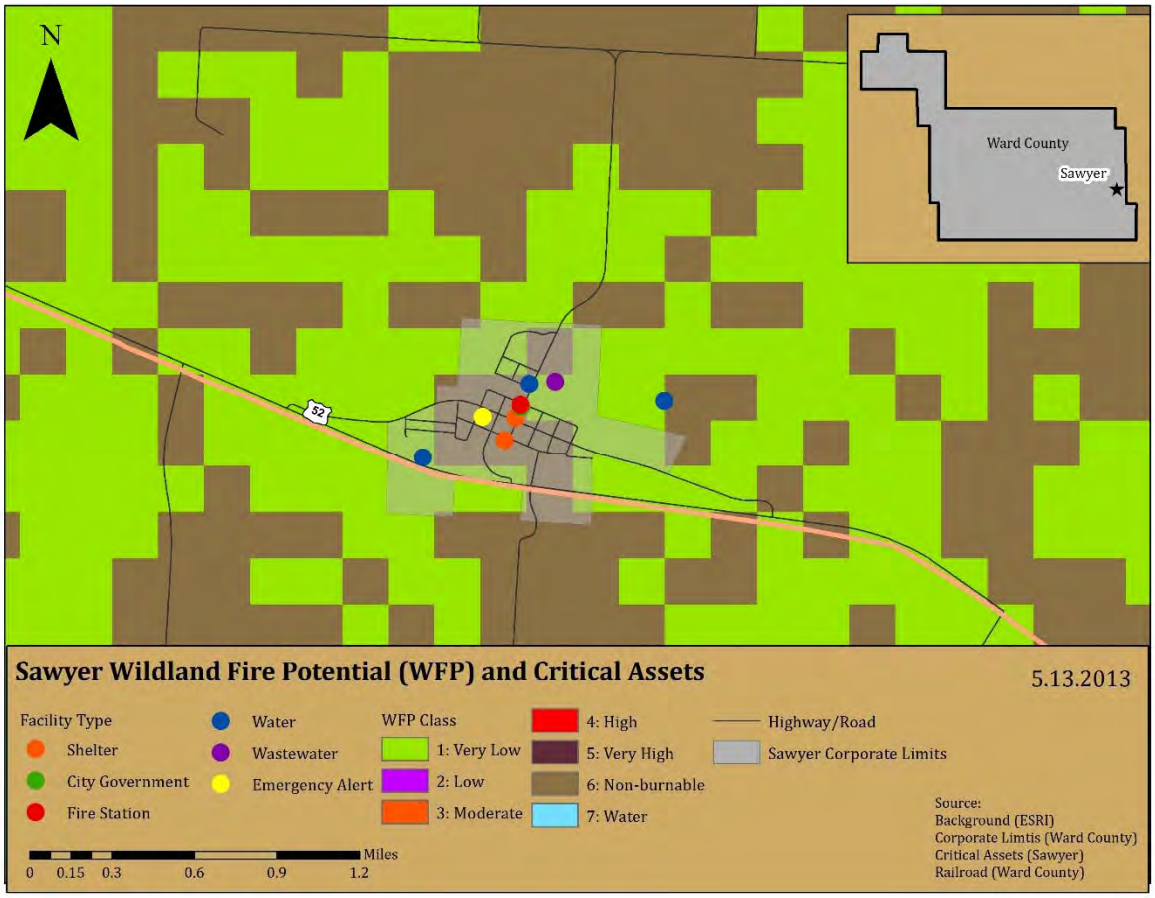
Estimate of Potential Losses
All structures within the city of Sawyer are at risk from fire. According to the 2010 Census, there are 160 housing units in the city; 143 of these units are occupied, and 17 are vacant. The majority of these structures are heated by bottled gas, fuel oil, or electricity. The median value of single family housing in Sawyer is $88,400, according to the Census. This equates to potential residential losses of $14,144,000.

In addition, all identified critical assets (identified in Table 14.3.1-1) within the city have the potential to be lost to fire. These assets have a combined estimated value of $917,295.

Using the US Forest Service's Wildland Fire Potential data, the city of Sawyer and its critical assets were mapped. Based on this data set, the city of Sawyer has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 14.3.2.3-1 (following) illustrates this fire potential in relation to the identified critical assets for the city.

Figure 6.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations

Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

14.3.2.4 Flood

Vulnerability to the Hazard
Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

Flood damages also take considerable time to recover from. The 2011 flooding that occurred throughout the county had far-reaching impacts, and recovery for many areas remains a work in progress as of this Plan update.

Sawyer's population and development decreased since the 2000 Census, as have the number of housing units in the community. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no changes to the city's vulnerability to this hazard in the near future.

Significant portions of the city lie within identified flood hazard areas. This vulnerability should be considered when considering any future development.

The city of Sawyer is a member of the NFIP (under Ward County), and is in good standing with the program. As of February 2013, there were no NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the city of Sawyer.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 14.3.1-1 (previous).

The representatives from the city of Sawyer determined that flooding has the potential to cause the impacts described in Table 14.3.2.4-1 (below).

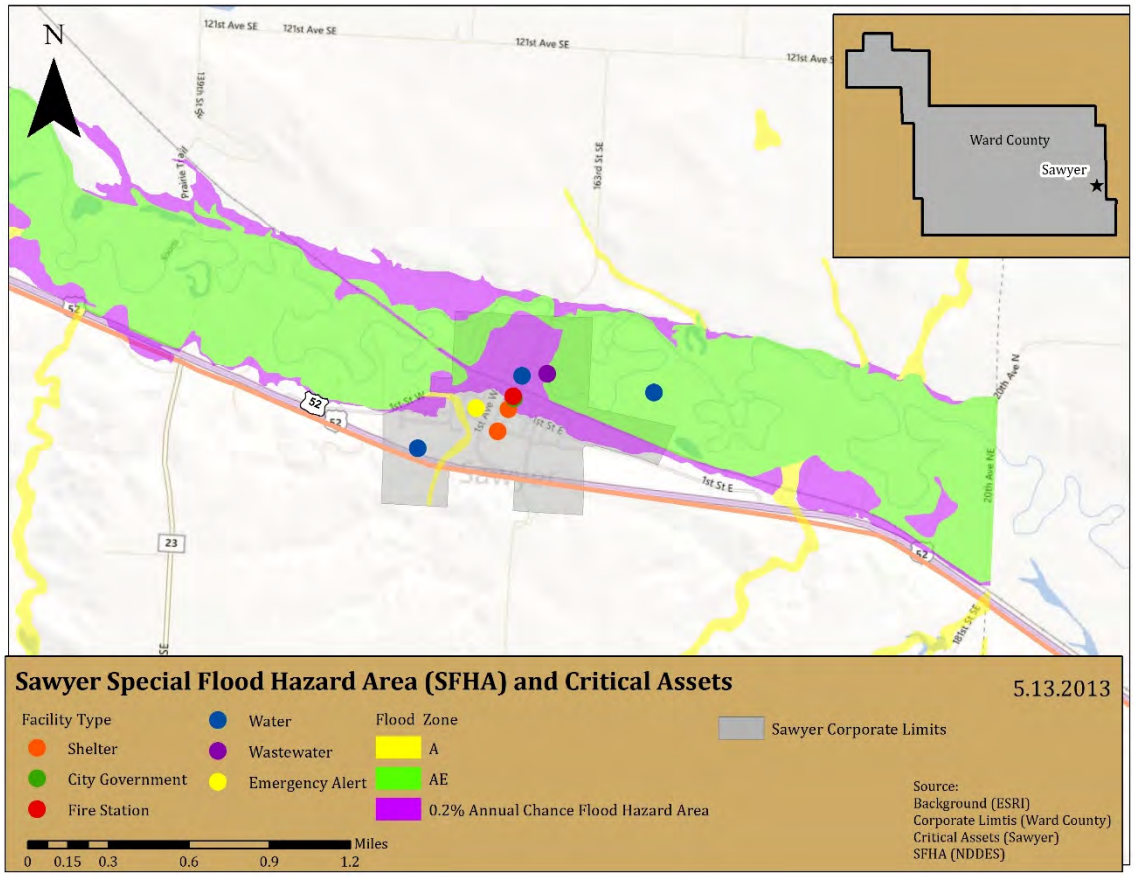
Table 14.3.2.4-1
Qualitative Hazard Impacts – Flood

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Flood	High	Moderate/High	Moderate/High

Estimate of Potential Losses – Quantitative

Sawyer has significant floodplains, both within the corporate limits and just outside of the corporate limits. Figure 14.3.2.4-1 (below) illustrates the locations and boundaries of both the one percent annual chance floodplain and the .02% annual chance floodplain. Critical assets for the city have been overlaid onto this hazard boundary map.

Figure 14.3.2.4-1
Special Flood Hazard Areas and Sawyer Critical Assets



The majority of Sawyer's critical assets lie within a floodplain; only the shelters, a siren, and a water facility lie outside of the hazard area. This means that the potential loss to the city of Sawyer from flooding is more than $900,000 for critical assets.

In addition, there are 135 people that reside in 53 structures that lie within the SFHA. This equates to an estimated $4,685,200 in potential structural losses from flooding.

Identified Data Limitations

Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);

- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

14.3.2.5 Severe Summer Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Sawyer's population and development decreased since the 2000 Census, as have the number of housing units in the community. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no changes to the city's vulnerability to this hazard in the near future.

During the plan update process, a vulnerability was identified regarding the city's utilities. It was determined that emergency power generators should be obtained, so that the city can mitigate this vulnerability.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 14.3.1-1 (previous).

The representatives from the city of Sawyer determined that severe summer storms have the potential to cause the impacts described in Table 14.3.2.5-1 (following).

Table 14.3.2.5-1
Qualitative Hazard Impacts – Severe Summer Storm

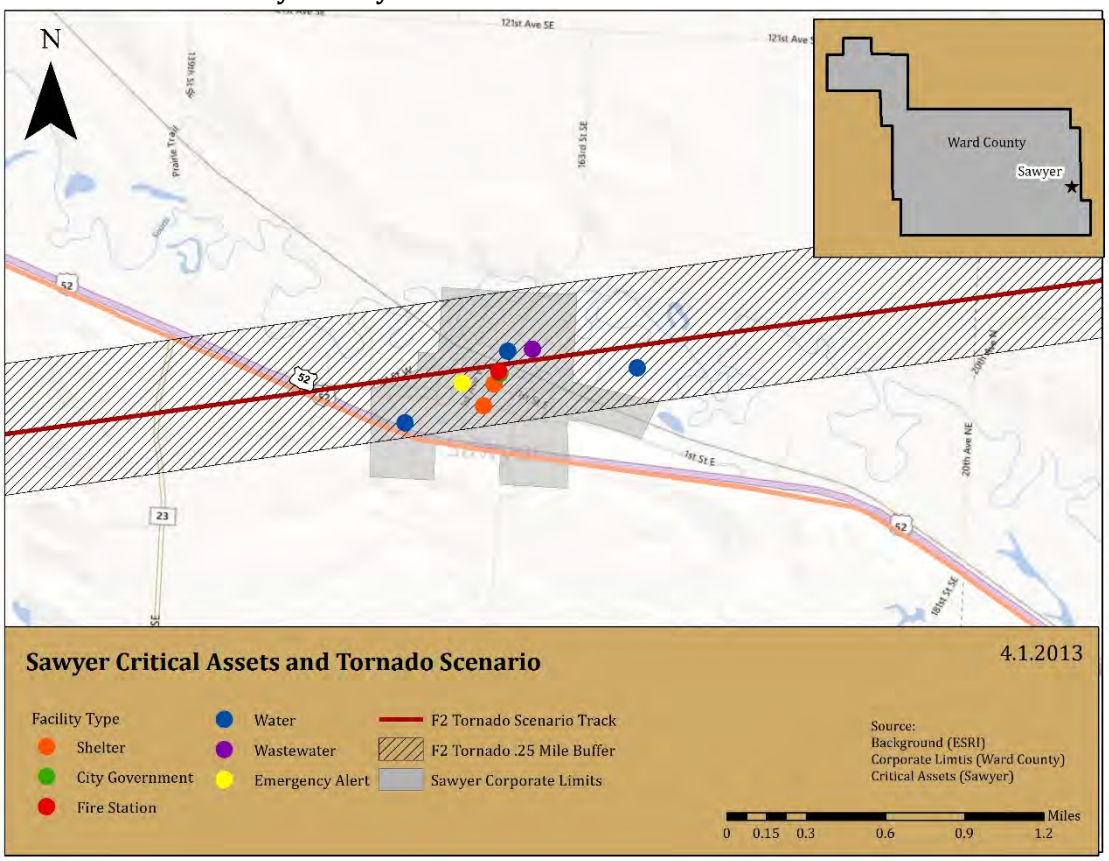
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Summer Storm	Low	Moderate	Moderate

Estimate of Potential Losses – Quantitative
Severe summer storms are a non-spatial hazard that can and do affect the entire city of Sawyer. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Sawyer are at risk from severe summer storms. According to the 2010 Census, there are 160 housing units in the city. The median value of these structures is $88,400, according to the Census. This equates to residential assets of approximately $14,144,000. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $1,414,400.

In addition, all identified critical assets (identified in Table 14.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of $917,295. For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Sawyer. Figure 14.3.2.5-1 (following) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 14.3.2.5-1
Tornado Scenario – City of Sawyer



As seen in the above figure, in such a scenario the majority of the city of Sawyer would be damaged, including critical assets (government and emergency services). This scenario would result in significant damages to the city's infrastructure, with potential losses equaling $917,295, and would greatly impact its ability to provide basic services, such as emergency response.

In addition, 128 residential structures would be damages, resulting in $$11,315,200 in potential losses, and 333 people would be at risk from injuries.

Finally, the 357 residents of Sawyer are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 9% (children under 5) and 6.1% (those over 70) of the population of Sawyer. Combined, these two groups account for more than 15% of the population, a total of 54 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limit;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

14.3.2.6 Severe Winter Storms

Vulnerability to the Hazard

People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

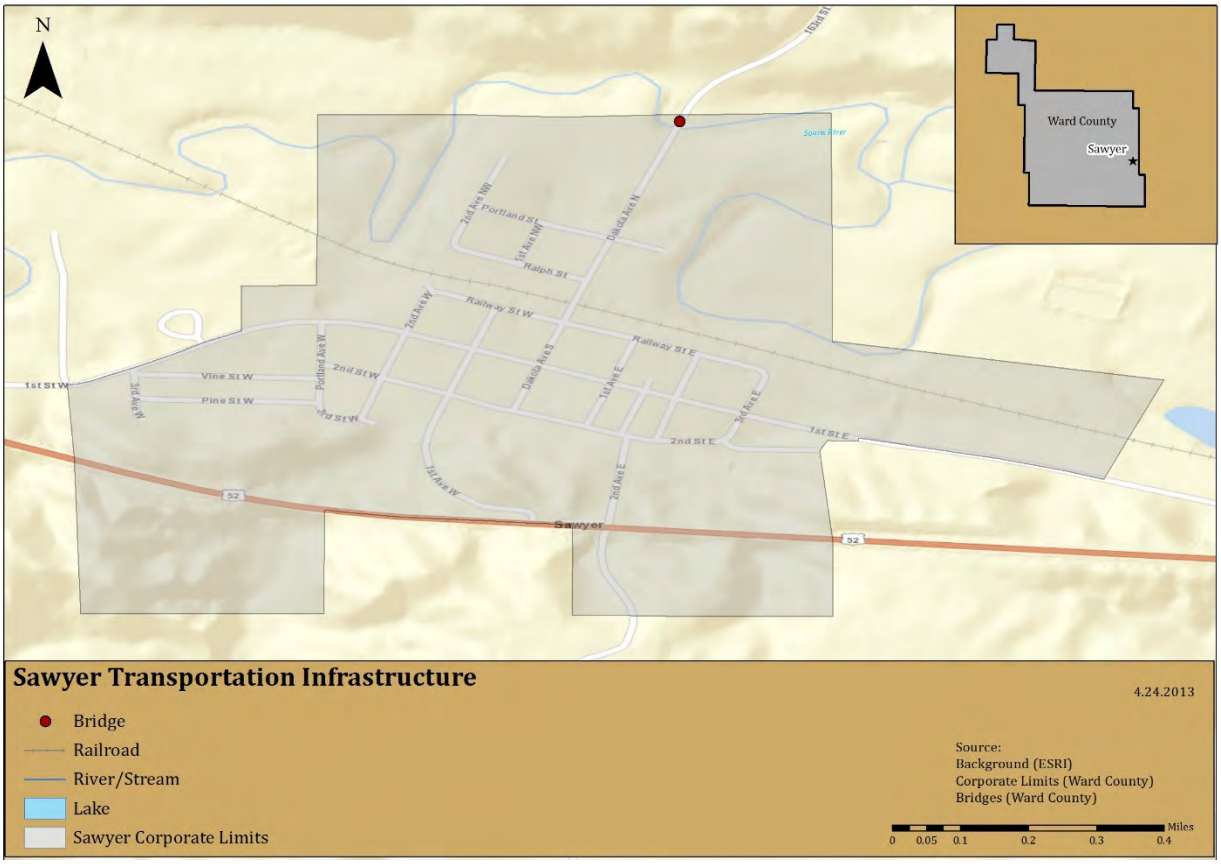
The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Sawyer's population and development decreased since the 2000 Census, as have the number of housing units in the community. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no changes to the city's vulnerability to this hazard in the near future.

During the plan update process, a vulnerability was identified regarding the city's utilities. It was determined that emergency power generators should be obtained, so that the city can mitigate this vulnerability.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents. Figure 14.3.2.6-1 (following) provides the locations of bridges in and around the city, which typically ice over before surround roadways, making them treacherous for travel.

Figure 14.3.2.6-1
Sawyer – Bridges



Estimate of Potential Losses – Qualitative

In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 14.3.1-1 (previous).

The representatives from the city of Sawyer determined that severe winter storms have the potential to cause the impacts described in Table 14.3.2.6-1 (below).

Table 14.3.2.6-1
Qualitative Hazard Impacts – Severe Winter Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Winter Storm	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Sawyer. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Sawyer are at risk from severe winter storms. According to the 2010 Census, there are 160 housing units in the city. The median value of these structures is $88,400, according to the Census. This equates to residential assets of approximately $14,144,000. If 1% of these residential assets were damaged by a severe summer storm, this would result in losses of $141,440.

In addition, all identified critical assets (identified in Table 14.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of $917,295. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $91,729.

Finally, the 357 residents of Sawyer are all at risk from the severe winter storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 9% (children under 5) and 6.1% (those over 70) of the population of Sawyer. Combined, these two groups account for more than 15% of the population, a total of 54 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

14.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

Sawyer's population and development has declined slightly since the 2000 Census. There are no identified plans for significant future development in the area, and no projected growth in population in the foreseeable future.

The roadways around Sawyer have seen an increase in traffic in recent years, due in large part to the increase in energy activities throughout the state. An incident on the roadways could impact the city and its residents, even if it did not occur within the city limits. This increase traffic has led to at least some increase in vulnerability to this hazard.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 14.3.1-1 (previous).

The representatives from the city of Sawyer determined that hazardous materials incidents have the potential to cause the impacts described in Table 14.3.2.7-1 (below).

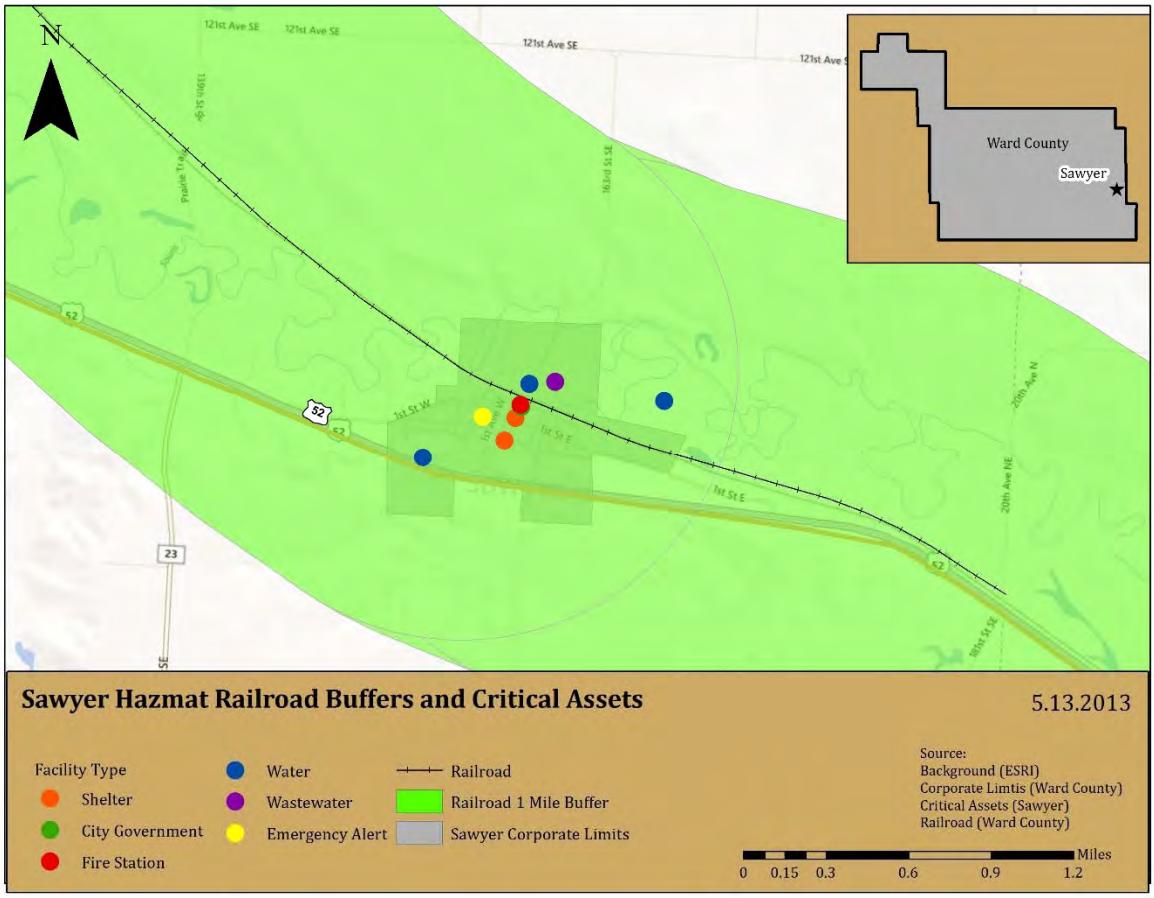
Table 14.3.2.7-1
Qualitative Hazard Impacts – Hazardous Materials Incident

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Hazardous Materials Incident	Moderate/High	Moderate	Moderate/High

Estimate of Potential Losses – Quantitative
For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Sawyer – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

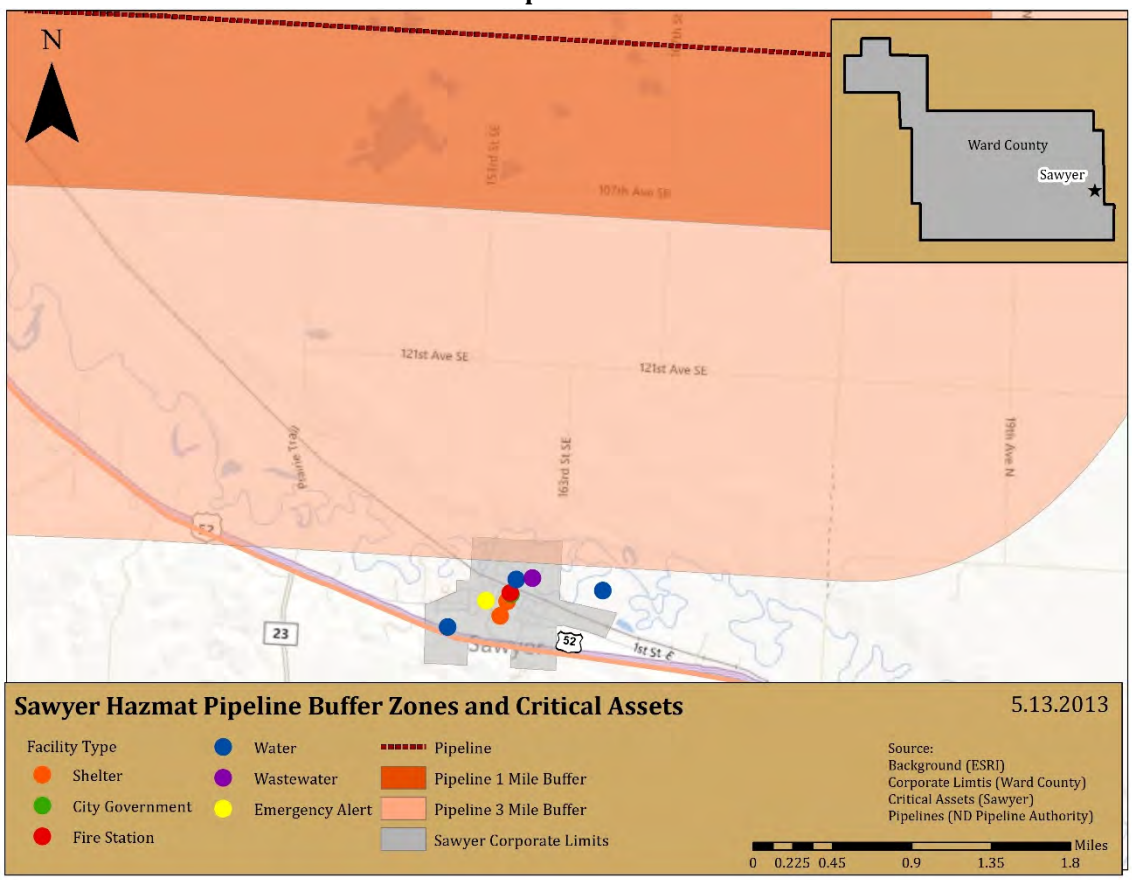
Sawyer's hazardous materials risk comes from the railroad, and from the materials that are moved pipelines. Figures 14.3.2.7-1 and 13.3.2.7-2 (following) illustrate the locations of the railroad and pipeline in relation to the city of Sawyer, and provides buffer zones around the railroad and pipeline. For the purposes of this assessment, all assets within this buffer would be impacted to some degree.

Figure 14.3.2.7-1
Hazardous Materials Incident Scenario – Railroad



As is evident from the above image, the entire city could be impacted by an incident hazardous materials and the railroad, as could all critical assets within the city, resulting in an estimated $917,295 in potential losses. In addition, all 357 residents and 160 residential structures would be at risk for potential losses.

Figure 14.3.2.7-2
Hazardous Materials Incident Scenario – Pipeline



The entirety of the city of Sawyer lies within 5 miles of the pipeline; this includes all critical assets and residents. The pump station, 13 structures, and 41 people lie within 3 miles of the pipeline.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

14.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Sawyer's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the city has limited familiarity with hazard mitigation programs, and hazard mitigation does not currently play a role in the decision-making process for the city.
- **Current/ongoing mitigation efforts** – currently, the city's mitigation efforts are limited to participating in the development of the Ward County Hazard Mitigation Plan Update.
- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city.
- **Planning** –the city does have an informal COOP/COG plan and an evacuation plan, and practices stormwater management. The city is a member of the NFIP (under Ward County).
- **Staff, personnel, and technical capability** – as of this Plan update, the city has a limited capability and capacity regarding hazard mitigation, and limited confidence in their abilities

to administer hazard mitigation projects and programs. Additional experience and resources would be beneficial to building this capacity.

Like other municipalities within Ward County, Sawyer depends on the framework established by the county and state government for technical assistance, and on the state and federal government for funding.

Conclusions and Recommendations
Sawyer should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county towards this end.

14.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there **must** be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

14.5.1 Mitigation Goals

Table 14.5.1-1 (following) provides the mitigation goals that guide the city of Sawyer's mitigation strategy.

Table 14.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

14.5.2 Mitigation Actions

Potential Mitigation Actions
Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions
Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike

wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions

Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (14.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (14.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped the city of Sawyer to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 14.5.2-2. Table 14.5.2-1 (below) describes the basic criteria considered as part of the prioritization process.

Table 14.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.

STAPLEE	Criteria Explanation
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness

Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (14.5.2-2) provides the identified and prioritized mitigation strategy for the city of Sawyer.

Table 14.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Continue to enforce floodplain management ordinance and practices	Flood	New	New and existing	Ward County Floodplain Management; Building Permit Official	General funds; Ward County EMA	$500+	Moderate	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	Ward County Floodplain Management	General funds; Ward County EMA	$500+	Moderate	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Council; City Auditor	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; Ward County EMA	$500+	Low	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Purchase and install emergency power generators for critical assets	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	City Auditor		NDDES & FEMA mitigation grant funding; Ward County EMA	$30,000+	High	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Auditor	City Council; Ward County EMA	$500+	Low	
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Auditor	General fund; in-kind contributions; Ward County EMA	$500+	Low	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Determine and implement solutions to existing drainage issues, including culverts	Flood	New	New and existing	City Auditor	NDDES & FEMA mitigation grant funding; Ward County EMA; Ward County Public Works	$1,000+	Moderate	

Section 15
City of Surrey: HIRA, Capability Assessment, and Mitigation Strategy

15.1 IFR for Hazard Identification and Risk Assessment
15.2 Hazard Identification (Updated)
15.2.1 Overview of Surrey's History of Hazards and Potential Hazards
15.2.2 Hazard Profiles
15.3 Risk Assessment (Updated)
15.3.1 Risk Assessment Methodology
15.3.2 Risk and Vulnerability Assessment
15.4 Capability Assessment (Updated)
15.5 Mitigation Strategy (Updated)
15.5.1 Mitigation Goals
15.5.2 Mitigation Actions

15.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of*

the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..

Requirement §201.6(c)(2)(ii)(C): *[The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment **must** assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in the city of Surrey.

15.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact the city of Surrey. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

15.2.1 Overview of Surrey's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 08 weather-related hazard events have occurred in the city of Surrey since 2000, including the following number and types of hazard events:

- Hail – 5
- Thunderstorm – 2
- Tornado/Funnel Cloud - 1

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 15.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the city since 1957.

Table 15.2.1-1
Presidential Disaster Declarations – City of Surrey

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to the City of Surrey

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 15.2.1-2 (below).

Table 15.2.1-2
Preliminary Hazard Identification and Determinations – City of Surrey

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Surrey	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓		Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Surrey	Reason for Exclusion and other notes
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	City of Surrey	Reason for Exclusion and other notes
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the seven hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

15.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

15.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk. Table 15.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 15.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance

and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact the city of Surrey.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 15.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 15.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 15.2.2.1-3 (below) provides the details of pertussis outbreaks since 2007.

Table 15.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 15.2.2.1-4 (below) provides occurrence information for rabies.

Table 15.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

The city of Surrey did not report any incidents of the communicable disease hazard. While there is no available data to confirm that any of these occurrences either occurred in or otherwise impacted the city of Surrey, there is also no available data to determine that they did not. Because of the non-spatial nature of communicable disease, it is possible that any of these occurrences could have happened in Surrey, and that any communicable illness could occur in the city in the future.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been no occurrences of communicable disease within the city of Surrey. Therefore, using the scale provided earlier in this section, the probability of a

future occurrence of this hazard is low, meaning that it is likely to occur less than once every five years.

15.2.2.2 Drought

Description of the Hazard
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard
Drought is a hazard that is not restricted to particular areas or types of environments. All areas within the city of Surrey are subject to the drought hazard.

Extent and Severity of the Hazard
Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.
- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

Table 15.2.2.2-1 (below) provides the PDSI classifications.

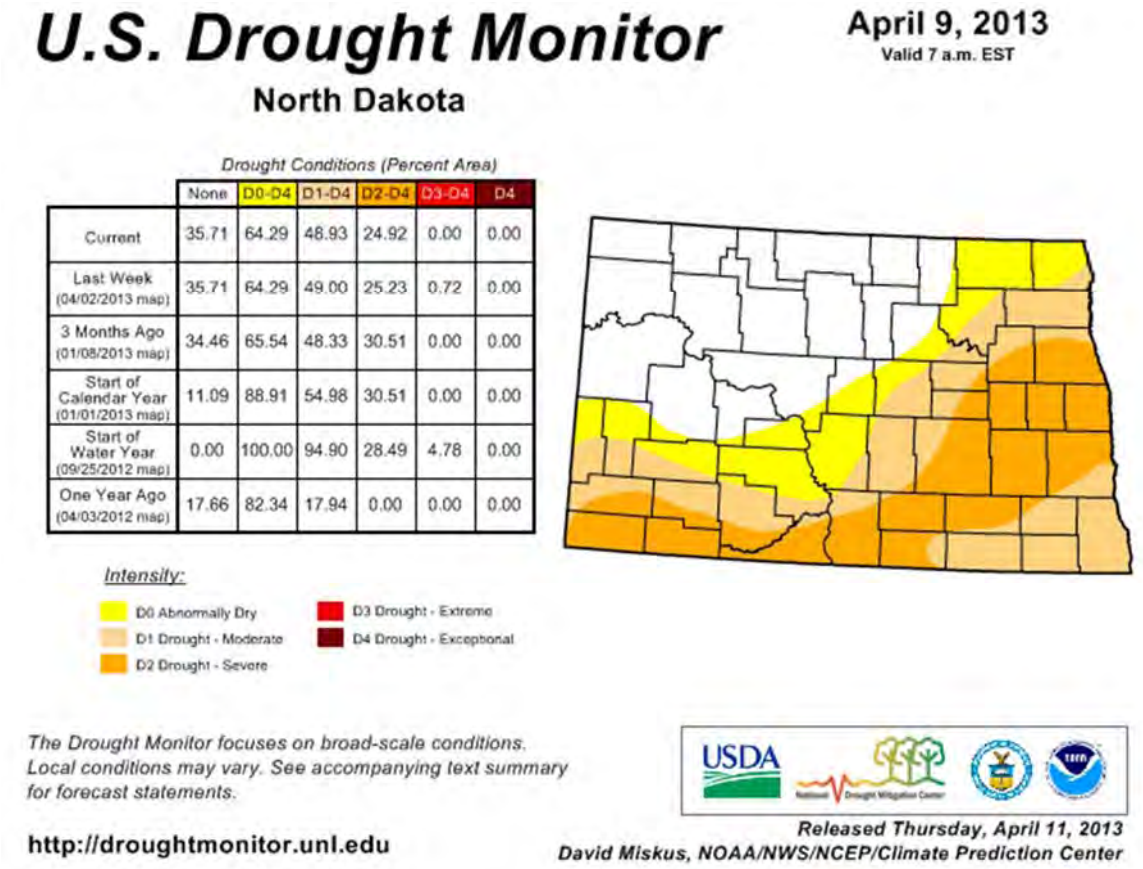
Table 15.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed

Classification	Description	Range of Possible Impacts
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County and the city of Surrey are not included in any of these classifications, and are not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 15.2.2.2-1 (following).

Figure 15.2.2.2-1
US Drought Monitor – North Dakota
(source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 15.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in the city of Surrey – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

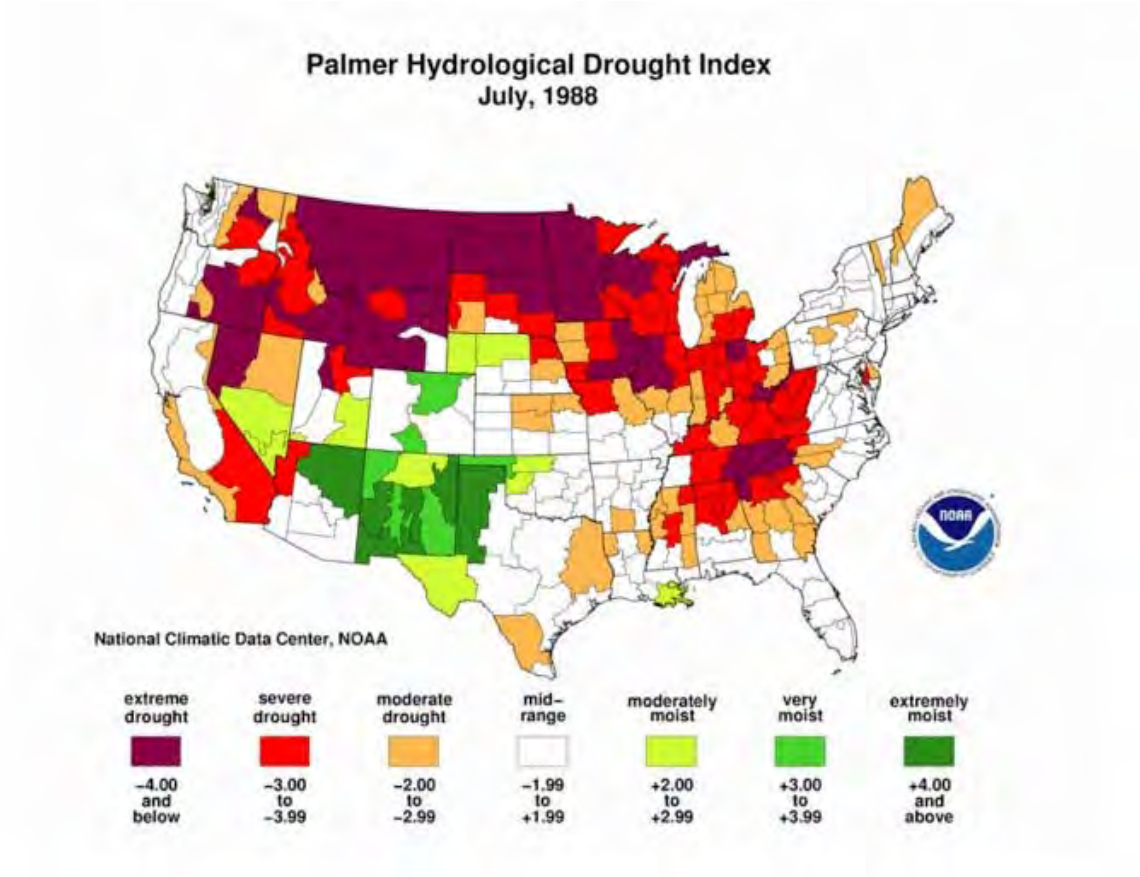
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including the city of Surrey. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 15.2.2.2-2 (following), the entire state – including the city of Surrey – was categorized as being in extreme drought during this time.

Figure 15.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities (including Surrey) were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years in more recent history.

15.2.2.3 Fire

This profile includes both structure fire and wildfire.

Description of the Hazard
Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

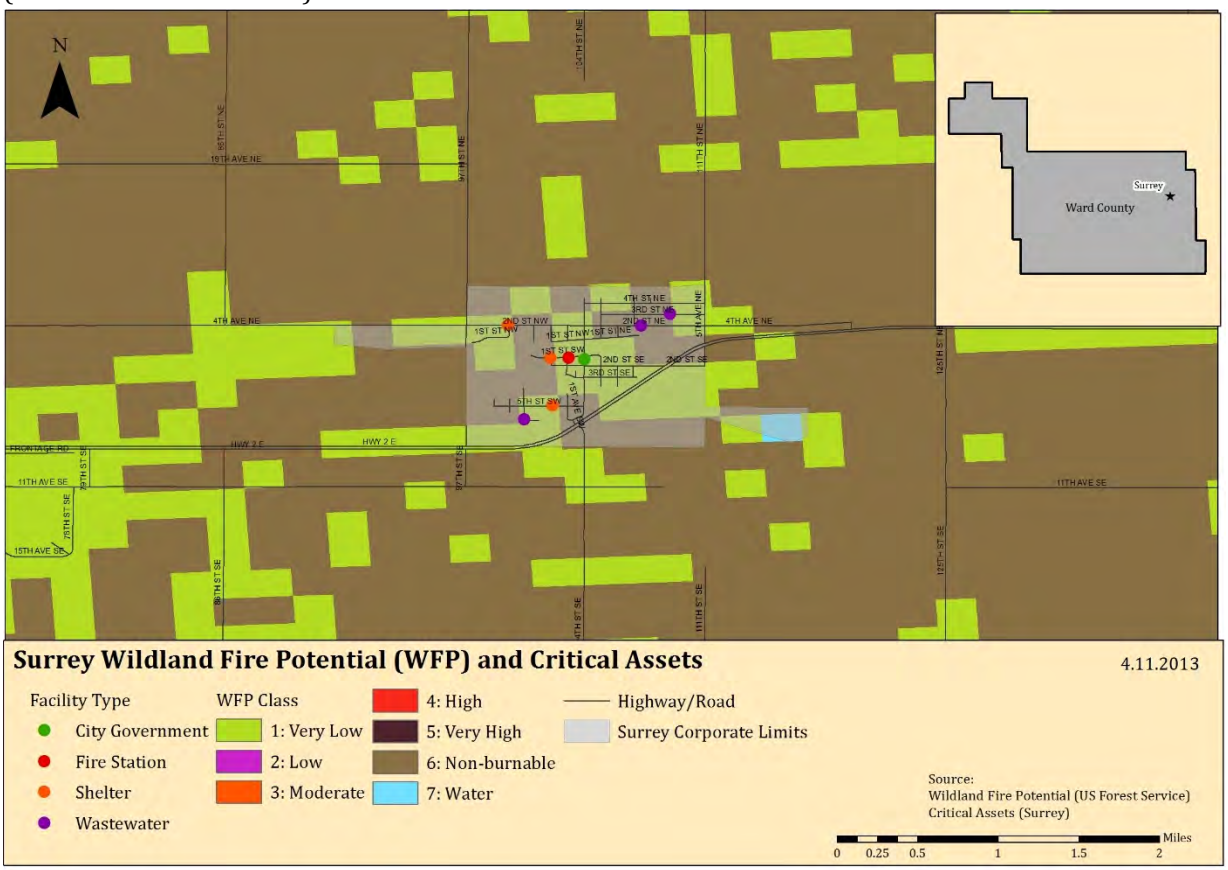
Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

Location of the Hazard
While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 15.2.2.3-1 (following) illustrates the wildland fire potential for the city of Surrey, as defined by the US Forest Service.

Note that the areas designated as "non-burnable" in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 15.2.2.3-1
City of Surrey – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard
The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 15.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System.

Table 15.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the

destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people. In addition, some structures (such as grain elevators) require specialized teams and equipment, and so response to these events may be delayed.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Based on data obtained from the National Reporting System, the city of Surrey has experienced 6 structure fires from January 2008 through December 2012, an average of 1.2 structure fires per year. For this same time period, 17 wildland fires were responded to, an average of 3.4 per year.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in the city of Surrey at least once per year. Using the scale provided earlier in this section, this equates to a high probability of a future occurrence.

15.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.*

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

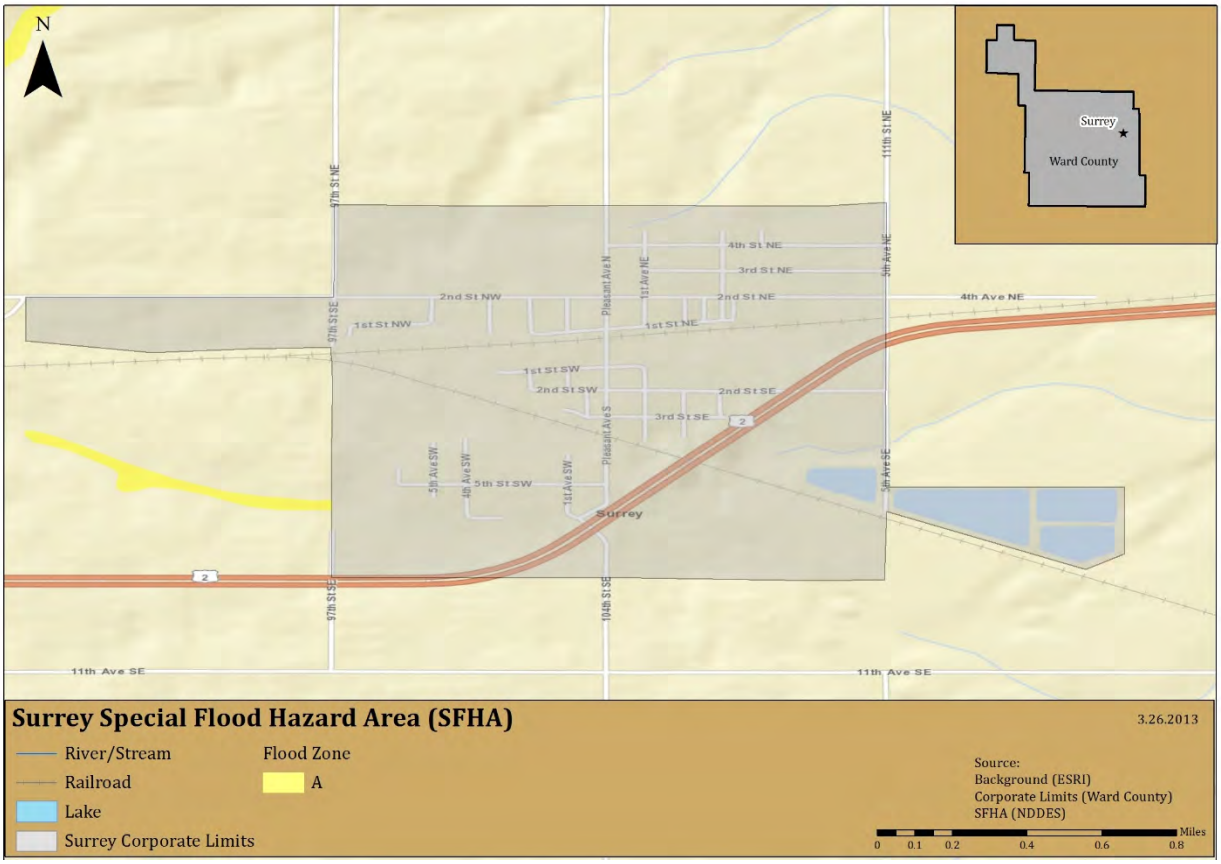
Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard

Surrey has no floodplains within the corporate limits; however, there is an area of flood hazard just outside of the corporate limits. This area is illustrated in Figure 15.2.2.4-1 (following).

Figure 15.2.2.4-1
Special Flood Hazard Areas



Extent and Severity of the Hazard

In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 15.5.2.4-1 (below).

Table 15.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.

Zone Designation	Percent Annual Chance of Flood	Description
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 15.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 15.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

Term	Definition
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

The city of Surrey is not currently a member of the NFIP. There are no designated Repetitive Loss or Severe Repetitive Loss properties within the city of Surrey.

Potential Impact of the Hazard
Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A major flood occurred in the Souris River Basin in 1969, which greatly impacted the region (though not specifically the city of Surrey). More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley.

Probability of a Future Occurrence of the Hazard
Based on the available data, flooding occurs at less than once every five years in the city of Surrey. Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is low.

15.2.2.5 Severe Summer Storms
This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

Extreme Heat
Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail
Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning
Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms
Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard
Severe summer storms are a non-spatial hazard, and can occur anywhere in the city of Surrey.

Extent and Severity of the Hazard
Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat
The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.
- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is

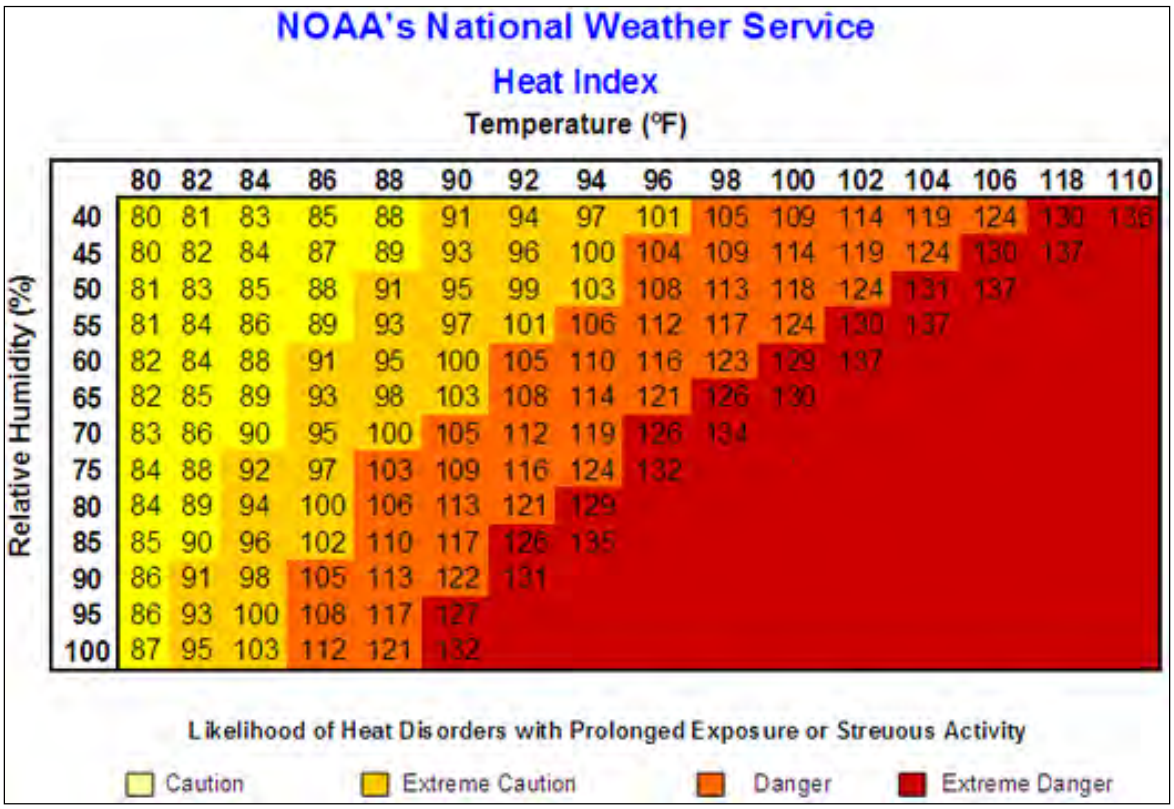
occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 15.2.2.5-1(following). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 15.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)



Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail
The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 15.2.2.5-1 (following) provides details of these scales.

Table 15.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33"	Pea	No damage
H1	Potentially Damaging	0.33" – 0.60"	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60" – 0.80"	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80" – 1.20"	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20" – 1.60"	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60" – 2.0"	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0" – 2.4"	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4" – 3.0"	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0" – 3.5"	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5" – 4.0"	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning

The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to

explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- Ground-to-Cloud Lightning**.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning.** Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning***.* Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 15.2.2.5-2 (following) provides this severity scale.

Table 15.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to

describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 15.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 15.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Table 15.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 15.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Given that Surrey is smaller than 15 miles in diameter, it is possible for the entire jurisdiction to be impacted by the same thunderstorm at any given time. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from

thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within the city of Surrey are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards.

