STATE OF SOUTH DAKOTA

HAZARD MITIGATION PLAN

BASIC PLAN

January 14, 2011

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SOUTH DAKOTA HAZARD MITIGATION TEAM

AS DIRECTED BY:
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FEMA

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Commonly Used Acronyms and Abbreviations

CDBG	Community Development Block Grants
DENR	South Dakota Department of Environment and Natural Resources
DMA 2000	Disaster Mitigation Act of 2000
DOA	South Dakota Department of Agriculture
EMPG	Emergency Management Performance Grants
FEMA	Federal Emergency Management Agency
FHA	Federal Housing Administration
FMA	Flood Mitigation Assistance
GF&P	South Dakota Game, Fish and Parks
HMGP	Hazard Mitigation Grant Program
PDM	Pre-Disaster Mitigation Grant Program
REA	Rural Electric Association
REC	Rural Electric Cooperatives
SDOEM	South Dakota Office of Emergency Management
SHMT	State Hazard Mitigation Team
SHSGP	State Homeland Security Grant Program
USCOE	United States Corps of Engineers
USFS	United States Forest Service

MISSION STATEMENT

The SHMT modified the Mission Statement to incorporate "economic impact" and "livelihood" concepts at the SHMT Meeting on June 3, 2010. The mission statement originally prepared on August 17, 2007 has been modified as follows:

To reduce the impacts to
life and property from hazards
through a long term sustainable
statewide mitigation strategy
while maintaining economic vitality.

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EXECUTIVE SUMMARY

Introduction

This plan is an update of the 2007 State Multi-Hazard Mitigation Plan pursuant to the Disaster Mitigation Act of 2000 as implemented by an Interim Final Rule (44 CFR Part 201) published in the Federal Register on February 26, 2002. This plan demonstrates the State's current and future mitigation actions in an organized fashion similar to the guidance materials provided by FEMA. Section 1 demonstrates the legal authority of this plan through the Governor's adoption. Section 2 documents the planning process for developing this plan, including coordination with local mitigation planning efforts. Section 3 outlines the identified hazards South Dakota is vulnerable to and assesses the risk for each hazard on a per county basis. Section 4 details the State's mitigation strategy based on the local and state vulnerability analyses and risk assessments. Section 5 describes how the State provides funding to local governments as well as how the local assistance and project grants are prioritized. Section 6 outlines the plan maintenance process. Each section includes details on how this 2010 plan was updated from the previous 2007 plan.

Section 1 Prerequisites

The State Hazard Mitigation Team, led by the director of the South Dakota Office of Emergency Management and charged by the governor with the responsibility of implementing a statewide Hazard Mitigation Program based upon Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 93-288, as amended), recommended that this 2010 revised and updated Multi-Hazard Mitigation Plan be adopted by the governor. Governor M. Michael Rounds adopted the revised and updated (in 2010) State plan by letter dated <INSERT DATE HERE>.

Section 2 Planning Process

On April 4, 2007, Governor M. Michael Rounds signed Executive Order 2007-07 directing the establishment of the South Dakota Hazard Mitigation Team and authorizing this team to function in compliance with the responsibilities specified in the order. The core leadership of the State Hazard Mitigation Team consists of one representative from each of the departments and offices listed in the executive order and in Table 2-1. The planning process involved several meetings of the State Hazard Mitigation Team, a stakeholder and public survey, many conference calls among team members and the contracted consulting staff, as well as, communication via e-mail and digital data sharing. A summary of the meetings and collaboration is presented in Table 2-2 Summary of Planning Process. Based on the collaboration among SDOEM, the SHMT, and the contracted consultants, Dewberry was able to draft a complete updated 2010 State of South Dakota Multi-Hazard Mitigation Plan for review and edit by the project team, SHMT, and regional stakeholders.

Participants

The formation of the State Hazard Mitigation Team (SHMT) provided a