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at

the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 15.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 15.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties

- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact

on life due to thunderstorm and associated hazards in Berthold would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard
Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least 8 occurrences of the summer storm hazard since 2000. (Note: Records prior to 2000 were kept at the county level, and therefore occurrences within a particular jurisdiction cannot be reliably determined.) Table 15.2.2.5-6 (below) provides details of these recorded incidents.

Table 15.2.2.5-6
Summer Storm Occurrences
(Source: National Climatic Data Center)

Date	Description	Magnitude (if applicable)
June 11, 2000	Tornado/Funnel cloud	Unknown
August 08, 2001	Thunderstorm wind	52 MPH
April 16, 2002	Hail	.75”
June 29, 2002	Thunderstorm wind	52 MPH
July 02, 2003	Hail	.75”
May 18, 2007	Hail	1.5”
July 17, 2011	Hail (2 occurrences)	3” (both)

Probability of a Future Occurrence of the Hazard
In the 12 year period for which records are available, the summer storm hazard has occurred at least eight times. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is moderate, as the summer storm hazard occurs at once every five years but less than annually.

15.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard

Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow
The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold
What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice
The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These

accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in the city of Surrey

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold
Winter temperatures in Surrey typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 15.2.2.6-1 (following) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 15.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)

NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

- **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous.
- **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard
Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard
According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes,

accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.

- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.
- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard

Based on the data available, winter storms occur in or otherwise impact the city of Surrey at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

15.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard

Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard

The locations in Surrey most at risk from a hazardous materials incident are those that are in proximity to transportation routes, specifically the railroad, and those that lie near pipelines. The following figures (15.2.2.7-1 and 15.2.2.7-2) illustrate these locations in Surrey. There are two fixed site facilities that utilize hazardous materials located outside of the corporate limits of Surrey. The location of these facilities is depicted in Figure 15.2.2.7-3.

Figure 15.2.2.7-1
Hazardous Materials Locations – Railroad

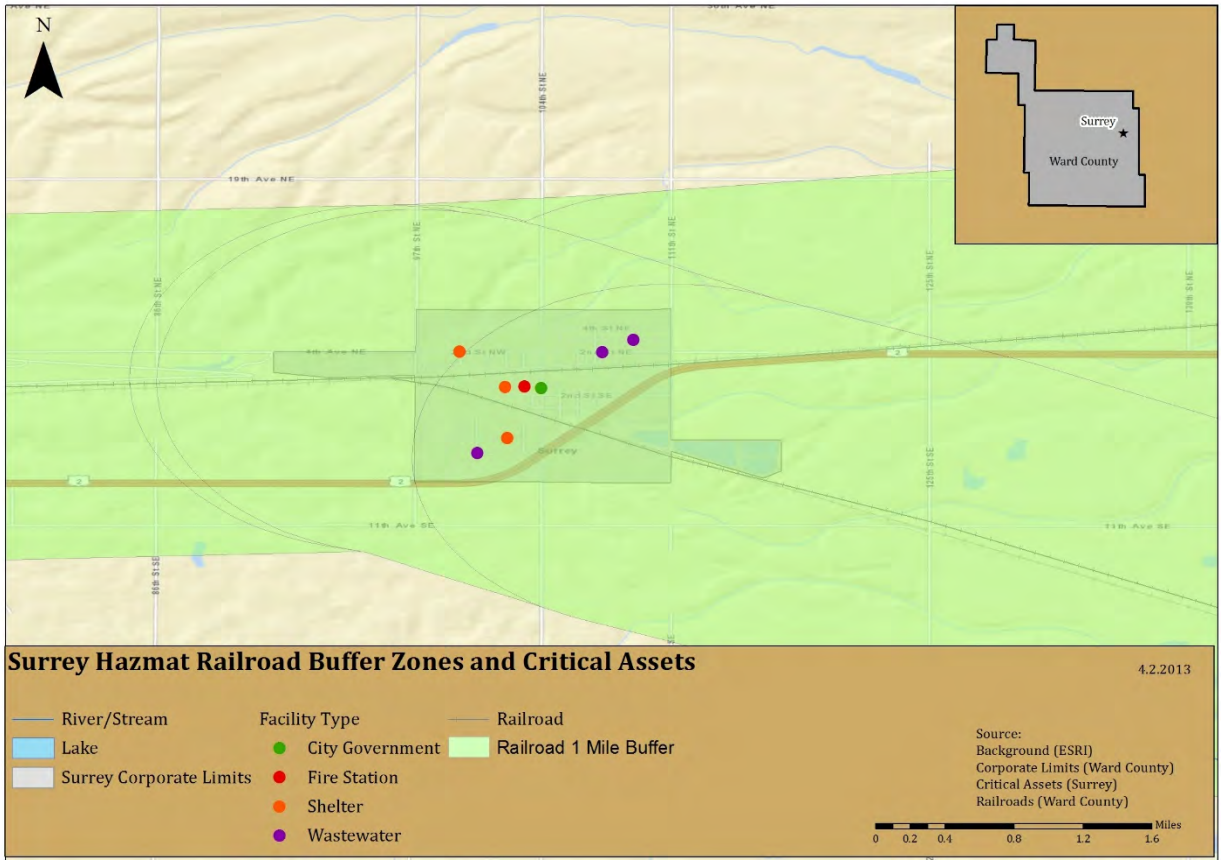


Figure 15.2.2.7-2
Hazardous Materials Locations – Pipeline

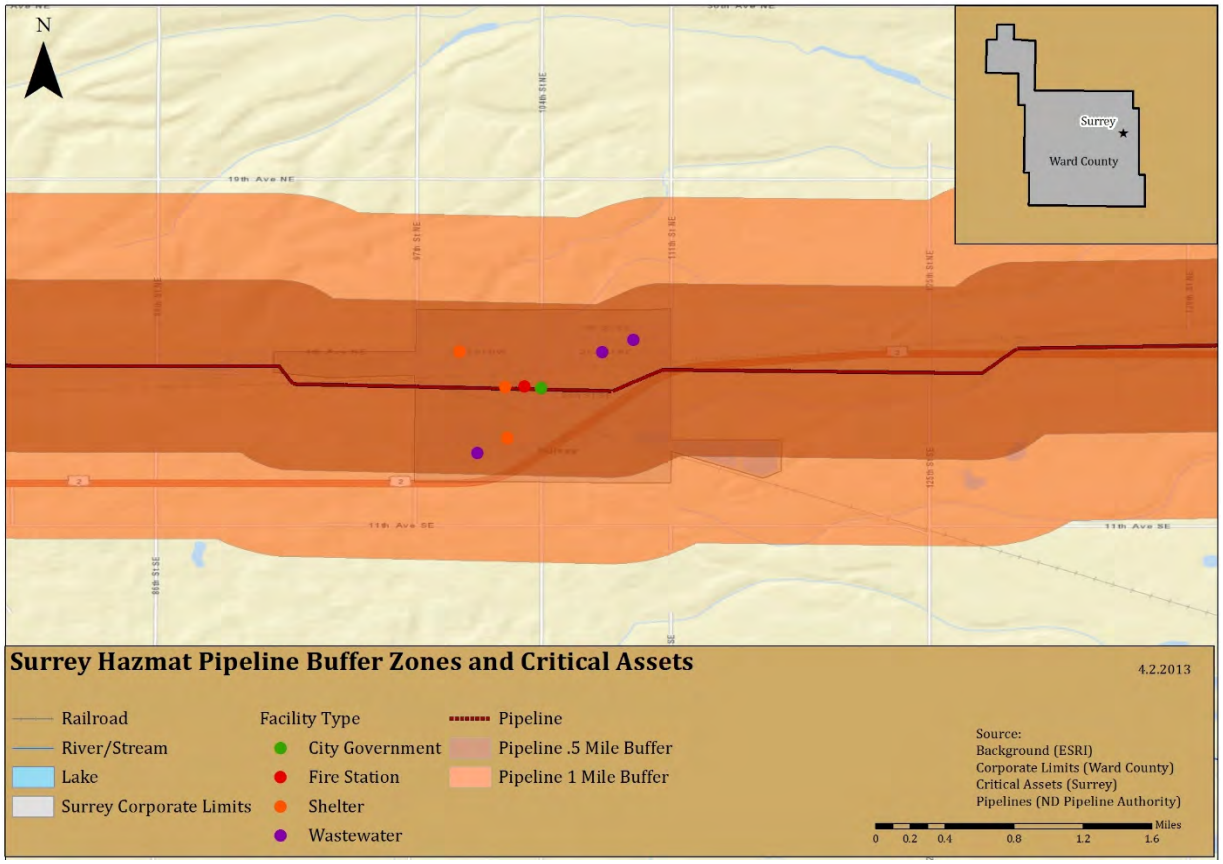
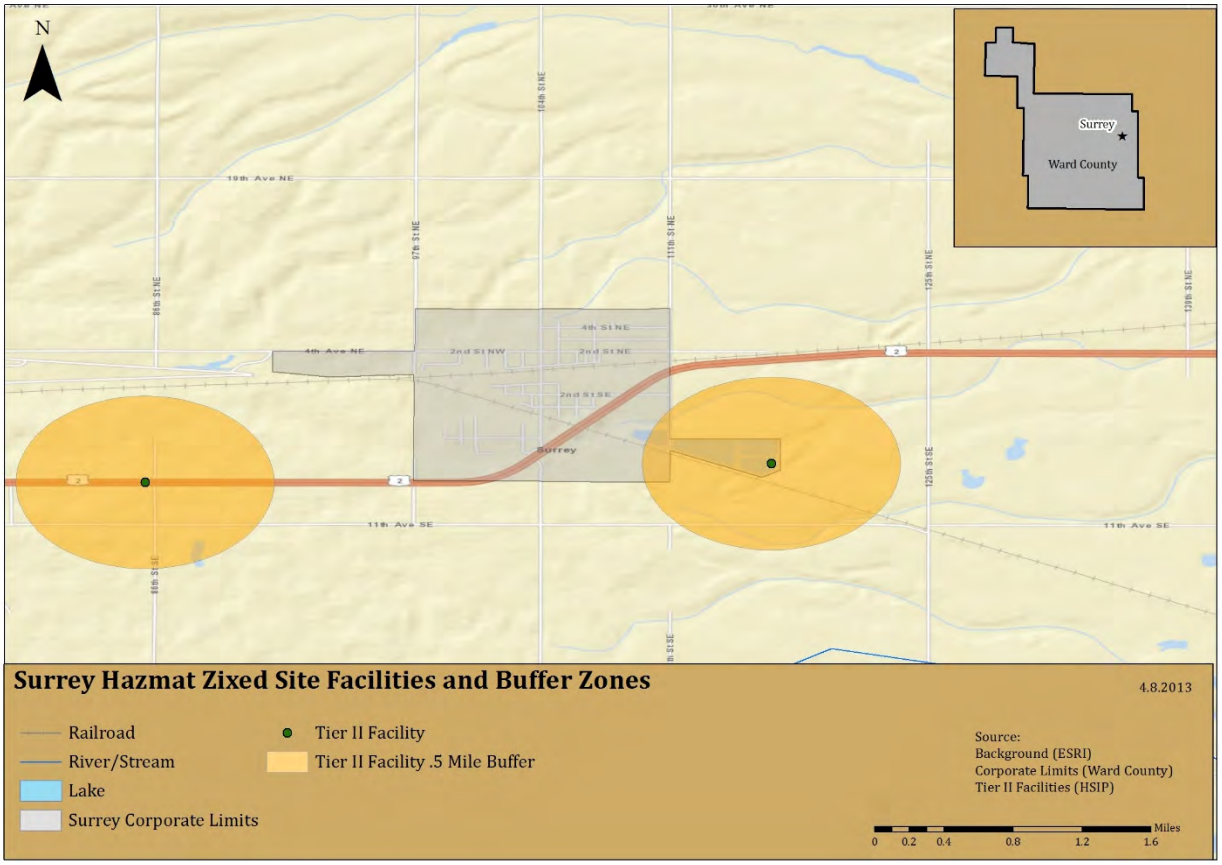


Figure 15.2.2.7-2
Hazardous Materials Locations – Fixed Site



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
Based on Tier II reporting data obtained from the EPA, no Tier II reports from the city of Surrey have been submitted to the EPA since 1987, the year that the EPA began keeping such reports.

According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in Ward County, though not necessarily in the city of Surrey. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is low.

15.3 Risk Assessment (Updated)

The following table (Table 15.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to the city of Surrey.

Table 15.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

15.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to the city of Surrey from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable).

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

Impact Scale Methodology
The potential impacts of each hazard were discussed by the Steering Committee. For the purposes of this discussion, a qualitative impact scale was developed, and was used by the Steering Committee in their discussions. As a result of these discussions, each hazard was assigned a qualitative impact ranking. This scale appears in Table 15.3.1-1 (below).

Table 15.3.1-1
Hazard Impact Scale

Term	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Low	Some minor injuries possible, but no fatalities	Cosmetic damages expected to assets; Infrastructure loss of function for less than 24 hours expected	System delivery delayed or temporarily interrupted; Interruptions in service delivery of less than 24 hours expected
Moderate	Injuries expected; Fatalities possible	Some structural damages to light construction (<50 % damage); Infrastructure loss of function for 24-72 hours expected	System delivery failures expected; Interruptions in service delivery of 24-72 hours expected
High	Serious and numerous injuries expected; Fatalities expected	Some structures irreparably damaged (>50% damage); Infrastructure loss of function for 72+ hours expected	Long-term system failures/damages expected; Cancellation of services (72+ hours) expected
Not Applicable	Hazard does not have the potential to impact people or life safety	Hazard does not have the potential to impact assets or infrastructure	Hazard does not have the potential to impact service delivery

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of the city of Surrey to the identified and profiled hazards.

Critical Assets
The following table (Table 15.3.1-1) provides details of the critical assets contained within the city of Surrey.

Table 15.3.1-1
Critical Assets – City of Surrey

Asset Name	Asset Use /Function	Street Number	Street Name	Insured or Estimated Value
Surrey Fire Station	Emergency Services	17	1st Avenue Southwest	$175,469
Surrey Police Department	Emergency Services	100	Pleasant Avenue South	$175,469
Surrey City Hall	Government	100	Pleasant Avenue South	$175,469
Surrey School	Shelter	--	2nd Avenue Southeast	$16,115
Senior Center	Shelter	400	2nd Avenue Northwest	$16,115
First Lutheran Church	Shelter	200	5th Street Southwest	$16,115
Lift Station	Utility	300	2nd Avenue Northeast	$62,206
Lift Station	Utility	400	3rd Street Southeast	$62,206
Lift Station	Utility	600	4th Avenue Southwest	$62,206
Pump Station	Utility	--	97th Street NE and Oak Drive	$303,999
Water Tower	Utility	100	Pleasant Avenue South	$396,353
Siren	Alert and Warning	--	--	$48,995
Siren	Alert and Warning	--	--	$48,995
Total estimated value of identified critical assets:				**$1,559,712**

Note on asset values: Valuation data for assets within the city was unavailable at the time this plan update was developed. All valuations used in the following estimates of potential losses are derived from an average of available data for the same or similar types of assets from other jurisdictions. The assessment that follows is an estimate only, and may not correlate with actual occurrences of the damage caused by the hazards described.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

15.3.2 Risk and Vulnerability Assessment

15.3.2.1 Communicable Disease

Vulnerability to the Hazard
Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2010 Census, there were 934 people residing in Surrey; this is an increase from the 2000 Census, which placed the population at 917. The 2012 Census Estimate further increased the population, to an estimated 1,016 people. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

The increase in Surrey's population means that more people are potentially exposed to this hazard. Given the longevity of the population increase, it can be reasonably assumed that this vulnerability will continue to grow along with Surrey's population.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 15.3.1-1 (previous).

The representatives from the city of Surrey determined that communicable disease has the potential to cause the impacts described in Table 15.3.2.1-1 (below).

Table 15.3.2.1-1
Qualitative Hazard Impacts – Communicable Disease

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Communicable Disease	Low	Low	Low

Estimate of Potential Losses – Quantitative
According to the 2012 Census estimate, there are 64,798 people in Ward County. The city of Surrey represents approximately 2% of the total population of Ward County, or 934 people.

While an outbreak of communicable disease in Surrey is unlikely to have significant impacts outside of Surrey, an outbreak could have significant impacts within the city.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012. Assuming an illness rate in Surrey that is similar to the illness rate across the county, the following numbers of people in Surrey could be expected to be at risk from these illnesses:

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people. Surrey accounts for approximately 2% of the county population. This equates to 90 cases of influenza in Surrey, on average, that could potentially impact the city.
- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people. Surrey accounts for approximately 2% of the county population. This equates to 130 cases of pertussis in Surrey, on average, that could potentially impact the city.

Identified Data Limitations
There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. No municipal-level data regarding potential impacts was available for this risk assessment, and only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding infection rates at the municipal level;
- Data regarding project population changes; and
- Data regarding absenteeism and increased operating costs as a result of absenteeism.

15.3.2.2 Drought

Vulnerability to the Hazard
Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies depend largely on agriculture, such as the State of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result

in significant societal disruption, which can worsen as the resource becomes more and more precious.

Surrey is not economically dependent on agriculture, making it less vulnerable to the economic ramifications of an agricultural drought.

Surrey's population and development have increased since the 2000 Census, as have the number of housing units in the community. There are no identified plans for significant future development in the area, and therefore no projected significant growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no significant changes to the city's vulnerability to this hazard in the near future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 15.3.1-1 (previous).

The representatives from the city of Surrey determined that drought has the potential to cause the impacts described in Table 15.3.2.2-1 (below).

Table 15.3.2.2-1
Qualitative Hazard Impacts – Drought

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Drought	Low	Moderate	Moderate

Estimate of Potential Losses – Quantitative
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no quantitative risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no quantitative risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

15.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

Surrey's population and development have increased since the 2000 Census, as have the number of housing units in the community. There are no identified plans for significant future development in the area, and therefore no projected significant growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no significant changes to the city's vulnerability to this hazard in the near future.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 15.3.1-1 (previous).

The representatives from the city of Surrey determined that fire has the potential to cause the impacts described in Table 15.3.2.3-1 (below).

Table 15.3.2.3-1
Qualitative Hazard Impacts – Fire

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Fire	Moderate	Moderate	High

Estimate of Potential Losses – Quantitative

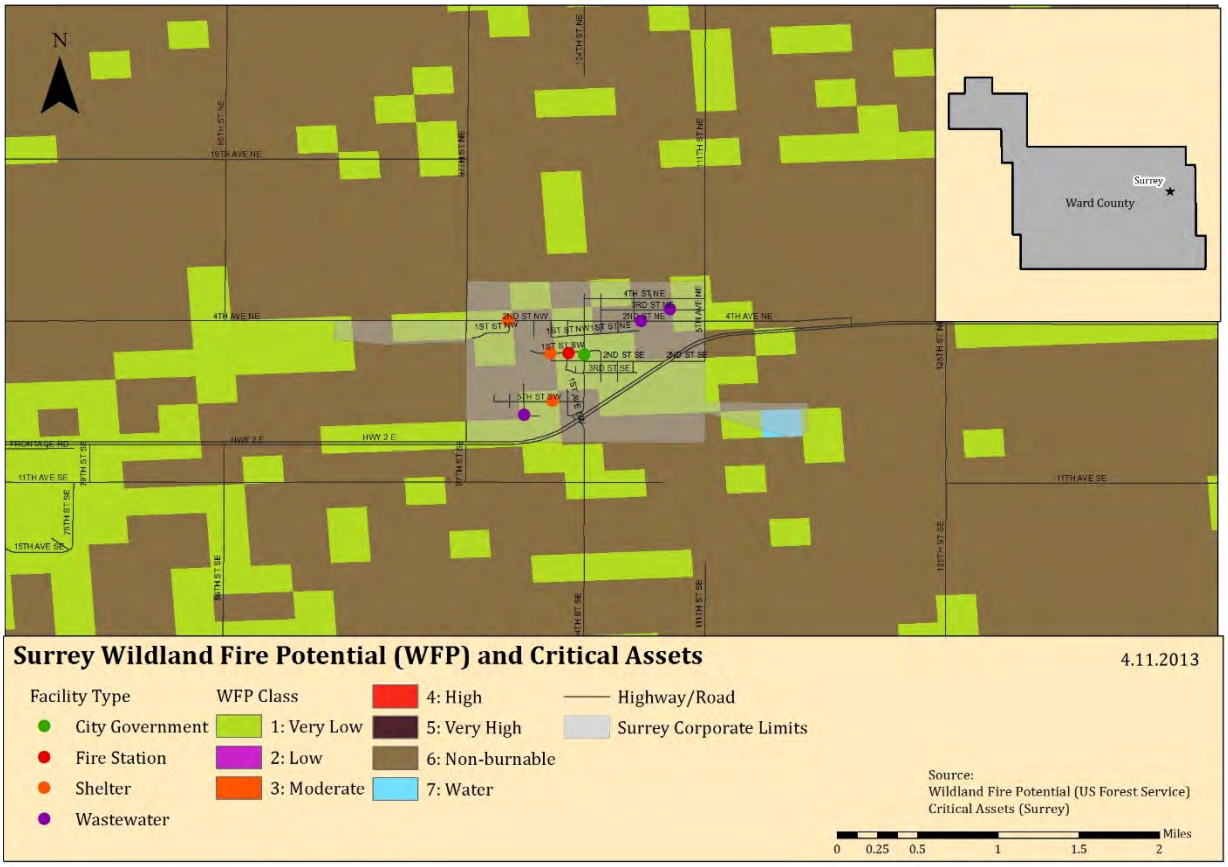
All structures within the city of Surrey are at risk from fire. According to the 2010 Census, there are 344 housing units in the city; 341 of these units are occupied, and 3 are vacant. The majority of these structures are heated by natural gas. The median value of single family housing in Surrey is $130,900, according to the Census. This equates to potential residential losses of $45,029,600.

In addition, all identified critical assets (identified in Table 15.3.1-1) within the city have the potential to be lost to fire. These assets have a combined estimated value of $1, 559,712.

Using the US Forest Service's Wildland Fire Potential data, the city of Surrey and its critical assets were mapped. Based on this data set, the city of Surrey has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 15.3.2.3-1 (following) illustrates this fire potential in relation to the identified critical assets for the city.

Figure 15.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

15.3.2.4 Flood

Vulnerability to the Hazard
Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding.

Flood damages also take considerable time to recover from. The 2011 flooding that occurred throughout the county had far-reaching impacts, and recovery for many areas remains a work in progress as of this Plan update.

Surrey's population and development have increased since the 2000 Census, as have the number of housing units in the community. There are no identified plans for significant future development in the area, and therefore no projected significant growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no significant changes to the city's vulnerability to this hazard in the near future.

The city of Surrey is not a member of the NFIP. As of February 2013, there were no NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the city of Surrey.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 15.3.1-1 (previous).

The representatives from the city of Surrey determined that flooding has the potential to cause the impacts described in Table 15.3.2.4-1 (below).

Table 5.3.2.4-1
Qualitative Hazard Impacts – Flood

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Flood	Low	Low	Low

Estimate of Potential Losses – Quantitative
It was the determination of the Steering Committee that quantitative risk assessments related to flooding should be performed for those areas within Ward County that contained a mapped or identified flood hazard area, and that all other areas should receive a qualitative assessment only.

In light of this determination, no quantitative risk assessment has been performed for this hazard for the city of Surrey.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the city, as well as the elevation of all critical assets and infrastructure.

15.3.2.5 Severe Summer Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Surrey's population and development have increased since the 2000 Census, as have the number of housing units in the community. There are no identified plans for significant future development in the area, and therefore no projected significant growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no significant changes to the city's vulnerability to this hazard in the near future.

During the development of this plan update, it was determined that the city should add warning sirens, to ensure that the population can be warned of approaching storms. This vulnerability's mitigation is included in the mitigation strategy for Surrey.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 15.3.1-1 (previous).

The representatives from the city of Surrey determined that severe summer storms have the potential to cause the impacts described in Table 15.3.2.5-1 (below).

Table 15.3.2.5-1
Qualitative Hazard Impacts – Severe Summer Storm

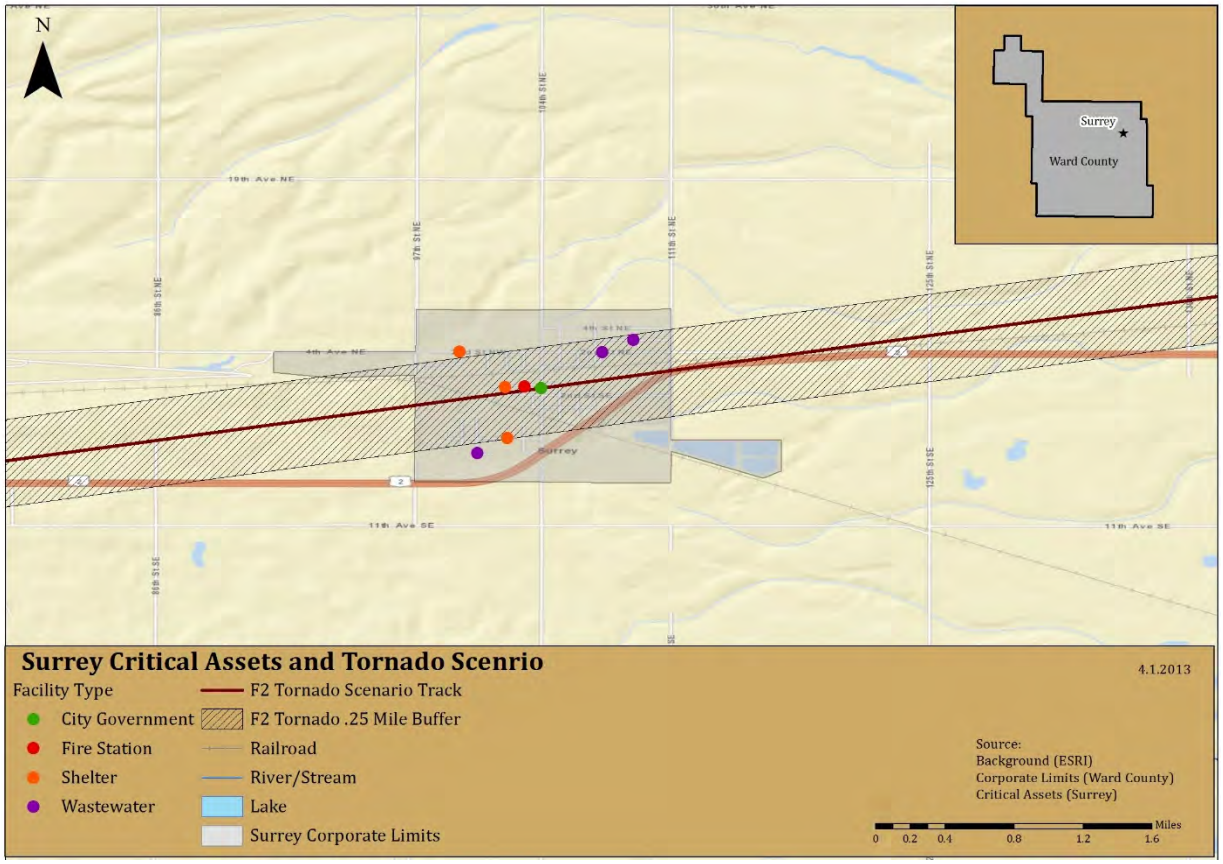
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Summer Storm	High	High	High

Estimate of Potential Losses – Quantitative
Severe summer storms are a non-spatial hazard that can and do affect the entire city of Surrey. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within the city of Surrey are at risk from severe summer storms. According to the 2010 Census, there are 3442 housing units in the city. The median value of these structures is $130,900, according to the Census. This equates to residential assets of approximately $45,029,600. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $4,502,960.

In addition, all identified critical assets (identified in Table 15.3.1-1) within the city have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of $1, 559,712. For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto the city of Surrey. Figure 15.3.2.5-1 (following) illustrates the results of this scenario, and shows the critical assets that would be at risk during such an event.

Figure 15.3.2.5-1
Tornado Scenario – City of Surrey



As seen in the above figure, in such a scenario the majority of the city of Surrey would be damaged, including critical assets (government and emergency services). This scenario would result in significant damages to the city's infrastructure – an estimated $1,224,506 in potential losses, the value of most of the city's critical assets - and would greatly impact its ability to provide basic services, such as emergency response.

Finally, the 934 residents of Surrey are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 8% (children under 5) and 4.2% (those over 70) of the population of Surrey. Combined, these two groups account for more than 12% of the population, a total of 115 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);

- Building valuations for all assets within the city limit;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe summer storm events.

15.3.2.6 Severe Winter Storms

Vulnerability to the Hazard

People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

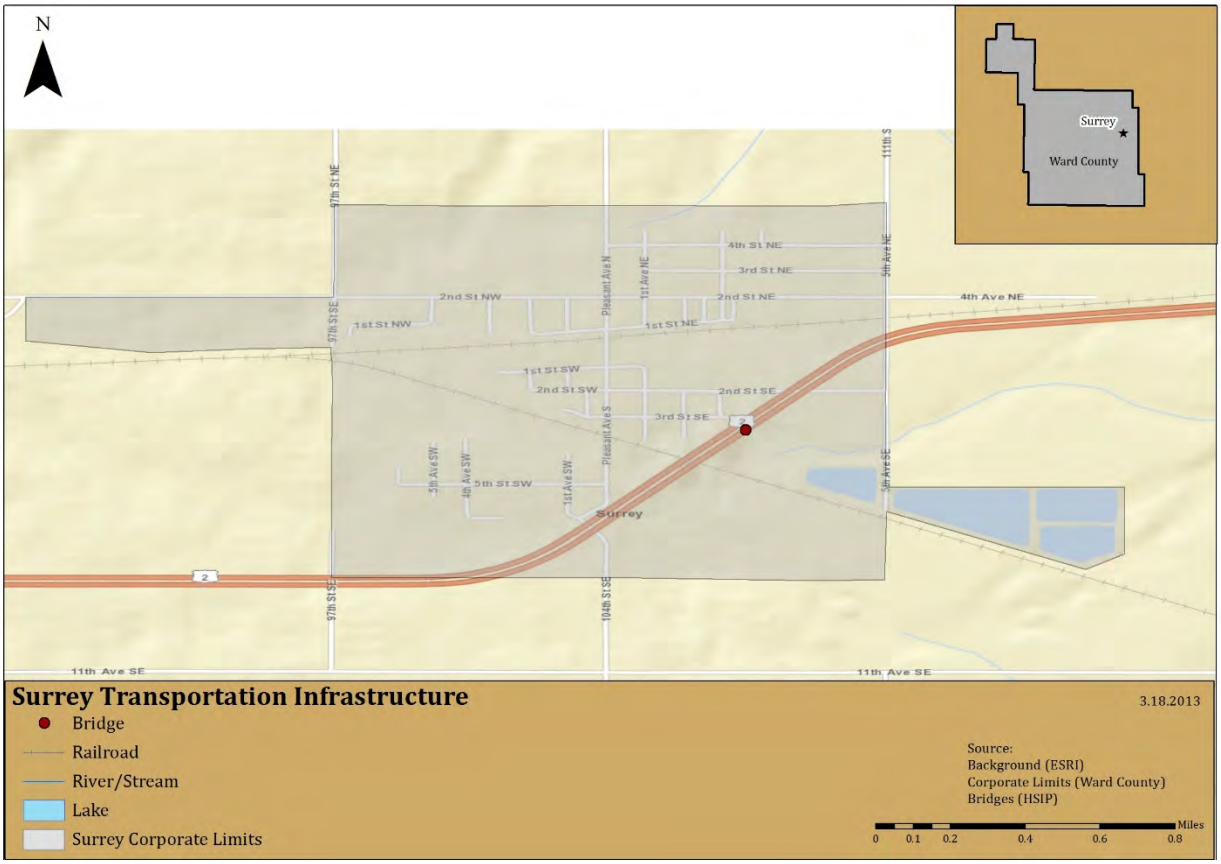
Surrey's population and development have increased since the 2000 Census, as have the number of housing units in the community. There are no identified plans for significant future development in the area, and therefore no projected significant growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no significant changes to the city's vulnerability to this hazard in the near future.

During the development of this plan update, it was determined that the city should add warning sirens, to ensure that the population can be warned of approaching storms. This vulnerability's mitigation is included in the mitigation strategy for Surrey.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents. Figure 15.3.2.6-1 (following) provides the locations of bridges in and around the city, which typically ice over before surround roadways, making them treacherous for travel.

Figure 15.3.2.6-1
Surrey – Bridges



Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 15.3.1-1 (previous).

The representatives from the city of Surrey determined that severe winter storms have the potential to cause the impacts described in Table 15.3.2.6-1 (below).

Table 15.3.2.6-1
Qualitative Hazard Impacts – Severe Winter Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Winter Storm	Low	Moderate	Low

Estimate of Potential Losses – Quantitative
Severe winter storms are a non-spatial hazard that can and do affect the entire city of Surrey. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within the city of Surrey are at risk from severe winter storms. According to the 2010 Census, there are 344 housing units in the city. The median value of these structures is $130,900, according to the Census. This equates to residential assets of approximately $45,029,600. If 1% of these residential assets were damaged by a severe summer storm, this would result in losses of $450,296.

In addition, all identified critical assets (identified in Table 15.3.1-1) within the city have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of $1, 559,712. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $155,971.

Finally, the 934 residents of Surrey are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 8% (children under 5) and 4.2% (those over 70) of the population of Surrey. Combined, these two groups account for more than 12% of the population, a total of 115 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during severe winter storm events.

15.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

Surrey's population and development have increased since the 2000 Census, as have the number of housing units in the community. There are no identified plans for significant future development in the area, and therefore no projected significant growth in population in the foreseeable future. Therefore, it can be assumed that there will likely be no significant changes to the city's vulnerability to this hazard in the near future.

The roadways around Surrey have seen an increase in traffic in recent years, due in large part to the increase in energy activities throughout the state. An incident on the roadways could impact the city and its residents, even if it did not occur within the city limits. This increase traffic has led to at least some increase in vulnerability to this hazard.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 15.3.1-1 (previous).

The representatives from the city of Surrey determined that hazardous materials incidents have the potential to cause the impacts described in Table 15.3.2.7-1 (below).

Table 15.3.2.7-1
Qualitative Hazard Impacts – Hazardous Materials Incident

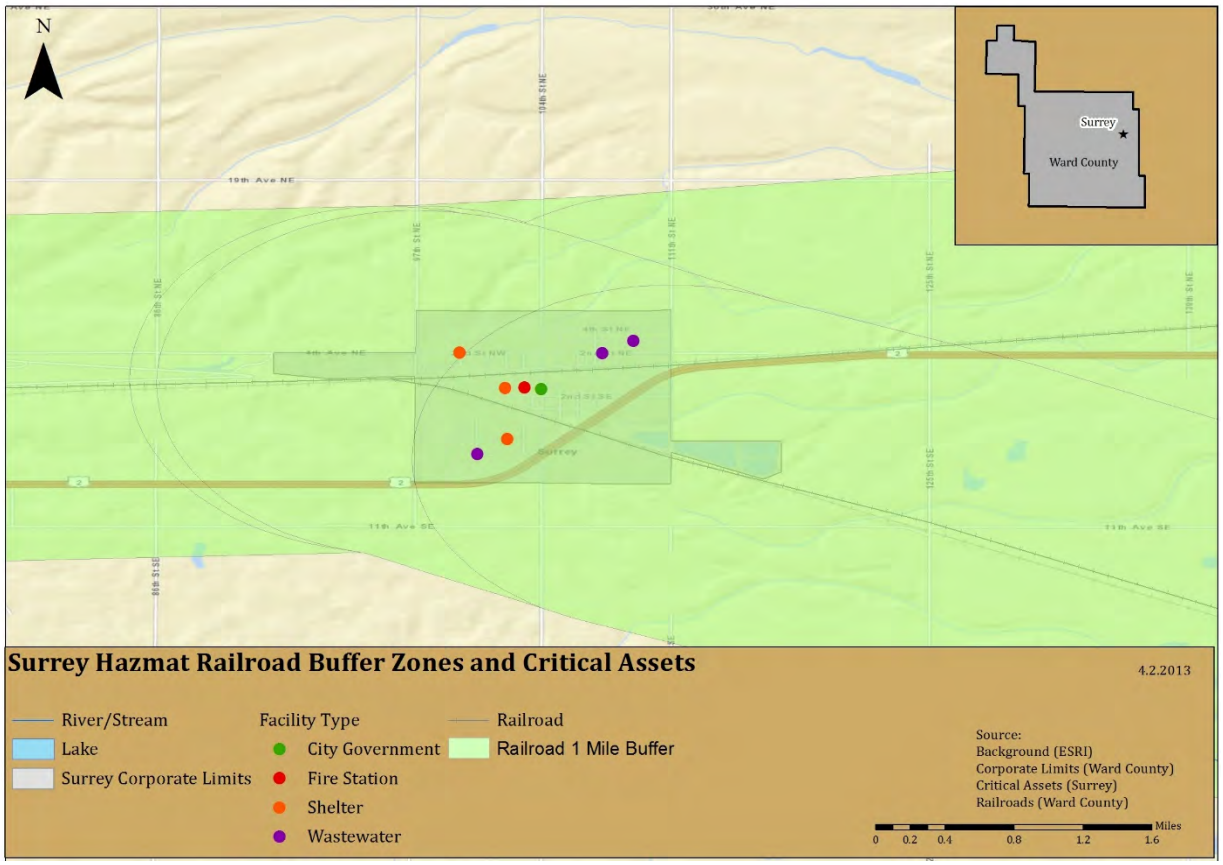
Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Hazardous Materials Incident	High	High	High

Estimate of Potential Losses – Quantitative
For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to the city of Surrey – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These

created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

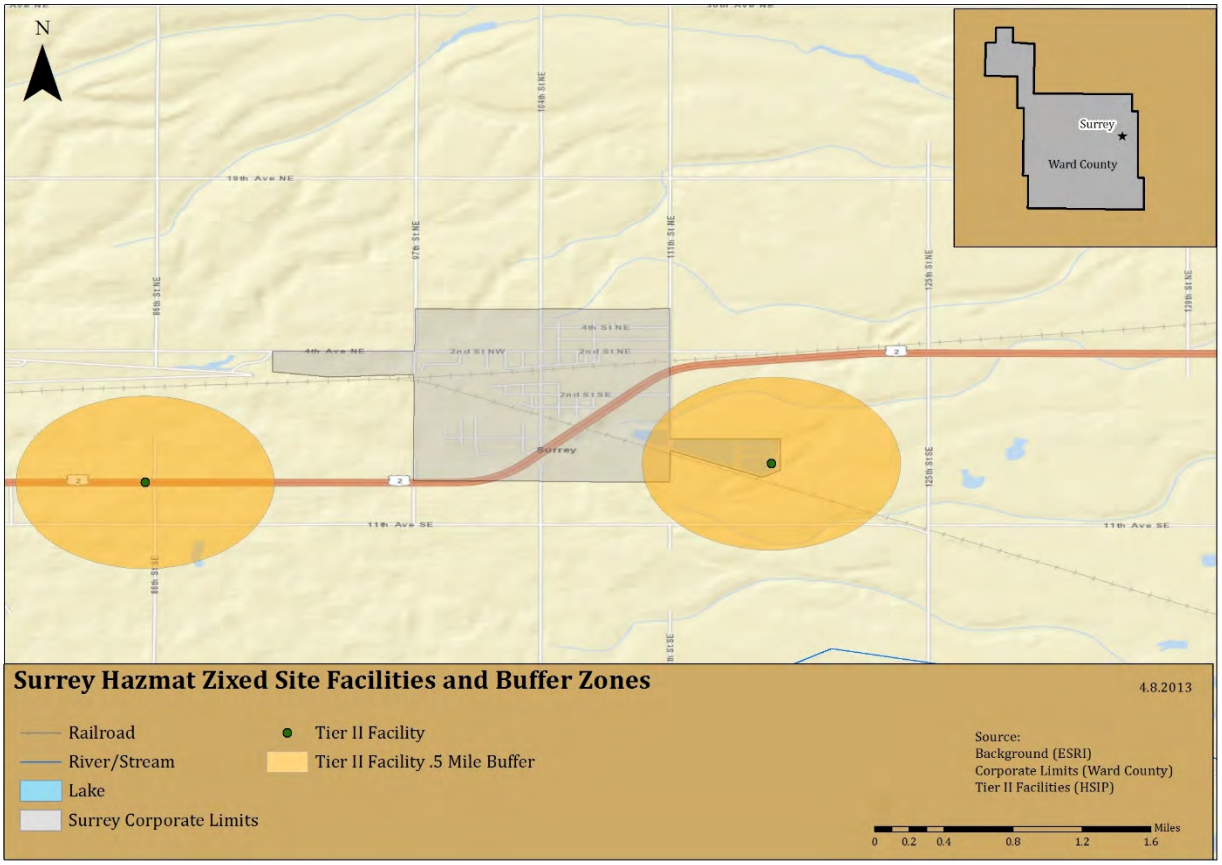
Surrey's hazardous materials risk comes from the railroad, and from the materials that are moved along the railroad, from pipelines, and from fixed site facilities. Figures 15.3.2.7-1 through 15.3.2.7-3 (below and following) illustrates the locations of these hazards, and provides given buffer zones around each, to illustrate the assets that may be impacted during an incident. For the purposes of this assessment, all assets within this buffer would be impacted to some degree.

Figure 15.3.2.7-1
Hazardous Materials Incident Scenario – Railroad



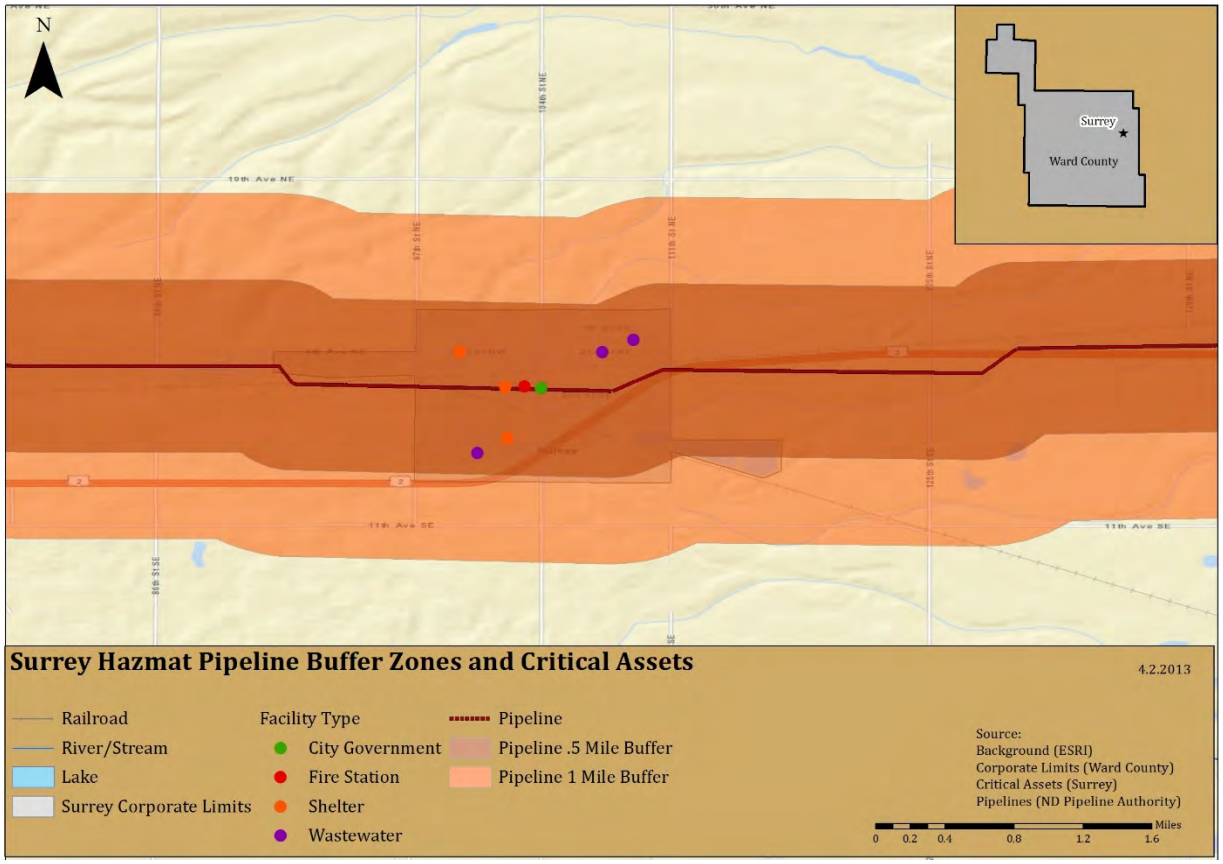
As is evident from the above image, the entire city could be impacted by an incident involving hazardous materials and the railroad, as could all critical assets within the city. This could result in potential losses of $46,316,312 (residential property and critical assets), and could result in injuries to all residents of Surrey.

Figure 15.3.2.7-2
Hazardous Materials Incident Scenario – Fixed Site



As seen in the image above, very little of Surrey would likely be impacted by an incident at either fixed site facility. No critical assets or residential structures fall within the ½ mile buffer zones used for this scenario.

Figure 15.3.2.7-3
Hazardous Materials Incident Scenario – Pipelines



As is evident from the above image, the entire city could be impacted by an incident involving pipelines, as could all critical assets within the city. This could result in potential losses of $46,316,312 (residential property and critical assets), and could result in injuries to all residents of Surrey.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes is development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

15.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of the city of Surrey's resources in order to identify, review, and analyze what the city is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with City staff. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. Summary information from these sources can be found in Section 03.

For this assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the city has limited familiarity with hazard mitigation programs, though hazard mitigation does play something of a role in the decision-making process for the city.
- **Current/ongoing mitigation efforts** – currently, the city's mitigation efforts include participating in the development of the Ward County Hazard Mitigation Plan Update.
- **Intra- and inter-governmental coordination** – the city does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the city is working with the county to be part of the Emergency Operations Plan, which will provide some framework for emergencies and disasters in the city.
- **Planning** –the city is currently developing an evacuation plan and a master plan, as well as a stormwater management plan. There is no recovery plan or COOP/COG for the city. The city is not a member of the NFIP, but they do have floodplain regulations, and do actively enforce them.

- **Staff, personnel, and technical capability** – as of this Plan update, the city has a limited capability and capacity regarding hazard mitigation, and is not particularly confident in their abilities to administer hazard mitigation projects and programs. Additional experience and resources would be beneficial to building this capacity.

Like other municipalities within Ward County, Surrey depends on the framework established by the county and state government for technical assistance, and on the state and federal government for funding.

Conclusions and Recommendations
Surrey should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the county towards this end.

15.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section **shall** include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008 **must** also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there **must** be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

15.5.1 Mitigation Goals

Table 15.5.1-1 (following) provides the mitigation goals that guide the city of Surrey's mitigation strategy.

Table 15.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

15.5.2 Mitigation Actions

Potential Mitigation Actions
Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the city.

Flood Mitigation Actions
Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike

wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions
Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions

The following table (15.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (15.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped the city of Surrey to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 15.5.2-2. Table 15.5.2-1 (below) describes the basic criteria considered as part of the prioritization process.

Table 15.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.

STAPLEE	Criteria Explanation
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness

Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (15.5.2-2) provides the identified and prioritized mitigation strategy for the city of Surrey.

Table 15.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Continue to enforce floodplain management ordinance and practices	Flood	New	New and existing	City Council; Planning and Zoning	General funds; County EMA; County Floodplain Manager	$500+	Low	
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	City Council; Planning and Zoning	General funds; County EMA; County Floodplain Manager	Negligible	Low	
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Establish public information and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	City Council; City Auditor; Police Department; Fire Department	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; County EMA	$500+	Moderate	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible department(s)	Resource(s)	Estimated cost	Priority	Notes/Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Purchase and install additional warning sirens	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council; City Auditor	NDDES & FEMA mitigation grant funding; general fund	$40,000+	High	
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recent annexations and/or recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New	City Council; City Engineer; City Auditor	County Roads and Bridges	$500+	Moderate	
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	City Council; Chief of Police; Fire Chief; City Auditor; Public Works	General fund; in-kind contributions; County EMA	$500+	Low	

Section 16
Ward County: HIRA, Capability Assessment, and Mitigation Strategy

16.1 IFR for Hazard Identification and Risk Assessment
16.2 Hazard Identification (Updated)
16.2.1 Overview of Ward County's History of Hazards and Potential Hazards
16.2.2 Hazard Profiles
16.3 Risk Assessment (Updated)
16.3.1 Risk Assessment Methodology
16.3.2 Risk and Vulnerability Assessment
16.4 Capability Assessment (Updated)
16.5 Mitigation Strategy (Updated)
16.5.1 Mitigation Goals
16.5.2 Mitigation Actions

16.1 Interim Final Rule for Hazard Identification and Risk Assessment

Requirement §201.6(c)(2): *The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment shall include a] description of the type…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.*

Requirement §201.6(c)(2)(ii)(A): *The plan* ***should*** *describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area .*

Requirement §201.6(c)(2)(ii)(B): *[The plan* ***should*** *describe vulnerability in terms of an] estimate of*

the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ..

Requirement §201.6(c)(2)(ii)(C): *[The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment **must** assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

This section addresses the specific requirements of the Interim Final Rule (IFR) with regard to hazards and risks in Ward County

16.2 Hazard Identification (Updated)

In accordance with IFR requirements, and as part of its efforts to support and encourage hazard mitigation initiatives, the Steering Committee prepared this general assessment of the hazards that have the potential to impact Ward County. This section provides an overview of past hazard events in the city and descriptions of potential hazards to the city.

16.2.1 Overview of Ward County's History of Hazards and Potential Hazards

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) database collects and maintains data about natural hazards in summary format. The data includes occurrences, dates, injuries, deaths, and costs. It should be noted that many of these databases and other data collection services, including the NCDC, have inherent data limitations when searching for information at a scale as small as a single municipality. The best available data and records were used throughout this section.

According to the NCDC database, at least 155 weather-related hazard events have occurred in the Ward County since 1954, including the following number and types of hazard events:

- Hail – 52
- Tornado/Funnel Cloud - 34
- Thunderstorm/Wind - 69

In the absence of definitive data on some of the hazards that may occur in the city, illustrative examples are useful. Table 16.2.1-1 (below) provides information on the Presidential Disaster and Emergency Declarations that have included the county since 1957.

Table 16.2.1-1
Presidential Disaster Declarations – Ward County

Presidential Disaster and Emergency Declarations – 1957-2012	
Date and Disaster or EM Number	**Nature of Event**
May 2011 DR-1986	Severe Winter Storm
May 2011 DR-1981	Flooding
April 2011 EM-3318	Flooding
November 2005 DR-1616	Severe Winter Storm and Record and/or Near Record Snow
September 2005 EM-3247	Hurricane Katrina Evacuation
July 2005 DR-1597	Severe Storms, Flooding, and Ground Saturation
April 2004 EM-3196	Snow
June 1999 DR-1279	Severe Storms, Tornadoes, Snow and Ice, Flooding, Ground Saturation, Landslides, and Mudslides
April 1997 DR-1174	Severe Storms/Flooding
January 1997 DR-1157	Severe Winter Storms/Blizzard
April 1979 DR-581	Storms, Snowmelt, Flooding
July 1976 EM-3016	Drought
April 1976 DR-501	Flooding
May 1975 DR-469	Flooding from Rains, Snowmelt
May 1974 DR-434	Heavy Rains, Snowmelt, Flooding
June 1972 DR-335	Severe Storms, Flooding
June 1970 DR-287	Severe Storms, Flooding
April 1969 DR-256	Flooding

Potential Hazards to Ward County

In the initial identification process, the Steering Committee considered potential hazards to identify those with the most chance to significantly affect the planning area. The hazards include those that have occurred in the past and may occur in the future. A variety of sources were used to develop the list of hazards considered by the Steering Committee. These included national, regional, and local sources such as emergency operations plans, the State of North Dakota Multi-Hazard Mitigation Plan, the 2008 Ward County Hazard Mitigation Plan, FEMA's *How-To Series,* websites, published documents, databases, and maps, as well as discussion among the Steering Committee members.

In the initial phase of the planning process, the Steering Committee considered 23 natural, manmade, and technological hazards and the risks they create for the city and its material assets, operations, and staff. The hazards initially considered, and the determination as to the treatment of those hazards, are shown in Table 16.2.1-2 (below).

Table 16.2.1-2
Preliminary Hazard Identification and Determinations –Ward County

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	Ward County	Reason for Exclusion and other notes
Natural Hazards						
Avalanche						Not a hazard in the area
Communicable Disease (Including human animal and plant diseases)	✓			✓	X	NA
Drought	✓	✓		✓	X	
Extreme Heat	✓					Included under severe summer storms
Flood	✓	✓	✓	✓	X	
Geologic Hazards (including landslide, earthquake, and other geologic/mining hazards)	✓			✓	X	Include for county only
Rabid Animals			✓			Include under Communicable Diseases
Severe Winter Storm	✓	✓		✓	X	
Summer Storm (including tornadoes, hail, strong winds, lightning and extreme heat)	✓	✓	✓	✓	X	
Volcano	✓			✓		Low probability with sufficient advance warning
Structural Fire	✓	✓		✓		Changed from Urban to Structural Fire

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	Ward County	Reason for Exclusion and other notes
Wildland/Rural Fire	✓	✓		✓	X	Combine structural and wildfire into a single profile
Intentional Hazards						
Civil Disorder/Terrorism		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Homeland Security Incident	✓					Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Mass Casualty		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
National Security Emergency		✓				Excluded due to duplication of efforts with other plans; decision to exclude based on focus on predominantly natural hazards
Population Influx (including lack of housing infrastructure)			✓			Excluded as hazard, included under planning considerations

Hazard	Included in SHMP (2011)	Included in Ward County HMP (2008)	Preliminary Hazards Identified by LEPC Members	Included in Ward County HMP Update (2012)	Ward County	Reason for Exclusion and other notes
Technological Hazards						
Abandoned Buildings			✓			Excluded as hazard, based on decision to focus on predominantly natural hazards
Dam Failure	✓	✓				Include under Flood Hazard
Hazardous Material Incident (Fixed Site and Transport)	✓	✓	✓	✓	X	
Levee Failure	✓		✓			Include under Flood Hazard as applicable
Shortage of Critical Materials	✓	✓				Excluded as hazard, discuss under vulnerabilities
Transportation Accident (including vehicular, railway, and aircraft)	✓		✓			Excluded as hazard, discuss under vulnerabilities

The following pages profile the eight hazards identified above, and include a description of the hazard, the location of the hazard, the extent and severity of the hazard, the potential impact to life and property that the hazard may have, past occurrences of the hazard, and the probability of future occurrences of the hazard.

Future Occurrence Probability Methodology
In order to determine the probability of future occurrences of each hazard profiled, the following scale was developed:

High – any hazard with the probability of occurring at least once per year
Moderate – any hazard with the probability of occurring at least once every five years
Low – any hazard with the probability of occurring less than every five years

The methodology is based on frequency of impact within a 5 year planning period, hence the 5 year break point between moderate and low.

16.2.2 Hazard Profiles

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

16.2.2.1 Communicable Disease

Description of the Hazard

Infectious pathologies are also called communicable diseases or transmissible diseases due to their potential of transmission from one person or species to another by a replicating agent (as opposed to a toxin). An infectious disease is a clinically evident illness resulting from the presence of pathogenic microbial agents, including pathogenic viruses, pathogenic bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. Transmission of an infectious disease may occur through one or more pathways including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, body fluids, contaminated objects, airborne inhalation, or through vector-borne spread.

Transmissible diseases which occur through contact with an ill person or their secretions, or objects touched by them, are especially infective, and are sometimes referred to as contagious diseases. Infectious (communicable) diseases which usually require a more specialized route of infection, such as vector transmission, or blood or needle transmission, are usually not regarded as contagious.

The term infectivity describes the ability of an organism to enter, survive and multiply in the host, while the infectiousness of a disease indicates the comparative ease with which the disease is transmitted to other hosts. An infection however, is not synonymous with an infectious disease, as an infection may not cause important clinical symptoms or impair host function.

Examples of communicable or infectious diseases include plague, malaria, tuberculosis, rabies, hepatitis B, influenza, HIV, and measles.

Location of the Hazard

This hazard impacts people, rather than physical assets. Therefore, all populated areas of the city are at risk from the communicable disease hazard.

Extent and Severity of the Hazard

The Center for Disease Control and Prevention (CDC) categorizes various diseases in levels of biohazard. In this scale, Level 1 equates to a minimal risk, and Level 4 describes extreme risk. Table 16.2.2.1-1 (below) describes these levels, and provides examples of communicable diseases that would typically fall in to these classifications, and the typical protections that would be necessary to prevent transmission of the disease.

Table 16.2.2.1-1
Biohazard Classification Levels
(Source: Center for Disease Control and Prevention)

Level	Examples	Typical Protection to Prevent Transmission
Biohazard Level I (BSL-I)	*E. Coli* Canine Hepatitis Chicken Pox	Precautions are minimal, most likely involving gloves and some sort of facial protection. Usually, contaminated materials are left in open (but separately indicated) waste receptacles. Decontamination procedures for this level are similar in most respects to modern precautions against everyday viruses (i.e.: washing one's hands with anti-bacterial soap, washing all exposed surfaces of the lab with disinfectants, etc.).
Biohazard Level II (BSL-2)	Hepatitis A, B, C Lyme disease Salmonella Mumps Measles Scrapie Dengue Fever HIV	These bacteria and viruses cause mild disease in humans, or are difficult to contract via aerosol. Routine diagnostic work with clinical specimens can be done safely at BSL-2, using BSL- 2 practices and procedures.
Biohazard Level III (BSL-3)	Anthrax West Nile Virus SARS Virus Smallpox Tuberculosis Typhus Yellow Fever Malaria	These bacteria and viruses cause severe to fatal disease in human, but vaccines or other treatments do exist to combat them. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents, and are supervised by competent scientists who are experienced in working with these agents. This is considered a neutral or warm zone.
Biohazard Level IV (BSL-4)	H5N1 (Bird Flu) Dengue Hemorrhagic Fever Marburg Virus Ebola Virus Hantaviruses Lassa Fever Crimean-Congo Hemorrhagic Fever Other Hemorrhagic Diseases	These viruses and bacteria cause severe to fatal disease in humans, for which vaccines or other treatments are *not* available. When dealing with biological hazards at this level the use of a Hazmat suit and a self-contained oxygen supply is mandatory. The entrance and exit of a BSL-4 lab will contain multiple showers, a vacuum room, an ultraviolet light room, autonomous detection system, and other safety precautions designed to destroy all traces of the biohazard. Multiple airlocks are employed and are electronically secured to prevent both doors opening at the same time. All air and water service going to and coming from a BSL- 4 lab will undergo similar decontamination procedures to eliminate the possibility of an accidental release.

Potential Impact of the Hazard

Communicable disease outbreaks and pandemics will have the most immediate impact on life and health safety. The extent of the impact will be contingent on the type of infection or contagion, the severity of the outbreak, and the speed at which it is transmitted. Property and infrastructure could be affected if large portions of the population were affected and unable to perform maintenance

and operations tasks. This would be particularly disruptive if those impacted were first responders or other essential personnel.

Past Occurrences of the Hazard

In general, North Dakota overall has been spared the devastating outbreaks of communicable disease that have impacted other areas. For example, the 1918 Spanish Flu pandemic killed an estimated 20-40 M people worldwide; 675,000 of those fatalities occurred in the US. In North Dakota, this same pandemic infected 6,000 people, and resulted in 2,700 fatalities – a significantly lower proportion of the population than other states.

Communicable diseases statistics are maintained by the state at the county level, and are not generally available at the municipal levels. The exception to this is when a geographically-specific outbreak occurs. Based on information obtained from the North Dakota Department of Health, all available data rests at the county level, and is not available for the municipal level. Therefore, this discussion will focus on occurrences in the county, and will reasonable assume that some of the occurrences could have or did occur in or otherwise impact Ward County.

Influenza is an illness that is specifically tracked by the State Department of Health, and detailed records are maintained for this illness. The table below (Table 16.2.2.1-2) provides information regarding influenza in Ward County and the State of North Dakota since the 2007-2008 influenza season, including the 2012-2013 season as of April.

Table 16.2.2.1-2
Influenza Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007-2008	3,817	178	5%
2008-2009	1,755	115	7%
2009-2010	3,259	221	7%
2010-2011	2,089	125	6%
2011-2012	1,487	115	8%
2012-2013	4,757	307	7%

Another communicable disease that is tracked by the State Health Department is pertussis, also known as whooping cough. Table 16.2.2.1-3 (following) provides the details of pertussis outbreaks since 2007.

Table 16.2.2.1-3
Pertussis Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County
2007	12	1	9%
2008	Unavailable	Unavailable	NA
2009	30	0	NA
2010	58	6	11%
2011	70	1	2%
2012	215	59	28%
2013 (as of April)	4	0	NA

As is evident in the table above, occurrences of pertussis have increased significantly in both North Dakota and in Ward County. This dramatic increase prompted the State Health Department to issue a Health Advisory in October 2012, which recommended that health care providers consider testing for pertussis for any patient that presented possible symptoms of the disease and also recommended immunizations be administered as recommended for children and infants.

Rabies is also a concern for the State Health Department, which specifically tracks reports of the illness by species infected. Table 16.2.2.1-4 (below) provides occurrence information for rabies.

Table 16.2.2.1-4
Rabies Occurrences
(Source: North Dakota Department of Health)

Years	Cases (Statewide)	Cases (Ward County)	Percentage of ND Cases in Ward County	Species Impacted
2007	30	1	4%	Horse
2008	34	3	9%	Cow, Dog
2009	16	0	NA	NA
2010	22	0	NA	NA
2011	23	0	NA	NA
2012	58	2	4%	Cow, Skunk

Ward County did not report any additional incidents of the communicable disease hazard.

Probability of a Future Occurrence of the Hazard
Based on the available data, there have been many documented cases of the communicable disease hazard within Ward County. Using the scale provided earlier in this section, the probability of a future occurrence is high.

16.2.2.2 Drought

Description of the Hazard

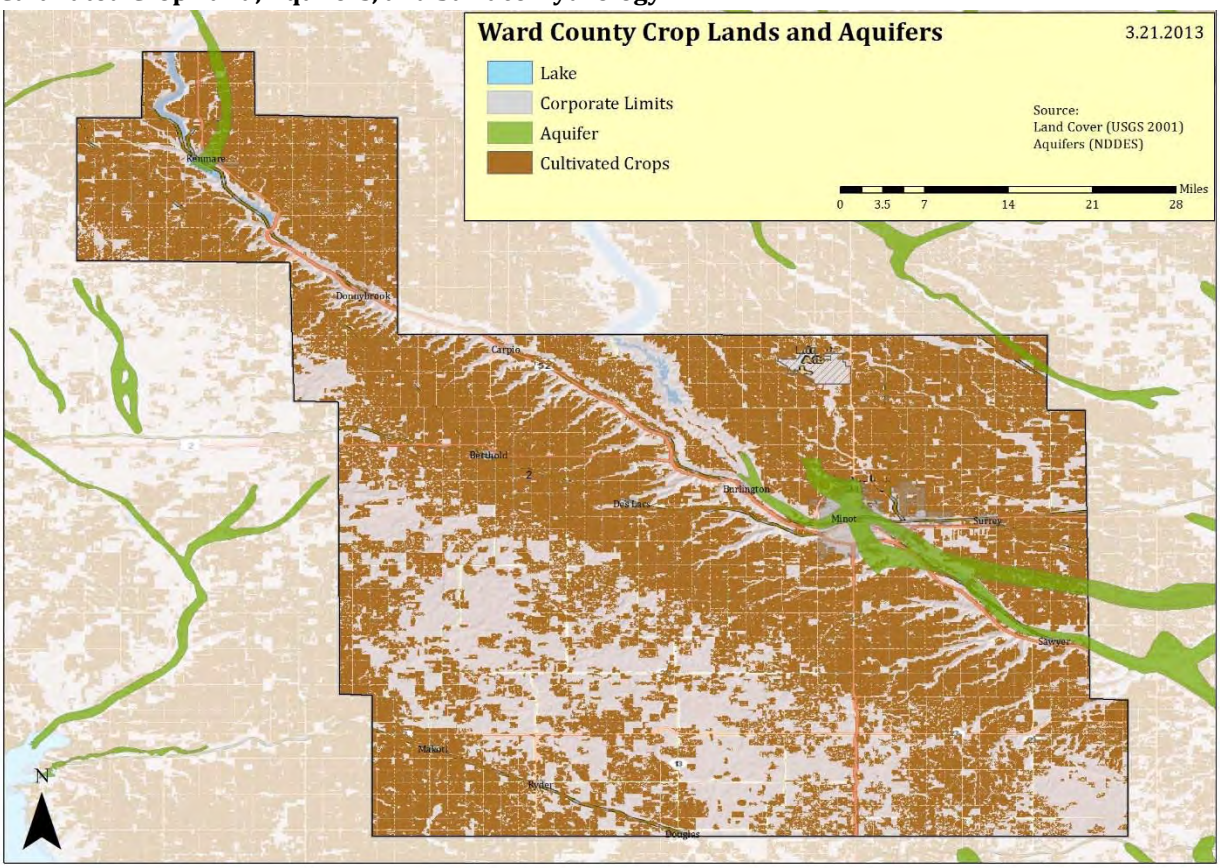
Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought is one of the most complex of all natural hazards, as it is difficult to determine a precise beginning or end. In addition, drought can lead to or be exacerbated by other hazards, such as extreme heat or wildfires.

Droughts are a slow-onset hazard. Over time, however, they can result in damage to agriculture, municipal water supplied, recreation and wildlife. Prolonged droughts can produce significant economic impacts, both directly and indirectly.

Location of the Hazard

Drought is a hazard that is not restricted to particular areas or types of environments. All areas within Ward County are subject to the drought hazard. Figure 16.2.2.2-1(below) shows the relationship in Ward County between cultivated crop lands, aquifers, and surface hydrology.

Figure 16.2.2.2-1
Cultivated Crop Land, Aquifers, and Surface Hydrology



Extent and Severity of the Hazard

Droughts are classified as meteorological, hydrologic, agricultural and socioeconomic. The following bullets illustrate how the classifications of drought are defined:

- **Meteorological drought** is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural drought** occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.
- **Socio-economic drought** occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are measured using the Palmer Drought Severity Index (PDSI), also known as the Palmer Index. The Palmer Index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index.

The Palmer Index is most effective in determining long term drought—a matter of several months—and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The Palmer Index is also useful for reflecting excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, +2 is moderate rainfall, etc.

The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water locked up in snow, so it works best east of the Continental Divide. Despite these shortcomings, it remains a useful tool for easily explaining the severity of a drought.

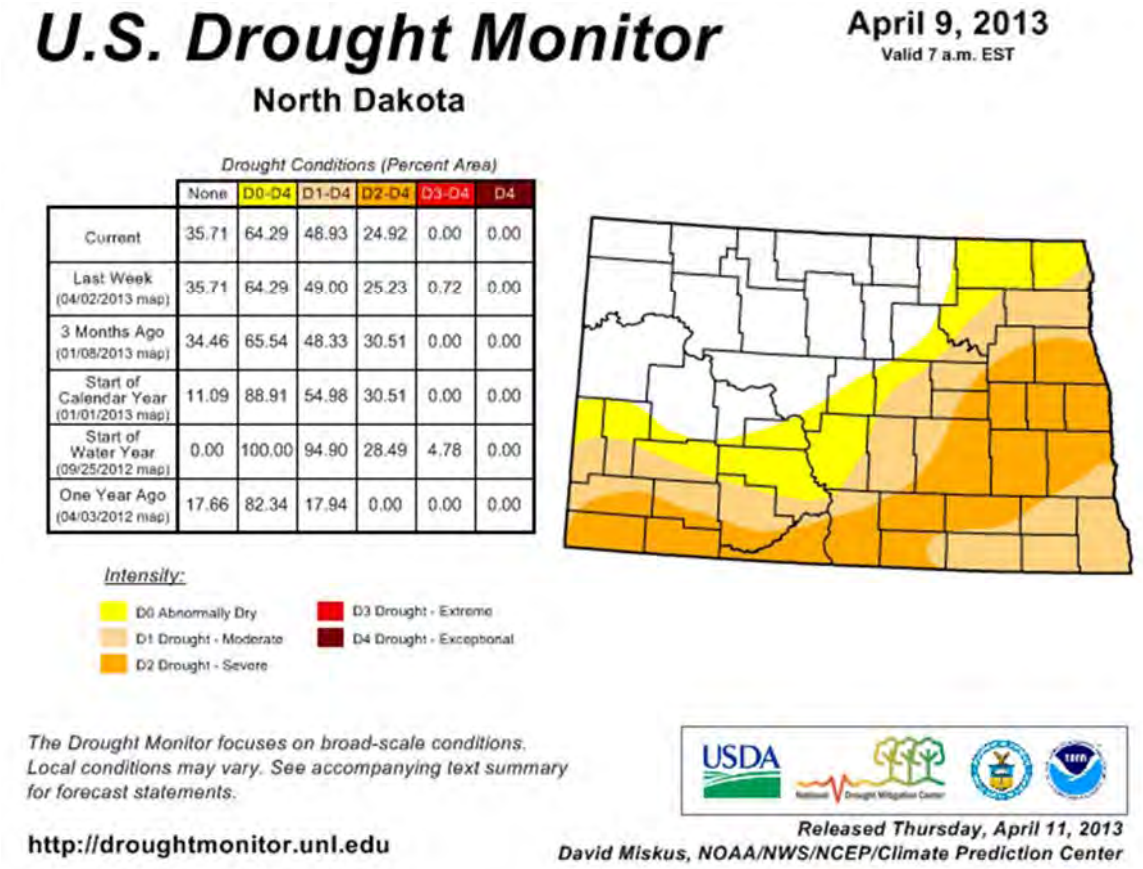
Table 16.2.2.2-1 (following) provides the PDSI classifications.

Table 16.2.2.2-1
Palmer Drought Severity Index
(Source: http://drought.unl.edu/whatis/indices.htm)

Classification	Description	Range of Possible Impacts
4.00 or more	Extremely wet	
3.00 to 3.99	Very wet	
2.00 to 2.99	Moderately wet	
1.00 to 1.99	Slightly wet	
0.50 to 0.99	Incipient wet spell	
0.49 to -0.49	Near normal	
-0.50 to -0.99	Incipient dry spell	
-1.00 to -1.99	Mild drought	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
-2.00 to -2.99	Moderate drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested
-3.00 to -3.99	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed
-4.00 to -4.99	Extreme drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions
-5.0 or less	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies

Drought is monitored nation-wide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the country. Indicators correspond to the intensity of the drought. Portions of North Dakota are currently classified as abnormally dry, in moderate drought, or in severe drought; however, Ward County is not included in any of these classifications, and is not considered to be experiencing drought conditions at this time. This current status is demonstrated by Figure 16.2.2.2-1 (following).

Figure 16.2.2.2-1
US Drought Monitor – North Dakota
(source: http://droughtmonitor.unl.edu/DM_state.htm?ND,HP)



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.71	64.29	48.93	24.92	0.00	0.00
Last Week (04/02/2013 map)	35.71	64.29	49.00	25.23	0.72	0.00
3 Months Ago (01/08/2013 map)	34.46	65.54	48.33	30.51	0.00	0.00
Start of Calendar Year (01/01/2013 map)	11.09	88.91	54.98	30.51	0.00	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	94.90	28.49	4.78	0.00
One Year Ago (04/03/2012 map)	17.66	82.34	17.94	0.00	0.00	0.00

Potential Impact of the Hazard
As illustrated by Figure 16.2.2.2-1 (above), droughts can affect a large geographic area, and can range in size from a few counties to a few states. Their potential to impact wildlife and agricultural concerns can be enormous. Droughts can kill crops, edible plants and wildlife habitat, and destroy grazing lands and trees. Dead or dying vegetation, a normal result of drought, can then serve as a prime ignition source for wildfires or grass fires.

The impacts of drought directly impact both economic and social stability in the affected area. Impacts do not generally include direct structural damages, but rather focus on the impacts to living things.

Perhaps the best known example of the impacts on life and property from drought is the Dust Bowl. The phenomenon was caused by severe drought coupled with decades of poor farming and land management practices. Deep plowing of the virgin topsoil of the Great Plains killed the natural grasses that normally kept the soil in place and trapped moisture even during periods of drought

and high winds. This led to widespread crop failure throughout the Great Plains, including throughout North Dakota.

During the Dust Bowl period, impressive drought-related research was carried out by the USDA, State Agricultural Experiment Station Systems, and agricultural colleges and universities. Notable accomplishments were technologies for soil erosion control, soil moisture conservation, higher yielding grain varieties, improved fertilizers, and better farm management.

When drought struck again in the early 1950's, the impact was much less severe. The widespread financial distress, interstate migration, and regional disruption characteristic of the Dust Bowl era were largely absent. Although comparable in meteorological severity (even if not spatially uniform) the impact was moderated by the trends in adjustment, as well as by improved farm prices and a healthy economy. Again, attention was directed to drought adjustment and research. Strong emphasis was placed on water conservation and augmentation, weather modification research, weather prediction and control, groundwater recharge, irrigation and river basin development, increasing runoff, evaporation control, desalination, phreatophyte control, and irrigation canal lining.

The worst drought since the Dust Bowl years affected at least 35 states – including North Dakota - during the summer of 1988 and into 1989. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50-85% below normal. Crops and livestock died and some areas became desert. To make matters worse, this event was accompanied by heat waves, which were estimated to kill 4,800-17,000 people, nationwide.

North Dakotans – including those in Ward County – are familiar with the impacts of drought. Given the areas dependence on agriculture, a significant drought in the modern era could have equally devastating consequences. Widespread crop failure, livestock death, inadequate drinking water, illness or diseases from inadequate sanitation – all of these are potential impacts from a widespread or prolonged drought.

A number of secondary hazards are often associated with drought. Rural grassland fires increase because of dry vegetation. Reduction in vegetation cover will expose the soil to wind, and dust storms and soil erosion will occur. Because of reduction in flow, the chemical quality of river and lake water will change, and the sediment transport regimes of streams will be altered.

Deterioration in water quality, in turn, results in injury and death to plants and animals. Stagnant pools along river courses will provide favorable habitats for insects, particularly mosquitoes and grasshoppers. Finally, with the return of the rains, the dry and unstable topsoil is vulnerable to gullying and flooding.

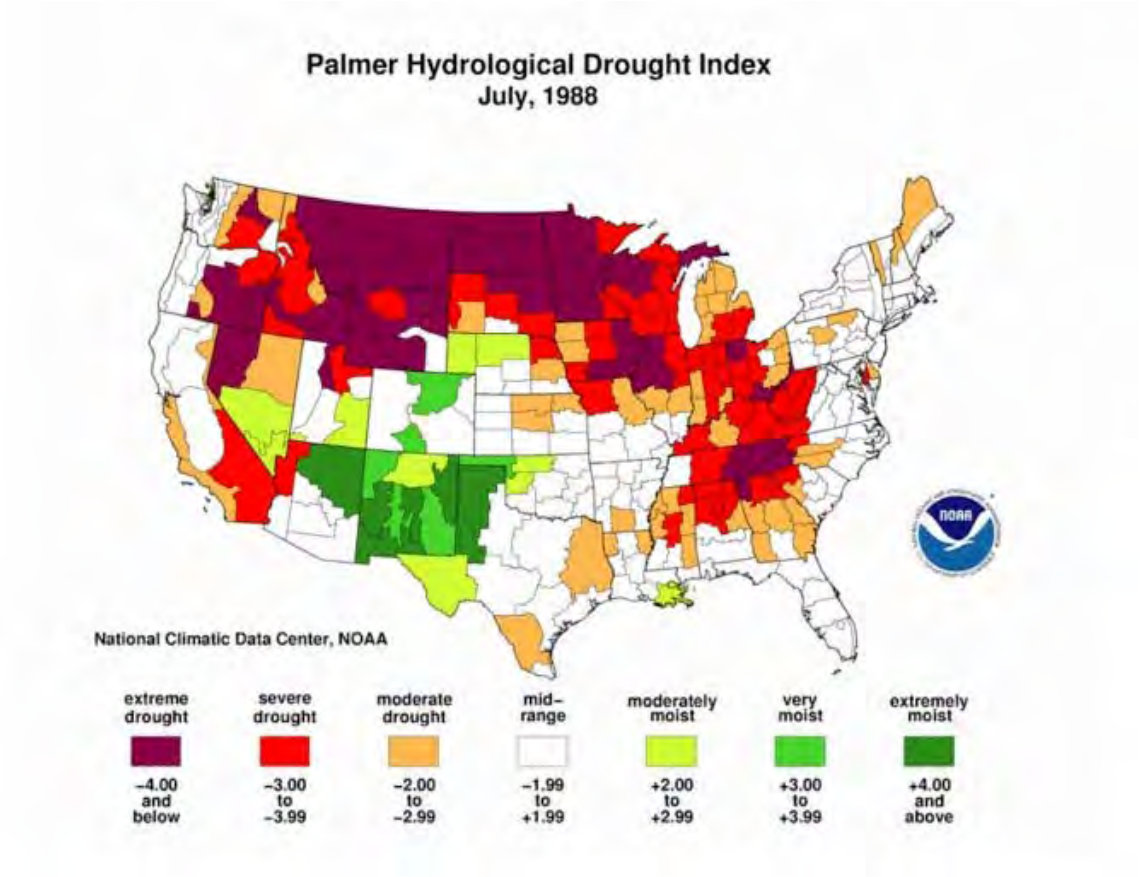
Past Occurrences of the Hazard

Information obtained from the State Hazard Mitigation Plan (SHMP) indicates that Ward County has a documented history of drought. For the purposes of this Plan, the assumption is made that all jurisdictions within Ward County would have experienced the hazard, including unincorporated county. According to the SHMP, 58-75 impacts from drought were recorded for Ward County for the period of July 1990 through June 2010. Most of these impacts were collected from newspaper articles.

The following are some notable occurrences of drought in the vicinity of the planning area. This list is not exhaustive, and includes only those occurrences that were notable.

- 1930s: The decade began with dry years in 1930 and 1931. By 1934, extremely dry conditions were recorded over 80% of the US, including most of North Dakota. By the end of the decade, the Great Plains were in extreme drought conditions. As rain continued to elude the area, crops and livestock failed. Exposed topsoil blew away in heat-driven winds, creating dust storms. According to the State Historical Society, thousands of North Dakotans lost their farms, and moved either to cities or towns, while others left the state altogether. One historian cited by the Society estimates that 70% of the state's population required one form of public assistance or another, but also notes that most North Dakotans held on, husbanding their resources wherever they could.
- 1950s: This drought, lasting most of the decade, was one of the most severe to impact the Great Plains. A pattern of low precipitation began in 1952 and continued until 1957. According to the USGS, this drought was intensified by the diversion of moisture-laden air masses away from drought-stricken areas by the formation of stronger-than-normal high pressure cells. Ground water throughout the Great Plains declined; in some areas, this decline was measured in tens of feet. Compared to other Great Plains states, North Dakota fared reasonably well during this drought, though significant hardships did occur. The USGS estimated that in 1955, approximately 614,000 acres throughout the State were damaged by wind, resulting in significant erosion. During this period, precipitation ranged from 50% to 75% of normal throughout North Dakota.
- 1988-1992: According to a report published by the ND State Water Commission, the drought of 1988-1992 was the second most severe drought to occur in North Dakota since 1930. Streams throughout the state had record low flows, and groundwater levels were impacted. These impacts included Rice Lake, which was strongly impacted by the drought. As depicted in Figure 16.2.2.2-2 (following), the entire state – including Ward County– was categorized as being in extreme drought during this time.

Figure 16.2.2.2-2
Palmer Hydrological Drought Index – July 1988
(source: http://localtvwqad.files.wordpress.com/2012/07/july1988drought.jpg)



- 2006: The meteorological summer of June, July, and August 2006 turned out to be the 3rd warmest and 14th driest in state history. Then-Governor John Hoeven issued a statewide agricultural drought emergency declaration in response to drought conditions that continued to deteriorate in southwest and south central portions of North Dakota. Drought declarations were issued in Grant, Hettinger, McIntosh, Sioux and Emmons County. According to the U.S. Drought Monitor, Ward County was in the moderate to severe intensity for the 2006 drought. No deaths or injuries were reported.
- 2012: The 2012 growing season in North Dakota was the 8th warmest and 13th driest on record. By August of 2012, 87% of North Dakota was experiencing drought conditions. Twenty counties were classified as being in severe drought. Pasture and range conditions were declining across the state. This prompted Governor Jack Dalrymple to declare an agricultural emergency in North Dakota; Ward County and its municipalities were included in this declaration.

Probability of a Future Occurrence of the Hazard
Based on the available data, drought occurs in the planning area less than once per year. Using the scale provided earlier in this section, this equates to a moderate probability of a future occurrence, as the hazard occurs at least one time every 5 years.

16.2.2.3 Fire

This profile includes both structure fire and wildfire.

Description of the Hazard

Fire is the rapid oxidation of a material in the chemical process of combustion, releasing heat, light, and various reaction products. Slower oxidative processes like rusting or digestion are not included by this definition. The flame is the visible portion of the fire and consists of glowing hot gases. If hot enough, the gases may become ionized to produce plasma. Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity might vary.

Fire in its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems across the globe. The positive effects of fire include stimulating growth and maintaining various ecological systems. Fire has been used by humans for cooking, generating heat, signaling, and propulsion purposes. The negative effects of fire include decreased water purity, increased soil erosion, an increase in atmospheric pollutants and an increased hazard to human life.

Wildfires, also known as a wild land fire, are any fire that occurs on grassland, forest or prairie, regardless of ignition source, damages or benefits. Wildfires are usually a naturally-occurring phenomenon, though they can be caused by human action – namely arson. A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks. Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.

Structures fires are considered a man-made hazard, in that their origins often arise from human activity and be fueled by dense development. (For the purposes of this hazard profile, structures fires are assumed to be accidental and their consequences unintended.)

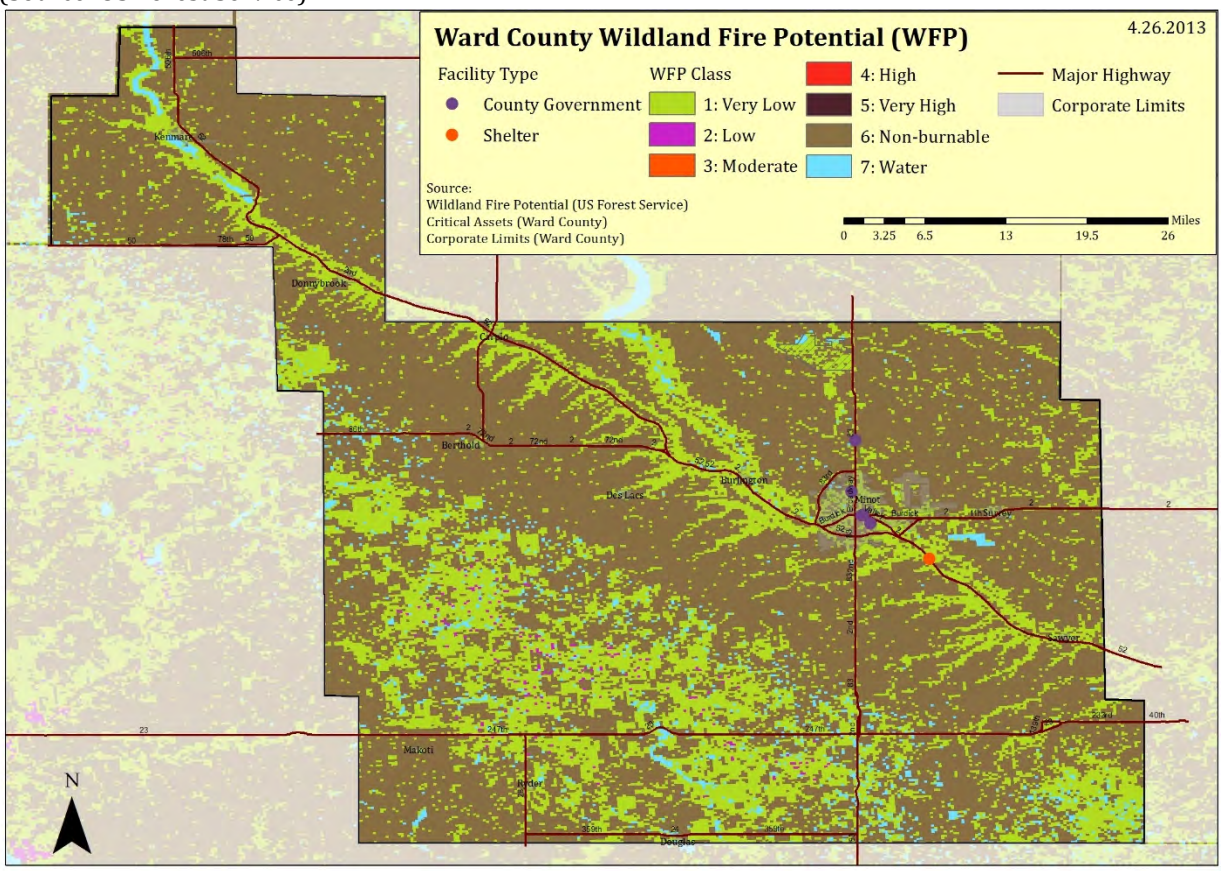
Location of the Hazard

While fire is a hazard that can occur anywhere, some areas are more prone to fire than others. Structure fires can and do occur anywhere that a structure exists. Wildfires can occur anywhere that burnable vegetation exists.

The US Forest Service has a new product available, called the Wildland Fire Potential assessment. This product provides an overview assessment of the areas within a defined area that have the potential to experience wildland fire. Figure 16.2.2.3-1 (following) illustrates the wildland fire potential for Ward County, as defined by the US Forest Service.

Note that the areas designated as “non-burnable” in the figure below are predominantly either developed or agricultural land, and that they are subject to other types of fire. By definition of the US Forest Service, however, they are outside of the wildland fire potential area.

Figure 16.2.2.3-1
Ward County – Wildland Fire Potential Areas
(Source: US Forest Service)



Extent and Severity of the Hazard
The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather. NFDRS output give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information.

Table 16.2.2.3-1 (following) depicts the NFDRS, from the US Forest Service's Wildland Fire Assessment System.

Table 16.2.2.3-1
Fire Danger Rating System
(Source: US Forest Service)

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) COLOR CODE: **Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Wildfire is a hazard with a somewhat unpredictable nature. While it is at least somewhat possible to determine the areas that may be subject to experiencing wildfire, it is not possible to determine in advance how or where a wildfire will begin. Only the conditions for a wildfire can be predicted with any accuracy.

Structure fires are often described in terms of the number of "alarms" required to suppress it. The number of alarms indicates the level of response from the fire department required to extinguish the fire. The level of response is typically measured in terms of the number of firefighters and equipment called to a scene.

Potential Impact of the Hazard
Though often a naturally occurring phenomenon, wildfires can devastate wooded or grassland areas by burning the natural resources of the area and disrupting habitat. In addition to the

destruction of valuable forestland and the impacts on the economy through the loss of this important natural resource, wildfires seriously threaten countless rural structures and equipment on a daily basis. Millions of dollars' worth of property and crops can be severely threatened by wildfire, but damage can be minimized by timely and effective wildfire suppression.

Structure fires have the potential for similar impacts in more developed areas, where there are more structures and more people in closer proximity. If not suppressed in time, fires can spread from one structure to another, endangering a large number of people.

The increasing cost of natural gas and fuel oil has caused families to utilize alternate heating methods during colder months. As a result, the use of space heaters, fireplaces, and wood burning stoves has increased the structure fire hazard. Portable LP (propane) gas or kerosene heaters with self-contained fuel supplies can be hazardous appliances, even when used according to the manufacturer's instructions, as their open flame design is a potential fire hazard. Fuel leaks can result in explosions, and vapors are a source of indoor air pollution, which is unhealthy for residents of the structure. Wood burning stoves can also be a point of ignition, if the stove or chimney is incorrectly installed or maintained.

Past Occurrences of the Hazard
Based on data obtained from the National Reporting System, Ward County has experienced 31 structure fires from January 2008 and December 2012, an average of 6.2 structure fires per year. For this same time period, 120 wildland fires were responded to, an average of 24 per year.

Probability of a Future Occurrence of the Hazard
Based on the available data, fire occurs in Ward County at least once per year. Using the scale provided earlier in this section, this equates to a high probability of a future occurrence.

16.2.2.4 Flood

Description of the Hazard
Floods are naturally occurring events. Excess water from snowmelt, rainfall, or dam release (controlled or uncontrolled) accumulates and either overflows onto banks or backs up into adjacent floodplains.

The National Flood Insurance Program (NFIP) defines flood in the following way:

> *A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow.*

This hazard profile considers flooding from all relevant sources. The Steering Committee determined that all sources of flooding should be treated in the same profile, as the effect on the area was generally the same, regardless of the source of origin of the flood. Flooding sources considered include:

- Snowmelt;
- Dam failure; and
- Excessive rain events.

Regional Hydrology Discussion
In order to understand the flood hazard, it is important to understand the larger hydrology of the region.

Much of North Dakota's terrain was shaped by glacial activity. The path of the Missouri River parallels the approximate limit of continental glaciers. Glaciers scoured much of the northeastern two-thirds of the state and then buried it under glacial debris, leaving a band of rich, black soil behind. The southwestern third of the state was largely unaffected by glaciers and has a more rugged, bedrock-controlled topography.

Ward County straddles the transition between the glacial flattened terrain and the relatively rougher terrain of the Missouri escarpment. It is important to note that rivers north of the Missouri escarpment (the Souris, the Des Lacs, and the Sheyenne) flow northward to Canada via the Nelson River to Hudson Bay. The Missouri River drains southward into the Mississippi River and eventually to the Gulf of Mexico.

The Souris (or Mouse) River originates in the Yellow Grasslands Marshes north of Weyburn, Saskatchewan, Canada and flows southeast, crossing into North Dakota, passing through Ward County and then looping back north into Canada to eventually flow into the Assiniboine River near Brandon, Manitoba.

The Des Lacs River flows south through Ward County to converge with the Souris River at a point six miles northwest of the City of Minot.

The Souris River originates in southeastern Saskatchewan and flows southeasterly to enter North Dakota near the northwestern corner of Renville County. From this point, it continues to flow in a southeasterly direction through the city of Minot in Ward County to Velva in McHenry County where its course changes to the northeast until it re-enters Canada west of the Turtle Mountains in north-central Bottineau County. The Souris River drains portions of Saskatchewan, Montana, North Dakota, and Manitoba. In North Dakota, the area drained by the Souris is 9,112 mi^2. Stream length in the state is 357 river miles.

In North Dakota above Minot, the Souris River Valley is comparatively straight with a fairly constant width of about one-half mile. Throughout this 64-mile reach of the river, valley walls rise

sharply 100 feet or more to broad, comparatively level benches. Between Minot and Verendrye, the valley displays the same general characteristics; however, it is wider in places and has benches which are somewhat lower and more broken. Below Verendrye, the north-side bench diminishes to low ridge and the lands toward Bantry and Upham tend to merge with the valley. The channel of the Souris River follows a meandering course, averaging slightly less than 100 feet wide and 15 to 25 feet deep, and meanders such that the total length of the channel is approximately twice the length of the valley through which it flows.

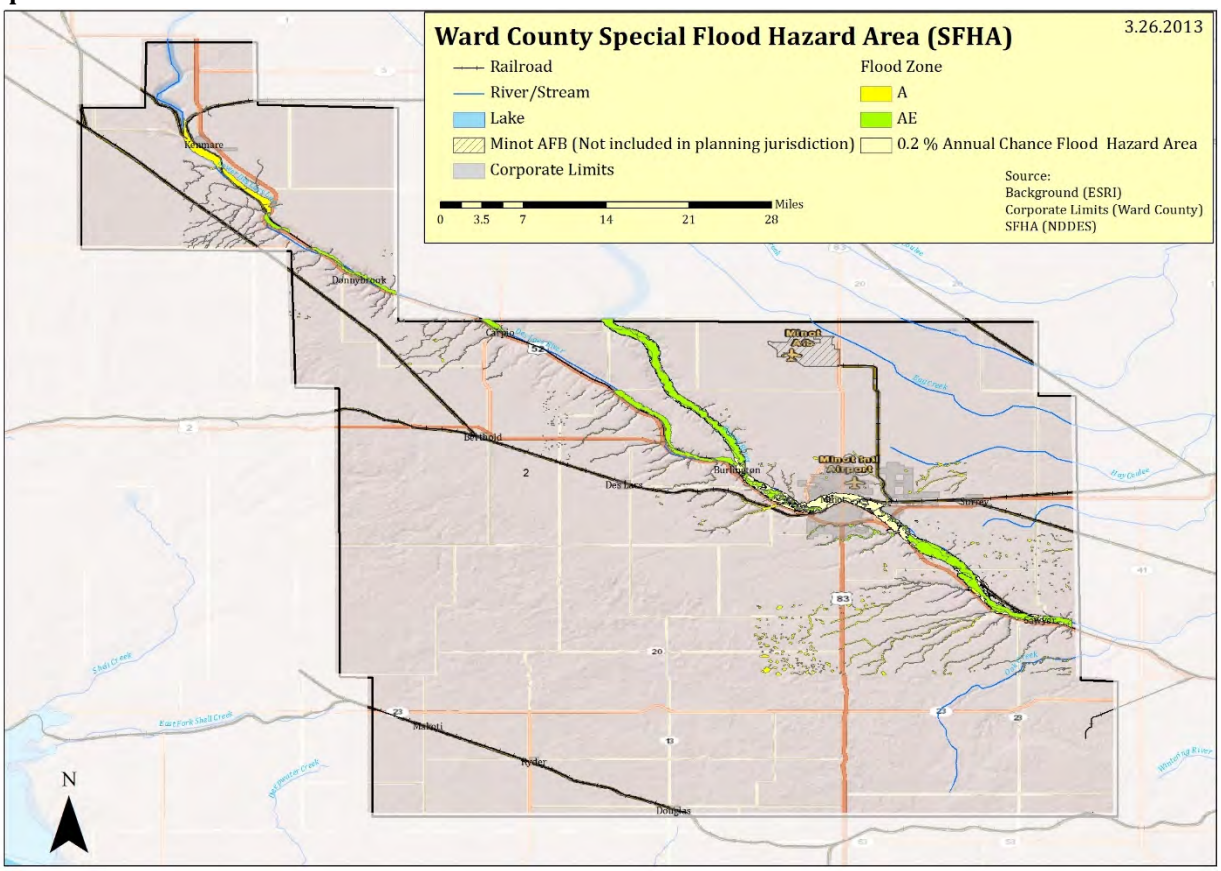
Principle tributaries above Minot are the Des Lacs River, which enters the Souris River approximately seven miles north of Minot near Burlington; Moose Creek, which receives runoff from the Moose Mountains in Canada; and Long Creek. Of these three streams, only the Des Lacs River, which rises just north of the US-Canada boundary, enters the Souris River in North Dakota.

Other important tributaries outside the Souris River "Loop" include the Wintering River, which flows through southern McHenry County, and Willow Creek, which arises in the Turtle Mountains and flows in a southwesterly direction to its confluence with the Souris River about eight miles east of Upham. The interior of the Souris River "Loop" is drained principally by a single stream system, the Deep River. Principal tributaries of the Deep River are Cut Bank Creek (north), Little Deep Creek, and Cut Bank Creek (south).

Location of the Hazard

Ward County has areas of one percent annual chance floodplain and areas of .02% annual chance floodplain. These areas are illustrated in Figure 16.2.2.4-1 (following).

Figure 16.2.2.4-1
Special Flood Hazard Areas



Extent and Severity of the Hazard

In support of the NFIP, FEMA identifies those areas that are more vulnerable to flooding by producing Flood Hazard Boundary Maps (FHBM), Flood Insurance Rate Maps (FIRM), and Flood Boundary and Floodway Maps (FBFM). Several areas of flood hazards are commonly identified on these maps. One of the areas identified in the Special Flood Hazard Area (SFHA), which is a high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (also known as the base flood). The flood zone designations are defined and described in Table 16.5.2.4-1 (below).

Table 16.2.2.4-1
Flood Zone Designations and Descriptions
(Source: FEMA and NFIP)

Zone Designation	Percent Annual Chance of Flood	Description
Zone V	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. Because hydraulic analyses have not been performed, no BFEs or flood depths are shown.

Zone Designation	Percent Annual Chance of Flood	Description
Zones VE and V1-30	1%	Areas along coasts subject to inundation by the 1% annual chance of flooding with additional hazards associated with storm-induced waves. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place on Zones V1-30.)
Zone A	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these areas.
Zone AE	1%	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Zone AH	1%	Areas with a 1% annual chance of flooding where shallow flooding (usually areas of ponding) can occur with average depths between one and three feet.
Zone AO	1%	Areas with a 1% annual chance of flooding, where shallow flooding average depths are between one and three feet.
Zone X (shaded)	0.2%	Represents areas between the limits of the 1% annual chance flooding and 0.2% chance flooding.
Zone X (unshaded)	Undetermined	Areas outside of the 1% annual chance floodplain and 0.2% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than one (1) foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than one (1) square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevation or depths are shown within this zone.

In addition, the National Weather Service (NWS) issues official watches and warnings, to alert those that may be at risk from potential flooding. Table 16.2.2.4-2 (below) defines the terms used by the NWS in these watches and warnings.

Table 16.2.2.4-2
Flood Watch/Warning Terminology
(Source: The National Weather Service)

Term	Definition
Flood Potential Outlook	In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send area rivers and streams into flood or aggravate an existing flood
Flood Watch	Issued to inform the public and cooperating agencies that current and developing hydrometeorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
Flood Warning	In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
Flood Statement	In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

Term	Definition
Flash Flood Watch	Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
Flash Flood Warning	Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
Flash Flood Guidance	Forecast guidance produced by the River Forecast Centers, often model output, specific to the potential for flash flooding (e.g., how much rainfall over a given area will be required to produce flash flooding).
Flash Flood Statement	In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

Ward County has a series of naturally occurring coulees that channel water towards the Souris and Des Lacs Rivers. Flows of water through these coulees have measured three feet or more during localized heavy rain (6-9 inches in 3 hours). This type of flooding has washed out roads, breached culverts and damaged bridges. Adding to these phenomena, as the water flows down through the coulees it picks up a great deal of debris and deposits it into the river, compounding the flood hazard.

Flood Control and the National Flood Insurance Program

North Dakota has long recognized that good floodplain management involves the utilization of a variety of tools to reduce the impact of flood disasters. It is also recognized that a balance must be reached between the four aspects of floodplain management which are: structural works designed to modify the flood itself, regulatory functions which may reduce susceptibility to flooding, emergency preparedness actions which may reduce susceptibility to flooding, and emergency preparedness actions which minimize a flood's effects during a flood event.

Flood control development had its beginning with the Flood Control Act of 1936. This act provided a basic plan and an authorized program for the control of water resources. In the early 1940's, the North Dakota State Water Commission cooperated with the federal agencies to plan and engineer the overall program for North Dakota.

The US Army Corps of Engineers occupies one of the major roles in flood control planning and construction. Two reservoirs built by the US Soil Conservation Service have contributed materially to flood control by the construction of watershed projects in North Dakota. These watershed projects include channel work and flood retention structures. In such projects, the Soil Conservation District has the responsibility for ensuring that 50% of the farms above a structure are under a basic conservation plan.

The Federal Disaster Protection Act of 1973 requires state and local governments to participate in the National Flood Insurance Program (NFIP) as a condition to the receipt of any federal loan or grant for construction projects in identified and mapped flood prone areas.

Participation in the NFIP requires communities to adopt floodplain regulations that meet NFIP objectives, which are: New buildings must be protected from flooding damages that occur as a result of the 1% annual chance flood, and new development must not cause an increase in flood damages to other property.

Communities have been provided assistance through passage, in 1981, of the state's first Floodplain Management Act which directed the State Engineer to aid local governments to reduce flood damages through sound floodplain management. As a start, the state legislature provided the State Engineer with an appropriation to be used in assisting communities to obtain base flood (1% annual chance flood) elevation data.

Ward County is a member of the NFIP, and its membership is in good standing. There are three designated Repetitive Loss or Severe Repetitive Loss properties within the county, as of February 2013.

Potential Impact of the Hazard
Any flood event could have significant impacts in the city. Moving water exerts hydrodynamic pressure on such structures, whereas still water exerts hydrostatic pressure. Both hydrostatic and hydrodynamic forces can cause serious damage, including complete destruction, of non-mitigated structures. Utility systems, such as HVAC systems, water and sewer lines, and electrical systems, can be compromised, damaged or destroyed by flood waters, even if not completely inundated.

In addition, flooding could impact transportation routes in and around the city, and could result in delays in receiving supplies and in decreased ingress and egress.

Past Occurrences of the Hazard
Both the Souris River and the Des Lacs River, a major tributary, overflow their banks to some extent almost annually. Most of these floods are small and short in duration causing only minor problems. Floods which result in more severe damages originate primarily from snowmelt in the Canadian portion of the Souris River Basin and have occurred seven times since 1969.

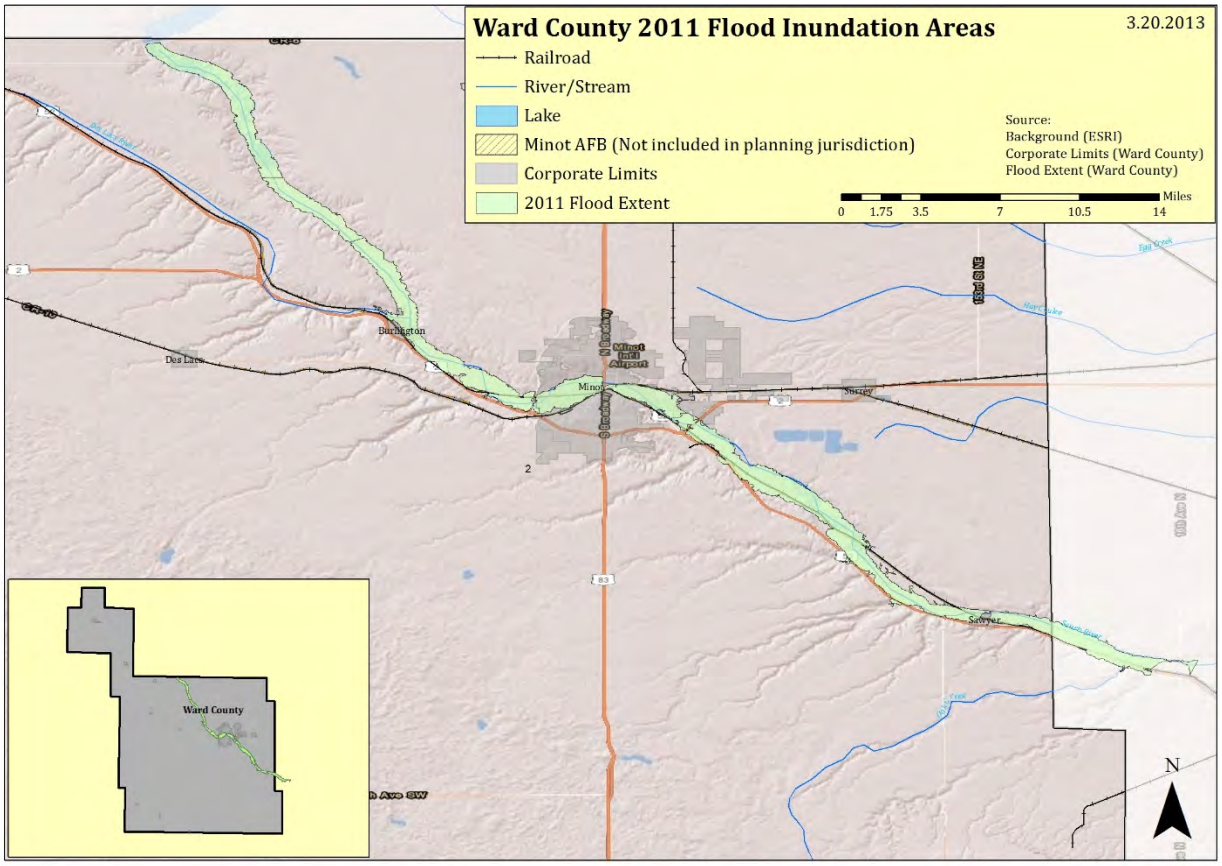
The one-half to one-mile wide valley along the river reach, between the upper Souris and J. Clark Salyer National Wildlife Refuge, usually sustains the basin's most significant flood losses.

Since 1936, Lake Darling Reservoir, owned and operated by the US Fish and Wildlife Service, has been a major factor in reducing damages in the Souris River Valley by controlling several small floods. The protection provided by the reservoir reduced concern about flooding and numerous residential and commercial developments were constructed at Minot in the river's floodplain. A major flood occurred in the Souris River Basin in 1969, which greatly impacted the region – including the city of Burlington.

More recently, in 2011, the basin was again inundated with severe flooding, resulting in hundreds of millions of dollars in damages throughout the valley. The stage was set for flooding in the summer of 2010, with above normal precipitation levels and saturated soil conditions. In the fall of 2010, the National Weather Service began issuing flood predictions for the following late winter/spring.

The first flood warning on the Souris (Mouse) River was issued on February 17, 2011, in response to high releases at Lake Darling, which were needed to create more storage space. In March 2011, forecasts were issued for significant runoff above the Canadian Rafferty and Alameda dams (in the Mouse River Basin). Eventually so much water entered these dams that they began an "inflows must match outflows" period, to prevent the reservoirs from overflowing. This led to extensive flooding along the Souris (Mouse) River, including in the city of Minot. By the time floodwaters in Minot receded in July 2011, the Souris (Mouse) River in Minot crested more than 3 feet above the previous record, 4,100 structures were inundated, and more than 12,000 people had been evacuated. Figure 16.2.2.4-2 (below) illustrates the areas of Ward County that were inundated in 2011.

Figure 16.2.2.4-2
2011 Flood – Areas of Inundation



As of April 2013, FEMA has approved almost $96 M in grant assistance to individuals and families affected by the flooding, and more than $246 M in assistance for repairs to public buildings and infrastructure. The vast majority of this assistance was obligated to Minot and Ward County.

In addition, Ward County has received more than $8 M in CDBG-DR funding as a result of the 2011 flooding. The majority of this funding has been used (or will be used) to fund the acquisition of flood prone property.

Ward County experiences minor flooding almost annually, as a result of spring thaw. The majority of this flooding is confined to unpopulated and undeveloped areas, and the flooding occurs in open space or agricultural areas.

Probability of a Future Occurrence of the Hazard
Based on the available data, minor flooding occurs annually in Ward County Therefore, using the scale provided earlier in this section, the probability of a future occurrence of flooding is high.

16.2.2.5 Severe Summer Storms
This hazard profile includes the following elements of severe summer storms: extreme heat, hail, lightning, tornadoes, and thunderstorms.

Description of the Hazard
Severe summer storms occur throughout the country, and can be seriously damages in areas where they occur. Severe summer storms can encompass a variety of hazards, including:

Extreme Heat
Extreme heat is defined as summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations.

Hail
Hail is defined as falling ice, roughly round in shape and at least 0.2' in diameter. Hail develops in the upper atmosphere as ice crystals that are bounced about by high velocity updraft winds; the ice crystals accumulate frozen droplets and fall after developing enough weight. The size of hailstones varies and is a direct consequence of the severity and size of the storm that produces them – the higher the temperatures at the Earth's surface, the greater the strength of the updrafts and the amount of time hailstones are suspended, the greater the size of the hailstone.

Lightning

Lightning is an atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000°F, hot enough to fuse silica sand into glass. There are some 16 M lightning storms in the world every year.

Lightning rapidly heats the air in its immediate vicinity to about 36,000°F - about three times the temperature of the surface of the sun. This compresses the surrounding air and creates a supersonic shock wave, which decays to an acoustic wave that is heard as thunder.

Some lightning strikes exhibit particular characteristics; scientists and the general public have given names to these various types of lightning. The lightning that is most-commonly observed is streak lightning. This is nothing more than the return stroke, the visible part of the lightning stroke. The majority of lightning occurs inside a cloud and is not observed during a thunderstorm.

Tornadoes
The most destructive of all atmospheric phenomena, tornadoes are violently rotating columns of air. These columns extend between and in contact with a cloud and the Earth's surface. The most violent tornadoes have rotational wind speeds of 250 MPH; in extreme cases, rotational wind speeds may approach 300 MPH. Tornadoes are often produced by severe thunderstorms.

Thunderstorms
Thunderstorms are caused by an atmospheric imbalance from warm unstable air rising rapidly into the atmosphere. Strong winds, rain, and hail can accompany large thunderstorm systems. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air channel of a lightning strike can reach temperatures higher than 50,000°F. The National Weather Service defines a severe thunderstorm as a thunderstorm that produces ¾ inch hail or larger in diameter and/or produces winds that equal or exceed 58 MPH

Thunderstorms are a unique threat because of their complex nature. Multiple hazards are present within a single system.

Location of the Hazard
Severe summer storms are a non-spatial hazard, and can occur anywhere in Ward County.

Extent and Severity of the Hazard
Severe summer storms have a wide range of extent and severity markers and characteristics.

Extreme Heat

The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat, as illustrated below:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.
- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI). The HI is sometimes referred to as the "apparent temperature". The HI, given in degrees F, is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart, found in Figure 16.2.2.5-1(following). As an example, if the air temperature is 96°F (found on the top of the table) and the RH is 65% (found on the left of the table), the HI - or how hot it really feels - is 121°F. This is the intersection of the 96°F column and the 65% row.

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

Note the shaded zone above 105°F on the Heat Index Chart. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 16.2.2.5-1
Heat Index Chart
(Source: The National Weather Service)

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Recent research has shown that a heat index threshold does not fully account for a variety of factors which impact health including the impact of consecutive stressful days on human health, the time of year, or the location where excessive heat events occur. For example, studies indicate large urban areas are particularly sensitive to heat early in the summer season. Based on this research, NOAA/NWS has supported the implementation of new Heat Health Watch/Warning System (HHWS) that its forecasters use as guidance in producing their daily warning and forecast products.

Hail

The National Oceanic and Atmospheric Administration (the parent agency for the NWS) and the Tornado and Storm Research Organization (TORRO) both created Hailstorm Intensity Scales. Table 16.2.2.5-1 (following) provides details of these scales.

Table 16.2.2.5-1
Combined NOAA/TORRO Hailstorm Intensity Scale
(Source: noaa.gov and torro.org)

Size Code	Intensity Category	Typical Hail Diameter	Approximate Size	Typical Damage Impacts
H0	Hard Hail	Up to 0.33"	Pea	No damage
H1	Potentially Damaging	0.33" – 0.60"	Marble or mothball	Slight damage to plants and crops
H2	Potentially Damaging	0.60" – 0.80"	Dime or grape	Significant damage to fruit, crops and vegetation
H3	Severe	0.80" – 1.20"	Nickel to quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20" – 1.60"	Half dollar to ping pong ball	Widespread glass damage, vehicle body damage
H5	Destructive	1.60" – 2.0"	Silver dollar to golf ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0" – 2.4"	Lime or egg	Aircraft body dented, brick walls pitted
H7	Very Destructive	2.4" – 3.0"	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0" – 3.5"	Baseball to orange	Severe damage to aircraft body
H9	Super Hailstorms	3.5" – 4.0"	Grapefruit	Extensive structural damage, risk of severe or fatal injuries to persons caught in the open

Lightning

The following are descriptions of various terms used to describe lightning, both scientific and common usage:

- **Cloud-to-Ground Lightning.** This is the best known and second most common type of lightning. Of all the different types of lightning, it poses the greatest threat to life and property since it strikes the ground. Cloud-to-ground lightning is a lightning discharge between a cumulonimbus cloud and the ground. It is initiated by a leader stroke moving down from the cloud.
- **Bead Lightning**. Bead lightning is a type of cloud-to-ground lightning which appears to break up into a string of short, bright sections, which last longer than the usual discharge channel. It is relatively rare. Several theories have been proposed to

explain it; one is that the observer sees portions of the lightning channel end on, and that these portions appear especially bright. Another is that, in bead lightning, the width of the lightning channel varies; as the lightning channel cools and fades, the wider sections cool more slowly and remain visible longer, appearing as a string of beads.

- **Ribbon Lightning.** Ribbon lightning occurs in thunderstorms with high cross winds and multiple return strokes. The wind will blow each successive return stroke slightly to one side of the previous return stroke, causing a ribbon effect.
- **Staccato Lightning**. Staccato lightning is a cloud to ground lightning strike which is a short-duration stroke that appears as a single very bright flash and often has considerable branching.
- Ground-to-Cloud Lightning**.** Ground-to-cloud lightning is a lightning discharge between the ground and a cumulonimbus cloud initiated by an upward-moving leader stroke. It is much rarer than cloud-to-ground lightning. This type of lightning forms when negatively charged ions called the stepped leader rises up from the ground and meets the positively charged ions in a cumulonimbus cloud. Then the strike goes back to the ground as the return stroke.
- **Cloud-to-Cloud Lightning.** Lightning discharges may occur between areas of cloud without contacting the ground. When it occurs between two separate clouds it is known as inter-cloud lightning and when it occurs between areas of differing electric potential within a single cloud, it is known as intra-cloud lightning. Intra-cloud lightning is the most frequently occurring type.
- **Heat Lightning.** Heat lightning is a common name for a lightning flash that appears to produce no thunder because it occurs too far away for the thunder to be heard. The sound waves dissipate before they reach the observer.
- **Dry Lightning***.* Dry lightning is a term used for lightning that occurs with no precipitation at the surface. This type of lightning is the most common natural cause of wildfires. Pyrocumulus clouds produce lightning for the same reason that it is produced by cumulonimbus clouds. When the higher levels of the atmosphere are cooler, and the surface is warmed to extreme temperatures due to a wildfire, volcano, etc., convection will occur, and the convection produces lightning. Therefore, fire can beget dry lightning through the development of more dry thunderstorms which cause more fires.

The National Weather Service (NWS) uses a Lightning Activity Level scale to indicate the frequency and character of cloud-to-ground (C/G) lightning, the most common form of lightning on Earth. The scale uses a range of 1 – 6, with 6 being the high end of the scale. Table 16.2.2.5-2 (following) provides this severity scale.

Table 16.2.2.5-2
Lightning Activity Level
(Source: http://www.crh.noaa.gov/gid/?n=fwfintro)

Lightning Activity Level Scale					
Rank	**Cloud and Storm Development**	**Areal Coverage**	**Counts C/G per 5 Minutes**	**Counts C/G per 15 Minutes**	**Average C/G per Minute**
1	No Thunderstorms	None	None	None	None
2	Cumulus clouds are common but only a few reach the towering stage. A single thunderstorm must be confirmed in the rating area. The clouds mostly produce virga but light rain will occasionally reach ground. Lightning is very infrequent.	<15%	1-5	1-8	<1
3	Cumulus clouds are common. Swelling and towering cumulus cover less than 2/10 of the sky. Thunderstorms are few, but 2 to 3 occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	15% to 24%	6-10	9-15	1-2
4	Swelling cumulus and towering cumulus cover 2-3/10 of the sky. Thunderstorms are scattered but more than three must occur within the observation area. Moderate rain is commonly produced, and lightning is frequent.	25% to 50%	11-15	16-25	2-3
5	Towering cumulus and thunderstorms are numerous. They cover more than 3/10 and occasionally obscure the sky. Rain is moderate to heavy, and lightning is frequent and intense.	>50%	>15	>25	>3
6	Dry lightning outbreak. (LAL of 3 or greater with majority of storms producing little or no rainfall.)	>15%	None	None	None

Tornadoes

Tornado wind forces are measured and described according to the Fujita Scale. The Fujita Scale is largely a residential structure damage scale, which tends to have much more standardized construction than commercial structures. The Fujita Scale is intended to

describe the expected damage to well-built residential structures. This makes its use often misleading, as poorly built structures can suffer significant structural damage under lesser winds than the Scale would suggest. The Storm Prediction Center, a NOAA office, states the following regarding the use of the Fujita Scale:

> Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place -- even from building to building. *Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown.*

In February 2007, use of the Fujita Scale was discontinued. In its place, the Enhanced Fujita Scale is used. The Enhanced Fujita Scale retains the same basic design as its predecessor, but reflects a more refined assessment of tornado damage surveys, standardization and damage consideration to a wider range of structure types. The new scale takes into account how most structures are designed, and is thought to be a much more accurate representation of the surface wind speeds in the most violent tornadoes. It is important to note the date a tornado occurred, as tornadoes which occurred prior to February 2007 are classified by the old scale and will not be converted to the Enhanced Fujita Scale. Table 16.2.2.5-3 (below) illustrates the Fujita Scale in use prior to February 2007.

Table 16.2.2.5-3
Fujita Tornado Scale (Pre-February 2007)
(Source: Storm Prediction Center)

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage
			F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

Table 16.2.2.5-4 (below) illustrates the Enhanced Fujita Scale, currently in use.

Table 16.2.2.5-4
Enhanced Fujita Tornado Scale (Post-February 2007)
(Source: Storm Prediction Center)

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Thunderstorms

Thunderstorms affect relatively small areas. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Despite their small size and relatively short duration, all thunderstorms are potentially dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe by the NWS. People most at risk from thunderstorms are those who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

All assets and people within Ward County are at risk from the effects of severe summer storms, and can expect to experience the complete range of the component hazards

Potential Impact of the Hazard

Extreme Heat

On average, more than 1,500 people in the US die each year from extreme heat. This number is greater than the 30-year mean annual number of deaths due to tornadoes, hurricanes, floods and lightning combined. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago, IL area were attributed to this event. And in August 2003, a record heat wave in Europe claimed an estimated 50,000 lives.

Heat-related disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When the body heats too quickly to cool itself safely, or when fluid or salt is lost through dehydration or sweating, the body's temperature rises and heat-related illness may develop.

Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in a 40-year-old and heat stroke in a person over 60.

Sunburn, with its ultraviolet radiation burns, can significantly impair the skin's ability to shed excess heat.

Hail

Hail typically impacts property by damaging structures, cars, and utilities as it falls. Dents in cars, broken glass, and holes in roofs are common impacts of hail. Injuries to people from hail are less common, though they can happen, as hail is a hard object falling in an unpredictable manner at a fairly high rate of speed.

Lightning

Lightning is the leading cause of weather-related personal injuries. Perhaps because lightning is a common weather phenomenon, most people do not take the associated risks of exposure to lightning as seriously as they should.

Lightning is a major cause of storm related deaths in the US, out pacing hurricanes and tornados in most years. A lightning strike can result in a cardiac arrest (heart stopping) at the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

On average, for every person actually struck by lightning, 10 additional people are affected by the strike. According to *Storm Data*, a National Weather Service publication, over the last 30 years the US has averaged 58 *reported* lightning fatalities per year. Due to under reporting, the figures are more realistically at least 70 deaths per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability.

Table 16.2.2.5-5 (below) illustrates statistics from the National Weather Service. Assuming a US population of 313 million (based on the 2010 Census estimate), the NWS has calculated the likelihood of the average person being struck or killed by lightning.

Table 16.2.2.5-5
Injury or Death from Lightning Probability Statistics
(Source: NWS - http://www.lightningsafety.noaa.gov/medical.htm)

Odds of Becoming a Victim of Lightning	
Characteristic	**Probability or Statistic**
Number of Deaths Reported	60
Estimated Number of Deaths	70
Number of Injuries Reported	340-400
Estimated Number of Injuries	540-600
Odds of Being Struck by Lightning in a Given Year (using reported numbers)	1 in 750,000
Odds of Being Struck by Lightning in a Given Year (using estimated numbers)	1 in 500,000
Odds of Being Struck by Lightning in Average Lifetime (80 years)	1 in 6,250
Odds of Being Affected by Someone Else Being Struck	1 in 625

While approximately one third of all injuries occur during work, workers compensation companies are often reluctant to acknowledge the injury or pay related medical expenses. An estimated third of injuries occur during recreational or sports activities. The last third occurs in diverse situation, including injuries to those inside buildings.

Those struck by lightning report a variety of affects, including:

- Personality changes, likely due to frontal lobe damage
- Fatigue
- Brain and nervous system damage
- Headaches
- Ringing in the ears
- Dizziness
- Nausea and vomiting
- Sleep difficulties
- Seizures
- Chronic pain

In addition to the impact lightning can have on people, lightning can have significant impact on property, including utility infrastructure, such as lift stations and electrical sub-stations. Lightning is the leading natural cause of wildfires, and can lead to structure fires as well. The historic structures and districts are particularly vulnerable, as they are primarily wood-frame construction and are closer together than modern residences.

The Lightning Protection institute, a non-profit organization dedicated to promoting lightning safety and protection, conducted a study that demonstrates that:

- 32% of lightning strikes hit roofs and projections such as satellite dishes or chimneys;
- 29 % of lightning strikes hit overhead power lines and phone lines;
- 29% of lightning strikes hit television antennas; and
- 10% of lightning-strikes hit trees near structures.

On average, lightning strikes cause 30% of the church fires and at least 18% of lumberyard fires in the United States annually. They also cause significant losses to more than 18,000 houses and 12,000 other buildings.

In addition to direct losses such as property damage to buildings, a lightning strike may result in the indirect losses that often accompany the destruction or damage of buildings and their contents. For example, municipalities rely upon the integrity of their structures as they provide services to their communities. A stroke of lightning to an unprotected building that houses the police or fire station may result in an interruption of vital services to the community. The consequences of such an interruption can range from the public's loss of confidence to a citizen's death when a department is unable to respond to an emergency call.

Tornadoes
Tornadoes have the potential to impact property, people, and operations throughout the city by disrupting the power supply (through downed power lines), transportation (by blocking roads with downed trees or other debris), and the habitability of buildings (by damaging roofs, windows, or other weak points in the envelope).

People caught in the open during a tornado are exposed to high winds and debris, and could be injured or killed.

Thunderstorms
Most impacts occur when trees or tree limbs are pushed over by the wind onto houses or vehicles. Vehicles are also sometimes pushed off roads during high wind events. The impact on life due to thunderstorm and associated hazards in Burlington would typically be minimal. Likewise, the impact to property would be minor unless exacerbated by falling trees and/or tree limbs due to wind or lightning.

Since thunderstorms and associated events often result in power failure, the operations of the city could be interrupted in the short-term. In terms of fallen tree limbs and other potential transportation hazards, thunderstorms may also cause disruption to community activities due to a lack of access.

Past Occurrences of the Hazard
Information obtained from the National Climatic Data Center (NCDC) indicates that there have been at least 155 occurrences of the summer storm hazard since 1957 – far too many too list here. These occurrences have included hail, tornado/funnel clouds, and thunderstorm winds, and have resulted in at least one fatality and two injuries. At least $1.7 M in property damage and $100,000 in crop damages have resulted from these incidents.

Probability of a Future Occurrence of the Hazard
In the 55 year period for which records are available, the summer storm hazard has occurred at least 155 times – at least three occurrences annually. Many of these occasions included multiple hazards occurring simultaneously. Therefore, based on the scale provided earlier in this section, the probability of a future occurrence is moderate, as the summer storm hazard occurs at least once every five years.

16.2.2.6 Severe Winter Storms
This hazard profile includes the following elements of severe winter storms: extreme cold, excessive snow or blizzard, and ice.

Description of the Hazard
Severe winter storms occur throughout the country, and can be seriously damages in areas where they occur. Severe winter storms can encompass a variety of hazards, including:

Blizzard/Excessive Snow
The National Weather Service defines snow as "precipitation is the form of ice crystals, mainly of intricately branched, hexagonal form and often agglomerated into snowflakes, formed directly from the freezing [disposition] of the water vapor in the air." Heavy snow accumulations, generally more than 8" of snow in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, transportation routes are slowed or closed completely, limiting or halting the transportation of goods, services, and people. These closures also disrupt emergency services. In addition, accumulations of snow on roofs can cause collapse, and can cause trees and power lines to fall. A quick thaw after a significant snowfall can lead to substantial flooding, particular in urban areas where there is more impermeable surface. Injuries and fatalities related to heavy snow are often associated with physical exertion (from shoveling) and from hypothermia.

Blizzards, as defined by the National Weather Service, are a combination of sustained winds or frequent gusts of 35 MPH or greater and visibilities of less than 1/4 mile from falling or blowing snow for three hours or more. A blizzard, by definition, does not indicate heavy amounts of snow, although they can happen together. The falling or blowing snow usually creates large drifts from the strong winds. The reduced visibilities make travel, even on foot, particularly treacherous. The strong winds may also support dangerous wind chills.

Blizzard conditions can also exist without a major storm system being in the area. Strong surface winds can blow already fallen snow, which is known as a "ground blizzard. Visibility can be reduced to near zero even though the sun is shining and the tops of power poles and trees are seen easily. These conditions are extremely variable in duration, from hours to even greater than a day. Ground blizzards are usually accompanied by very cold temperatures and wind chill conditions, making them as potentially deadly as a conventional blizzard.

Extreme Cold
What is considered an excessively cold temperature varies according to the normal climate for that region. Excessive or extreme cold can accompany severe winter weather, or it can occur without severe weather. The greatest danger from extreme cold is to people, as prolonged exposure can cause frostbite or hypothermia, and can become life-threatening.

Ice
The National Weather Service defines an ice storm as "occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater." The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms can be the most damaging of winter phenomena, and are often the cause of automobile accidents, utility failures, personal injury, and death. Moreover, they significantly impact the delivery of emergency services.

Location of the Hazard
Severe winter storms are a non-spatial hazard, and can – and do - occur anywhere in Ward County.

Extent and Severity of the Hazard
Severe winter storms have a wide range of extent and severity markers and characteristics.

Blizzard/Excessive Snow
Various intensities of snowfall are defined differently:

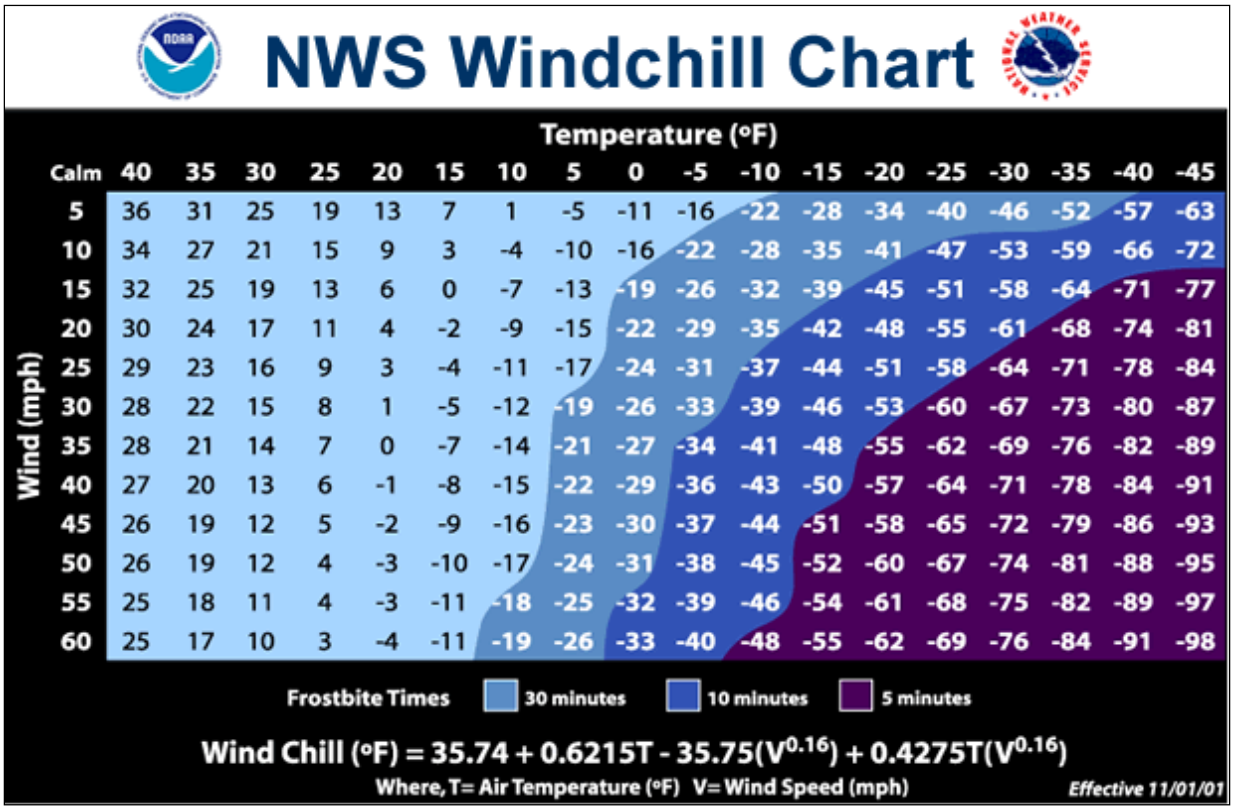
- **Blizzard** describes winds of 35 miles (56 kilometers) per hour or more with snow and blowing snow that reduce visibility to less than one-quarter mile (0.4 kilometer) for at least three hours.
- **Blowing snow** describes wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squall** describes a brief, intense snow shower accompanied by strong, gusty winds. Accumulation from snow squalls can be significant.
- **Snow shower** describes snow that falls at varying intensities for short durations with little or no accumulation.

Extreme Cold

Winter temperatures in Ward County typically range from the 20s and 30s (high) to single digits to 20s (lows.)

Figure 16.2.2.6-1 (below) depicts the National Weather Service's methodology for determining wind chill, using wind speed and actual temperature. Winter storm severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

Figure 16.2.2.6-1
Methodology for Determining Windchill
(Source: National Weather Service)



NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Ice

Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair damage. Even small accumulations of ice can be severely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Ice forms in different ways:

> **Sleet** is rain that freezes into ice pellets before it reaches the ground. Sleet usually bounces when hitting a surface and does not stick to objects; however, it can accumulate like snow and cause roads and walkways to become hazardous. **Freezing rain** is rain that falls onto a surface that has a temperature below freezing. The cold surface causes the rain to freeze so the surfaces—trees, utility wires, vehicles, and roads—become glazed with ice.

Potential Impact of the Hazard

Severe winter weather can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and by causing structural collapse in buildings not designed to withstand the weight of accumulated snow. Repair and snow removal costs can be significant, and can easily surpass an entity's annual salt and snow removal budget, often before the end of the winter weather season. Ice buildup can cause utilities to fail, and communication towers to cease functioning. Without electricity, heaters and pumps fail to work, causing water and sewer pipes to freeze or rupture. If extreme cold temperatures are combined with low snow cover, the ground's frost level can change, creating the possibility of failure in underground infrastructure.

Structure fires and carbon monoxide poisoning are also possible impacts of severe winter weather, as people rely on auxiliary heating devices, such as candles, portable heaters, and fuel burning lanterns. According to NOAA observations, 20% of all winter deaths attributed to exposure to cold occur in the home, whereas 25% of all winter deaths attributed to ice and snow involve people caught in the storm.

Rural residents can be hit particularly hard by severe winter storms, if they do not have adequate stockpiles of food, water, and heating fuel. The livestock industry can be severely impacted by severe winter weather as well. The inability to get feed and water to livestock can quickly escalate to a critical situation, and can lead to dehydration, a major cause of livestock causalities. Cattle cannot lick enough snow to satisfy their thirst, and will die of dehydration before they succumb to cold or suffocation.

In addition to the threat posed to humans, severe winter storms pose a significant threat to utility production, which in turn threatens facilities and operations that rely on utilities, specifically climate

stabilization. As temperature drop and stay low, increased demand for heating places a strain on the electrical grid, which can lead to temporary outages.

Past Occurrences of the Hazard

According to the ND State Hazard Mitigation Plan (SHMP), winter in North Dakota can begin as early as September and last into May, though the bulk of winter weather occurs from mid-November until early April. On average, there are approximately 10 winter storms each year; three or four of these storms will reach severe status. North Dakota typically leads the nation in blizzard and severe winter storm frequency.

There is a long history of severe winter storm events, going back to when North Dakota was a territory and not a state:

- 1886-1887: A severe winter storm in the western part of the state put an end to open range ranching.
- January 12, 1888: This storm, known as the "Schoolhouse Blizzard," swept through the entire territory in an afternoon. The day began relatively warm, around 32°F. Temperatures reportedly dropped to -20°F in a matter of minutes, accompanied by winds so strong that people were unable to stand upright. Schools throughout the state were closed, and children sent home. Many of those children, as well as adults, became disorientated in the storm, and lost their sense of direction, eventually succumbing to hypothermia. An estimated 400 people died throughout the state, and thousands of head of cattle perished. Transportation came to a standstill, and many buildings collapsed under the weight of the snow.
- March 1966: This severe storm was notable for its excessive duration. Bismarck (100 miles to the south) recorded near zero visibility for 42 consecutive hours. More than 100,000 head of livestock, and 15 people, died in the storm.
- January 09, 1997: Bitter cold wind chills ranged from 40-60 below in the south and east and 30-45 below in the northwest. Some schools closed for as many as nine days. A National Weather Service report indicated snow depths up to 30 inches in eastern and south central North Dakota. The state livestock industry sustained approximately $32.8 M in losses. FEMA had approximately $5 M in snow removal costs, National Guard exceeded $1.1 M and the North Dakota Department of Transportation spent approximately $3.7 M. All but one county in North Dakota, and 75 cities and 3 Indian Reservations issued emergency or disaster declarations. A total of 7 deaths across the state were reported along with many injuries due to traffic accidents.
- March 12, 1997: .Approximately $15 K in damages was reported in North Dakota. Snowfall amounts were up to 4 inches in Minot. Many of the smaller school districts cancelled school and I-94 was also closed. A car accident near Berthold sent 4 to the hospital. Roads were very icy and visibility near zero.

- April 4, 1997: This blizzard was the worst of the season and brought much of the state to a complete halt. Snow accumulations were on average 1.5 to 2 inches an hour with 50 to 60 mph winds as well. The additional snow at Bismarck brought the season snowfall total to 101.4 inches, which set an all-time record. An estimated 100,000 head of cattle (10% of the state's herd) was lost with an estimated dollar loss across the state of over $5 M. An estimated 75,000 homes in North Dakota were without power for some time over the weekend. The reported property damage was $44.7 M with 16 injuries and 2 deaths were reported statewide.

The National Climatic Data Center (NCDC) records winter storm hazards at the state level, rather than at the county or municipal level. NCDC has recorded hundreds of occurrences of winter storm hazards (with each hazard recorded as a separate entry).

Probability of a Future Occurrence of the Hazard
Based on the data available, winter storms occur in or otherwise impact Ward County at least annually. Therefore, using the scale previously provided, the probability of a future occurrence of the winter storm hazard is high.

16.2.2.7 Hazardous Materials Incident

This hazard profile includes all types of hazardous materials incidents – transportation routes, fixed sites, and pipelines.

Description of the Hazard
Hazardous materials incidents are technological (meaning non-natural hazards created or influenced by humans) events that involve large-scale accidental or intentional releases of chemical, biological, or radiological materials. These incidents may occur at fixed site locations, such as factories or storage facilities, or may occur while these materials are being transported to another location.

Hazardous materials come in the form of explosives, corrosive, reactive, flammable and combustible substances, toxic releases and waste materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in fixed facilities. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products containing hazardous chemicals are routinely used and stored in homes and offices. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

Location of the Hazard
The locations in Ward County most at risk from a hazardous materials incident are those that are in proximity to either locations that store/use hazardous materials or that are adjacent to transportation or transmission lines. The following figures (16.2.2.7-1 through 16.2.2.7-3) illustrate these locations in Ward County.

Figure 16.2.2.7-1
Hazardous Materials Locations – Fixed Sites

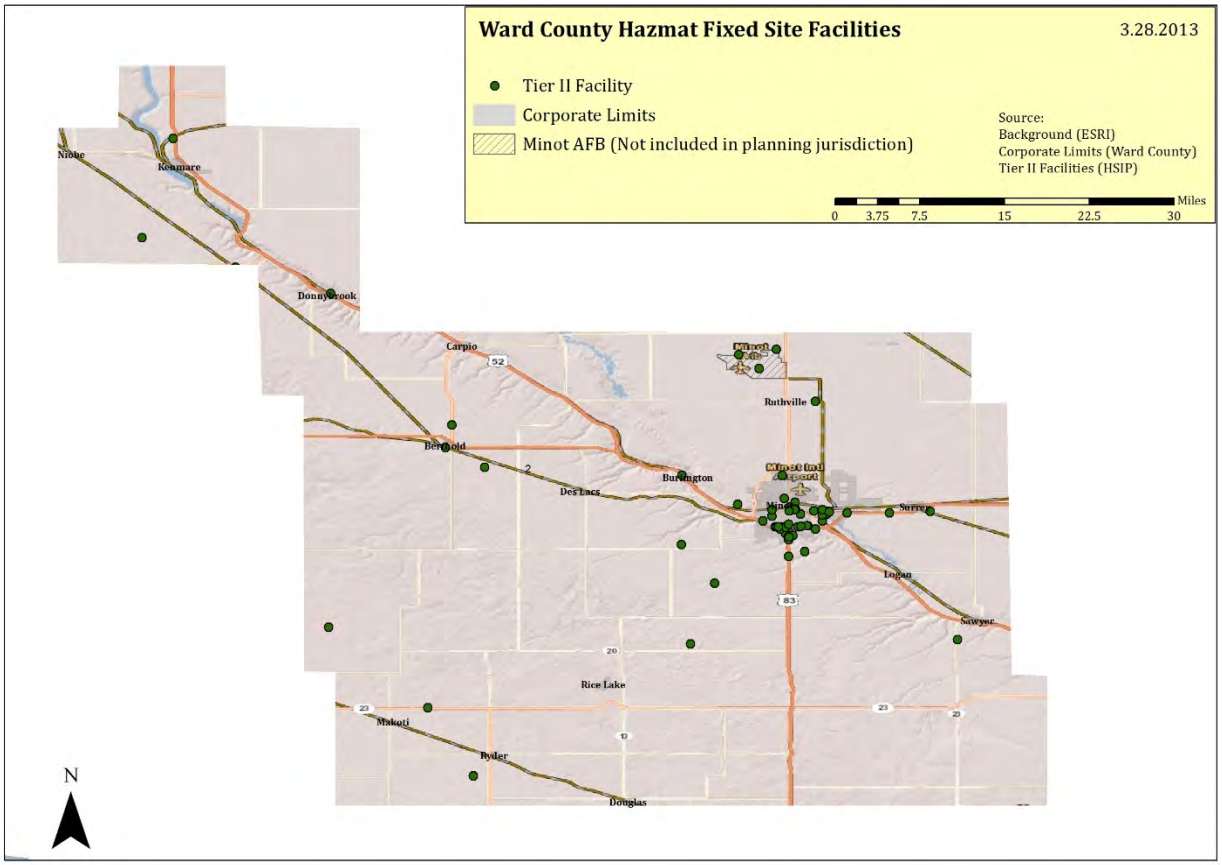


Figure 16.2.2.7-2
Hazardous Materials Locations – Railroads

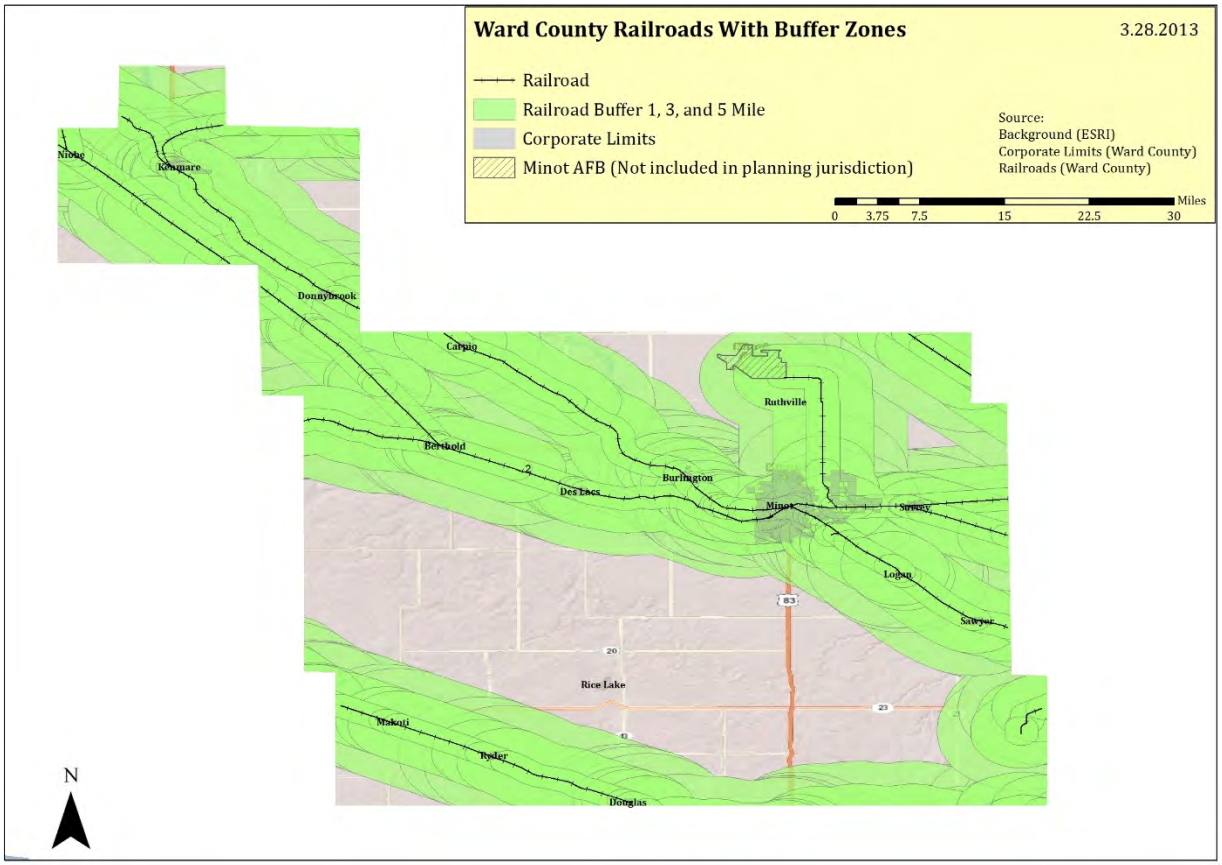
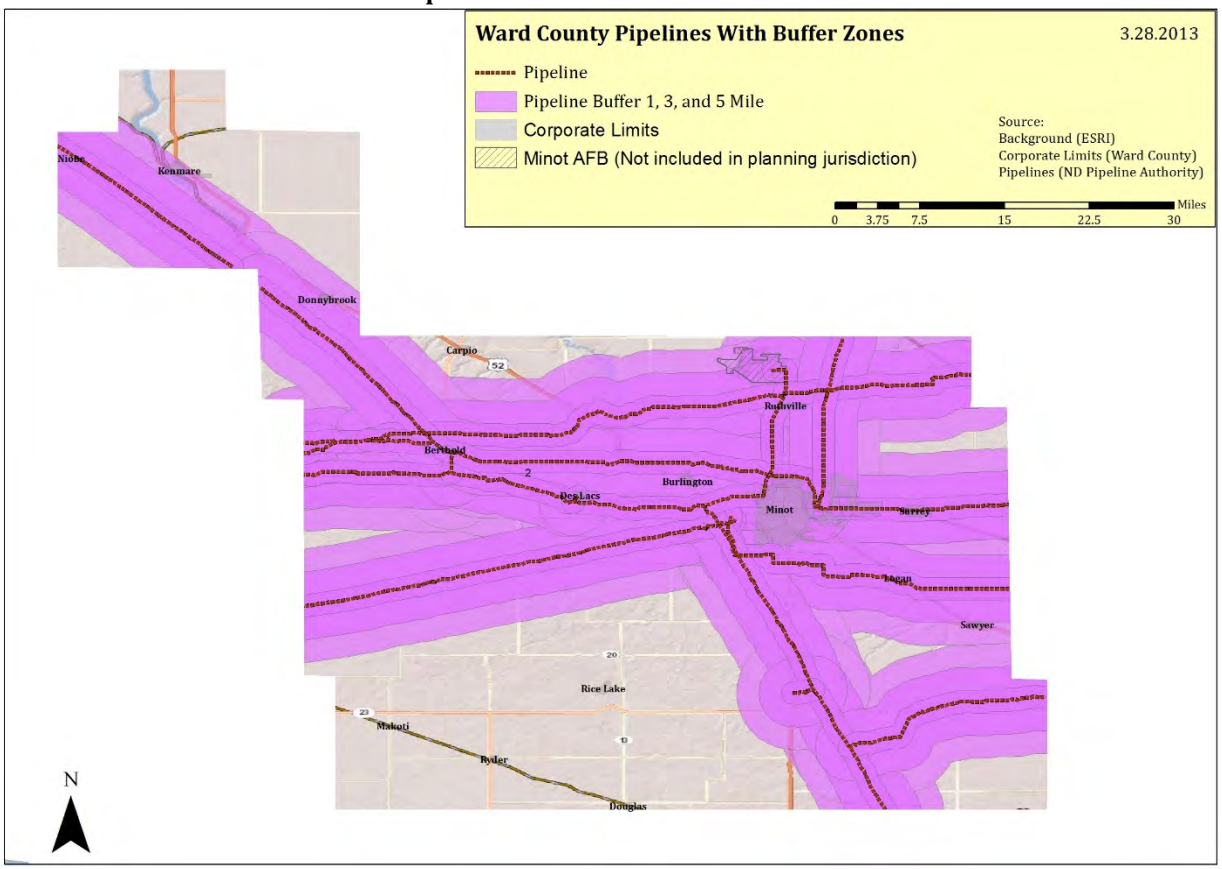


Figure 16.2.2.7-3
Hazardous Materials Locations – Pipelines



Extent and Severity of the Hazard
The severity of a hazardous materials release depends upon the type of material released, the amount of the release, and the proximity to populations or environmentally sensitive areas such as wetlands or waterways. The release of materials can lead to injuries or evacuation of nearby residents. Wind direction at the time of the release can also have a bearing on the severity (as well as the location and extent) of a hazardous materials releases.

Potential Impact of the Hazard
The primary threat from the hazardous materials incident hazard is to the structures located along transmission lines and transportation routes, or near facilities that use or store hazardous materials. Minor incidents would likely cause no damage and little disruption. Major incidents could have fatal and disastrous consequences. The severity of a hazardous material release relates primarily to its impact on human safety and welfare and on the threat to the environment.

Threats to Human Safety and Welfare:

- Poisoning of water or food sources and/or supply
- Presence of toxic fumes or explosive conditions

- Damage to personal property
- Need for the evacuation of people
- Interference with public or commercial transportation

Threats to the environment:

- Injury or loss of animals or plants or habitats that are of economic or ecological importance such as; commercial, recreation, or subsistence fisheries (marine plants, crustaceans, shellfish, aquaculture facilities) or livestock; seal haul outs; and marine bird rookeries
- Impact to ecological reserves, forests, parks, archaeological, and cultural sites

In terms of property, property and people could be either directly impacted by an explosion or fire resulting from a hazardous materials release, contamination of buildings and contents, or indirectly impacted by the release of materials that necessitates evacuation and long-term abandonment of facilities.

Past Occurrences of the Hazard
According to the EPA's Tier II database, there were more 4,211 releases of hazardous materials in Ward County in 2011 that resulted in a reportable incident. Data for 2010 was unavailable during the development of this update. In 2009, there were 18, 031 reported releases in Ward County. In 2008, there were 22,292 reported releases in Ward County.

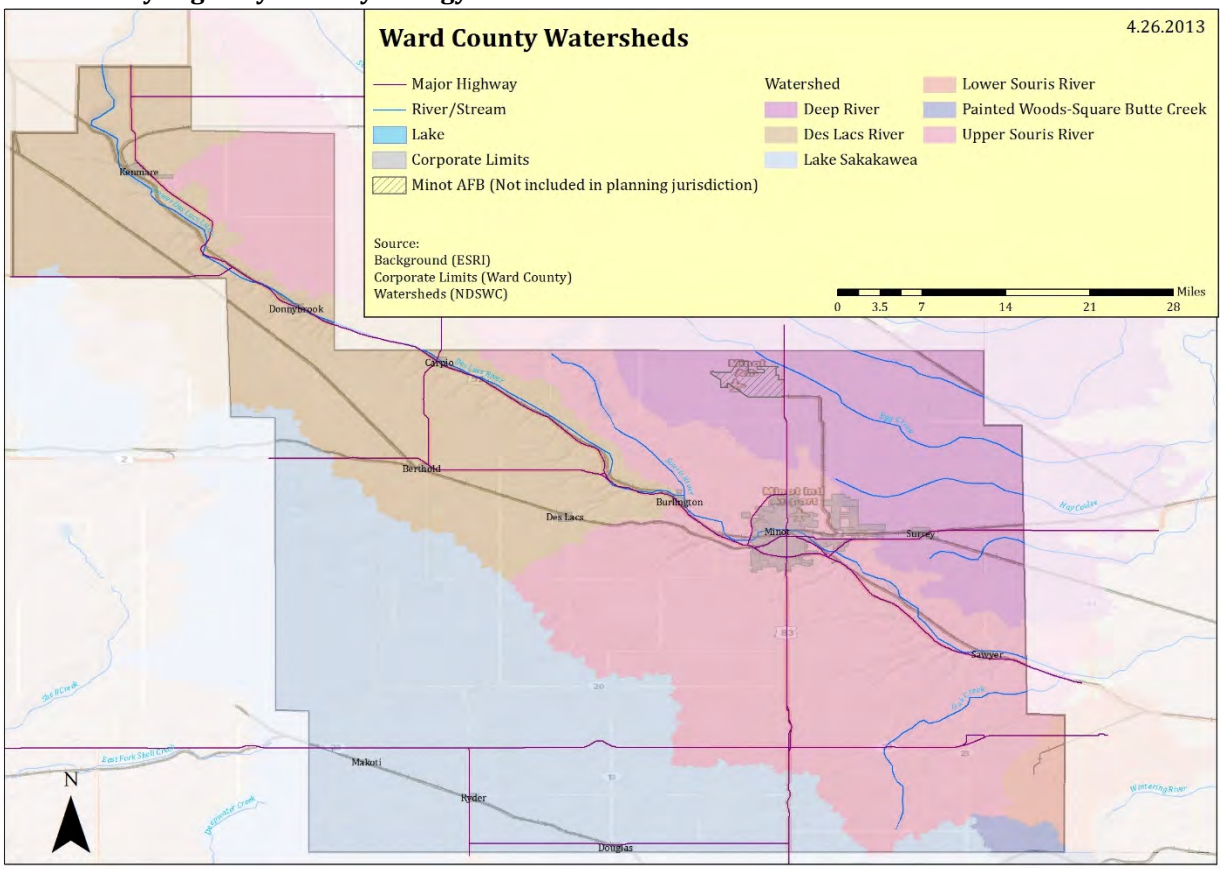
Probability of a Future Occurrence of the Hazard
Based on the data available, hazardous materials incidents occur with regularity in Ward County – multiple times per year. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is high.

16.2.2.8 Landslides

Description of the Hazard
Ward County experiences slumping of hillsides caused primarily by saturated soils underneath or adjacent to county roadways. The moisture in the soil increases the weight of the soil, resulting in weaker soil, as wet soil has less strength. These occurrences are typically found in hilly areas (where one side of the road is higher in elevation than the other) that are also in watersheds (such as coulee areas), and often follow the course of rivers.

Location of the Hazard
The locations in Ward County most at risk from the landslide hazard are those that contain highways, are in hilly areas, and that are along waterways. Figure 16.2.2.8-1 (following) illustrates the locations of major roadways in Ward County and the watersheds in Ward County, as well as the major surface hydrology in the county.

Figure 16.2.2.8-1
Ward County Highways and Hydrology



According to the Ward County Highway Department, there is no way to predict with absolute accuracy the areas or exact locations in which this hazard may occur. All areas that meet the conditions stated above (roadways in hilly areas that generally follow rivers or waterways) are considered to be potential locations for the hazard to occur.

Extent and Severity of the Hazard

There is no standard extent or severity scale or measurement for this hazard. It is specific to Ward County, and the severity is dependent on the particular roadway impacted, the amount of time that it will take to repair the damage, and the availability of funding to repair the damage.

Potential Impact of the Hazard

The landslide hazard creates significant roadway and transportation impacts for Ward County, as it causes the roadways to be impassable, resulting in traffic that must be re-routed, sometimes several miles. Figures 16.2.2.8-2 through 16.2.2.8-4 provide photographs of the potential impacts of this hazard.

Figure 16.2.2.8-2
Ward County Landslide Impacts

Note: date stamp that appears in photograph is inaccurate.

Figure 16.2.2.8-3
Ward County Landslide Impacts

Note: date stamp that appears in photograph is inaccurate.

Figure 16.2.2.8-4
Ward County Landslide Impacts

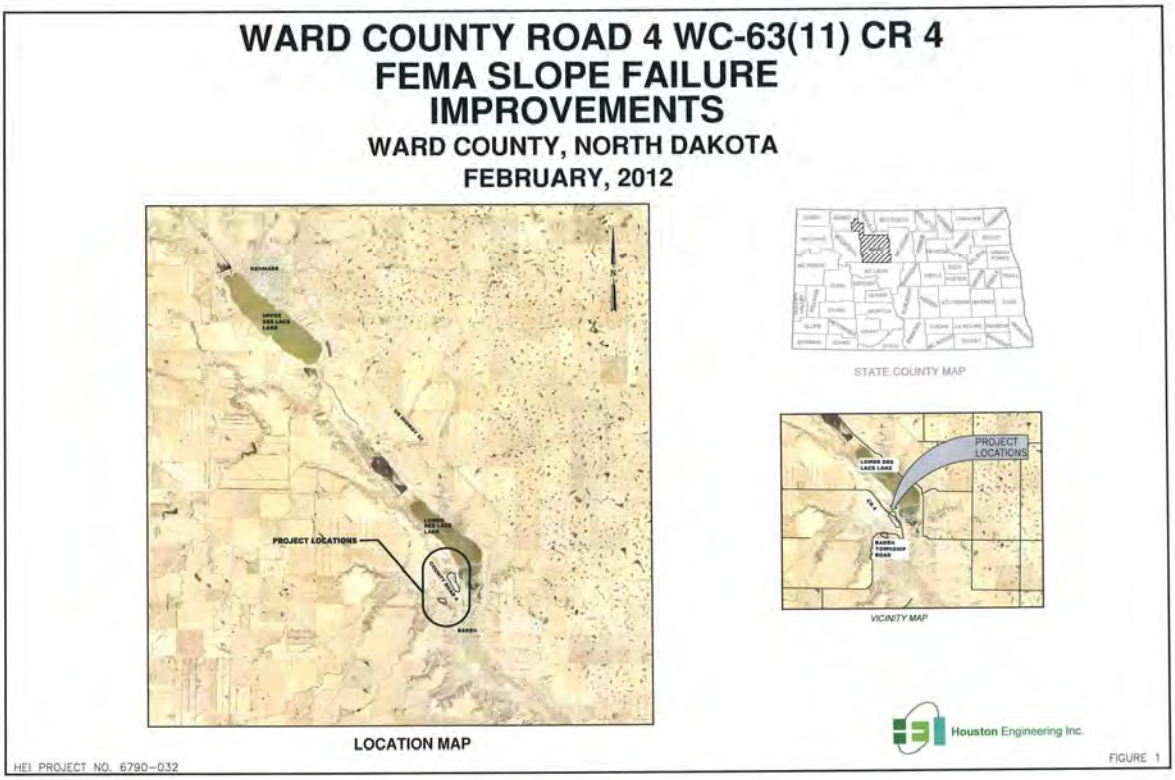
Note: date stamp that appears in photograph is inaccurate.

As seen in the preceding figures, the impacts of this hazard can range from moderate (cracks in the surface of the roadway) to severe (failure of the entire roadway).

Past Occurrences of the Hazard
This hazard occurs with regularity in Ward County, and is expected to continue as long as the region remains in a wet cycle. After the 2011 flooding in the Souris (Mouse) River Basin, the frequency of the hazard increased, as soil saturation increased.

In 2011, a significant slide occurred along Ward County Road 04, approximately five miles southeast of Kenmare. This failure caused the entire roadway to be impassable, and greatly impacted access to the area. Engineering analysis concluded that the unseasonably wet conditions in the area during 2011 greatly contributed to this failure. Figure 16.2.2.8-5 (following, and obtained from the Houston Engineering report) shows the location of this slide.

Figure 16.2.2.8-5
Ward County Landslide – County Road 04



This slide resulted in more than $2.6 M in repair costs, and caused serious disruptions in travel and access in the area.

Probability of a Future Occurrence of the Hazard
Based on the data available, landslides occur with regularity in Ward County, though not necessarily annually. Therefore, based on the scale provided at the beginning of this section, the probability of a future occurrence is moderate.

16.3 Risk Assessment (Updated)

The following table (Table 16.3-1) provides a summary of the risk assessment findings from the 2008 Ward County Hazard Mitigation Plan, as it relates to Ward County.

Table 16.3-1
Summary of 2008 Ward County Hazard Mitigation Plan Risk Assessment Data

Hazard Risk Ranking from 2008 Ward County Hazard Mitigation Plan		
Hazard	**Ranking**	**Disposition in the 2013 Plan Update**
Flood	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Winter Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Summer Storm	Frequency: Highly Likely Severity: Catastrophic	Included; qualitative and quantitative risk assessment (where applicable)
Hazardous Materials Incident	Frequency: Likely Severity: Critical	Included; qualitative and quantitative risk assessment (where applicable)
Urban Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Rural Fire	Frequency: Highly Likely Severity: Negligible	Included; qualitative and quantitative risk assessment (where applicable) Note: hazard is combination of structure and wildland fire
Drought	Frequency: Likely Severity: Catastrophic	Included; qualitative risk assessment
Civil Disorder/Terrorism	Frequency: Possible Severity: Critical	Excluded from profiling and risk assessment
Mass Casualty	Frequency: Possible Severity: Negligible	Excluded from profiling and risk assessment
Dam Failure	Frequency: Unlikely Severity: Limited	Included in flood profile and assessment (where applicable)
Shortage of Materials	Frequency: Unlikely Severity: Critical	Excluded from profiling and risk assessment
National Security Incident	Frequency: Unlikely Severity: Catastrophic	Excluded from profiling and risk assessment

16.3.1 Risk Assessment Methodology

The risk assessment describes and analyzes the risks and vulnerabilities to Ward County from the hazards profiled. The assessment includes a vulnerability description and information as to the identified risk to public and private assets (where applicable). Where applicable, this assessment includes information from the 2008 Ward County Hazard Mitigation Plan.

The Steering Committee conducted a risk assessment exercise to determine the vulnerabilities to assets within the planning area. The updated hazard profiles were used as the basis to determine

the vulnerability of and risk to assets within the city. A variety of data sources were used to complete this risk assessment, including:

- Local knowledge and experience of Steering Committee, city staff, and county staff
- Plans and documents produced and maintained by the city
- Reports and studies provided by other agencies, both state and federal

In all instances, the best available data was utilized.

Impact Scale Methodology
The potential impacts of each hazard were discussed by the Steering Committee. For the purposes of this discussion, a qualitative impact scale was developed, and was used by the Steering Committee in their discussions. As a result of these discussions, each hazard was assigned a qualitative impact ranking. This scale appears in Table 16.3.1-1 (below).

Table 16.3.1-1
Hazard Impact Scale

Term	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Low	Some minor injuries possible, but no fatalities	Cosmetic damages expected to assets; Infrastructure loss of function for less than 24 hours expected	System delivery delayed or temporarily interrupted; Interruptions in service delivery of less than 24 hours expected
Moderate	Injuries expected; Fatalities possible	Some structural damages to light construction (<50 % damage); Infrastructure loss of function for 24-72 hours expected	System delivery failures expected; Interruptions in service delivery of 24-72 hours expected
High	Serious and numerous injuries expected; Fatalities expected	Some structures irreparably damaged (>50% damage); Infrastructure loss of function for 72+ hours expected	Long-term system failures/damages expected; Cancellation of services (72+ hours) expected
Not Applicable	Hazard does not have the potential to impact people or life safety	Hazard does not have the potential to impact assets or infrastructure	Hazard does not have the potential to impact service delivery

The following risk and vulnerability assessment uses a GIS-based methodology, with accompanying narrative and calculations, to demonstrate the assessed risk and vulnerability of Ward County to the identified and profiled hazards.

Critical Assets
The table below (Table 16.3.1-2) provides details of select critical assets contained within Ward County.

Table 16.3.1-2
Critical Assets – Ward County

Asset Name	Asset Use /Function	Address	Insured or Estimated Value
Ward County Sherriff's Office	Emergency Services	315 3rd Street Southeast (in Ward County Courthouse)	$24,577,921*
Ward County Emergency Management	Emergency Services	315 3rd Street Southeast (in Ward County Courthouse)	
Ward County Courthouse	Government	315 3rd Street Southeast	
Plaza School	Shelter	Covell Street	$20,586
Ward County North Building	Government	7200 Highway 83 North	$3,123,649*
Ward County Highway Department (includes equipment outbuildings)	Emergency Services	913 13th Street Southeast	$2,119,040*
Ward County Social Services	Government	400 22nd Avenue Northwest	$806,368*
Ward County Library	Government	405 3rd Avenue Southeast	$940,571*
		Total:	**$31,522,134**

Note on asset values: Most asset values (denoted with an asterisk) were provided by Ward County; the remaining are estimated, based on insurance valuations for similar types of assets in the City of Minot. These figures represent estimated values only, and may not reflect actual damages from an actual event. However, it is a reasonable estimate to use for the purposes of this Plan.

Note on the maps: the maps in this section provide estimates of municipal and county boundaries based on data available as of February and March 2013. In some cases, the boundaries depicted may not reflect recent annexations or other changes to corporate limits. However, these images reflect the best available data at the time of plan development. Future updates to this plan will reflect changes to municipal and county boundaries.

16.3.2 Risk and Vulnerability Assessment

16.3.2.1 Communicable Disease

Vulnerability to the Hazard

Vulnerability to the communicable diseases hazard resides in the population of a given area, both human and animal. While it is possible that assets and infrastructure could be impacted by communicable disease, these impacts would come as a secondary impact to the illness of human operators and caretakers, and not as a result of the hazard itself.

As of the 2012 Census estimate, there were 64,798 people residing in Ward County; this is a significant increase from both the 2000 Census and the 2010 Census. Each of these persons is vulnerable to communicable disease, particularly if it is a pathogen that that individual has not been immunized against, or for which no immunization exists. Prolonged outbreaks could result in a loss of city services, failure of infrastructure (from lack of operators or maintenance), and closure of facilities, including schools and social centers.

In general, the very young and the elderly, as well as those with underlying health conditions or who are immunocompromised, are more vulnerable to communicable disease.

Ward County is undergoing significant fluctuations regarding population. In 2012, the Census Bureau estimated the population to be 64,798 – an increase of more than 3,000 residents in two years (and more than 5,000 since the 2000 Census), and this figure does not account for all of the temporary residents and workers in the area who would not have been counted as part of the official Census or Census estimate. This increase in population, combined with the influx of temporary residents and workers – for both energy and flood recovery – increases the vulnerability of the area to the communicable disease hazard, as new people from other areas may bring new illnesses and diseases with them, and potentially infect a population unaccustomed population.

Estimate of Potential Losses – Qualitative

In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 16.3.1-1 (previous).

The representatives from Ward County determined that communicable disease has the potential to cause the impacts described in Table 16.3.2.1-1 (below).

Table 16.3.2.1-1
Qualitative Hazard Impacts – Communicable Disease

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Communicable Disease	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative
According to the 2012 Census estimate, there are 64,798 people in Ward County. An outbreak within the county could have devastating and far-reaching impacts throughout the region, as the city of Minot serves as the regional hub for a variety of services, and is located in Ward County.

As discussed in the communicable disease profile, influenza and pertussis are both communicable diseases that are tracked by the State Health Department. For each of these illnesses, cases were reported in Ward County between 2007 and 2012.

- **Influenza:** Ward County accounted for an annual average of 7% of the cases in the state from 2007 through 2012, equating to 4,536 people.
- **Pertussis:** Ward County accounted for an annual average of 10% of the cases in the state from 2007 through 2012, equating to 6,479 people.

Identified Data Limitations
There is a wealth of technical information available for communicable disease, but limited data available regarding risk or vulnerability of specific populations. Only limited county level data was available. Much of the data that does exist is protected by HIPPA or other privacy policies. Therefore, performing a highly detailed quantitative assessment for this hazard is very difficult. Data that could be collected prior to the next update in order to improve this methodology includes:

- Data regarding absenteeism and increased operating costs as a result of absenteeism; and
- Data regarding projected population changes.

16.3.2.2 Drought

Vulnerability to the Hazard
Though there are obvious vulnerabilities for people and animals that will result from a prolonged drought, the most common impacts are generally felt in the area's economy. This is particularly true in areas whose economies are connected to agriculture, such as the State of North Dakota as a whole. Agricultural losses from drought can be staggering, and can be in the billions of dollars. Shortages as a result of drought can have far-reaching consequences, given the centralized food system that currently exists in modern society.

As water becomes more and more precious, the value of that water will increase, resulting in issues of supply and demand. The decrease in availability of this necessary resource can result in significant societal disruption, which can worsen as the resource becomes more and more precious.

Ward County's economy is not reliant on agriculture – less than 5% of the workforce is employed in the agriculture sector. Thus, Ward County is not as vulnerable to agricultural drought as other areas of the state.

Ward County has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. There are plans to increase the infrastructure throughout the county, to accommodate this increase in demand and need. These increases in population and development, coupled with the projected future increases in both, increase the vulnerability of the community to drought, as the county will require more and more utility services in the future, just to meet normal demands.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 16.3.1-1 (previous).

The representatives from Ward County determined that drought has the potential to cause the impacts described in Table 16.3.2.2-1 (below).

Table 16.3.2.2-1
Qualitative Hazard Impacts – Drought

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Drought	Low	Low	Low

Estimate of Potential Losses – Quantitative
Given that the entire state of North Dakota is experiencing a significant wet cycle, that this cycle has been evolving for the previous two decades, and that scientists do not anticipate that this cycle will end in the near future, the Steering Committee directed that no quantitative risk assessment should be conducted for this hazard. It was the decision of the Steering Committee that this hazard does not present a significant threat to the planning area, and is unlikely to present a threat for the foreseeable future.

In light of this determination, no quantitative risk assessment has been performed for this hazard.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a quantitative risk assessment includes:

- Data regarding the volume of water required to maintain and support municipal operations;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Estimates of potential increases in operating costs that would result from a lack of water.

16.3.2.3 Fire

Vulnerability to the Hazard
Fire has the potential to devastate a community. All people and assets within a community are vulnerable to fire.

Fire can result in fatalities and injuries, in property damage or destruction, in the interruption of services, in transportation disruptions, and in economic losses.

The ability to suppress and fight a fire is contingent on having the necessary training, personnel, and equipment to bring the fire under control and to extinguish it. If one of these areas is lacking or is unavailable, the community can suffer extensive losses as a result of fire.

Ward County has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. There are significant plans to increase the infrastructure throughout the county, to accommodate this increase in demand and need. These increases in population and development, coupled with the projected future increases in both, increase the vulnerability of the community to fire, as more structures and more people will be exposed to the risk of fire.

In addition, as of this plan update, many residents are still living in temporary housing as a result of the 2011 flood. These temporary residences are generally more vulnerable to hazards than traditional structures, as they are not as well constructed and cannot withstand hazards as well.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 16.3.1-1 (previous).

The representatives from Ward County determined that fire has the potential to cause the impacts described in Table 16.3.2.3-1 (following).

Table 16.3.2.3-1
Qualitative Hazard Impacts – Fire

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Fire	High	High	Moderate

Estimate of Potential Losses – Quantitative
All structures within Ward County are at some risk from fire. According to the 2010 Census, there are 26,574 housing units in the county; 24,453 of these units are occupied, and 2,121 are vacant.[1] The majority of these structures are heated by natural gas, bottled gas, or electricity. The average value of single family housing in Ward County is $124,300, according to the Census. This equates to potential residential losses of $3,303,148,200. If 1% of structures in the county are damaged by fire, this would result in $33,031,482 in potential structural losses.

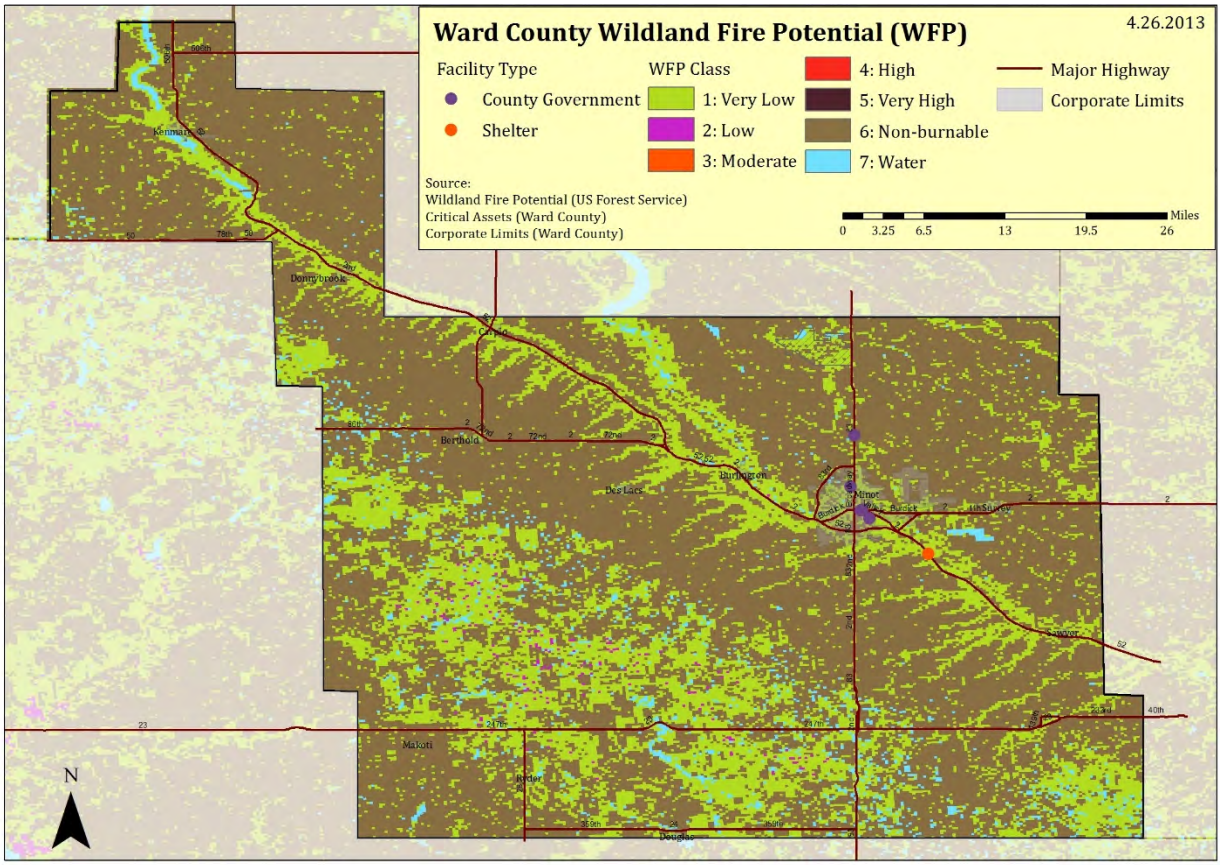
In addition, all identified critical assets (identified in Table 16.3.1-1) within the county have the potential to be lost to fire. These assets have a combine estimated value of $31,522,134. If 1% of these assets are lost to or damaged by fire, this would result in $315,221 in potential asset damages.

Using the US Forest Service's Wildland Fire Potential data, Ward County and its critical assets were mapped. Based on this data set, the Ward County has very low potential for wildland fires. However, this data set does not account for agricultural lands, and so may present a diminished risk where a higher level of risk actually exists.

Figure 16.3.2.3-1 (following) illustrates this fire potential in relation to the identified critical assets for the city.

[1] The figures for housing are from the 2010 Census, which was completed prior to the 2011 flood which depleted the housing stock in Ward County. However, the 2010 Census figures remain the best available data for housing estimates within the county and municipalities, and so are used here to perform estimates of potential losses.

Figure 16.3.2.3-1
Wildland Fire Potential and Critical Assets



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction types and age;
- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding fire protection systems within individual buildings, particularly those where flammable or combustible materials are routinely used or stored.

16.3.2.4 Flood

Vulnerability to the Hazard
Flooding affects people and property in a variety of ways – from forced evacuations to property damage to transportation interruptions to service disruptions, there is almost no facet of modern society that cannot be impacted by flooding. Road closures, loss of utilities, delays in

emergency response, property damage – all of these are vulnerabilities faced by communities at risk from flooding.

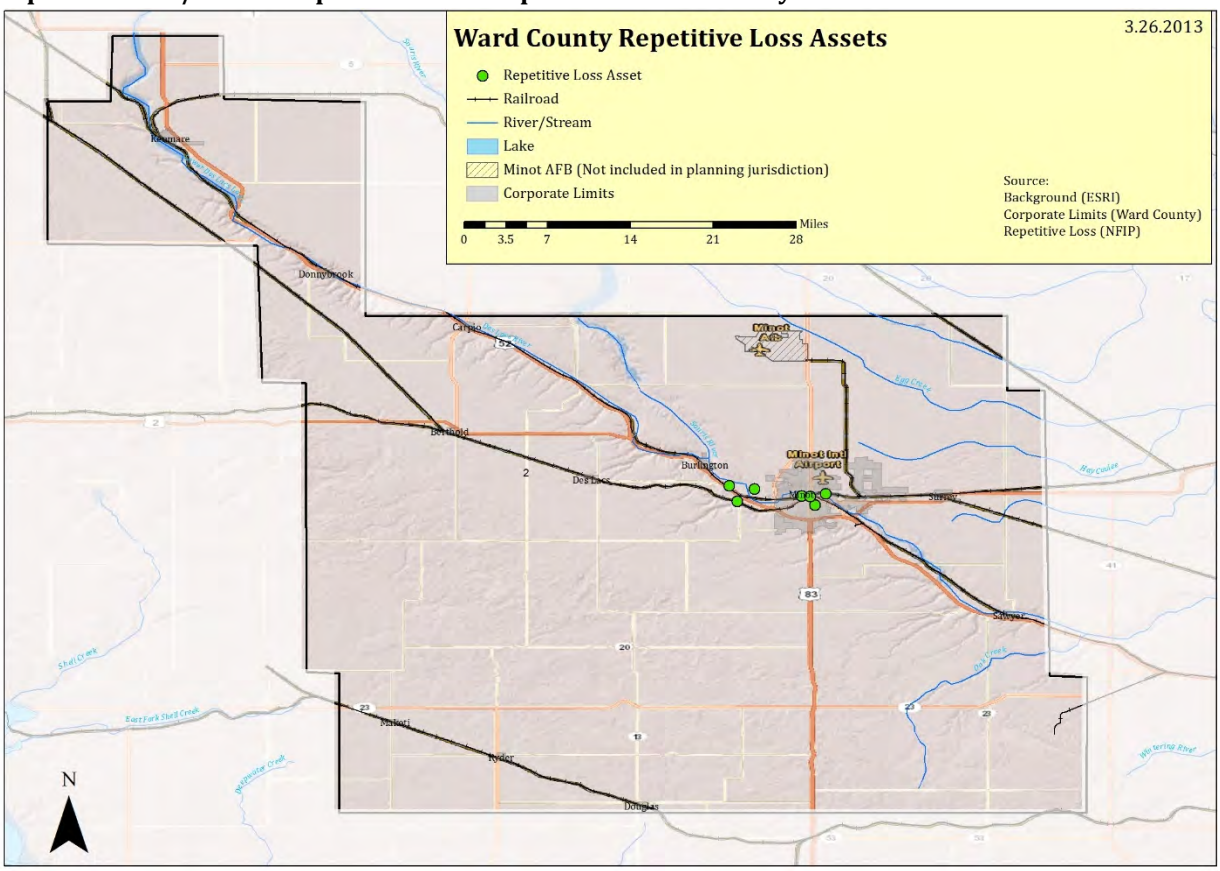
Flood damages also take considerable time to recover from. For example, as of the development of this Plan update, Ward County continues to work towards full recovery from the 2011 Souris (Mouse) River flooding.

Ward County has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. A large swath of the county lies within an identified floodplain; in addition, much of the county that was flooded in 2011 was outside of these identified and mapped areas. The flood risk in Ward County is significant, and the vulnerability to this hazard must be considered when any future development is planned.

In addition, as of this plan update, many residents are still living in temporary housing as a result of the 2011 flood. These temporary residences are generally more vulnerable to hazards than traditional structures, as they are not as well constructed and cannot withstand hazards as well.

Ward County is a member of the NFIP, and is in good standing with the program. As of February 2013, there were three NFIP-designated Repetitive Loss or Severe Repetitive Loss structures within the county. The location of these properties is represented in Figure 16.3.2.4-1 (following).

Figure 16.3.2.4-1
Repetitive Loss/Severe Repetitive Loss Properties – Ward County



Combined, these three properties account for seven flood insurance claims, with payments totaling more than $130,000.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 16.3.1-1 (previous).

The representatives from Ward County determined that flooding has the potential to cause the impacts described in Table 16.3.2.4-1 (below).

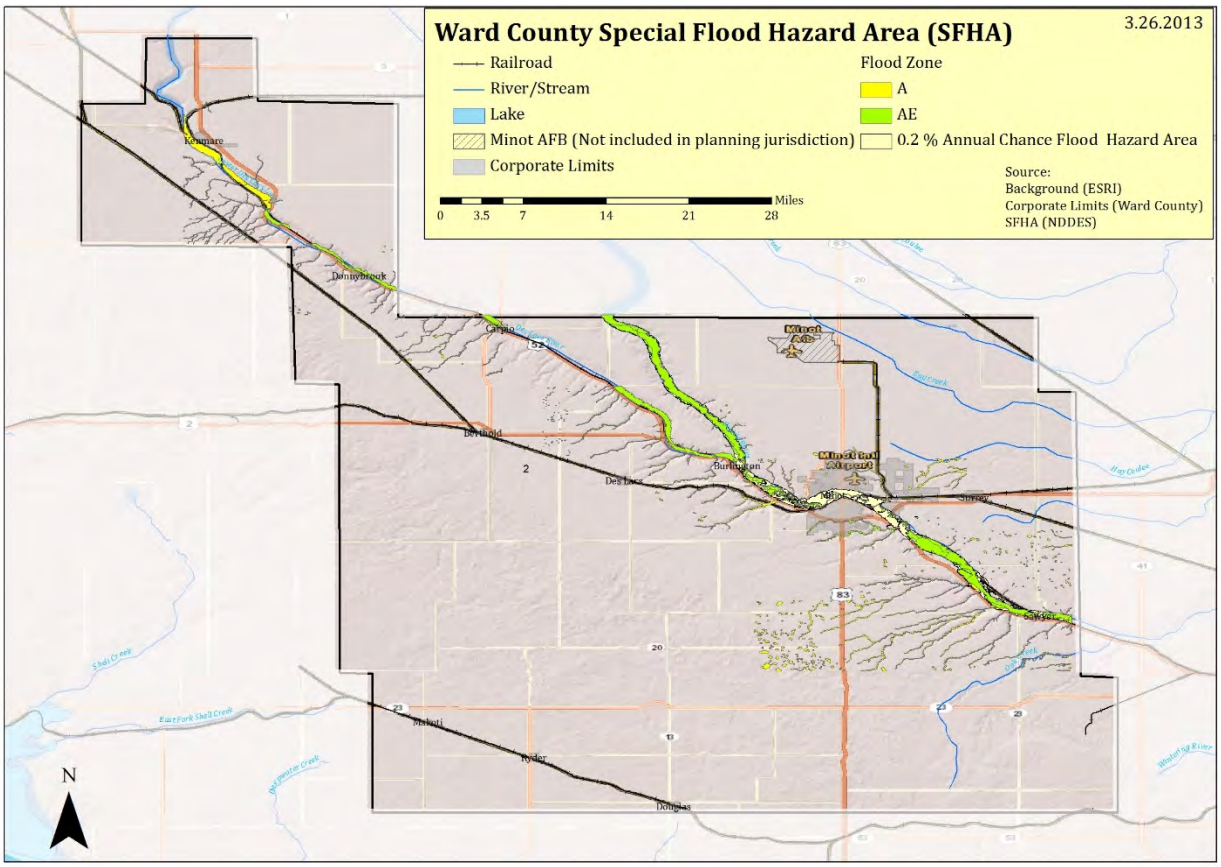
Table 16.3.2.4-1
Qualitative Hazard Impacts – Flood

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Flood	Moderate	High	High

Estimate of Potential Losses – Quantitative

Ward County has mapped floodplains that generally follow rivers. Figure 16.3.2.4-2 (below) illustrates the locations and boundaries of both the one percent annual chance floodplain and the .02% annual chance floodplain.

Figure 16.3.2.4-2
Special Flood Hazard Areas

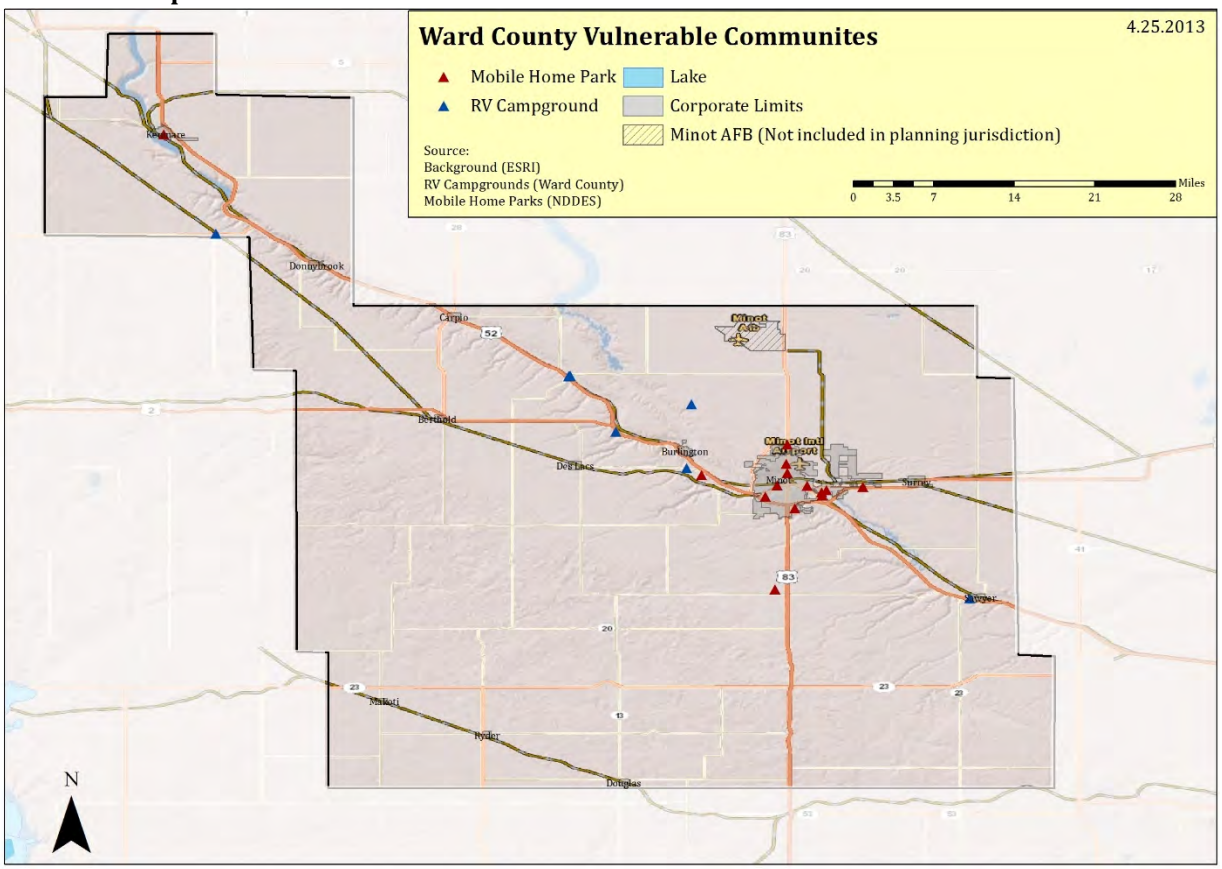


There are at least eight RV parks in Ward County, most of which are located in floodplains. In addition, there are approximately 14 mobile home parks throughout the county, some of which are located in floodplains.

Residents of mobile home parks and RV parks are often more at risk from flooding, as the structures they reside in are less able to withstand extreme weather. In addition, many of these parks are located along rivers, and are within the floodplain.

Figure 16.3.2.4-3 (following) illustrates the locations of these vulnerable populations.

Figure 16.3.2.4-3
Vulnerable Populations



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, location of utilities and connections);
- Building valuations for all assets within the county limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the first floor elevation of all buildings within the county, as well as the elevation of all critical assets and infrastructure.

16.3.2.5 Severe Summer Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe summer storms. Infrastructure can be damaged or destroyed by hail, wind, lightning, or tornadoes, which can result in service interruptions and outages. Structures can be damaged or destroyed

by wind, lightning, or tornadoes, and thus be useless to humans for protection from the elements. People can be injured or killed by wind, tornadoes, lightning, hail, or extreme heat.

Those who reside in mobile homes, RVs, or other lightweight housing are more vulnerable than those who reside in traditional construction, as these lightweight types of structures generally fail in the face of summer storms much sooner than their heavier counterparts.

In addition, some portions of the population are more at risk to the effects of extreme heat. The very young and the elderly are generally more vulnerable to the effects of extreme heat, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

Ward County has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. There are significant plans to increase the infrastructure throughout the county, to accommodate this increase in demand and need. These increases in population and development, coupled with the projected future increases in both, increase the vulnerability of the community to storm damage, as more structures and more people will be exposed to the risk of summer storms. To mitigate this vulnerability, a need for additional warning sirens and emergency generators was identified during the plan update process; these needs were included in the mitigation strategy for Ward County.

In addition, as of this plan update, many residents are still living in temporary housing as a result of the 2011 flood. These temporary residences are generally more vulnerable to hazards than traditional structures, as they are not as well constructed and cannot withstand hazards as well.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 16.3.1-1 (previous).

The representatives from Ward County determined that severe summer storms have the potential to cause the impacts described in Table 16.3.2.5-1 (below).

Table 16.3.2.5-1
Qualitative Hazard Impacts – Severe Summer Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Summer Storm	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative

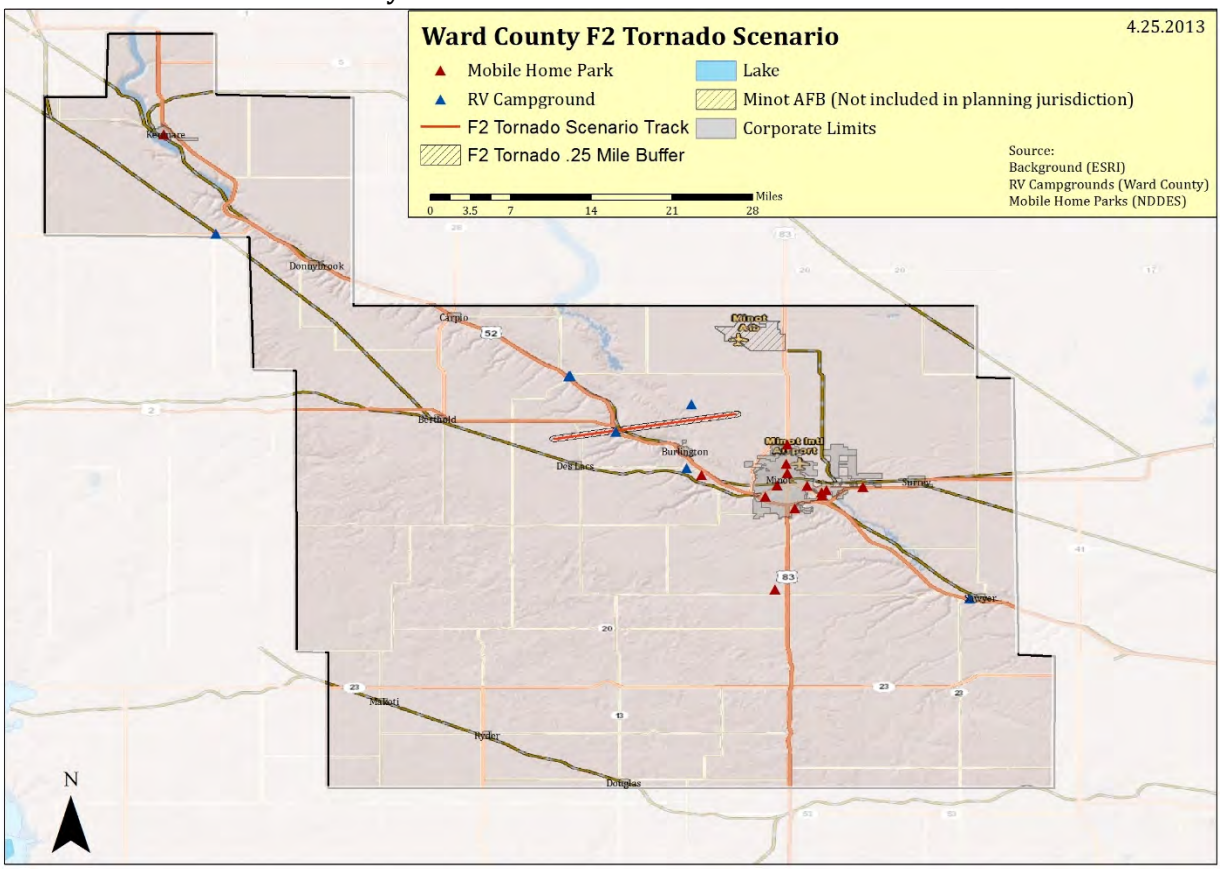
Severe summer storms are a non-spatial hazard that can and do affect all of Ward County. Each of the hazards associated with severe summer storms can result in losses throughout the planning area.

All structures within Ward County are at risk from severe summer storms. According to the 2010 Census, there are 26,574 in the county. The median value of these structures is $124,300, according to the Census. This equates to residential assets of approximately $3,303,148,200. If 10% of these residential assets were damaged by a severe summer storm, this would result in losses of $330,314,820.

In addition, all identified critical assets (identified in Table 16.3.1-1) within the county have the potential to be damaged or destroyed by severe summer storms. These assets have a combined estimated value of at least $31,522,134.

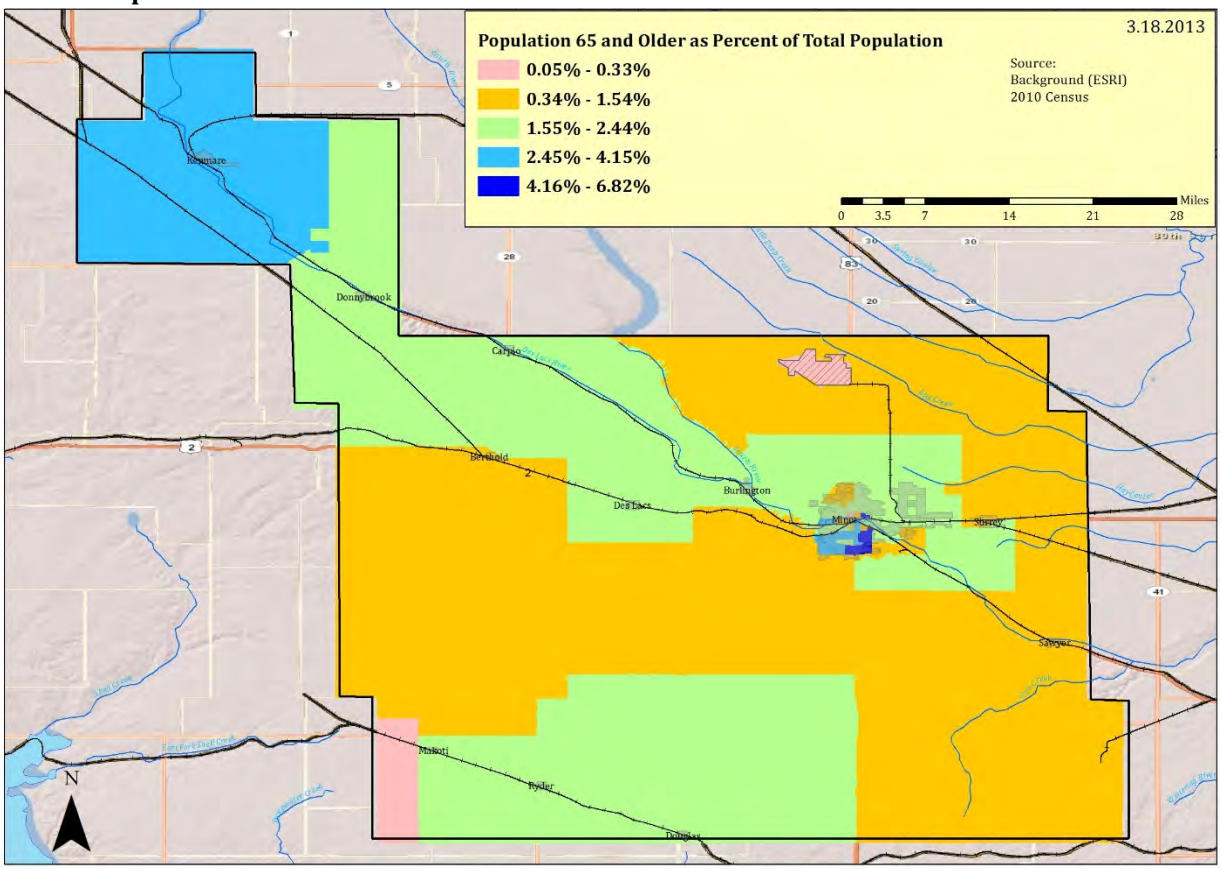
For the purposes of this assessment, a scenario was created, based on the documented tornado touchdown history for Ward County. The track of the most likely tornado (based on history) was overlaid onto Ward County. Figure 16.3.2.5-1 (following) illustrates the results of this scenario, and shows the RV and mobile home park populations that would be significantly at risk during such an event.

Figure 16.3.2.5-1
Tornado Scenario – Ward County



Finally, the 64.798 residents of Ward County are all at risk from the severe summer storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 7.8% (children under 5) and 9.6% (those over 70) of the population of Ward County. Combined, these two groups account for more than 17% of the population, a total of 11,275 people. Figure 16.3.2.5-2 (following) illustrates the distribution of those 65 and over throughout Ward County, based on 2010 Census data.

Figure 16.3.2.5-2
Over 65 Population Distribution



Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the county;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the specific location of all vulnerable populations that may require services or special attention during severe summer storm events.

16.3.2.6 Severe Winter Storms

Vulnerability to the Hazard
People, structures, and assets are all vulnerable to the impacts associated with severe winter storms. Infrastructure can be damaged or destroyed by wind or ice, which can result in service interruptions and outages. Structures can be damaged or destroyed by wind, ice, or snow

weight, and thus be useless to humans for protection from the elements. People can be injured or killed by transportation accidents (resulting from icy roadways) or extreme cold.

In addition, some portions of the population are more at risk to the effects of extreme cold. The very young and the elderly are generally more vulnerable to the effects of extreme cold, and are more likely to suffer illness or death as a result. This is especially true if exposure is extended for a period of time.

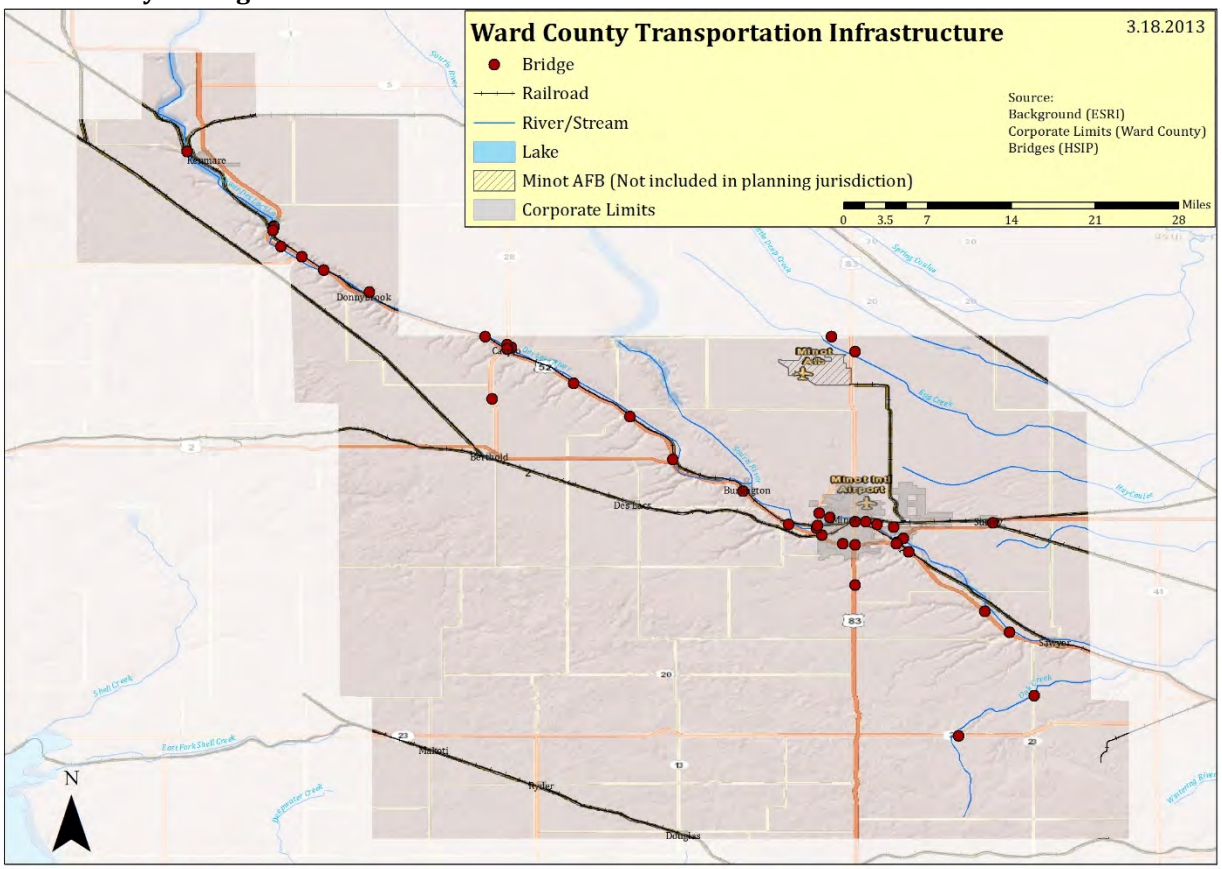
Ward County has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. There are significant plans to increase the infrastructure throughout the county, to accommodate this increase in demand and need. These increases in population and development, coupled with the projected future increases in both, increase the vulnerability of the community to storm damage and utility loss, as more structures and more people will be exposed to the risk of winter storms. To mitigate this vulnerability, a need for additional warning sirens and emergency generators was identified during the plan update process; these needs were included in the mitigation strategy for Ward County.

In addition, as of this plan update, many residents are still living in temporary housing as a result of the 2011 flood. These temporary residences are generally more vulnerable to hazards than traditional structures, as they are not as well constructed and cannot withstand hazards as well.

The majority of the vulnerability related to severe winter storms is related to either transportation accidents or to utility failures. Utility failure results in disruption to electrical service, water, and natural gas, which results in loss of heat to structures.

Transportation accidents occur when roadways and bridges become impacted and ice over, which results in loss of vehicular control and subsequent accidents. Figure 16.3.2.6-1 (following) provides the locations of bridges in and around the city, which typically ice over before surround roadways, making them treacherous for travel.

Figure 16.3.2.6-1
Ward County – Bridges



Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 16.3.1-1 (previous).

The representatives from Ward County determined that severe winter storms have the potential to cause the impacts described in Table 16.3.2.6-1 (below).

Table 16.3.2.6-1
Qualitative Hazard Impacts – Severe Winter Storm

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Severe Winter Storm	Moderate	Moderate	Moderate

Estimate of Potential Losses – Quantitative
Severe winter storms are a non-spatial hazard that can and do affect the entirety of Ward County. Each of the hazards associated with severe winter storms can result in losses throughout the planning area.

All structures within Ward County are at risk from severe winter storms. According to the 2010 Census, there are 26,574 housing units in the city. The median value of these structures is $124,300, according to the Census. This equates to residential assets of approximately $3,303,148,200. If 1% of these residential assets were damaged by a severe summer storm, this would result in losses of $33,031,482.

In addition, all identified critical assets (identified in Table 16.3.1-1) within the county have the potential to be damaged or destroyed by severe winter storms. These assets have a combined estimated value of at least $31,522,134. If these critical assets suffered a 10% loss, the resulting damage would equate to at least $3.1 M.

Finally, the 64,798 residents of Ward County are all at risk from the severe winter storm hazard. As previously stated, those most at risk from the extreme heat hazard are the very young and the elderly. These two groups account for 7.8% (children under 5) and 9.6% (those over 70) of the population of Ward County. Combined, these two groups account for more than 17% of the population, a total of 11,275 people.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Data regarding building construction (materials, roof types, wind ratings, etc.);
- Building valuations for all assets within the county;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the specific location of vulnerable populations that may require services or special attention during severe winter storm events.

16.3.2.7 Hazardous Materials Incident

Vulnerability to the Hazard
Vulnerabilities to people are often significant during hazardous materials incidents. Depending on the exact material and concentration released, the health impacts to humans can be short term, long term, minor, or significant. Those in the area of the immediate release would have little or no warning prior to exposure, and would have little or no time to evacuate. Those further away may have more time to evacuate, depending on the circumstances and the conditions.

Vulnerabilities also exist to the environment, in particular air, water, and soil. For example, water sources can be threatened or contaminated by hazardous releases. A single release can create hazardous conditions for an entire area or an entire watershed. Sensitive habitats can be damaged by a reduction in air, water, and soil quality, which can lead to plant and wildlife injury or death.

While it is possible that structural losses would occur, these are more likely to occur in the immediate area of an incident involving an explosion or fire. In most cases, the vulnerability lies in contamination and in the resulting loss of use/function prior to clean up.

Ward County has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. There are significant plans to increase the infrastructure throughout the county, to accommodate this increase in demand and need. These increases in population and development, coupled with the projected future increases in both, increase the vulnerability of the community, as more structures and more people will be exposed to the risk of hazardous materials incidents. To mitigate this vulnerability, a need for additional warning sirens and emergency generators was identified during the plan update process; these needs were included in the mitigation strategy for Ward County.

In addition, as of this plan update, many residents are still living in temporary housing as a result of the 2011 flood. These temporary residences are generally more vulnerable to hazards than traditional structures, as they are not as well constructed and cannot withstand hazards as well.

The roadways in and around Ward County have also seen a significant increase in traffic in recent years, due to the combination of energy activities and disaster recovery, as well as the increased development in the area. This increased traffic increases the chances of a hazardous materials incident occurring. Even if an incident occurred outside of the city it could still impact the county and its residents.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 16.3.1-1 (previous).

The representatives from Ward County determined that hazardous materials incidents have the potential to cause the impacts described in Table 16.3.2.7-1 (following).

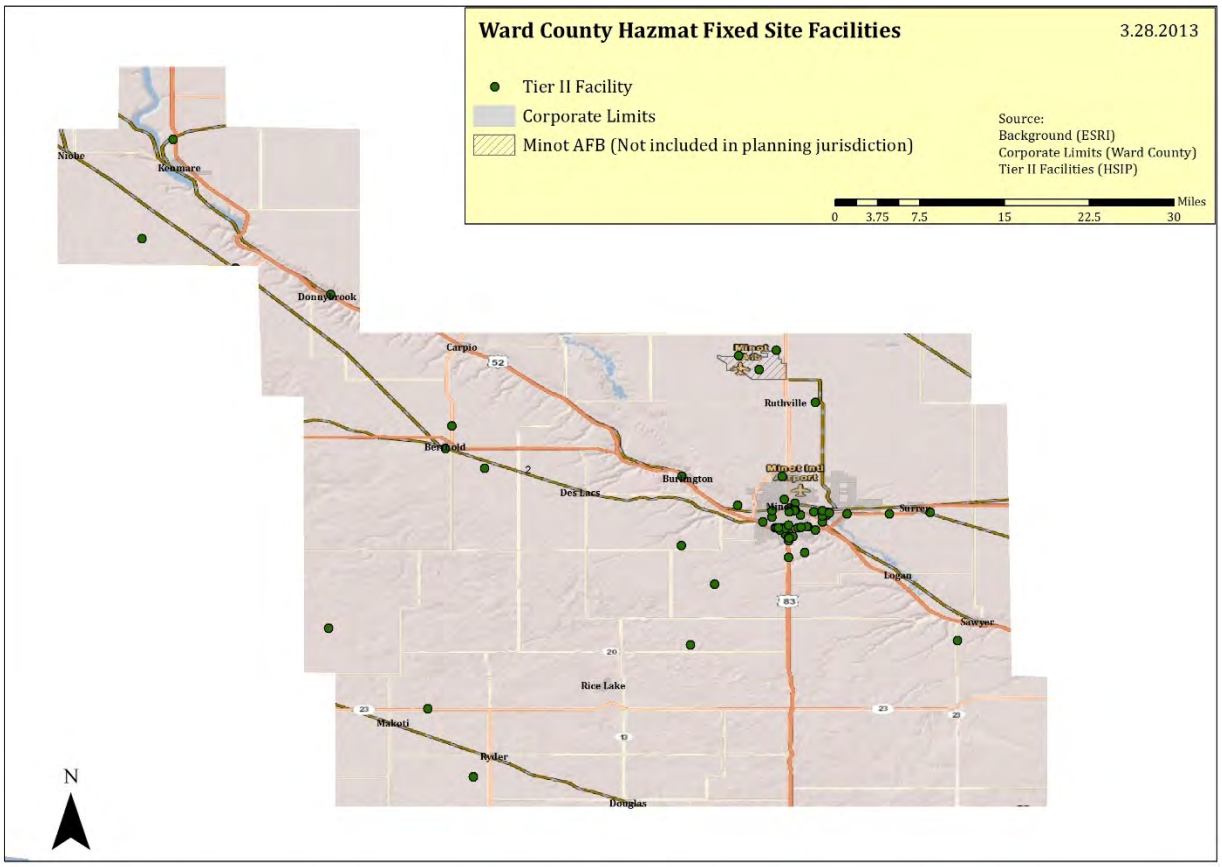
Table 16.3.2.7-1
Qualitative Hazard Impacts – Hazardous Materials Incident

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Hazardous Materials Incident	High	High	High

Estimate of Potential Losses – Quantitative
For the purposes of this assessment, a series of scenarios were created. Too many variables exist to specifically assess the quantitative risks to Ward County – variations in material, concentration, location, weather, wind, time of day, etc., will all result in differing losses. These created scenarios assume that all assets and populations within the area are equally at risk, and no assumptions are made regarding health impacts to people.

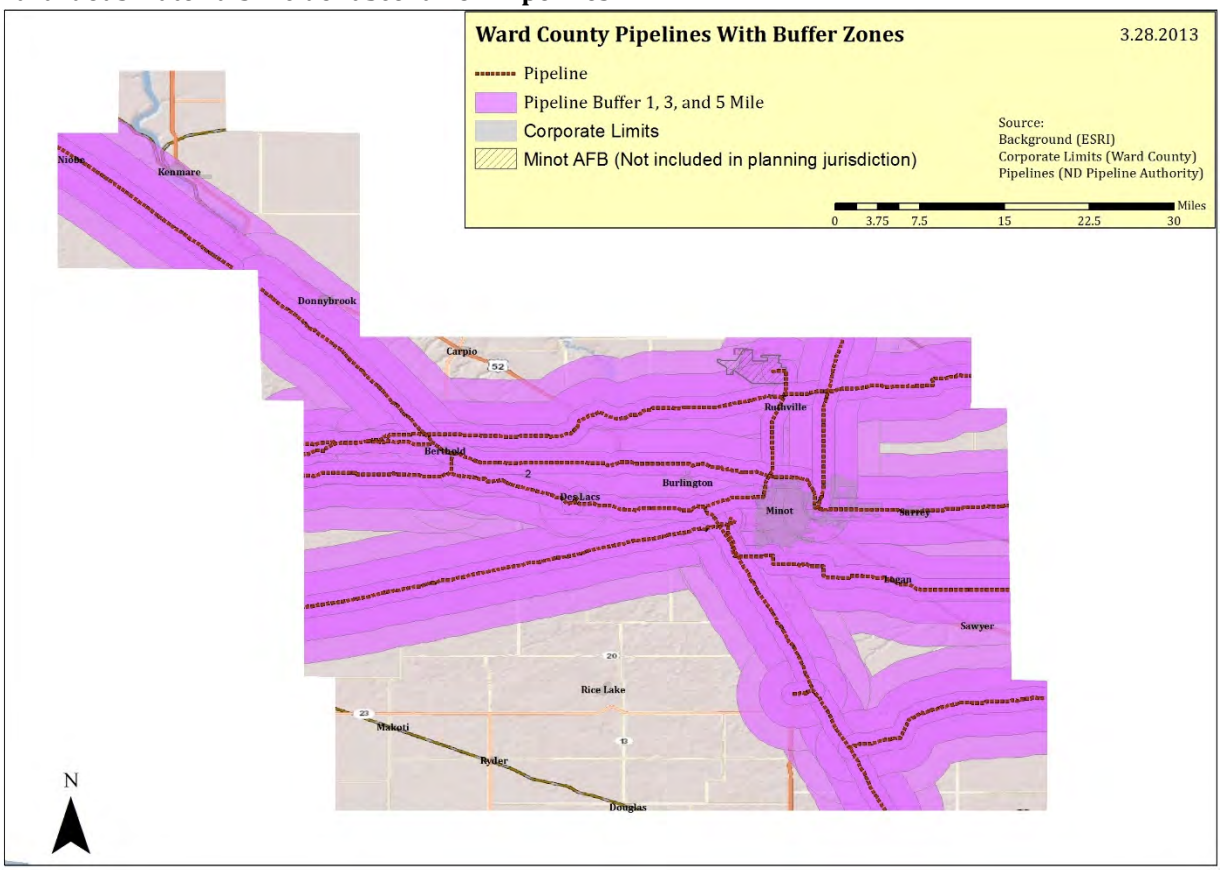
Figure 16.3.2.7-1 (following) illustrates the locations of fixed sites hazardous materials facilities in relation to Ward County.

Figure 16.3.2.7-1
Hazardous Materials Incident – Fixed Site Facilities



Pipelines also have the potential to cause significant impacts within the county. Figure 16.3.2.7-2 (below) illustrates the location of identified pipelines under the county, and provides a ½ mile, one mile, and three mile buffer zone around these pipelines. As seen in this image, the majority of the area of Ward County could be impacted by an incident with the pipeline. These losses could be structural or physical damage, or could be a loss of function due to contamination or inaccessibility.

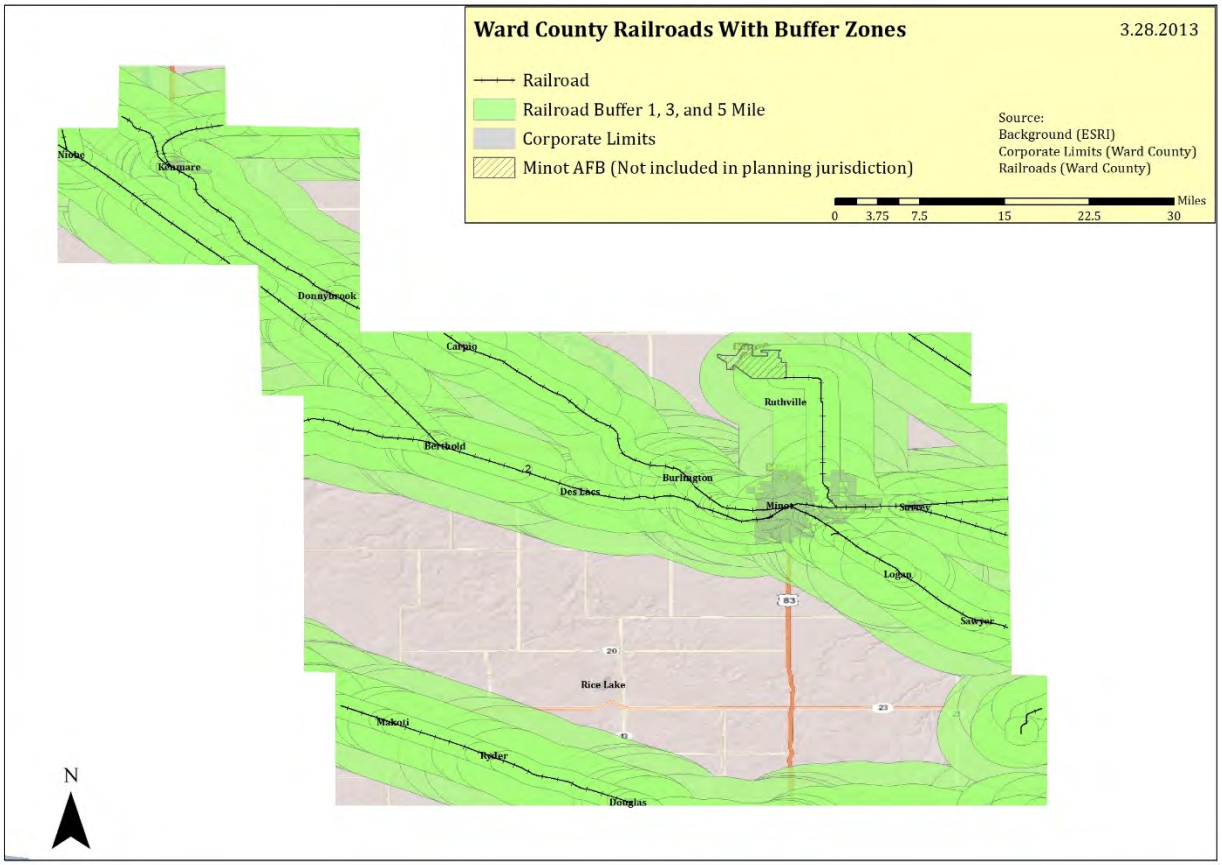
Figure 16.3.2.7-2
Hazardous Materials Incident Scenario – Pipelines



As is evident from the above image, the entire county could be impacted by an incident involving pipelines, depending on the substance involved, the location of the incident, and the specifics of the incident.

Finally, railroads also pose a significant hazardous materials threat to Ward County, as railroads are routinely used to transport hazardous materials. Figure 16.3.2.7-3 (following) illustrates the location of the railroad, and provides a one, three, and five mile buffer zone around these railroads. These losses could be structural or physical damage, or could be a loss of function due to contamination or inaccessibility.

Figure 16.3.2.7-3
Hazardous Materials Incident – Railroads



As is evident from the above image, the entire city could be impacted by an incident hazardous materials and the railroad. In addition, an incident with the railways could have transportation ramifications, as trains and other modes of transportation were forced to come to a stop until the incident scene is cleared and cleaned.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed quantitative risk assessment includes:

- Building valuations for all assets within the city limits;
- Data regarding expected/projected changes in development;
- Data regarding projected population changes; and
- Data regarding the location of vulnerable populations that may require services or special attention during hazardous materials incidents.

16.3.2.8 Landslides

Vulnerability to the Hazard
This hazard, which is specific to Ward County and its roadways, results in transportation and ingress/egress disruptions, and can leave a community cut off or otherwise vulnerable, as assistance from outside communities is unable to reach the community.

To date, this hazard has not occurred in areas that have impacted structures. However, it is possible that this will happen in the future, and will result in structural damage as well as roadway/hillside damage. If the structure is occupied at the time, injuries to the occupants could result.

Each occurrence of the landslide hazard results in significant costs to the county. Occurrences typically range from $500,000 to more than $2 M in repair costs, depending on the scale of the slide and the types of repairs required.

Ward County has experienced significant increases in both population and development, with increases in both expected in the foreseeable future. There are significant plans to increase the infrastructure throughout the county, to accommodate this increase in demand and need. These increases in population and development, coupled with the projected future increases in both, increase the vulnerability of the community, as more structures and more people will be exposed to the risk of landslides.

The roadways in and around ward County have also seen a significant increase in traffic in recent years, due to the combination of energy activities and disaster recovery, as well as the increased development in the area. This increased traffic increases the chances of a landslide impacting the population of the county.

Estimate of Potential Losses – Qualitative
In the course of updating this Plan, the Steering Committee completed a qualitative risk assessment exercise. This exercise asked the representatives from each participating jurisdiction to rank the hazards in the Plan according to their potential to impact and cause loss to their particular jurisdiction. The explanation for these rankings appears in Table 16.3.1-1 (previous).

The representatives from Ward County determined that landslides have the potential to cause the impacts described in Table 16.3.2.8-1 (below).

Table 16.3.2.8-1
Qualitative Hazard Impacts – Landslides

Hazard	Potential Impact to People or Life Safety	Potential Impact to Assets or Infrastructure	Potential Impacts to Service Delivery
Landslides	Low	Moderate	Low

Estimate of Potential Losses – Quantitative
As of the development of this Plan update, insufficient data existed to allow for the completion of a full quantitative risk assessment. Therefore, for this Plan update, the assessment will be limited to qualitative.

Identified Data Limitations
Data that could be collected prior to the next update in order to develop a more detailed risk assessment includes:

- Documented history of occurrences and repairs, including costs (in-kind and contractor)
- Data regarding expected/projected changes in development; and
- Data regarding projected population changes.

16.4 Capability Assessment (Updated)

A capability assessment adds context to a mitigation plan by providing an inventory of a municipality's programs and policies, and an analysis of its capacity to carry them out. These are essential for developing mitigation strategies and actions.

This capability assessment is a review of Ward County's resources in order to identify, review, and analyze what the county is currently doing to reduce losses, and to identify the framework that is in place for the implementation of new mitigation activities. In addition, this assessment will be useful in gauging whether the current local organizational structures and inter-jurisdictional coordination mechanisms for hazard mitigation could be improved, and how.

This local capability is extremely important, because the municipal officials know their own landscape best. Additionally, many of the most critical and effective hazard mitigation strategies and programs, including enforcement of floodplain management, building codes, and land-use planning, require a strong local role to achieve effective implementation.

This capability assessment primarily results from research and interviews with county staff and with interviews with municipal staff throughout the county. Relevant documents were reviewed related to hazard mitigation, including the State of North Dakota Hazard Mitigation Plan, as well as state and federal sources related to funding, planning, and regulatory capability. (Summary information from these sources can be found in Section 03.)

In addition, the capability assessment contained within the 2008 Plan was a source document for this assessment. This information was reviewed for continued accuracy and relevance; information regarding capabilities and capacities that was determined to remain accurate and relevant appears below:

- Ward County EMA:
  - coordinates planning, response activities, training, and exercises;
  - coordinates mitigation grant applications and project implementation (where required);
  - coordinates public information and education campaigns;
  - coordinates Tier 2 data reporting; and
  - general coordination with local, state, and federal agencies.
- Ward County Highway Department:
  - responsible for design of bridges, culverts, and overflow sections, and project regulation and inspection;
  - maintains extensive GIS data, which is available county-wide;
  - grant management; and
  - general coordination with local, state, and federal agencies.
- Ward County Sheriff's Department:
  - responsible for law enforcement in unincorporated county and incorporated areas as required/agreed (includes dive team);
  - provides rescue assistance, evacuation assistance, security, and traffic control;
  - coordinates and conducts public information and awareness campaigns (911 education, Safe Kids);
  - maintains mutual aid agreements with all surrounding counties and the ND Highway Patrol: and
  - general coordination with local, state, and federal law enforcement agencies.
- Ward County Water Resources Board:
  - provides engineering expertise;
  - responsible for water storage and drainage issue resolution.
- Ward County Social Services:
  - provides temporary assistance programs.

For this updated assessment, a written questionnaire was provided to the jurisdiction, with a request that it be completed by a person or persons knowledgeable of the topics. The survey generally covered a variety of topics, including administrative and fiscal capacity, planning and zoning, floodplain management, and inter- and intra-governmental coordination.

The general findings of the survey were:

- **Knowledge of mitigation programs and practices** – the county has significant familiarity with hazard mitigation programs, and has implemented multiple hazard mitigation projects in the wake of the 2011 Souris (Mouse) River flooding. In addition, the county is working with various municipalities and agencies to implement and administer a variety of mitigation grants from various programs.
- **Current/ongoing mitigation efforts** – the county is currently working on property acquisition projects and other hazard mitigation grants as a result of the 2011 flooding, and

has plans for implementation of several county-wide mitigation projects, pending available funding.

- **Intra- and inter-governmental coordination** – the county does participate in intra- and intergovernmental coordination efforts, including participating in planning efforts. For example, the county is working with each municipality to update the Emergency Operations Plan, which provides framework for emergencies and disasters in the county. In addition, the county is working with all incorporated areas to update the Ward County Hazard Mitigation Plan.
- **Planning** – the county has an EOP (currently being updated), a COOP/COG, an evacuation plan, and a master plan, as well as a range of ordinances for zoning and stormwater management. The county is a member of the NFIP
- **Staff, personnel, and technical capability** – as of this Plan update, the county has a high capability and capacity regarding hazard mitigation, and is confident in their abilities to administer hazard mitigation projects and programs. Like most capabilities, it could be improved with experience and additional resources.

In addition, Ward County partners have notable capabilities and capacities:

- First District Health Unit (state agency):
    - responsible for the mitigation of public health events within their jurisdiction (enforcement of statutes, immunization plans, etc.);
    - provides assistance with hazardous materials incidents through the environmental health division;
    - programs include wastewater treatment, water pollution, vector control, and immunization.
- Minot State University (state agency):
    - maintains an EOP that was recently updated and includes their evacuation plan;
    - participates or orchestrates annual drills/exercises;
    - has a master plan and participates in regional planning; and
    - plans to develop a campus-specific COOP.
- NDSU County Extension Service (state agency):
    - subject matter experts in agriculture, natural resources, horticulture, family/consumer science, 4-H, and youth community development;
    - provides expert information regarding:
        - beef/dairy cattle, swine, other livestock
        - water quality
        - waste management
        - forage
    - serves as information resource for natural disasters in relation to agriculture, environmental concerns, water resources, etc.; and
    - coordinates with NDSU, ND State Health Department, USDA, and FSA.
- Other state agency partners include:
    - ND Highway Patrol

  - State Fire Marshal
  - ND Forestry Service
  - ND Game and Fish
  - State Radio Communications
  - ND Department of Agriculture
  - Job Service ND
  - North Central Human Service Center
  - State Historical Society
  - State Water Commission
  - ND Department of Health
  - ND Department of Transportation
  - ND Department of Emergency Services
  - ND National Guard
- Other partners include:
  - Verendrye Electric Co-op
  - Excel Energy
  - Montana Dakota Utilities
  - SRT Communications
  - Earthmovers, Inc.
  - The American Red Cross
  - The Salvation Army
  - US Army Corps of Engineers
  - Verizon
  - United Way
  - AT&T
  - VOAD Council
  - Mid-Continent Communications
  - Lutheran Disaster Response
  - Minot Air Force Base
  - OtterTail
  - Brook Divide

Conclusions and Recommendations
Ward County should continue to build its capability and capacity for disaster recovery and hazard mitigation, and should continue to work with the federal and state governments – as well as private partners and other local entities - towards this end.

16.5 Mitigation Strategy (Updated)

Requirement §201.6(c)(3): *[The plan **shall** include the following] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment,*

based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. This section ***shall*** *include:*

Requirement §201.6(c)(3)(i): *A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

Requirement §201.6(c)(3)(ii): *A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008* ***must*** *also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.*

Requirement: §201.6(c)(3)(iii): *An action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization* ***shall*** *include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there* ***must*** *be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

16.5.1 Mitigation Goals

Table 16.5.1-1 (below) provides the mitigation goals that guide Ward County's mitigation strategy.

Table 16.5.1-1
Mitigation Goals (2008 and 2013)

2008 Goals	2013 Goals	Notes
Reduce flood effects in county.	Reduce the effects of hazards throughout the planning area.	Goal remains valid, with minor language change.
Increase public awareness of hazards and support for mitigation activities.	Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increased awareness.	Goal remains valid, with minor language change.
Protect health and safety.	Protect public health and safety before, during, and after hazard events.	Goal remains valid, with minor language change.
Improve county-wide communications abilities.	Ensure post-disaster operability of critical assets and infrastructure.	Communications has been addressed through other means; new goal identified as valid.

2008 Goals	2013 Goals	Notes
Improve county-wide capability of response to a hazard event.	Provide long-term mitigation solutions to vulnerable areas/structures that experience hazard damage or loss, particularly those with repetitive damage or loss.	Response capability addressed through other means; new replaced with more focus on mitigation and repetitive loss.

16.5.2 Mitigation Actions

Potential Mitigation Actions
Potential actions were identified in the Steering Committee meetings. This was based in part on consideration of the range of potential mitigation actions for hazards faced by the county.

Flood Mitigation Actions
Retrofitting structures prone to periodic flooding is an effective mitigation technique to reduce the flood loss of property. Techniques include the elevation of structures, mitigation reconstruction, dry flood proofing, wet flood proofing, and drainage improvements and installation of generators.

Elevation: involves raising a structure on a new foundation so that the lowest floor is above the Base Flood Elevation (BFE). Almost any type and size of structure can be elevated.

Dry flood proofing: is completely sealing the exterior of a building to prevent the entry of flood waters. Techniques include the building of floodwalls adjacent to existing walls, the installation of special doors to seal out floodwaters, and special backflow valves for water and sewer lines. Unlike wet flood proofing, which allows water to enter the house through wall openings, dry flood proofing seals all openings below the flood level and relies on the walls of the house to hold water out.

Wet flood proofing: includes measures applied to a structure that prevent or provide resistance to damage from flooding while allowing floodwaters (this includes flooding of interior spaces with clean water from city water or wells, instead of flood water) to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the determined flood elevation, protection of mechanical and utility equipment, and use of openings or breakaway walls. Wet flood proofing includes low-cost mitigation measures such as raising air conditioners, heat pumps, and hot water heaters on platforms above the determined flood elevation.

Generators: Another cost-effective retrofitting technique includes the installation of generators. By providing power with generators during and after severe storms many critical facilities may continue to provide necessary services to the community. The installation of generators serves to

assist the communities with problems experienced from floods, hurricanes, tornadoes, and extreme wind events.

NFIP/CRS Membership: Being a member of the NFIP and/or the CRS program would provide the community with access to flood insurance and with increased floodplain management and regulation, which will lead to a decrease in the level of risk and vulnerability faced by the community as a whole.

Wind Retrofitting Mitigation Actions
Structures can be retrofitted to withstand high winds by installing hurricane shutters, roof tie-downs and other storm protection features. The exterior integrity (i.e. building envelope) is maintained by protecting the interior of the structure and providing stability against wind hazards associated with extreme winds This also improves the ability to achieve a continuous load path. These types of measures can be relatively inexpensive and simple to put in place.

Early Warning Systems

With sufficient warning of a hazard event, a community and its residents can take protective measures such as moving personal property, cars, and people out of harm's way. When a threat recognition system is combined with an emergency response plan that addresses the community's hazard vulnerabilities, considerable damage can be prevented. This system must be coupled to warning the public, carrying out appropriate tasks, and coordinating the hazard response plan with operators of critical facilities. A comprehensive education and outreach program is critical to the success of early warning systems so that the public, operators of critical facilities, and emergency response personnel will know what actions to take when warning is disseminated.

Early warning systems include siren systems, reverse 911 systems, and other technologies used to warn faculty and students of impending events.

Early warning systems serve to assist the communities with problems experienced from floods, hurricanes, tornadoes, and thunderstorms, and can also be used to notify people regarding announced evacuations.

Drought

In general, communities can have little influence or impact on mitigating the impact of droughts except through ensuring adequate water supplies for normal circumstances and through implementation of water conservation measures when drought conditions are imminent. Undertaking drought impact studies, as well as searching for alternative water supplies can both set the foundation for future mitigation measures.

Prioritized Mitigation Actions
The following table (16.5.2-2) identified specific mitigation actions to achieve the stated goals of the Plan. For each action, an appropriate responsible party has been identified, as well as the

action's applicability to either new or existing development. Also, each action has been assigned an estimated cost and suggested funding sources.

For all of the actions in the following table (16.5.2-2), the timeframe for implementation is 1-4 years, depending on availability of funding and resources.

Each of these actions has been prioritized. Priorities were determined on a qualitative basis; factors such as general feasibility and anticipated effectiveness of risk reduction. Detailed cost-benefit analyses were not performed, but general cost-effectiveness of the actions was taken into account.

The method that was used to determine prioritization is called STAPLEE. This methodology considers a variety of factors; specifically, Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors. This method helped Ward County to weigh the pros and cons of different alternatives and actions for each of the actions described in Table 16.5.2-2. Table 16.5.2-1 (following) describes the basic criteria considered as part of the prioritization process.

Table 16.5.2-1
STAPLEE Criteria

STAPLEE	Criteria Explanation
S-Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T-Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.
A-Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P-Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L-Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E-Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E-Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with federal, state, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Cost-Effectiveness

Per the IFR, communities are required to use cost-effectiveness in the prioritization of projects and actions. At this point, the analysis of costs and benefits has been completed at a general level. As funding becomes available, a more extensive and specific process will be completed.

Benefit-cost analysis (BCA) compares the benefits of mitigation actions to the costs, and is a technique used for evaluating the cost-effectiveness of mitigation actions. FEMA requires a BCA for all mitigation projects that received FEMA-funding.

The following Table (16.5.2-2) provides the identified and prioritized mitigation strategy for Ward County. Where applicable, actions from the 2008 Plan are included, and a status update is provided.

Table 16.5.2-2
Mitigation Strategy

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible Department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 01: Reduce the effect of hazards throughout the planning area.	Continue to enforce floodplain management ordinance and practices	Flood	Previous	New and existing	Ward County Commission /Floodplain Administrator	General funds; Ward County EMA	$500+	High	On-going; Carried over from 2008 Plan; slightly altered language, with same mitigation intent
Goal 01: Reduce the effects of hazards throughout the planning area.	Consider joining the NFIP's Community Rating System program	Flood	New	New and existing	Ward County Commission /Floodplain Administrator	General funds; Ward County EMA	$500+	High	--
Goal 01: Reduce the effects of hazards throughout the planning area.	Assist incorporated municipalities with NFIP and CRS membership and compliance	Flood	New	New and existing	Ward County Commission /Floodplain Administrator	General funds; Ward County EMA	$500+	High	--
Goal 02: Increase public and local leadership awareness of hazards, risks, and vulnerabilities; increase support for mitigation activities through increases awareness.	Continue public information, training, and outreach program, to educate leaders, residents and business owners about hazards and mitigation	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	Previous	NA	Ward County EMA; Ward County Auditor; LEPC	NDDES & FEMA mitigation grant funding; First District Health Unit; American Red Cross; staff time and labor; in-kind contributions; Ward County EMA	$500+	Moderate	On-going; Nine similar actions from 2008 plan (all addressing public education / outreach for nine individual hazards) were combined into a single action for this Plan update

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible Department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Construction of a flood control structure at US 83 on First Larson Coulee, to allow low flows to pass while controlling high flows, to protect structures downstream	Flood	Previous	Existing	Ward County Water Board	General funds; Department of Transportation; NDDES & FEMA mitigation grant funding; in-king contributions	$500,000	Low	Application pending for funding; action carried over from 2008 Plan
Goal 03: Protect public health and safety before, during, and after hazard events.	Construction of a flood control structure at CR 14 on Second Larson Coulee, to allow low flows to pass while controlling high flows, to protect structures downstream	Flood	Previous	Existing	Ward County Water Board	General funds; Department of Transportation; NDDES & FEMA mitigation grant funding; in-king contributions	$500,000	Low	Application pending for funding; action carried over from 2008 Plan
Goal 03: Protect public health and safety before, during, and after hazard events.	Enforcement of burn bans during high fire index days	Fire	Previous	New and existing	Minot Rural Fire Department	Ward County EMA	$500+	Moderate	On-going; carried over from 2008 Plan
Goal 03: Protect public health and safety before, during, and after hazard events.	Promote the use of all-hazard radios to the public and businesses	Communicable disease; Drought; Fire; Flood; Landslide; Severe summer storm; Severe winter storm; Hazardous materials incident	Previous	New and existing	Ward County EMA	Ward County EMA	$500+	High	On-going, pending funding; carried over from 2008 Plan

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible Department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Utilize social media to improve public information and timely delivery	Communicable disease; Drought; Fire; Flood; Landslide; Severe summer storm; Severe winter storm; Hazardous materials incident	Previous	NA	Ward County EMA; Ward County Commission	Ward County EMA; NDSU	$500+	Medium	On-going; carried over from 2008 Plan; proven successful in recent flooding
Goal 03: Protect public health and safety before, during, and after hazard events.	Purchase and install emergency warning sirens	Fire; Flood; Landslide; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	Ward County E-911; P-Sat Manager; Ward County EMA	General funds; NDDES & FEMA mitigation grant funding; in-king contribution; Ward County EMA	$50,000+	Low	--
Goal 03: Protect public health and safety before, during, and after hazard events.	Install stream gauges to gather real time data to better predict, prepare for, and respond to high water events in flood prone areas.	Flood	New	New	Ward County Water Board	General funds; State Water Commission; NDDES & FEMA mitigation grant funding; in-king contributions	$25,000 each	Moderate	--

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible Department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 03: Protect public health and safety before, during, and after hazard events.	Purchase/install or construct storm shelters or safe rooms in populated areas to provide life safety protection, particularly in areas of vulnerable populations, such as mobile home parks	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	NA	Ward County EMA; Ward County Commission	General funds; NDDES & FEMA mitigation grant funding; in-king contribution; Ward County EMA	$50,000+	High	--
Goal 03: Protect public health and safety before, during, and after hazard events.	Dam safety / mitigation activities, including physical evaluations, failure analysis, inundation mapping, and other similar activates.	Flood	New	New and Existing	Ward County Water Board	General funds; NDDES & FEMA mitigation grant funding; in-king contribution; Ward County EMA	$500,000+	Low	--
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Develop GIS data regarding recently constructed assets, to provide for better hazard and risk mapping	Communicable disease; Drought; Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New/ Previous	New	Ward County Highway Department (GIS Department)	Ward County EMA	$1,000+	Moderate	New action for 2013, but based on a similar action from the 2008 Plan to identify critical facilities throughout the county for the NDSU Loss Estimation Project, which was not carried over to 2013 Plan

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible Department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 04: Ensure post-disaster operability of critical assets and infrastructure.	Ensure the operability of communications systems before, during, and after hazard events through mitigation measures to protect function	Communicable disease; Drought; Fire; Flood; Landslide; Severe summer storm; Severe winter storm; Hazardous materials incident	Previous	NA	Ward County E-911; P-Sat Manager; Ward County EMA	Ward County EMA	$10,000-$100,000	Medium	On-going; modification of 2008 action to erect communication towers, as towers and equipment must now be interoperable with other communications systems in the county
Goal 04: Ensure post-disaster operability of critical assets and infrastructure	Purchase and install emergency power generators for critical assets	Fire; Flood; Landslide; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and Existing	Ward County EMA	General funds; Department of Transportation; NDDES & FEMA mitigation grant funding; in-king contribution; Ward County EMA	$50,000+	High	--
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Continue collection and storage of data regarding the vulnerabilities of public assets and infrastructure, to develop mitigation actions to better protect them.	Fire; Flood; Severe summer storm; Severe winter storm; Hazardous materials incident	New	New and existing	Ward County EMA	General fund; in-kind contributions	$1,000+	Moderate	--

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible Department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Control water entering dead loops that are presently causing flooding of structures, to allow water to leave the dead loops and stay in the main channel. This will prevent flood waters from entering the loops and enhance existing dikes for flood protection.	Flood	Previous	Existing	Ward County Water Board	General funds; State Water Commission; NDDES & FEMA mitigation grant funding; in-king contributions	$100,000+	Low	Currently seeking funding for project; action carried over from 2008 Plan
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Design and construct flood control retention/detention areas to alleviate flooding in flood prone areas	Flood	New		Ward County Water Board	General funds; State Water Commission; NDDES & FEMA mitigation grant funding; in-king contribution; Ward County EMA	$100,000+	Low	--
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Acquire and relocate or demolish flood-damaged structures	Flood	New	Existing	Ward County Commission; Ward County EMA	General funds; State Water Commission; NDDES & FEMA mitigation grant funding; in-king contribution; Ward County EMA	$100,000+	Moderate	--

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible Department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Mitigate sewer systems to be more flood resistant in flood prone areas.	Flood	New	Existing	Ward County Water Board	General funds; State Water Commission; NDDES & FEMA mitigation grant funding; in-king contributions	$100,000 each	Low	
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Design and construct drainage channels/channel upgrades to manage flows in flood prone areas.	Flood	New	New and Existing	Ward County Water Board	General funds; State Water Commission; NDDES & FEMA mitigation grant funding; in-king contributions	$500,000+	High	
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Design and construct box culvert installation/box culvert upgrades to manage flows in flood prone areas.	Flood	New	New and Existing	Ward County Water Board	General funds; State Water Commission; NDDES & FEMA mitigation grant funding; in-king contributions	$1,000,000 each	Low	
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Design and culvert installation/ culvert upgrades to manage flows in flood prone areas.	Flood	New	New and Existing	Ward County Water Board	General funds; State Water Commission; NDDES & FEMA mitigation grant funding; in-king contributions	$50,000 each	Moderate	

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible Department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
Goal 05: Provide long-term mitigation solutions to areas / structures that experience repetitive hazard damage or loss.	Develop hydrologic models to better understand the relationship between flow, stage, and impact in flood prone areas.	Flood	New	New	Ward County Water Board	General funds; State Water Commission; NDDES & FEMA mitigation grant funding; in-king contributions	$20,000+ each	Moderate	
2008 Actions/Activities Not Carried Over to 2013 Plan Update, and Justification									
	Grade raise of CR 14 ¾ mile W of 16th Street SW in Minot to road/culvert standards, approximately 4" higher than current elevation, to provide flood protection to near 1% annual chance flows to prevent structure flooding.	Flood	Previous	Existing	Ward County Water Board	General funds; Department of Transportation; NDDES & FEMA mitigation grant funding; in-king contributions	$150,000	--	No longer required; project did not have public support, and was removed from Water Board's project listing
	Develop / implement measures and plans to identify potential water sources.	Drought	Previous	New and existing	Ward County EMA; County Engineer	--	--	--	Not carried over due to current wet cycle; may be revisited in future updates; Action not carried over to 2013 Plan due to lack of need at this time
	Assist fire department/EMS in purchasing new radio equipment	Rural Fire	Previous	New and Existing	Ward County EMA; Ward County LEPC	Homeland Security Grants have been secured to fund this project	$1,000,000	--	Action completed in 2008

Goal	Action	Hazard(s)	New or previous action	New or existing development	Responsible Department(s)	Resource(s)	Estimated Cost	Priority	Notes / Updates
	Install towers to provide county-wide interoperable communication network	Civil Disorder / Terrorism	Previous	New	Ward County EMA; Ward County LEPC	Homeland Security Grants have been secured to fund this project	$775,000	--	Action completed in 2008; hazard was not carried over to 2013 Plan
	Launch aggressive mass casualty and training/exercise schedule	Mass Casualty	Previous	--	Ward County; Ward County EMA	--	Unknown; costs vary	--	Project was completed with 2004 airport full scale exercise and 3006 state fair tabletop; hazard was not carried over to 2013 Plan
	Utilize reverse 911 (Community Alert Network CAN)	All hazards	Previous	--	Ward E-911	--	Negligible	--	Action currently funded through Homeland Security Grants and not carried over to 2013 Plan
	Become a "Storm Ready" county by meeting criteria	All hazards	Previous	--	Ward County EMA	--	$5,000	--	Project completed; not carried over to 2013 Plan

Section 17
HIRA Summary

17.1 Summary of HIRA for Planning Area

17.1 Summary of HIRA for Planning Area

Sections 04 through16 of this Plan Update provide the details of the Hazard Identification and Risk Assessment for Ward County and for all incorporated municipalities within Ward County, and provides the mitigation strategy developed for each participating jurisdiction. This section provides a summary of the findings in those sections, applicable to the planning area as a whole.

- The majority of the participating jurisdictions in the Ward County Hazard Mitigation Plan are small, both in area and in population, and have limited resources for hazard mitigation. The exceptions to this are Burlington, Kenmare, Surrey, and Minot, each of whom has varying degrees of resources. All jurisdictions in Ward County, to varying degrees, utilize the resources of the county for disaster preparedness, response, and recovery, for planning, and for hazard mitigation.
- Communicable disease is an emerging concern for the jurisdictions in the planning area. As the population of the are changes and new people move into the area, and as travel in and out of the area increases, the likelihood of exposure to new pathogens and illnesses increases, and poses a greater risk to the population.
- As of this Plan update, drought is not a hazard of concern for the planning area, though this will almost certainly change at some point in the future. North Dakota is in a wet cycle, which will end at some point. Once the current cycle ends, the likelihood of drought will increase, and the vulnerabilities associated with drought will once again become an issue for this largely agricultural area with a large population base.
- Fire is always a hazard of concern, and is a constant threat to the planning area. The emergence of temporary housing areas throughout the planning area increases the vulnerability of the area, as these temporary structures may not have the same level of fire resistance that more traditional structures have. In addition, wildland fire is always a concern in largely rural areas, and Ward County is no exception to this.
- Flooding is a concern for much of the planning area, but not for all of the planning area. For those areas where it is a concern, it is often a significant concern, and the vulnerability is significant.
- Severe summer storms are frequent occurrences that typically cause little damage, though the county and its municipalities are highly vulnerable to the impacts of these storms.
- Severe winter storms are a serious and frequent hazard. Transportation and supply issues are the primary concern, as these storms often leave transportation routes compromised,

which results in inabilities to deliver supplies (such as heating fuel) to areas that are in need.

- Though not a natural hazard, hazardous materials incidents are a significant threat to most of Ward County and the majority of incorporated municipalities. Agriculture, industry, military, and oil – the predominant industries in the planning area – are all typically users of hazardous materials, and those in the planning area are no exception.
- Landslides (Ward County only) are an emerging hazard of concern. As roadways age and hydrology changes, these events are likely to continue, and will likely continue to impact travel and transportation in the impacted areas. In addition, the county must continue to allocate resources towards addressing these incidents – resources that could be allocated elsewhere.

Development and population growth are occurring in some parts of the planning area, but not in all parts of the area. The growth is heavily concentrated in Minot; other municipalities are experiencing decline in both population and development. While some of this growth is due to flood recovery activities from the 2011 flood, the majority is attributable to the increase in energy acitivies throughout the state.

Some jurisdictions, such as Minot, have significant planning infrastructure, and so have formalized plans to guide future development. The majority of jurisdictions, however, do not have this infrastructure, or any pusblished guidance regarding development.

The participating jurisdictions in this Plan Update are aware of the hazards that are most likely to impact them, and are aware of their existing vulnerabilities. They are also aware of their capabilities and capacities, and of those areas that would benefit from additional resources. The mitigation strategies developed for each participating jurisdiction are intended to aid each community with their particular vulnerabilities, and to assist them with building capability and capacity at both the local and regional levels.

Section 18
Plan Monitoring and Maintenance

18.1 Interim Final Rile Requirement for Plan Monitoring and Maintenance
18.2 Method for Monitoring the Plan
18.2.1 Implementation
18.2.2 Public Education and Outreach
18.2.3 Hazard Mitigation Plan Steering Committee
18.3 Schedule for Monitoring the Plan
18.4 Method and Schedule for Evaluating and Updating the Plan
18.5 Incorporating the Plan into Existing Planning Mechanisms
18.6 Circumstances that Will Initiate Plan Review and Updates
18.7 Continued Public Involvement
18.8 Points of Contact for Plan Monitoring and Maintenance Activities

18.1 Interim Final Rule Requirement for Plan Monitoring and Maintenance

Requirement §201.6(c)(4)(i): *[The plan maintenance process* ***shall*** *include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle*

Requirement §201.6(c)(4)(ii): *[The plan* ***shall*** *include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.*

Requirement §201.6(c)(4)(iii): *[The plan maintenance process* ***shall*** *include a] discussion on how the community will continue public participation in the plan maintenance process.*

The Ward County Hazard Mitigation Plan will be monitored, maintained, and updated by the Ward County Emergency Management Director (EMD), with the assistance and participation of all participating jurisdictions included in the Plan.

The contact information for the Ward County EMD is:

Amanda Schooling
Amanda.Schooling@wardnd.com
701.857.6534

18.2 Method for Monitoring the Plan

The County's maintenance strategy for implementation, monitoring, and evaluation provides a structure that encourages collaboration, information sharing, and innovation. Through a multi-tiered implementation method, the County will work with partners and residents to implement a highly localized approach to loss reduction while serving communal needs through coordinated policies and programs. Through this strategy, Ward County will work to break the disaster cycle and achieve more disaster resistant communities.

This Plan will be monitored by the Ward County Emergency Management Director (EMD). The EMD will monitor the plan for several related purposes:

- To maintain the currency of hazard and risk information;
- To ensure that the mitigation strategies reflect the priorities of participating communities and stakeholders;
- To comply with Federal Emergency Management Agency (FEMA) and State of North Dakota requirements for Plan maintenance;
- To maintain eligibility for state and federal disaster assistance and mitigation grants for both Ward County and for all participating jurisdictions; and
- To ensure this Plan is in harmony with other planning efforts throughout the planning area.

The EMD will continuously monitor the Plan with respect to the purposes noted above, and with respect to the update triggers noted below.

18.2.1 Implementation

In order to ensure efficient and effective implementation, the County will make use of its existing capabilities and infrastructure. The County and all participating jurisdictions will implement the mitigation strategies described in this Plan over the next five years. In many cases, it is intended that these strategies will be implemented as collaborative efforts, as partnerships between the County and the respective jurisdiction.

The County EMD will work in conjunction with those departments identified in both the capability identification and the mitigation strategy section to initiate the strategy outlined in the Mitigation Strategy for each participating jurisdiction. For example, all measures involving public information and outreach will be coordinated with the City Council or County Commission, which serves as the elected representatives of the jurisdiction.

18.2.2 Public Education Programs

At the individual resident level, public education and outreach programs provide the planning area with localized mechanisms for implementation. This approach to mitigation can adapt to the varying vulnerabilities and needs throughout the planning area. Public education programs are

also a means for involving the public in mitigation policy development. Departments conducting mitigation-related programs will provide information regarding proposed mitigation measures to individuals, to aid individuals in choosing methods those that would be most effective in their communities.

The public education programs level will also include NFIP recommended aspects that will help establish the planning area's participating in the CRS, should entity opt to join the program.

18.2.3 Hazard Mitigation Plan Steering Committee

The Ward County Hazard Mitigation Plan Steering Committee, who oversaw the development of this Plan update, will be the body responsible for determining the direction of mitigation policy recommendations and will be responsible for reviewing the performance measures and Plan implementation. The Steering Committee, which also serves as the County's LEPC, represents a County-wide group of hazard and vulnerability experts and government employees whose departments will be responsible for many of the implementation activities. The Steering Committee will be responsible for collaborating on County-wide policies and programs on the city-wide level.

Steering Committee/LEPC meetings occur twice monthly on a regular schedule. When required, but at least annually, the Steering committee will be responsible for monitoring, evaluating, and updating the Plan (discussed below). The Steering Committee will ultimately provide a mechanism for coordination among those departments engaged in mitigation to ensure that a comprehensive and efficient approach be undertaken in the planning area's efforts at all-hazards mitigation. The Ward County Emergency Management Director will initiate and coordinate these efforts.

18.3 Schedule for Monitoring the Plan

Plan monitoring activities will be ongoing. In addition to the FEMA-mandated five year update cycle, the Ward County EMD will perform a review of the Plan at least annually, or more often as circumstances require. At least annually, a progress report will be prepared by each participating jurisdiction, noting any updates to information in the Plan or progress that has been made towards the goals, objectives or actions identified in the Plan. These reports can be found in Appendix E.

In addition to the scheduled reports, the Steering Committee will convene meetings after damage-causing natural hazard events to review the effects of such events. Based on those effects, adjustments to the mitigation priorities identified in the mitigation strategies may be made or additional event-specific actions identified.

18.4 Method and Schedule for Evaluating and Updating the Plan

The Ward County Hazard Mitigation Plan will be updated within five years, and will be submitted to NDDES and FEMA for review and approval.

Comprehensive review of and revisions to this Plan will be undertaken on a five-year cycle. This Plan was adopted in September 2013, and thus must undergo a formal FEMA-compliant update process by September 2018. Approximately 18-24 months prior to the five year anniversary of Plan adoption, the EMD will initiate a comprehensive review of the Plan with particular attention to FEMA guidance, and will seek funding to perform this update.

The EMD will prepare a report (1) describing the update requirements; (2) summarizing the staff analysis of the Plan, highlighting areas that require modification and explaining the reasons why the modification is needed, and; (3) providing detailed recommendations about how the Plan should be updated, noting any technical work that may be required. The report will be provided to the Steering Committee for consideration; the Committee will review the report and provide recommendations for updates. The report will also be posted on the County's website for public review and comment, with notifications provided to all participating jurisdictions for dissemination within their community.

The County EMD will be responsible for the completion of any updates determined by the Steering Committee to be necessary.

When the draft updates are completed, the Steering Committee will conduct a comprehensive evaluation and revision. The EMD will produce a final draft of the updated Plan for consideration by the Steering Committee, who will review the updated Plan, indicate any desired changes, and recommend approval and adoption of the Plan in sufficient time to meet FEMA requirements.

18.5 Incorporation into Existing Planning Mechanisms

A wide array of planning authority and action capability exists within the planning area. Some participating jurisdictions have taken the opportunity to incorporate information from the 2008 Plan into their existing programs and decision-making processes, and have used this information to inform themselves of the risks and vulnerabilities they face, in addition to the mitigation strategy described in that Plan. This information has been used, to the extent possible and practicable, to create more sustainable, disaster-resilient communities. This effort will continue with the adoption and approval of this Plan, which contains a higher degree of detailed information by jurisdiction than previous versions of the Plan.

A variety of existing plans were reviewed and considered during the development of this Plan update, including:

- Comprehensive Plans;
- Land Use Plans;
- Master Plans;
- Zoning Codes/Ordinances; and
- Stormwater Plans/Policies.

Going forward, this Plan will be considered in the development and updating of new and existing plans and planning efforts. All participating jurisdictions in this Plan are responsible for creating and maintaining a process by which this Plan will be considered and incorporated into their other planning mechanisms. This work will be accomplished with the assistance of the Ward County EMD.

Upon approval of this Plan, each participating jurisdictions will be provided with a copy of the approved Plan. The identified point of contact for each participating jurisdiction will be responsible for ensuring that the approved Plan is available to the appropriate staff within the jurisdiction, to ensure that the Plan can be incorporated into all applicable planning mechanisms. In addition, the Plan will be posted to the County's website, where it will be available to and accessible by the general public as well as all participating jurisdictions.

18.6 Circumstances that will Initiate Plan Review and Updates

This section identifies the circumstances or conditions under which the Ward County EMD will initiate Plan reviews and/or updates:

- On the recommendation of the Steering Committee or on its own initiative, any City Council or County Commission may initiate a Plan review at any time.
- At the close of each calendar year.
- After natural hazard events that appear to significantly change the apparent risk to planning area's assets, operations and/or constituents.

The Plan will guide the planning area's mitigation efforts for the foreseeable future. The Steering Committee has developed a method to ensure that regular review and update of the Plan occurs within a five-year cycle. The Ward County EMD will coordinate all reviews.

The Ward County EMD will collaborate with members of the Steering Committee to monitor and evaluate the mitigation strategy implementation. This will be done through project implementation tracking. Findings will be presented and discussed at LEPC/Steering Committee meetings.

At the close of each calendar year, the Ward County EMD will provide each participating jurisdiction with a project implementation questionnaire. This questionnaire will provide the

mechanism by which project implementation information can be collected and tracked, and will allow for an assessment of the overall implementation of the Plan, at both the County and the municipal levels.

The EMD will provide a report of the entire implementation strategy to the Steering Committee during meetings. This report will drive will include the following:

- Updates on implementation at the public education and community planning levels;
- Updates on mitigation activities undertaken;
- Changes or anticipated changes in hazard risk and vulnerability at the county, regional, State, FEMA, and US Department of Homeland Security levels;
- Any implementation activities undertaken, by participating jurisdiciton;
- Problems encountered or success stories; and
- Any technical or scientific advances that may alter, make easier, or create new measures.

Finally, the Steering Committee will determine updates to the strategy based on the above information and a discussion of:

- The various resources available through budgetary means as well as any relevant grants;
- The current and expected political environment and public opinion; and
- Meeting the mitigation goals with regards to changing conditions.

18.7 Continued Public Involvement

As noted above, this Plan will be evaluated and updated periodically and when certain triggering events occur. The County and participating jurisdictions will utilize public notices in an effort to include the public in the update process. The County EMD, in conjunction with the participating jurisdictions, will undertake public outreach and awareness activities as outlined in the Mitigation Strategy.

Ward County and its participating jurisdictions are dedicated to continued public involvement and education in review and updates of the Plan. This dedication is reflected in many of the mitigation measures described in the Mitigation Strategies. The Steering Committee will seek comment at such time the plan undergoes a formal update. In addition, the Steering Committee is committed to public education and will include information regarding hazard mitigation and community disaster resistance in educational materials and presentations as appropriate.

The public will also have the opportunity to provide ongoing feedback about the Plan. The County will maintain a copy of the Plan on its website, which will be accessible to the general public for the entire approval period.

The tiered implementation structure provides an opportunity for continuous public involvement. Public education campaigns and community planning groups are a means of informing the public on updates and implementation activities. Each participating jurisdiction will provide a public meeting prior to the adoption of the Plan; public comments will be requested during this meeting. The meeting will provide the public a forum for expressing concerns, opinions, or ideas about the Plan as well as other plans. These meetings will be advertised in advance through a variety of media.

18.8 Points of Contact for Plan Monitoring and Maintenance Activities

The following table (Table 18.8-1) lists the identified points of contact for each participating jurisdiction in the Plan.

Table 18.1-1
Ward County Hazard Mitigation Plan – Points of Contact

Ward County Hazard Mitigation Plan – Points of Contact			
Name	**Title**	**Municipality /Department**	**Contact Information**
Rich Blahut	Chief	City of Berthold Fire Department	701.833.5734
Jeanine Kabanuk	Councilmember	City of Burlington	kabanuk@min.midco.net
Kal Myers	Mayor	City of Carpio	Kalmyers.km@gmail.com
Darrell Francis	Councilmember	City of Des Lacs	jfrancis@minot.com
Gayle Lawson	City Auditor	City of Donnybrook -	701.482.7856
Joe Nelson	Mayor	City of Douglas	701.529.4473
Barb Wiedmer	City Auditor	City of Kenmare	701.385.4232
Tyler Stafslien	Mayor	City of Makoti	701.726.5000
Dan Jonasson	Director	City of Minot Public Works	Dan.Jonasson@minotnd.org
Jodi Reinisch	Mayor	City of Ryder	reinisch@rtc.coop
Cody Roteliuk	City Auditor	City of Sawyer	Sawyer81@srt.com
Jason Vaagen	City Auditor	City of Surrey	surreycityauditor@srt.com
Amanda Schooling	Director	Ward County Emergency Management	Amanda.Schooling @wardnd.com

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Appendix A
Glossary

100-year flood or 1% flood: The flood elevation that has a 1% chance of being equaled or exceeded each year (see also BFE, SFHA). Thus, the 1% flood could occur more than once in a relatively short period of time. The 100-year flood, which is the standard used by most federal and state agencies, is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance.

500-year flood or 0.2% flood: The flood elevation that has a .02% chance of being equaled or exceeded each year.

Acquisition: Local governments can acquire lands in high hazard areas through conservation easements, purchase of development rights, or outright purchase of property.

Acquisition of hazard prone structures: Local governments can acquire lands in high hazard areas through conservation easements, purchase of development rights, or outright purchase of property.

All-hazards approach: Integrated hazard mitigation strategy that incorporates planning for and consideration of all potential natural and manmade hazard threats.

Asset: Any manmade or natural feature that has value, including, but not limited to people; buildings; infrastructure like bridges, roads, and sewer and water systems; lifelines like electricity and communication resources; or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks.

Base flood: Flood that has a 1% probability of being equaled or exceeded in any given year. Also known as the 100-year flood.

Base Flood Elevation (BFE): Elevation of the base flood in relation to a specified datum, such as the National Geodetic Vertical Datum of 1929. The Base Flood Elevation is used as the standard for the National Flood Insurance Program.

Bedrock: The solid rock that underlies loose material, such as soil, sand, clay, or gravel.

Benefit: Net project outcomes, usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of conducting a benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable risk reduction factors, including a reduction in expected property losses (building, contents, and function) and protection of human life.

Benefit-cost analysis (BCA): Benefit-cost analysis is a systematic, quantitative method of comparing the projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Biological event: An occurrence of a biological substance that poses a threat to the health of living organisms, primarily that of humans. This can include medical waste or samples of a microorganism, virus or toxin (from a biological source) that can impact human health. It can also include substances harmful to animals.

Building: A structure that is walled and roofed, principally above ground and permanently affixed to a site. The term includes a manufactured home on a permanent foundation on which the wheels and axles carry no weight.

CFR: Code of Federal Regulation

Contour: A line of equal ground elevation on a topographic map.

Critical facility: Facilities that are vital to the health and welfare of the population and that are especially important following disasters. Critical facilities include, but are not limited to, shelters, police and fire facilities, and hospitals.

CRS: Community Rating System a Nation Flood Insurance Program that provides incentives for NFIP-member communities to complete activities that reduce flood hazard risk. When the community completes specified activities, the insurance premiums of NFIP policyholders in these communities are reduced.

DFRIM: Digital Flood Insurance rate Map

Debris: The scattered remains of assets broken or destroyed in a hazard event. Debris caused by a wind or water hazard event can cause additional damage to other assets.

Disaster Mitigation Act of 2000 (DMA 2000): DMA 2000 (Public Law 106-390) was signed into law on October 10, 2000. This legislation reinforces the importance of mitigation planning and emphasizes planning for disasters before they occur.

Drought: The consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length.

Environmental disaster: An incident which causes harm or negative consequences to the natural environment due to human activity. Environmental disasters may be exacerbated by natural phenomenon, but they do not originate from nature.

Erosion: Wearing away of the land surface by detachment and movement of soil and rock fragments, during a flood or storm or over a period of years, through the action of wind, water, or other geologic processes.

Extent: The size of an area affected by a hazard or hazard event.

Federal Emergency Management Agency (FEMA): Independent agency created in 1979 to provide a single point of accountability for all federal activities related to disaster mitigation and emergency preparedness, response, and recovery. The agency was later merged into the US Department of Homeland Security.

Federal Insurance Administration: A division of FEMA responsible for administering the flood insurance aspects of the NFIP.

Flash flood: A flash flood is a specific type of flood that appears and moves quickly across the land with little warning, making it very dangerous. A flash flood is the fastest-moving type of flood. It happens when heavy rain collects in a stream or gully, turning the normally calm area into an instant rushing current.

Flood: A general and temporary condition of partial or complete inundation of normally dry land areas from: (1) the overflow of inland or tidal waters; (2) the unusual and rapid accumulation of runoff of surface water from any source.

Flood boundary and floodway map: A flood plain management map issued by FEMA that shows, based on detailed and approximate analyses, the boundaries of the 1% and .02% floodplains and the 1% floodway.

Flood depth: Height of the flood water surface above the ground surface

Flood elevation: Elevation of the water surface above an established datum, e.g. National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988 or Mean Sea Level.

Flood fringe: That portion of the 1% floodplain outside the floodway in which total encroachment is permissible.

Flood Hazard Boundary Map (FHBM): The initial insurance map issued by FEMA that identifies approximate areas of 1% flood hazard in a community.

Flood Insurance Rate Map (FIRM): Also referred to as **DFIRM (Digital Flood Insurance Rate Map)**; the official map of a community for which FEMA has delineated both the special hazard areas (1% floodplain) and the risk premium zones applicable to the community.

Flood Insurance Study (FIS): A study that is produced by FEMA and evaluates flood hazard areas, describes its causes, and identifies flood protection measures. Depending on the area studied, the FIS may include water surface elevations. An FIS is developed in conjunction with a Flood Insurance Rate Map (FIRM).

Floodplain: Any land susceptible to inundation by floodwaters from any source.

Floodproofing: Any combination of structural and non-structural additions, changes or adjustments to structures which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures, and their contents.

Fujita scale: The Fujita Scale measures tornado damage severity by assigning numerical values based on wind speeds. Tornadoes are categorizes from 0 to 5 depending on wind speeds. The letter "F" often precedes the numerical value. As with the Fujita scale, the **Enhanced Fujita Scale** remains a damage scale and only a proxy for actual wind speeds. While the wind speeds associated with the damage listed have not undergone empirical analysis (e.g., detailed physical or any numerical modeling) owing to excessive cost, the wind speeds were obtained through a process of expert elicitation based on various engineering studies since the 1970s as well as from field experience of meteorologists and engineers. In addition to damage to structures and vegetation, radar data, photogrammetry, and cycloidal marks (ground swirl patterns) may be utilized when available.

Geographic Information System (GIS): A computer software application that relates physical features on the earth to a database to be used for mapping and analysis.

Hazard: A source of potential danger or adverse conditions.

Hazard identification: The process of identifying hazards that threaten an area.

Hazard mitigation: Sustained actions taken to reduce or eliminate long-term risk from hazards and their effects.

Hazard Mitigation Grant Program (HMGP): Provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.

Hazard profile: A description of the physical characteristics of hazards and a determination of various descriptors including magnitude, duration, frequency, probability, and extent.

Hazardous materials incident: A biological, chemical or physical agent with the potential to cause harm to the environment or people on its own or when combined with other factors or materials.

HAZUS (Hazards U.S.): A GIS-based, nationally standardized, loss estimation tool developed by FEMA.

Heat index: Heat stress can be indexed by combining the effects of temperature and humidity. The National Weather Service will initiate alert procedures such as special weather statements when the heat index is expected to exceed 105˚F-110˚F (depending on local climate), for at least two consecutive days.

Hydrology: The science of dealing with the waters of the earth. A flood discharge is developed by a hydrologic study.

Infrastructure: Refers to the public services of a community that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or Internet access, vital services such as public water supplies and sewer treatment facilities, and includes an area's transportation system such as airports, heliports, highways, bridges, tunnels, roadbeds, overpasses, railways, bridges, rail yards, depots; and waterways, piers, and regional dams.

Intensity: A measure of the effects of a hazard event at a particular place.

Landslide: Downward movement of a slope and materials under the force of gravity.

Lightning: An atmospheric discharge of electricity accompanied by thunder, which typically occurs during thunderstorms, and sometimes during volcanic eruptions or dust storms. In the atmospheric electrical discharge, a leader of a bolt of lightning can travel at speeds of 130,000 MPH, and can reach temperatures approaching 54,000 °F, hot enough to fuse silica sand into glass.

Local Emergency Planning Committee (LEPC): LEPCs consist of community representatives and are appointed by the State Emergency Response Commissions (SERCs), as required by Superfund Amendments and Reauthorization Act (SARA), Title III. They develop an emergency plan to prepare for and respond to chemical emergencies. They are also responsible for coordinating with local facilities to find out what they are doing to reduce hazards, prepare for accidents, and reduce hazardous inventories and releases. The LEPC serves as a focal point in the community for information and discussions about hazardous substances, emergency planning, and health and environmental risks.

Loss of Function: Damage to a facility or interruption of service to a point that the facility or service can no longer provide a public benefit. Most often associated with utilities and critical service providers, such as police and fire facilities.

Lowest Floor: Under the NFIP, the lowest floor of the lowest enclosed area (including basement) of a structure.

Magnitude: A measure of the strength of a hazard event. The magnitude (also referred to as severity) of a given hazard is usually determined using technical measures specific to a hazard.

Mitigate: To cause something to become less harsh or hostile, to make less severe or painful.

Mitigation: The process of reducing the severity of the impact of natural hazards through planning. Each hazard requires a specific type of mitigation. In some cases, we can use engineering solutions (such as an earthquake-resistant building) to at least temporarily reduce the impact of a natural hazard. In other cases, the only form of mitigation that is guaranteed to be successful is to limit or not allow human activities where the hazard occurs (such as in floodplains).

Mitigation plan: A systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards typically present in the state and includes a description of actions to minimize future vulnerability to natural hazards.

Monitoring: periodic collection of data to study changes in an environment over time.

National Fire Danger Rating System (NFDRS): A set of computer programs and algorithms that allow land management agencies to estimate today's or tomorrow's fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather, or what is commonly called the fire triangle.

National Flood Insurance Program (NFIP): A federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

Natural disaster: A natural hazard event, such as a flood or tornado, which results in widespread destruction of property or caused injury and/or death.

NFIP: National Flood Insurance Program

NOAA: National Oceanic and Atmospheric Administration

PA: Public Assistance

Palmer Drought Index: This index was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index. The Palmer Index is most effective in determining long term drought.

PDA: Preliminary Damage Assessment

Planning: The act or process of making or carrying out plans; the establishment of goals, policies, and procedures for a social or economic unit.

Pre-Disaster Mitigation Program (PDM): Authorized by Section 204 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 USC, as amended by 102 of the Disaster Mitigation Act Mitigation Fund to assist States and local governments (to include Indian Tribal governments) in implementing cost-effective hazard mitigation activities that complement a comprehensive mitigation program.

Preparedness: Actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Probability: A statistical measure of the likelihood that a hazard event will occur.

Recovery: The actions taken by an individual or community after a catastrophic event to restore order and lifelines in a community.

Regulatory Power: Local jurisdictions have the authority to regulate certain activities in their jurisdiction. With respect to mitigation planning, the focus is on such things as regulating land use development and construction through zoning, subdivision regulations, design standards, and floodplain regulations.

Repetitive Flood Claims (RFC): The Repetitive Flood Claims (RFC) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108-264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S. C. 4001, et al).

Repetitive Loss property: A property that is currently insured for which two or more National Flood Insurance Program losses (occurring more than ten days apart) of at least $1,000.00 each have been paid within any 10-year period of time since 1978.

Response: The actions taken during an event to address immediate life and safety needs and to minimize further damage to properties.

Risk: The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to a specific type of hazard event. It also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk management: the process by which the results of an assessment are integrated with political, economic, and engineering information to establish programs, projects, and policies for reducing future losses and dealing with the damage after it occurs.

Riverine: Of or produced by a river

Scale: A proportion used in determining a dimensional relationship; the ratio of the distance between two points on a map and the actual distance between the two points on the earth's surface.

Scour: Removal of soil or fill material by the flow of floodwaters. The term is frequently used to describe storm-induced, localized conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence.

Severe Repetitive Loss (SRL): The Severe Repetitive Loss (SRL) grant program was authorized by the Bunning-Bureuter-Blumenaure Flood Insurance Reform Act of 2004, which amended the National Flood Insurance Act of 1968 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP).

Special Flood Hazard Area (SFHA): A high-risk area defined as any land that would be inundated by a flood having a 1% chance of occurring in any given year (see also BFE, 100-year flood). The SFHA is commonly identified on NFIP Flood Insurance Rate Maps (FIRMs). A structure located within a SFHA shown on a FIRM has a 26% chance of suffering flood damage during the term of a 30-year mortgage.

Stafford Act: The Robert t. Stafford Disaster Relief and Emergency Act, P.L. 100-107 was signed into law November 23, 1988 and amended the Disaster Relief Act of 1974, P.L. 23-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

State Hazard Mitigation Officer (SHMO): The representative of state government who is the primary point of contact with FEMA, other state and federal agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation activities.

Substantial damage: Damage of any origin sustained by an obstruction whereby the cost of restoring the obstruction to its before-damage condition would equal or exceed 50 percent of the market value of the obstruction before the damage occurred.

Substantial improvement: Any reconstruction, rehabilitation, addition, or other improvement of an obstruction, the cost of which equals or exceed 50% of the obstruction before "start of construction" of the improvement. This includes obstructions which have incurred "substantial damage, "regardless of the actual repair work performed. The term does not, however, include either (1) any project for improvement of a structure or other obstruction to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living condition, or (2) any alteration of a "historic structure," provided that the alteration will not preclude the structure's continued designation as a "historic structure."

Technological disaster: A disaster that results from a technological or man-made hazard event.

Technological hazard: A hazard that originates in accidental or intentional human activity (oil spill, chemical spill, building fires, terrorism, etc.).

Topographic map: A map that shows natural features and indicates the physical shape of land using contour lines. These maps may also include manmade features.

Tornado: A violently rotating column of air extending ground-ward.

Tornado and Storm Research Organization (TORRO) Scale: The scale extends from H0 to H10 with its increments of intensity or damage potential related to hail size (distribution and maximum), texture, numbers, fall speed, speed of storm translation, and strength of the accompanying wind. This is scale is often used in conjunction with the **NOAA hail intensity scale**, which focuses on diameter and description (compared to objects such as coins) for the purpose of measuring hail events.

UHMA: Unified Hazard Mitigation Assistance Program

USACE: United States Army Corps of Engineers

USDA: United States Department of Agriculture

US Drought Monitor: Provides a consolidated depiction of national drought conditions based on a combination of drought indicators and field reports.

USGS: United States Geological Survey

Vulnerability: Describes how exposed or susceptible to damage an asset is. Vulnerability depends upon an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another.

Vulnerability assessment: the qualitative or quantitative examination of the exposure of some component of society, economy, or the environment to natural hazards.

Wildfire An uncontrollable fire spreading through vegetative fuels, exposing and possibly consuming structures.

Wind: The horizontal motion of the air past a given point. Winds begin with differences in air pressures. Pressure that's higher at one place than another sets up a force pushing from the high toward the low pressure. The greater the difference in pressures, the stronger the force. The

distance between the area of high pressure and the area of low pressure also determines how fast the moving air is accelerated. Meteorologists refer to the force that starts the wind flowing as the "pressure gradient force." High and low pressures are relative. There's no set number that divides high and low pressure. Wind is used to describe the prevailing direction from which the wind is blowing with the speed given usually in miles per hour or knots.

Zone A (Unnumbered): Special Flood Hazard Areas subject to inundation from the 1% flood. Because detailed hydraulic analyses have not been performed, no base flood elevations or depths are shown. Mandatory flood insurance purchase requirements apply.

Zone AE and A1-30: Special Flood Hazard Areas subject to inundation by the 1% flood determined in a Flood Insurance Study by detailed methods. Base flood elevations are shown within these zones. Mandatory flood insurance purchase requirements apply. (Zone AE is used on new and revised maps in place of Zones A1-30.)

Zone AH: Special Flood Hazard Areas subject to inundation by 1% shallow flooding (usually areas of ponding) where average depths are between one and three feet. Base flood elevations derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements apply.

Zone AO: Special Flood Hazard Areas subject to inundation by 1% shallow flooding (usually sheet flow on sloping terrain**)** where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown within this zone. Mandatory flood insurance purchase requirements apply.

Zone B, C, and X: Areas that have been identified in the community flood insurance study as areas of moderate or minimal flooding from a principal source in the area. However, buildings in these zones could be flooded by severe, concentrated rainfall coupled with inadequate local drainage systems. Flood insurance is available in participating communities but is not required by regulation in these zones. (Zone X is used on new and revised maps in place of Zones B and C.)

Zone D: Unstudied areas where flood hazards are undetermined but flooding is possible. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

Appendix B
Adoption Resolutions and Approval Documentation

B.1 City of Berthold
B.2 City of Burlington
B.3 City of Carpio
B.4 City of Des Lacs
B.5 City of Donnybrook
B.6 City of Douglas
B.7 City of Kenmare
B.8 City of Makoti
B.9 City of Minot
B.10 City of Ryder
B.11 City of Sawyer
B.12 City of Surrey
B.13 Ward County

B.1 City of Berthold

B.2 City of Burlington

B.3 City of Carpio

B.4 City of Des Lacs

B.5 City of Donnybrook

B.6 City of Douglas

B.7 City of Kenmare

B.8 City of Makoti

B.9 City of Minot

B.10 City of Ryder

B.11 City of Sawyer

B.12 City of Surrey

B.13 Ward County

Appendix C
Steering Committee Meeting Documentation

C.1 Meeting #1 (February 07, 2013)
C.2 Meeting #2 (March 07, 2013)
C.3 Meeting #3 (April 04, 2013)
C.4 Municipality Meetings (April 01-05, 2013)
C.5 Meeting Presentations

C.1 Meeting #1 (February 07, 2013)

Meeting #1, also referred to as the Kickoff Meeting, was held February 07, 2013, at the Minot Rural Fire Department in Minot, ND. This section contains the following meeting documentation:

- Invitation to Meeting #1,
- Meeting #1 Sign-In Sheet,
- Meeting #1 Agenda, and
- Meeting #1 Notes.

Note that the same invitation was sent to all participants in the Plan Update, but that only one invitation is presented here, to avoid duplication, as all invitations were the same except for the address and the salutation. If necessary, copies of invitations to all 13 participants can be provided.

Figure C.1-1
Invitation to Kickoff Meeting

WARD COUNTY EMERGENCY MANAGEMENT AGENCY
315 3RD STREET SE
PO BOX 5005
MINOT ND 58702-5005

January 31st, 2013

Ward County Emergency Management Office
315 3rd St SE
P.O. Box 5005
Minot, ND 58701

City of Surrey
Attn: Mayor
209 Pleasant Ave N
Surrey, ND 58785

Dear Officials of the City of Surrey,

We want to remind you of the planning meeting for the Ward County Hazard Mitigation Plan Update that will be held in conjunction with our Local Emergency Planning Council on **Thursday, February 7th at 9:00am at Minot Rural Fire Department (400 31st Ave SW, Minot). We want to stress that it is important to have at least one person from each city attend this kickoff meeting.** This representative could be a City Council Member, Mayor, Auditor, or Fire Department/Law Enforcement Official.

If you have any further questions please contact our office at (701) 857-6534 or email to Amanda.schooling@wardnd.com.

Sincerely,

Amanda Schooling

Amanda Schooling
Ward County Emergency Management

Follow us on Facebook (search for Ward County Emergency Management) or visit us at
www.co.ward.nd.us/emergency-management

Figure C.1-2
Meeting #1 Sign-in Sheet (page 1 of 3)

Ward County, ND
Hazard Mitigation Plan Update
Kickoff Meeting – February 07, 2013

Sign-in Sheet

Name	Office/Department/Agency	Title	Email
JASON OISON	MINOT POLICE DEPT.	CHIEF	JASON.OISON@MINOTND.ORG
Bob Dannard	Ward Sped. Ed	Dir	bob.dannard@wardsped.com
Steven P. Kulkowski	WARD CO. S.O.	SHERIFF	steve.kulkowski@wardnd.com
Jack Nybakken	Ward Co. Commission	Commissioner	jack.nybakken@wardnd.com
Tim Beach	Minot Fire Dept	Asst. Chief	tim.beach@minotnd.org
Rob White	Minot Police Dept.	Captain	rob.white@minotnd.org
Al Schmidt	Bethold Police Dept	Chief	Bethold PD@Gmail.com
Dan Jonassen	City of Minot Public Works	Director of Public Works	Dan.Jonassen@minotnd.org
Lance Meyer	City of Minot Engineering	City Engineer	lance.meyer@minotnd.org
Dana Larsen	Ward County Highway	County Eng.	dana.larsen@wardnd.com
Jeff Weaver	City of Burlington PW	Public Works Dir	BurlPW@SRT.com
Kalvin Myers	City of Carpio	Mayor/Fire chief	kalmyers.km@gmail.com
Jake Halley	Witt O'Brien's	GIS Specialist / Planner	jhalley@wittassociates.com
Kelly George	Witt O'Brien's	Project Manager / Senior Hazard Mitigation Planner	kgeorge@wittassociates.com

Meeting #1 Sign-in Sheet (page 2 of 3)

Ward County, ND
Hazard Mitigation Plan Update
Kickoff Meeting – February 07, 2013

Sign-in Sheet			
Name	Office/Department/Agency	Title	Email
Heather Harris	Ward Co EM	Assistant	heather.harris@wardnd.com
DAN GREEN	WARD CO. EM	ASSISTANT EM	DANIER.GREEN@WARDND.COM
Jim Bertz	Ward Co Hwy	GIS specialist	
BRANDON NEISS	MINOT STATE U.	CAMPUS SEC. OFFICER	brandon.neiss@minotstateu.edu
Cody Rotelink	City of Sawyer	Aud. for	sawyer81@sET.com
Connie Fischer	City of Makoti	City Council	fischerconnie@hotmail.com
Brian Horinka	Minot City Transit	Superintendent	brian.horinka@minotnd.org
CLAYTON FEGLEY	Berthold Ambulance	Squad leader	cfegley@SRT.COM
Chuck Leet	City of Kenmare	City Council Pres.	cjleet@restel.net
Jake Halley	Witt O'Brien's	GIS Specialist / Planner	jhalley@wittassociates.com
Kelly George	Witt O'Brien's	Project Manager / Senior Hazard Mitigation Planner	kgeorge@wittassociates.com

Meeting #1 Sign-in Sheet (page 3 of 3)

Ward County, ND
Hazard Mitigation Plan Update
Kickoff Meeting – February 07, 2013

Sign-in Sheet			
Name	**Office/Department/Agency**	**Title**	**Email**
Mark Norby	Des Lacs Fire Dept	chief	mcsnd@hotmail.com
Al HANSON	NDDES	Regional Coord.	allanhanson@nd.gov
Marcy Rose	Community Amb.	Clinical Spec.	Marcy R @ CAS Minot. Com
Mark Chilson	Community Amb.	Field Supervisor Paramedic	Mark C @ CASMINOT COM
Rosa Rivera	City of Carrington	City Council	RRIVERSAWW@ SRT. COM
Dave Kohlman	Trinity Health	VP Facilities	dave. Kohlman @trinityhealth.org
Bill Gagnon	CITY OF DOUGLAS	COUNCILMAN	
Jennifer Johns	City of Surrey	Dep. Auditor	Surreycityauditor@ srt. com
ART HASKINS	ENBRIDGE PIPELINES	EMERGENCY RESPONSE COORDINATOR	ART. HASKINS@. ENBRIDGE. COM
Jose Estrada	First District Health	Emergency Response Coord & Preparedness	Jestrada@ nd. gov
Jake Halley	Witt O'Brien's	GIS Specialist / Planner	jhalley@wittassociates.com
Kelly George	Witt O'Brien's	Project Manager / Senior Hazard Mitigation Planner	kgeorge@wittassociates.com

Figure C.1-3
Meeting #1 Agenda

Ward County, ND
Ward County Hazard Mitigation Plan Update
Kick-off Meeting
02.07.13

Agenda

Welcome and Introductions

Project Background and Purpose

- Why this project is being undertaken
- Why the plan should be updated

Overview of Project

- Requirements for hazard mitigation plan updates
- Process for development of plan update

Hazard Identification Exercise

Asset Criticality Ranking Worksheet

Capability Assessment Questionnaire (homework for next meeting)

Q&A and Next Steps

Figure D.1-4
Meeting #1 Notes

Ward County Hazard Mitigation Plan Update Kickoff Meeting
02.07.13

Meeting Summary:

Introductions of all participating members were initiated by Ward County EM staff.

Kelly George, of Witt O'Brien's, provided an overview of Hazard Mitigation and the Hazard Mitigation Plan Update process. Kelly discussed the following topics in detail.

- Requirements of the plan update process
- Advisory Committee's roles and responsibilities

The Hazard Mitigation Steering Committee agreed that the hazard terminology presented was acceptable for the plan update.

A discussion on identified hazard for the plan update ensued. The advisory committee determined the following:

- Avalanche was discounted from further discussion by the committee
- Landslides should be included as a stand-alone hazard, and will apply to the county only.
- Civil disorder/Terrorism/National Security Emergencies should be excluded from the Mitigation Plan due to duplication of efforts and potential conflicts with other planning mechanisms.
- Mass Casualty should be removed as a hazard and included as a planning consideration under other hazard events.
- Extreme Heat should be included under the Summer Storm Hazard.
- Rabid Animals should be included under the Communicable Diseases Hazard.
- Volcano was discussed due to potential impacts from Mt. St Helens and was determined to have a low probability.
- Urban Fire should be changed to Structural Fire.
- Population Influx was determined to be excluded as a hazard and discussed as a planning consideration under other hazard events.
- Dam and Levee Failure should be included under the Flood Hazard, where applicable.
- Shortage of Critical Materials should be excluded as a hazard and discussed under other hazard events vulnerabilities.
- Transportation Accidents should be excluded as a hazard and discussed under other hazard events vulnerabilities.

A review of the assets criticality ranking methodology was provided. The committee agreed with the criticality rankings with the exception of moving social services under level 2 ranking.

The potential of including a capability assessment in the plan update was discussed. The committee determined at this point of the plan update process to include a capability assessment.

Next meeting date was discussed and agreed upon for the first Thursday in March.

Meeting adjourned.

C.2 Meeting #2 (March 7, 2013)

Meeting #2 was held March 7, 2013, at the Minot Rural Fire Department in Minot, ND. This Appendix contains the following meeting documentation:

- Meeting #2 Reminder,
- Meeting #2 Sign-In Sheet,
- Meeting #2 Agenda, and
- Meeting #2 Notes.

Note that the same invitation was sent to all participants in the Plan Update, but that only one invitation is presented here, to avoid duplication, as all invitations were the same except for the address and the salutation. If necessary, copies of invitations to all 13 participants can be provided.

Figure C.2-1
Meeting #2 Reminder

WARD COUNTY EMERGENCY MANAGEMENT AGENCY
315 3RD STREET SE
PO BOX 5005
MINOT ND 58702-5005

February 26th, 2013

Ward County Emergency Management Office
315 3rd St SE
P.O. Box 5005
Minot, ND 58701

City of Surrey
Attn: Mayor
209 Pleasant Ave N
Surrey, ND 58785

Dear Officials of the City of Surrey,

We want to remind you of the next planning meeting for the Ward County Hazard Mitigation Plan Update that will be held in conjunction with our Local Emergency Planning Council on **Thursday, March 7th at 9:00am at Minot Rural Fire Department (400 31st Ave SW, Minot). It is critical for your community's participation that you have at least one representative in attendance.** This representative could be a City Council Member, Mayor, Auditor, or Fire Department/Law Enforcement Official. **Please do not forget to bring the capability assessment surveys** that you received in the mail or by email after our last meeting.

If you have any further questions please contact our office at (701) 857-6534 or email to Amanda.schooling@wardnd.com.

Sincerely,

Amanda Schooling

Amanda Schooling
Ward County Emergency Management

Follow us on Facebook (search for Ward County Emergency Management) or visit us at
www.co.ward.nd.us/emergency-management

Figure C.2-2
Meeting #2 Sign-in Sheet (page 1 of 2)

Ward County, ND
Hazard Mitigation Plan Update
Meeting #2 – March 07, 2013

Sign-in Sheet			
Name	**Office/Department/Agency**	**Title**	**Email**
P. KEITH CRABB	BURLINGTON POLICE	CHIEF OF POLICE	bpd1270@srt.com
Mark Chilson	Community Ambulance	Paramedic Supervisor	MarkC@CASMinot.com
Jim Mertz	Ward County Highway	GIS Specialist	jim.mertz@wardnd.com
Heather Harris	WCEM	Assistant	heather.harris@wardnd.com
Ross Rivers	City of Carpio	City Council	ross.rivers@yahoo.com
CLAYTON FEGLEY	Berthold Ambulance	Squad Leader	cfegley@srt.com
Al Schmidt	Berthold Police Dept	Chief of Police	BertholdPD@Gmail.com
JASON OLSON	MINOT PD	Chief of Police	jason.olson@minotnd.org
José L. Estrada	First District Health Unit	Emergency Preparedness Coord.	Jestrada@nd.gov
CJ CRAVEN	MINOT FIRE	CHIEF	CJ.CRAVEN@MINOTND.ORG
Tim Beach	Minot F.D.	Asst. Chief	tim.beach@minotnd.org
Randy Schwan	Trinity Health	VP	randy.schwan@trinityhealth.org
Robert Roed	Ward County S.O.	Patrol Lieutenant	Robert.Roed@WardND.com
Darrell Francis	City of Des Lacs	Representative Mayor & FD	jfrancis@minot.com

Meeting #2 Sign-in Sheet (page 2 of 2)

Ward County, ND
Hazard Mitigation Plan Update
Meeting #2 – March 07, 2013

Sign-in Sheet

Name	Office/Department/Agency	Title	Email
Rex Weltihol	Minot Rural Fire	Chief	Mrfd@srt.com
Amanda Schooling	Emergency Management	Director	amanda.schooling@uwrcind.com
Bill Gasvor	DOU SLAS	CITY COUNCIL	
Cody Robelinde	Lyay Sawyer	Auditor	Sawyer81@srt.com
Dan Greer	EMERGENCY MGT	ASST DIRECTOR	Daniel.greer@wardnd.com

Figure C.2-3
Meeting #2 Agenda

Ward County, ND
Ward County Hazard Mitigation Plan Update
Meeting #2
03.07.13

Agenda

Welcome and review of last meeting

Review asset criticality rankings and note any changes

Hazard Identification and Risk Assessment:

- Review historic hazard occurrence history
- Complete qualitative risk assessment
- Determine hazards to receive quantitative risk assessment
- Review preliminary maps

Capability Assessment – collect questionnaires

Mitigation Strategy Goals – retain or revise?

Municipality Meetings to discuss jurisdiction-specific mitigation strategy

- April 01-05, 2013

Figure C.2-4
Meeting #2 Notes

Welcome and review of last meeting

Review asset criticality rankings and note any changes

- The Steering Committee reviewed the rankings for the jurisdiction that they represented, and made changes/additions accordingly.

Hazard Identification and Risk Assessment:

- Review historic hazard occurrence history
  - No jurisdictional-specific occurrences were noted at this time.
- Complete qualitative risk assessment
  - All hazards will receive a qualitative risk assessment.
  - Landslides should only be included for the county, as they are only a concern for the county.
- Determine hazards to receive quantitative risk assessment
  - All hazards (except drought) will receive a quantitative risk assessment where there is an identified risk of the hazard.
  - Areas without mapped SFHAs will not receive a quantitative risk assessment.
- Review preliminary maps
  - Preliminary base maps were reviewed.
  - Discussion of recent annexations was held.

Capability Assessment – collect questionnaires

- Questionnaires were collected; others will be emails.

Mitigation Strategy Goals – retain or revise?

- Discussion of 2008 goals and suggested new/revised goals.

Municipality Meetings to discuss jurisdiction-specific mitigation strategy

- April 01-05, 2013

C.3 Meeting #3

Meeting #3 was held April 4, 2013 at the Minot Police Department's Training Room. This Appendix contains the following meeting documentation:

- Meeting #3 Reminder,
- Meeting #3 Sign-In Sheet,
- Meeting #3 Agenda, and
- Meeting #3 Notes.

Note that the same invitation was sent to all participants in the Plan Update, but that only one invitation is presented here, to avoid duplication, as all invitations were the same except for the address and the salutation. If necessary, copies of invitations to all 13 participants can be provided.

Figure C.3-1
Meeting #3 Reminder

WARD COUNTY EMERGENCY MANAGEMENT AGENCY
315 3RD STREET SE
PO BOX 5005
MINOT ND 58702-5005

March 28, 2013

Ward County Emergency Management Office
315 3rd St SE
P.O. Box 5005
Minot, ND 58701

City of Surrey
Attn: City Auditor
PO Box 429
Surrey, ND 58785

Dear City Auditor,

We want to remind you of the next planning meeting for the Ward County Hazard Mitigation Plan Update that will be held in conjunction with our Local Emergency Planning Council on **Thursday, April 4th at 9:00am at the Minot Police Training Room (515 2nd Ave SW Minot, ND 58701). It is critical for your community's participation that you have at least one representative in attendance.** This representative could be a City Council Member, Mayor, Auditor, or Fire Department/Law Enforcement Official.

If you have any further questions please contact our office at (701) 857-6534 or email to Amanda.schooling@wardnd.com.

Attached is a map of where the meeting is as well as where to park.

Sincerely,

Amanda Schooling

Amanda Schooling
Ward County Emergency Management

Follow us on Facebook (search for Ward County Emergency Management) or visit us at
www.co.ward.nd.us/emergency-management

Figure C.3-2
Meeting #3 Sign-in Sheet

Ward County HMP Update
Meeting #3
April 04, 2013

Name	Agency/Department/Organization	Title	Email or Phone
Darrell Francis	City of Des Lacs	Planning Commissioner	jfrancis@minot.com
Brian Hornka	Minot City Transit	Bus Superintendent	brian.hornka@minotnd.org
Barb Wiedmer	City of Kenmare	City Auditor	City of Kenmare@reskii.net
Dana Larsen	Ward County Highway	County Engineer	dana.larsen@wardnd.com
Amanda Schooling	Ward County EM	EM	amanda.schooling@wardnd.com
CJ CRAVEN	Minot Fire Dept	Chief	CJ.CRAVEN@MINOTND.ORG
Rex Weltikol	minot Rural Fire	chief	mrfd@srt.com
Jim Mertz	Ward County Highway	GIS Specialist	jim.mertz@wardnd.com
JAMIE HYATT	ND ARMY NATIONAL GUARD	OPERATIONS NCO	jamie.l.hyatt2@us.army.mil
BOB BANARD	WARD SO	CAPT	BOB.BANARD@WARDND.COM
Steve Kukowski	WARD S.O.	SHERIFF	steve.kukowski@wardnd.com
Randy Schwan	Trinity Health	VP	randy.schwan@trinityhealth.org
Dave Kehlman	Trinity Health	VP	dave.kehlman@trinityhealth.org
BILL EASTON	CITY OF DOUGLAS	COUNCILMAN	
JASON OLSON	MINOT P.D.	CHIEF	jason.olson@minotnd.org
DeVawn Beckman	Minot Central Dispatch	PSAP Manager	devawn.beckman@minotnd.org
DARIN EGGE	MINOT PD	911 COORD / LT.	darin.egge@minotnd.org
ROB WHITE	MINOT PD	CAPTAIN	rob.white@minotnd.org
Susan Vaagen	City of Surrey	City Administrator	surreycityauditor@srt.com
BRANDON NEISS	MINOT STATE U.	CAMPUS SECURITY OFFICER	brandon.neiss@minotstateu.edu

Figure C.3-3
Meeting #3 Agenda

Ward County, ND
Ward County Hazard Mitigation Plan Update
Meeting #3
04.04.13

Agenda

Welcome and review of last meeting

Update on municipality meetings

Hazard Identification and Risk Assessment:

- Review of qualitative hazard rankings
- Review of selected hazard maps

Capability Assessment – review of findings
- Include or not?

Overview of review/public comment/ submission process, and what happens after

Figure C.3-4
Meeting #3 Notes

Welcome and review of last meeting

Update on municipality meetings

- KG provided an update on the meetings held to date, and the progress made at each meeting

Hazard Identification and Risk Assessment:

- Review of qualitative hazard rankings
  - Steering Committee confirmed rankings, and assented to information presented
- Review of selected hazard maps
  - Steering Committee confirmed rankings, and assented to most information presented
    - Noted disagreement with US Forest Service's Wildland Fire Prediction Data, as it does not adequately account for crop land, but consent to use images with that notation was granted

Capability Assessment – review of findings

- Include or not?
  - Each jurisdiction's capability assessment (from 2008 plan and from questionnaires) was presented and reviewed
  - Steering Committee determined that all information presented should be included in Plan Update

Overview of review/public comment/ submission process, and what happens next

C.4 Municipality Meetings

As part of the Plan Update process, meetings were held with each participating jurisdiction. The purpose of these meetings was to develop the mitigation strategy for each jurisdiction, and to assign priority rankings to all actions included in the strategy. Actions were suggested to each

jurisdiction, based on the results of their individual HIRAs, and they were asked for any additional actions that they would add to address any other vulnerabilities known to the jurisdiction.

The following table (C.4-1) provides a summary of these meetings.

Table C-4.1
Summary of Municipality Meetings

Jurisdiction	Date of Meeting	Attendees		Summary of Meeting
Berthold	04.03.13	Gary Rademacher	Berthold Fire Department	Review of proposed mitigation actions and discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
		Rich Blahut	Berthold Fire Department	
		Amanda Schooling	Ward County EMA	
		Kelly George	Witt O'Brien's	
Burlington	04.01.13	Jeanine Kabanak	Burlington City Council	Review of proposed mitigation actions and discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
		Amanda Schooling	Ward County EMA	
		Dan Green	Ward County EMA	
Carpio	04.04.13	Kal Myers	Carpio Mayor and Fire Chief	Review of proposed mitigation actions and discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
		Amanda Schooling	Ward County EMA	
		Kelly George	Witt O'Brien's	
Des Lacs	04.01.13	Darrell Francis	Des Lacs Planning Commission	Review of proposed mitigation actions and discussion of any
		Amanda Schooling	Ward County EMA	

Jurisdiction	Date of Meeting	Attendees		Summary of Meeting
		Dan Green	Ward County EMA	additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
Donnybrook	04.01.13	Dennis Huff	Donnybrook Mayor	Review of proposed mitigation actions and discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
		Tom Lawson	Donnybrook City Council	
		Larry Goettle	Donnybrook City Council	
		Mary Knutson	Donnybrook City Council	
		Lee Breland	Donnybrook City Council	
		Amanda Schooling	Ward County EMA	
		Kelly George	Witt O'Brien's	
Douglas	04.03.13	Joe Nelson	Douglas Mayor	Review of proposed mitigation actions and discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
		Kay Olson	Douglas City Council	
		Linda Bergesun	Douglas City Council	
		Bill Gagnon	Douglas City Council	
		Myrna Ness	Douglas City Council	
		Amanda Schooling	Ward County EMA	
		Kelly George	Witt O'Brien's	
Kenmare	04.04.13	Barb Widemer	Kenmare City Auditor	Review of proposed mitigation actions and discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
		Amanda Schooling	Ward County EMA	
		Kelly George	Witt O'Brien's	
Makoti	04.03.13	Tyler Stafslien	Makoti Mayor	Review of proposed mitigation actions and
		Darwin Quandy	Makoti City Council	

Jurisdiction	Date of Meeting	Attendees		Summary of Meeting
		Mike Bailey	Makoti City Council	discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
		Harold Rasmussen	Makoti City Council	
		Lonnie Fischer	Makoti City Council	
		Amanda Schooling	Ward County EMA	
		Kelly George	Witt O'Brien's	
Minot	04.02.13	Dan Jonasson	Minot Public Works	Review of proposed mitigation actions and discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
		Amanda Schooling	Ward County EMA	
		Kelly George	Witt O'Brien's	
Ryder	04.01.13	Jody Reinish	Ryder Mayor	Review of proposed mitigation actions and discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
		Amanda Schooling	Ward County EMA	
		Dan Green	Ward County EMA	
Sawyer	04.02.13	Cody Roteliuk	Sawyer City Auditor	Review of proposed mitigation actions and discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
		Rex Weltikol	Sawyer City Council	
		Dan Green	Ward County EMA	
		Kelly George	Witt O'Brien's	

Jurisdiction	Date of Meeting	Attendees		Summary of Meeting
Surrey	04.01.13	Jason Vaargen	Surrey City Administrator	Review of proposed mitigation actions and discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy
		Pete Schneider	Surrey Chief of Police	
		Amanda Schooling	Ward County EMA	
		Dan Green	Ward County EMA	
		Kelly George	Witt O'Brien's	
Ward County	04.05.13	Amanda Schooling	Ward County EMA	Review of proposed mitigation actions and discussion of any additional actions that should be added; discussion of actions and implementation of actions, including assignments and estimated costs; discussion of prioritization methodology; assignation of priority to each action in strategy; review of actions from 2008 Plan, current status of those actions, and whether or not they should be included in Plan Update
		Kelly George	Witt O'Brien's	

C.5 Meeting Presentations

The pages following contain copies of the meeting presentations used to facilitate the Steering Committee Meetings. In some cases, notes and directions were taken in the presentation. In those instances, the notes or directions are indicated in red text.

Ward County Hazard Mitigation Plan Update

Kickoff Meeting

February 07, 2013

Kickoff Meeting Agenda

- Welcome and introductions
- Project background and purpose
- Overview of the project
- Hazard identification exercise
- Asset criticality ranking worksheet (homework)
- Capability assessment questionnaire (homework)
- Q&A and next steps

Introductions

- Realizing you all know one another....
- Jake Halley, Planner/GIS Specialist
- Kelly George, Project Manager & Senior Mitigation Planner

Project Background & Purpose

- Why are we doing this project?
  - In 2006-2007, Ward County completed their first hazard mitigation plan (HMP), which was approved by FEMA/NDDES in 2008
  - That approval is valid for 5 years, and expires in September 2013
  - To avoid a lapse in approval status, the updated plan must be reviewed and approved by FEMA/NDDES prior to the current plan's expiration
- Why should we update the hazard mitigation plan?
  - In order to receive hazard mitigation grant funding from FEMA/NDDES, sub-applicants must have a current, approved hazard mitigation plan

Overview of the Project

- What is hazard mitigation?
  - Any long-term measure undertaken to reduce or eliminate the risks posed by hazards to people or property.
  - Mitigation measures may be structural or non-structural.
- What is a hazard mitigation plan?
  - A plan that identifies the range of hazards that can affect a community and details ways to reduce the community's risk and exposure to hazards
  - Mitigation plans form the foundation for the community's long-term strategy to reduce disaster losses and break the cycle of damage-repair-damage-repair

Requirement for HMP Updates

- Enabling legislation:
  - The Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (the Stafford Act), as amended by the Disaster Mitigation Act of 2000 (DMA2K)
    - This established the requirement for states, local governments, and other eligible applicants seeking hazard mitigation funding to develop, implement, and maintain an HMP in order to receive mitigation grant funding
  - Codified by FEMA in 44 CFR, Part 201
  - Local Plan Review Guide published by FEMA October 2011
- HMP Updates *must* build on the approved plan

Required Elements for HMP Updates

- Hazard Identification and Profiles
  - Must address all possible natural hazards, not just the most likely to occur
    - Only natural hazards are required, though others are encouraged (but not reviewed)
  - Any hazard that is excluded must be justified
- Risk Assessment
  - Quantitative where possible
  - Should include future development where possible
  - GIS/mapping is not required by FEMA or NDDES, but is strongly recommended

Required Elements for HMP Updates (continued)

- Mitigation Strategy
  - Must address the vulnerabilities, risks, and hazards identified in the HIRA
  - Must address NFIP compliance
- Plan development process must be thoroughly documented
- Public and outside stakeholder participation is required
- For plan updates:
  - we are required to address any changes to the hazards, risks, and vulnerabilities between the previous plan and the update, and
  - identify any completed mitigation actions

Plan Update Process

- Established in FEMA 386
  - Organize resources
  - Assess risks
  - Identify priorities
  - Identify opportunities
  - Develop (update) plan
  - Implement plan
  - Monitor plan

Plan Review Process

- Ward County HMP Update Advisory Committee recommends submittal of draft to NDDES for review
- NDDES reviews the draft and makes requests for revisions
- NDDES submits amended draft to FEMA, who has final review/approval authority; revisions may continue
- When satisfied, FEMA issues a letter that the plan is approval pending adoption (APA)
- Participating jurisdictions adopt the plan, and provides documentation of adoption to NDDES/FEMA
- FEMA/NDDES issues formal approval letter

Advisory Committee Role

- The Ward County HMP Update Advisory Committee provides oversight to the plan update process, and serves as a source of local knowledge
- Contributions to the process include:
  - Attending planning meetings
  - Providing local knowledge and input, including questionnaires and surveys
  - Providing review and comment on drafts of plan update

Hazard Terminology

- Hazards are referred to by a variety of terms
- Some hazard terminology has specific connotations or meanings
- Where applicable, recommend use of the broadest terminology possible to describe the hazard, with definitions of individual hazard elements within the profiles
  - Severe winter storm – to encompass all manner of severe winter weather phenomenon (blizzard, heavy snow, extreme cold, etc.)
  - Flooding – to encompass flooding from all sources (flash, urban, riverine, etc.)
  - Severe summer storm – to encompass all manner of severe weather in warmer temperatures (lightning, hail, etc.)

Asset Criticality Ranking

- Task: identify those assets within the community that are the most critical to the community in the post-disaster environment
- Please refer to handout titled *Asset Criticality Ranking*
- Discussion of criteria on handout
- Any changes or tweaks to criteria?
- We will assign rankings to the assets provided, and the Advisory Committee will review designations at the next meting in March

Hazard Identification Exercise

- Task: to determine the final list of hazards to be considered in the Ward County HMP Update, and those hazards that will be excluded from further consideration
- Sources:
  - Ward County Hazard Mitigation Plan (2008)
  - Interviews with Advisory Committee members (2012)
  - North Dakota State Hazard Mitigation Plan (2011)
  - FEMA 386
- Please refer to handout titled *Preliminary Hazard Identification Table*

Capability Assessment Questionnaire

- Task: to survey participating jurisdictions to determine the existing capability and capacity to manage and implement hazard mitigation plans, projects, and programs
  - Not a required element for local plans, but highly recommended
  - Helps to define the context in which hazards, risks, vulnerabilities, and strategies exist
- Do you want to include a capability assessment in the plan update?
- If so, please complete the handout and return it to me by our next meeting in March
  - If you would prefer an electronic version that you can email, please let me know

Next Meeting

- March 7th, 2013
- We will:
  - Discuss historical occurrence of hazards
  - Review asset criticality assignments
  - Complete a qualitative risk assessment
  - Determine the hazards to receive a quantitative risk assessment
  - Review preliminary imagery and mapping
  - Collect completed capability questionnaires
  - Review current strategy goals and determine any changes

Ward County Hazard Mitigation Plan Update

Meeting #2

March 07, 2013

Meeting #2 Agenda

- Review of last meeting
- Review asset criticality rankings (handout)
- Hazard Identification & Risk Assessment:
  - Additional information questions (sent after kickoff meeting)
  - Complete qualitative risk assessment exercise (handout)
  - Review hazard data (federal & state sources)
  - Determine quantitative risk assessment hazards
  - Review preliminary base maps
- Capability Assessment questionnaire collection
- Mitigation Strategy: Goals (handout)
- Q&A and next steps:
  - Municipality meetings - April 01-05, 2013

Kickoff Meeting Recap

- Project background and purpose
- Overview of the project
- Hazard identification exercise
- Asset criticality ranking worksheet
- Capability assessment questionnaire (homework)
  - Emailed after meeting
- Additional information request sent after kickoff meeting

Asset Criticality Ranking

- We reviewed the criteria at the last meeting:
  - Level 01 – Essential facilities (EOC, first responder, shelters, city halls, critical infrastructure, etc.)
  - Level 02 – Service or operations support facilities (planning / permitting offices, essential infrastructure, etc.)
  - Level 03 – Important but non-essential facilities or infrastructure (senior centers)
  - Level 04 – Non-essential day-to-day operations facilities
  - Level 05 – Non-essential support buildings and structures (sheds, warehouses, etc.)
- Please refer to the handout
  - Broken out by jurisdiction

Hazard Identification & Risk Assessment (HIRA)

- Hazards included in plan update:
  - Communicable disease
  - Drought
  - Fire
  - Flood
  - Landslides
  - Severe summer storms
  - Severe winter storms
  - Hazardous materials incident

HIRA Discussion

- Hazard data sources from federal and state sources
  - Local information will be added from responses to additional information request (sent after kickoff meeting)
- Quantitative risk assessment determination
- Qualitative risk assessment exercise (handout)
- Preliminary base map review

Qualitative vs. Quantitative

- **Qualitative Risk/Impact Assessment:**
  - Measure of relative risk by ranking.
  - Process is subjective, and based on individual's experience and knowledge of the jurisdiction and its vulnerabilities.
  - All hazards in the plan update will receive a qualitative risk/impact assessment.
- **Quantitative Risk/Impact Assessment:**
  - An estimate of potential losses from the profiled hazards.
  - Based on available data, probability of occurrence, and potential impacts (calculated).
  - Not all hazards will receive a quantitative risk/impact assessment, due to data limitations.

Qualitative Risk/Impacts Assessment

- **Please refer to handout, and complete the table at the bottom of the page**
- **Your responses to this exercise apply only to the jurisdiction that you represent, and should be based on what you would expect regarding impacts to your jurisdiction from the identified hazards**
  - **Your answers do not have to match anyone else's answers – they will be averaged for an overall ranking**

Communicable Disease

- Definition: Any disease that is transmissible by direct or indirect contact, such as rabies, influenza, or meningitis.
- Data sources: CDC, ND Department of Health, local reports
- Potential quantitative measurements/sources:
  - Staff absenteeism - from morbidity reports
  - Other factors may be too reliant on specific vectors, conditions, etc., and outside the scope of this assessment
- Perform quantitative assessment? _X_ Yes___ No

Drought

- Definition: a prolonged period of abnormally low precipitation; a shortage of water resulting from this.
- Data sources: National Drought Monitor, NCDC, USDA, ND Department of Agriculture, SHMP, local reports
- Potential quantitative measurement/source:
  - Acres / value of crops/livestock at-risk from drought
    - Would require localized estimates of the acreage/value of crops, and the number/value of livestock
- Perform quantitative assessment? ___ Yes _X_ No
- Note: Defer to next update, when conditions may have changed

Fire

- Includes both structure fires and wildland fires
  - Discussed separately
- Data sources: US Fire Administration, NFIRS, local reports
- Potential quantitative measurement/source:
  - Number of structures/acres burned
    - Have info on number of calls since 2008
  - Wildland Urban Interface estimates
- Perform quantitative assessment? _X_ Yes___ No

Flood

- Includes flooding from all sources, including dam/levee failure
  - Discussed/assessed separately
- Data sources: NFIP, FEMA, NCDC, USACE, SWC, local
- Potential quantitative measurement/source:
  - Areas at risk (1% and .02% annual chance)
  - Critical assets at risk in each area
  - Dam/levee failure inundation areas (if public)
  - RL/SRL properties
- Perform quantitative assessment? _X_ Yes___ No

Landslides

- Is this one applicable to the County only, or are there other jurisdictions that have this concern?
- Data sources: Ward County Highway Department
- Potential quantitative measurement/source:
  - Dependent on data available
- Perform quantitative assessment? ___ Yes _X_ No
- Note: this hazard is only for the county; no municipal concerns

Severe Summer Storms

- Includes extreme heat, tornadoes, severe thunderstorms, hail
  - Discussed/assessed separately
- Data sources: FEMA, NCDC, NWS, SHMP, local
- Potential quantitative measurement/source:
  - Scenario assessment based on historic tornado activity
  - Assets/populations at risk from storms/heat
    - Elderly, children, homeless, etc.
    - Mobile homes, man camps
- Perform quantitative assessment? _X_ Yes___ No

Severe Winter Storms

- Includes extreme cold, blizzards, excessive snowfall, ice
  - Discussed/assessed separately
- Data sources: FEMA, NCDC, NWS, SHMP, local
- Potential quantitative measurement/source:
  - Scenario assessment based on historic blizzard activity
  - Assets/populations at risk from storms/cold
    - Elderly, children, homeless, etc.
    - Mobile homes, man camps
- Perform quantitative assessment? _X_ Yes___ No
- Note: focus on power outage and roads

Hazardous Materials Incident

- Includes transportation incidents, fixed site incidents, and pipelines
  - Discussed/assessed separately
- Data sources: EPA, USDoT, NDDES, NDDoT, local
- Potential quantitative measurement/source:
  - Scenario assessment based defined buffer zones (1/2 mile, 1 mile, 5 miles)
  - Critical assets within those defined buffer zones
- Perform quantitative assessment? _X_ Yes___ No

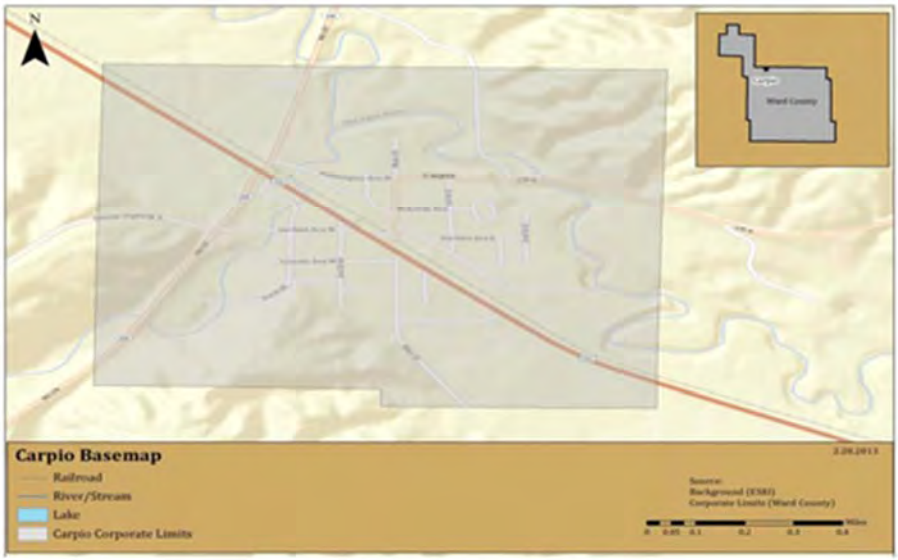
Preliminary Base Maps

- We have developed preliminary base maps for each jurisdiction in the plan update.
  - These maps are preliminary, and may be tweaked in the future
- These maps will be used to form the basis of each jurisdiction's risk assessment.
- Hazard information / boundaries will be overlaid on the base maps, as will the location of critical assets.

City of Berthold

City of Burlington

City of Carpio



City of Des Lacs

City of Donnybrook

City of Douglas

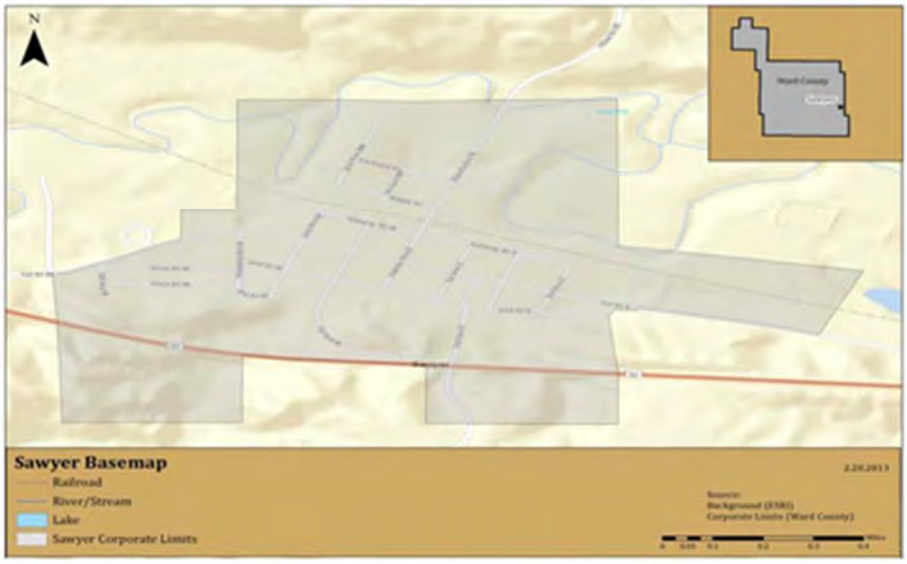
City of Kenmare

City of Makoti

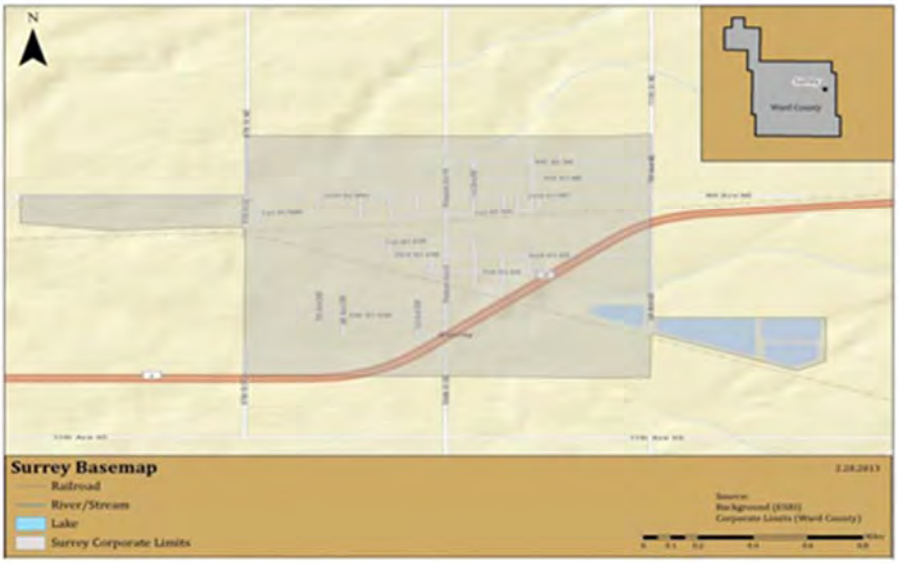
City of Minot

City of Ryder

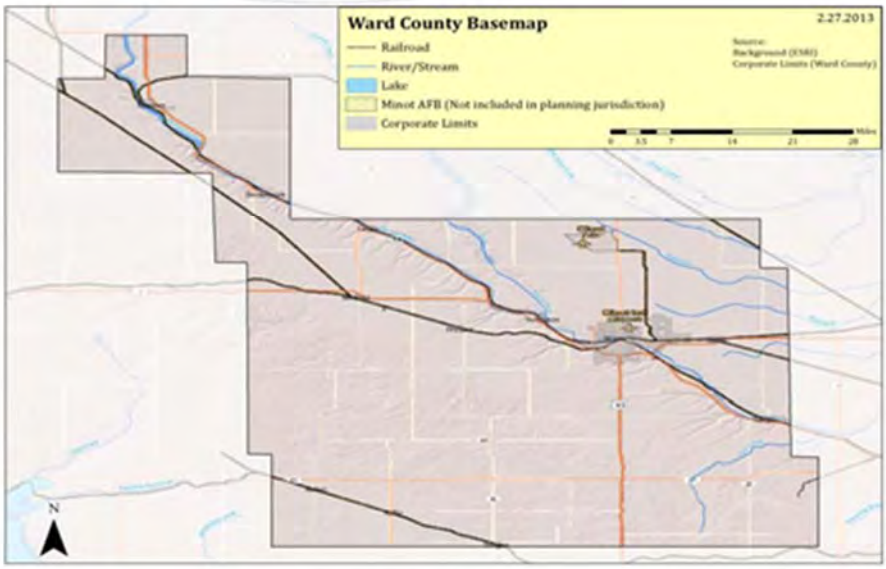
City of Sawyer



City of Surrey



Ward County



Mitigation Strategy: Goals

- Mitigation plans are required to have goals as part of the strategy (44 CFR, 201.6(c)(3)(i).
- Goals are defined as broad policy statements that explain what is to be achieved.
- The handout contains the goals from the 2008 plan and suggested revisions/replacements
  - The revisions/replacements are based on the change in guidance since the 2008 plan was approved.

Capability Assessment Questionnaire

- If you have your completed questionnaire, please give it to me before you leave.
- Otherwise, please email it to me at:
  - kgeorge@wittassociates.com

Next Meeting

- April 4th, 2013 – we will:
  - Review risk assessment
  - Review capability assessment results
    - Determine whether or not to include the results in the plan update
  - Discuss the review/adoption process
- I will also need to meet with representatives from each jurisdiction between April 1-5, in order to develop the mitigation strategy for each jurisdiction

Questions?

- Kelly George, Project Manager & Senior Hazard Mitigation Planner
  - kgeorge@wittassociates.com
  - 813.810.5429
- Jake Halley, GIS Specialist & Planner
  - jhalley@wittassociates.com
  - 318.381.3429

Ward County Hazard Mitigation Plan Update

Meeting #3

April 04, 2013

Meeting #3 Agenda

- Review of last meeting
- Update on municipality meetings
- Hazard Identification and Risk Assessment (HIRA)
  - Review of selected maps
- Capability Assessment results
  - Decision on inclusion of survey findings
- What happens next

Meeting #2 Recap

- Review asset criticality rankings (handout)
- Hazard Identification & Risk Assessment:
  - Additional information questions (sent after kickoff meeting)
  - Complete qualitative risk assessment exercise (handout)
  - Review hazard data (federal & state sources)
  - Determine quantitative risk assessment hazards
  - Review preliminary base maps
- Capability Assessment questionnaire collection
- Mitigation Strategy: Goals (handout)
- Q&A and next steps:
  - Municipality meetings - April 01-05, 2013

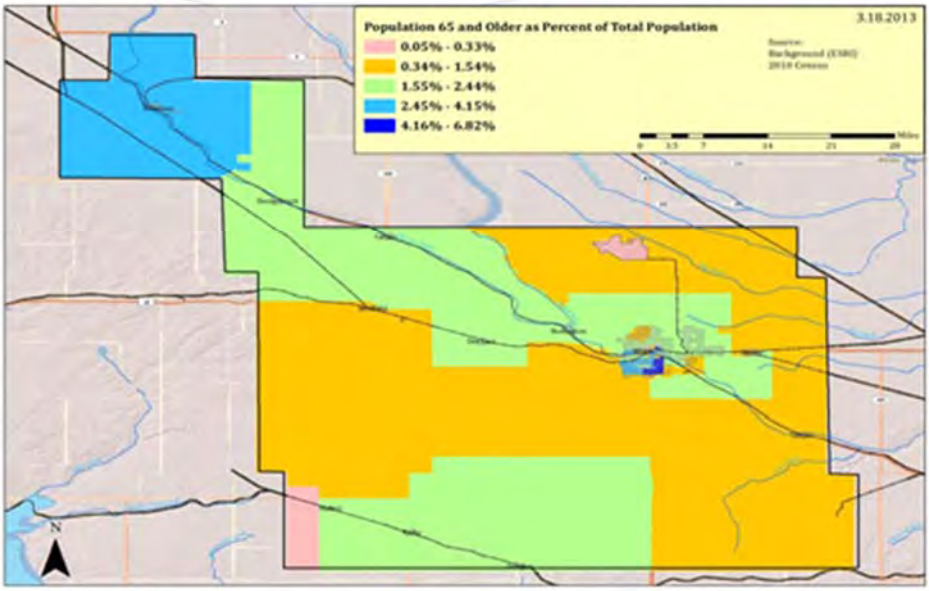
Update on Municipality Meetings

- Meeting with each participating jurisdiction to discuss:
  - Hazard mitigation strategy for each jurisdiction
  - Identification of any additional actions to be included in strategy
  - Prioritization of actions within the strategy
  - Timeline for review, public comment, adoption, and approval of Plan Update
- All meetings will be complete by 04.05.13

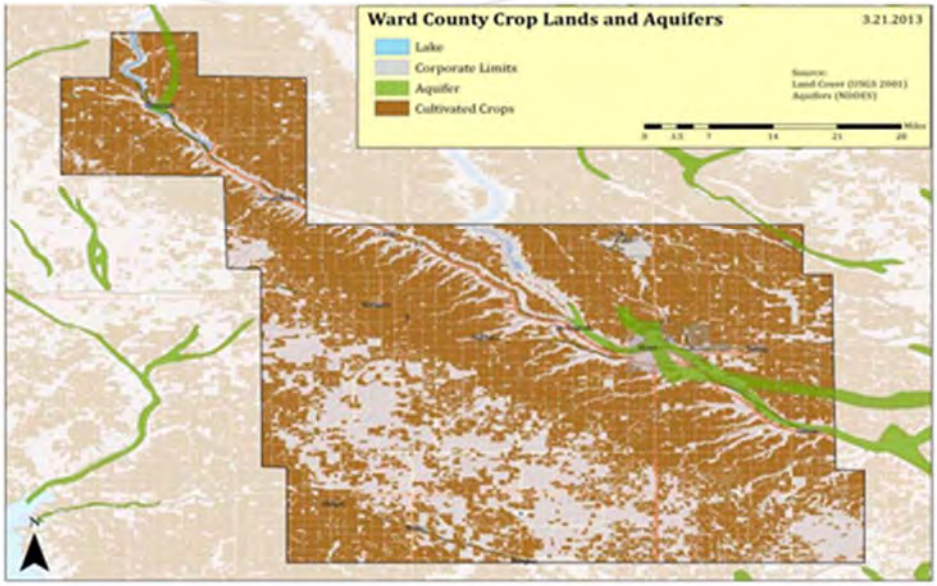
Hazard Identification & Risk Assessment (HIRA)

- Hazards included in plan update:
  - **Communicable disease** – quantitative & qualitative assessment
  - **Drought** – quantitative assessment
  - **Fire** – quantitative & qualitative assessment
  - **Flood** – quantitative & qualitative assessment
  - **Landslides** – county only
  - **Severe summer storms** – quantitative & qualitative assessment
  - **Severe winter storms** – quantitative & qualitative assessment
  - **Hazardous materials incident** – quantitative & qualitative assessment

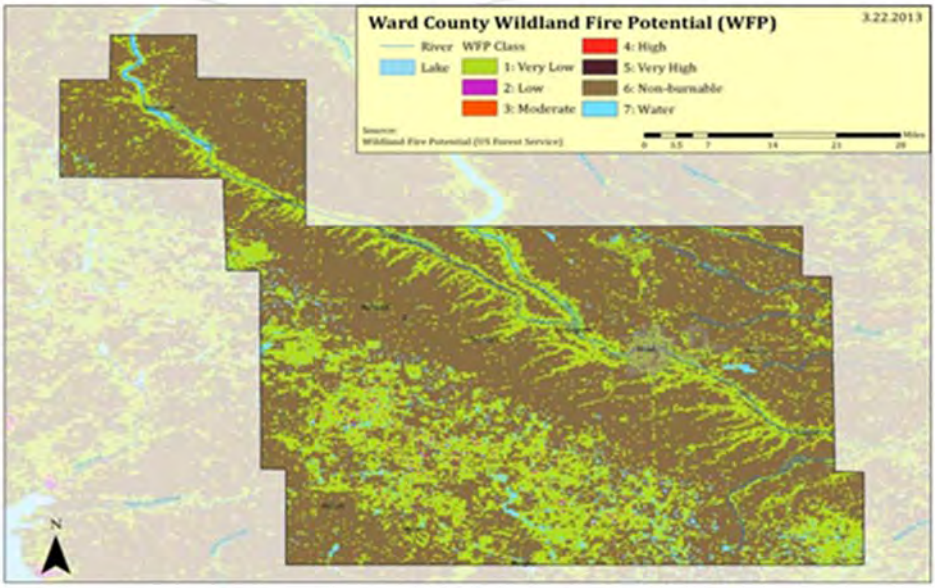
Communicable Disease Hazard Mapping



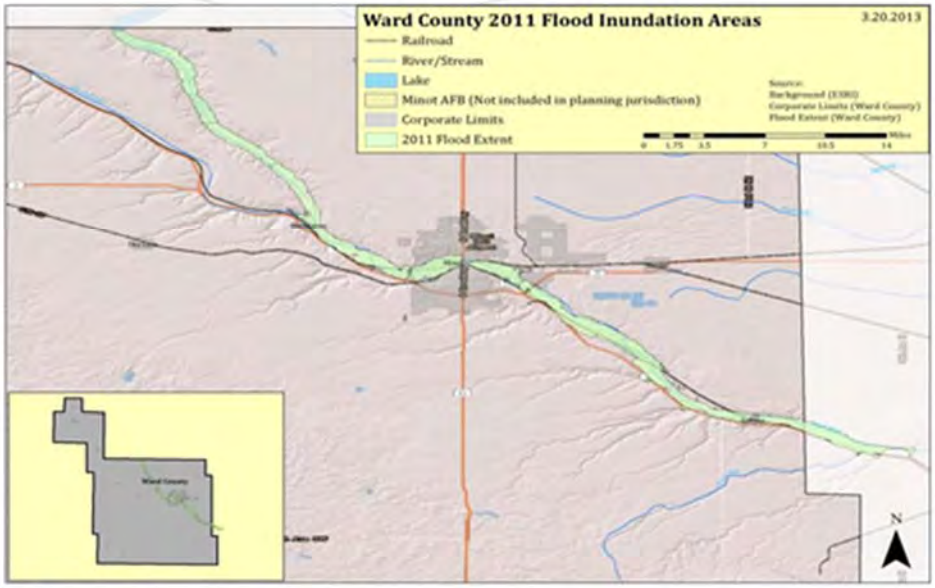
Drought Hazard Mapping



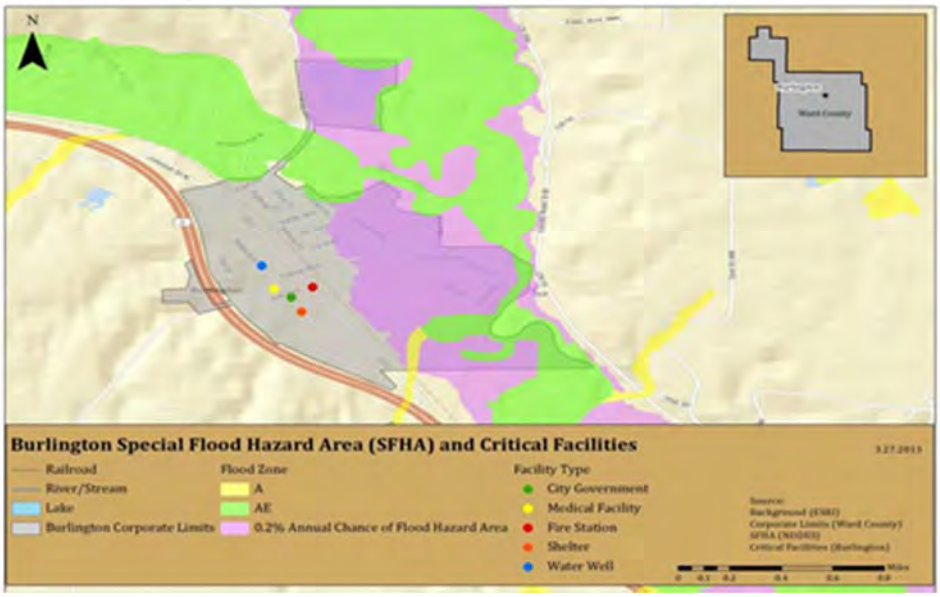
Fire: Wildland Fire Potential Mapping



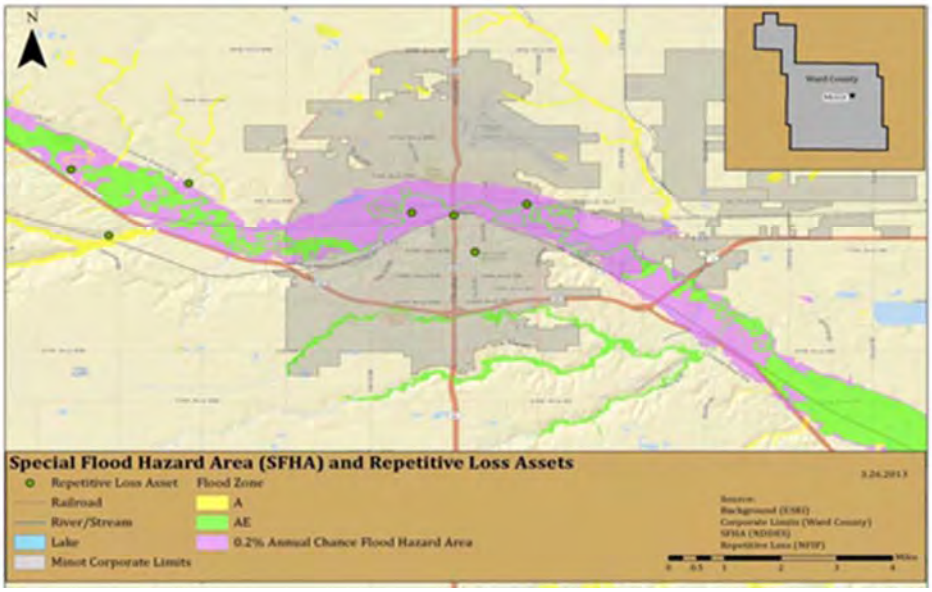
Flood Hazard Mapping



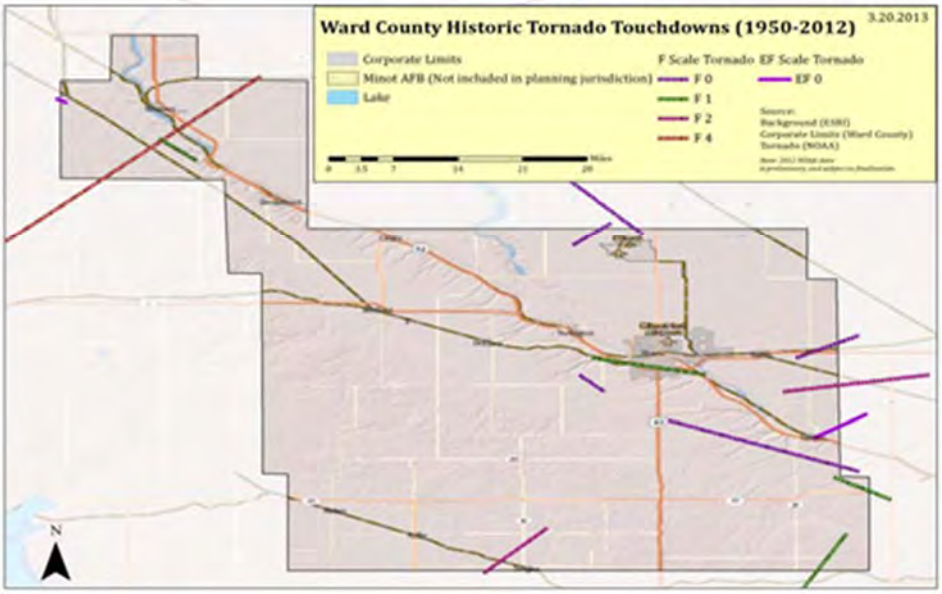
Flood Hazard Mapping with Critical Assets



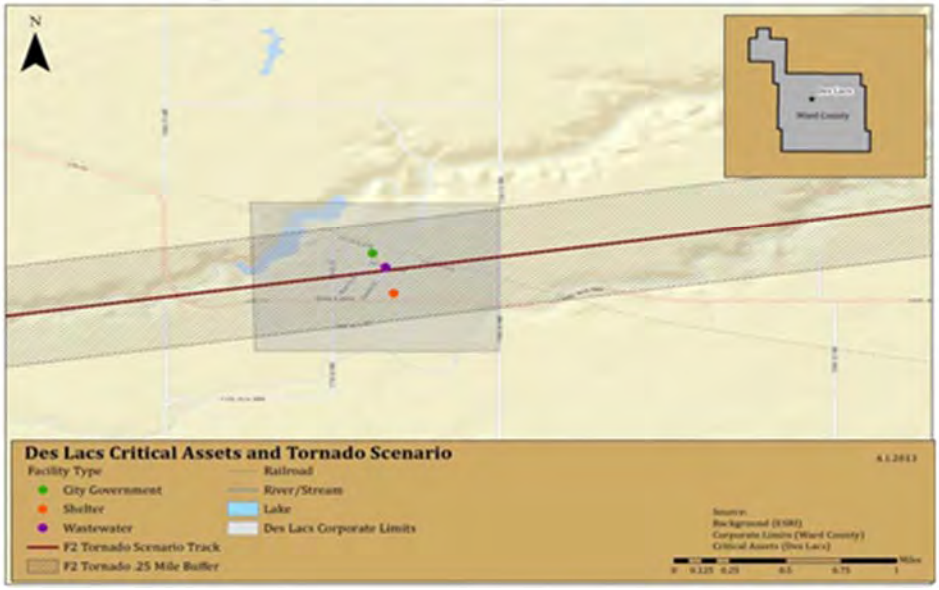
Repetitive Flood Loss Properties



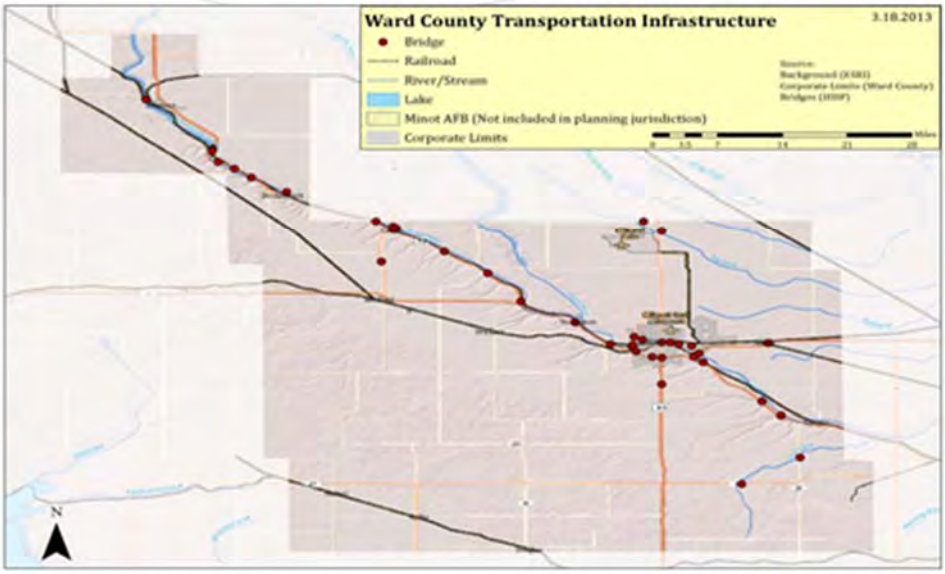
Severe Summer Storms: Tornado History

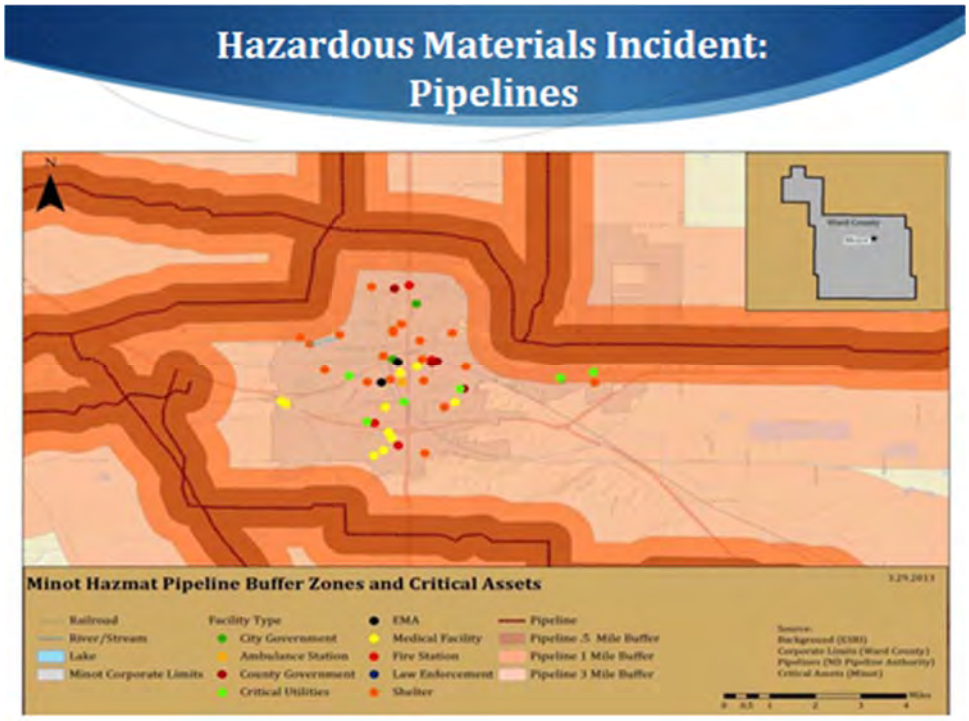


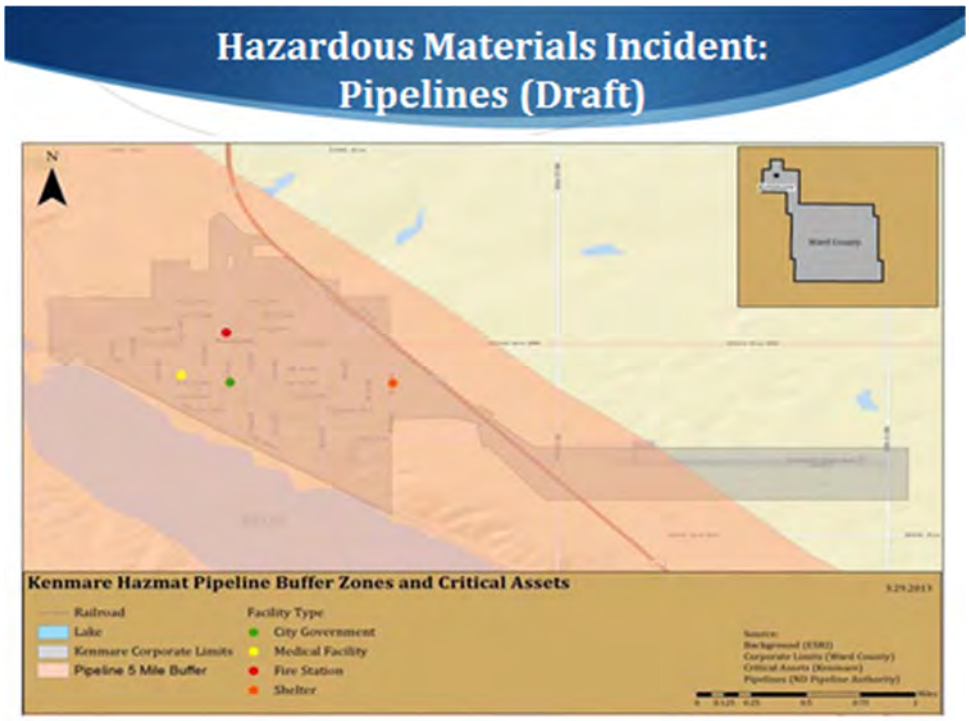
Severe Summer Storms: Tornado Scenario with Critical Assets



Severe Winter Storms: Transportation Infrastructure

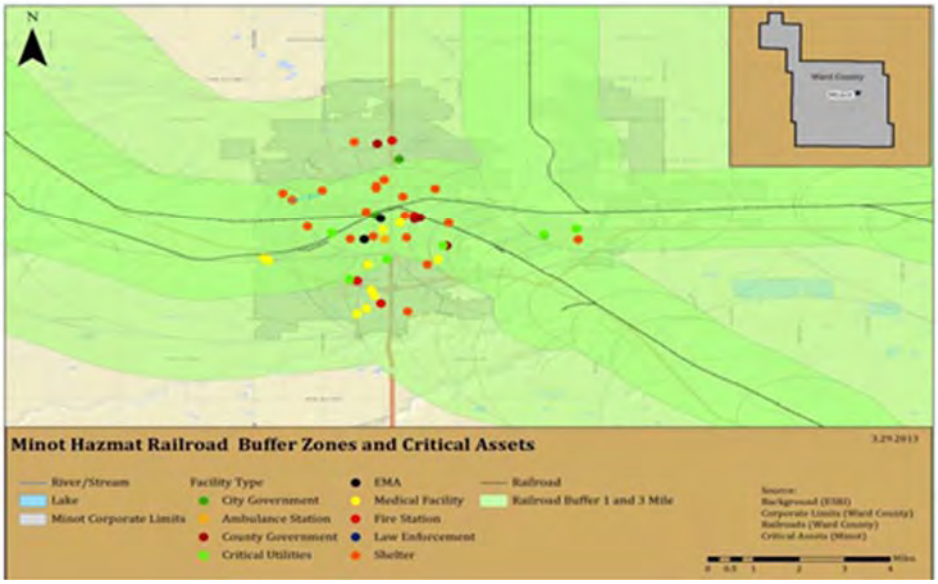



Hazardous Materials Incident:
Pipelines
N
Minot Hazmat Pipeline Buffer Zones and Critical Assets
Railroad
River/Stream
Lake
Minot Corporate Limits
Facility Type
City Government
Ambulance Station
County Government
Critical Utilities
EMA
Medical Facility
Fire Station
Law Enforcement
Shelter
Pipeline
Pipeline .5 Mile Buffer
Pipeline 1 Mile Buffer
Pipeline 3 Mile Buffer

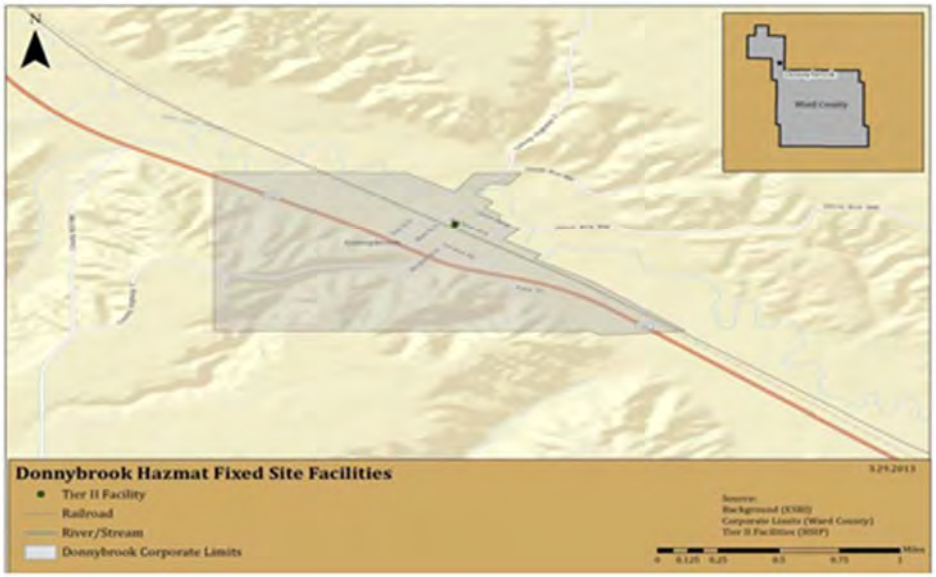

Hazardous Materials Incident:
Pipelines (Draft)
N
Kenmare Hazmat Pipeline Buffer Zones and Critical Assets
Railroad
Lake
Kenmare Corporate Limits
Pipeline 5 Mile Buffer
Facility Type
City Government
Medical Facility
Fire Station
Shelter

Hazardous Materials Incident: Transportation Routes

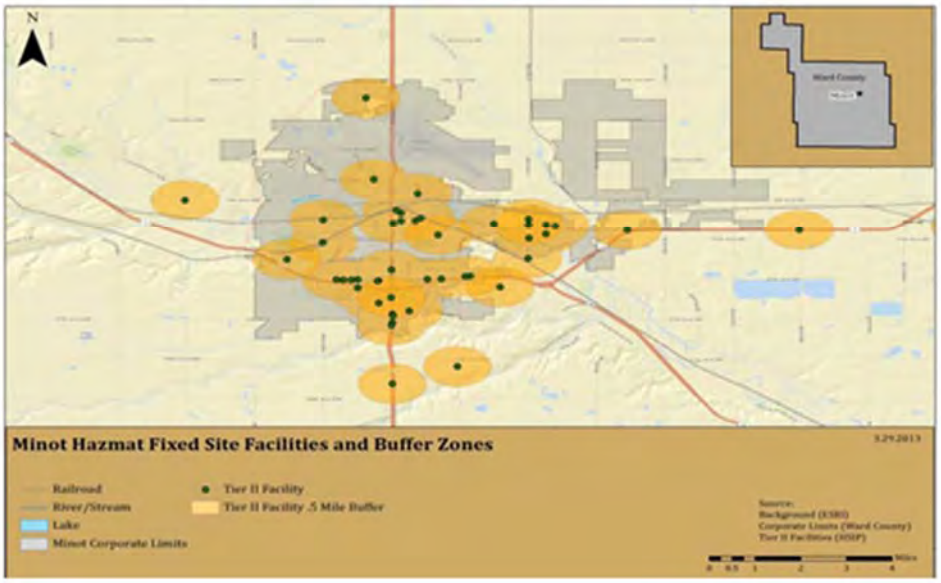
Hazardous Materials Incident: Transportation Routes



Hazardous Materials Incident: Fixed Site Facilities (Draft)



Hazardous Materials Incident: Fixed Site Facilities



Capability Assessment

- The 2008 plan provided information regarding the existing mitigation capabilities of state, county, and municipal agencies
- The following slides provide an overview of that information and highlights from the capability surveys

Capability Assessment: Ward County EMA (from 2008)

- General: coordinates planning, response activities, training, and exercises
- Response/mitigation: coordinates mitigation grant applications and project implementation (where required)
- Public awareness and education campaigns
- Coordinates Tier II data reporting
- Coordination with local, state, and federal agencies

Capability Assessment: Ward County Highway Department (from 2008)

- General: design of bridges, culvert, and overflow sections; project regulation and inspection
- Response/mitigation: maintains extensive GIS data; grant management
- Coordination with local, state, and federal agencies

Capability Assessment: Sheriff's Department (from 2008)

- General: Law enforcement in unincorporated county and incorporated areas as required (including dive team)
- Response/mitigation: Rescue assistance, evacuation assistance, security, traffic control
- Public awareness and education campaigns: 911 education, Safe Kids
- Maintains mutual aid agreements with all surrounding counties and ND State Highway Patrol
- Coordination with local, state, and federal law enforcement agencies

Capability Assessment: Other county capabilities (from 2008)

- Ward County Water Resources Board – engineering expertise, water storage and drainage issues
- Ward County Social Services – Temporary assistance programs

Capability Assessment: Ward County

- Planning:
  - EOP (currently being updated)
  - COOP/COG – has been activated
  - Evacuation plan
  - Master plan
- Member of the NFIP
- Hazard and vulnerability data is maintained
- Confidence in administrative and fiscal capacity

Capability Assessment: Minot Fire Department (from 2008)

- General: Fire response/suppression, accident response, hazmat response
- Educational programs: fire prevention, fire safe/fire smart activities
- Alarm and suppression equipment inspection and certification
- Assist with Tier II reporting
- Coordination with local fire agencies and the ND State Fire Marshal

Capability Assessment: Minot Police Department (from 2008)

- General: Law enforcement within city limits, 911 service
- Public awareness: DARE, juvenile diversion programs, CrimeStoppers, gang awareness, Citizen Police Academy, etc.
- Response/mitigation: warning, rescue assistance, evacuation assistance, security, traffic control, and information
- Assist with Tier II reporting
- Coordinates with local law enforcement and response agencies, ND State Highway Patrol, FBI, ATF, FEMA

Capability Assessment: Other Minot capabilities (from 2008)

- Rural Fire Department
- Air Force Fire Department
- Community Ambulance Service of Minot

Capability Assessment: Minot

- Planning:
  - EOP, Master plan, stormwater management, evacuation plan
  - No COOP/COG (?) or disaster recovery plan
- Member of the NFIP
- Limited data on hazards and vulnerabilities
- Moderate confidence in administrative and fiscal capacity

Capability Assessment: Berthold

- Fire Department, Ambulance Service, Emergency Alert Sirens
- Capability survey pending

Capability Assessment: Burlington

- Police Department, Fire Department, Emergency shelter
- Planning:
  - COOP/COG plan in place – has been activated
  - Written disaster recovery procedures – has been activated
  - Evacuation plan – has been activated
  - Master plan and construction restrictions in hazard areas
  - Stormwater management plan
  - Participant in regional planning
- Member of the NFIP; floodplain management occurs
- City identifies vulnerabilities and maintains hazard data
- Confident in administrative and fiscal management capacities

Capability Assessment: Carpio

- Fire Department, Ambulance Service
- Planning:
  - No EOP, COOP/COG, or disaster recovery plan
  - No formal evacuation plan, but historical precedents exist
  - Master plan under development; zoning ordinance in place
  - No stormwater management plan, but member of the NFIP
- Member of the NFIP (under county)
- Limited data maintained regarding vulnerabilities and hazards
- Limited confidence in administrative and fiscal capacities

Capability Assessment: Des Lacs

- Fire Department, Emergency Shelter
- Planning:
  - Part of county's EOP
  - No COOP/COG, disaster recovery, or local evacuation plan
  - No Master Plan, but stormwater management requirements in place and current member of the NFIP
- Limited data maintained regarding vulnerabilities and hazards
- Limited confidence in administrative and fiscal capacities

Capability Assessment: Donnybrook

- Fire Department
- Planning:
  - EOP development in process; Fire participates in drills/exercises
  - No COOP/COG, disaster recovery, evacuation, or master plan
  - Participates in regional planning
- No stormwater management issues; current member of the NFIP
- Data maintained regarding vulnerabilities and hazards
- Limited confidence in administrative and fiscal capacities

Capability Assessment: Douglas

- Fire Department, Emergency Alert
- Planning:
  - EOP and evacuation plans in process
  - No COOP/COG, disaster recovery, master plan, or stormwater management plan
  - Participates in regional planning
- Not a current member of the NFIP
- Limited data maintained regarding vulnerabilities and hazards
- Moderate confidence in administrative and fiscal capacities

Capability Assessment: Kenmare

- Police Department, Fire Department, Ambulance Service, Shelter
- Add: 25 bed hospital with ER
- Planning:
  - EOP in progress
  - No COOP/COG, disaster recovery, evacuation, master plan, or stormwater management plan
- Not a current member of the NFIP
- Data maintained regarding vulnerabilities and hazards
- Limited confidence in administrative and fiscal capacities

Capability Assessment: Makoti

- Fire Department (combined with Ryder), Ambulance Service, Shelter, Emergency Alert
- Planning:
  - EOP (part of county)
  - No COOP/COG, disaster recovery, evacuation, master plan, or stormwater management plan
  - Land Use Plan
- Not a current member of the NFIP
- Limited data maintained regarding vulnerabilities and hazards
- Limited confidence in administrative and fiscal capacities

Capability Assessment: Ryder

- Fire Department and Ambulance Service (combined with Makoti), Emergency Shelters
- Planning:
  - EOP in process
  - Building codes, informal COOP/COG
  - No disaster recovery, evacuation, master plan, or stormwater management
- Not currently a member of the NFIP
- Limited data maintained regarding vulnerabilities and hazards
- Moderate confidence in administrative and fiscal capacities

Capability Assessment: Sawyer

- Fire Department, Emergency Shelter
- Planning:
  - EOP, informal COOP/COG plan, evacuation plan, stormwater management
  - Participates in regional planning
  - No disaster recovery or master plan
- Member of the NFIP (under county)
- Limited data maintained regarding vulnerabilities and hazards
- Limited confidence in administrative and fiscal capacities

Capability Assessment: Surrey

- Police Department, Fire Department, Emergency Shelter
- Planning:
  - EOP; evacuation plan and master plan in progress
  - Stormwater management plan under development
  - No COOP/COG or disaster recovery plan
- Not a current member of the NFIP – confirm this; EMA thinks they are members
- Limited data maintained regarding vulnerabilities and hazards
- Limited confidence in administrative and fiscal capacities

Capability Assessment: First District Health Unit

- Mitigation of public health events within the jurisdiction (enforcement of statutes, immunization plans, etc.)
- Assistance with hazardous materials incidents through environmental health division
- Programs include:
  - Wastewater treatment
  - Water pollution
  - Vector control
  - immunization
- State agency

Capability Assessment: Minot State University

- Planning:
  - EOP (recently updated) that includes evacuation plan; annual drills/exercises
  - Master plan
  - Participates in regional planning
  - Follow city/county stormwater management ordinances
  - NDUS has a COOP; campus is planning to develop one
  - No disaster recovery plan
- Unclear if campus hazard and vulnerabilities are tracked
- High confidence in administrative and fiscal capacity

Capability Assessment: NDSU County Extension Service

- General: subject matter experts in agriculture, natural resources, horticulture, family/consumer science, 4-H, and youth community development
  - Beef/dairy cattle, swine, other livestock
  - Water quality
  - Waste management
  - Forage
- Serve as information resource for natural disasters in relation to agriculture, environmental concerns, water resources, etc.
- Coordinate with NDSU, ND State Health Department, USDA, and FSA

Capability Assessment: Other state agencies

- North Dakota Highway Patrol
- State Fire Marshal
- North Dakota Forestry Service
- North Dakota Game and Fish
- State Radio Communications
- North Dakota Department of Agriculture
- Job Service
- North Central Human Service Center
- State Historical Society
- add: SWC, NDDOH, NDDOT, NDDES, NDNG

Capability Assessment: Other organizations

- Verendrye Electric Co-Op
- Excel Energy
- Montana Dakota Utilities
- SRT Communications
- Earthmovers, Inc.
- American Red Cross
- Salvation Army
- US Army Corps of Engineers
- Add: Verizon, United Way, AT&T, VOAD Council, Mid-Continent Communications, Lutheran Disaster Response, AFB, Reservations, OtterTail (electical), Brook Divide (electrical – Kenmare)

Capability Assessment

- Do you want to include the survey results as part of the capability assessment?

- Yes __X__
- No ____

What Happens Next?

- April 25-May 10: Draft will be posted online for your review and comment
  - Comments/corrections/revisions must be received by May 10th
  - If no comments are received, I will assume consent
- May 15-30: 1st public comment period
  - Jurisdictions will need to post public notice
  - I will need a copy of the posting, for inclusion in the plan update
- June 5th: Submission of draft plan update to NDDES/FEMA
  - June – August: technical edits/revisions, based on NDDES and FEMA reviews

What Happens Next? (continued)

- Late August 2013 (estimated): NDDES/FEMA issue "Approvable Pending Adoption" notice
- September 2013 (estimated): 2nd public comment period
  - Jurisdictions will need to post public notice
  - I will need a copy of the posting, for inclusion in the plan update
- September 2013 (estimated): Jurisdictions adopt the plan update
  - I will need a copy of the adoption resolution for submission to NDDES/FEMA
- September 2013 (estimated): Plan update is approved

Questions?

- Kelly George, Project Manager & Senior Hazard Mitigation Planner
  - kgeorge@wittassociates.com
  - 813.810.5429
- Jake Halley, GIS Specialist & Planner
  - jhalley@wittassociates.com
  - 318.381.3429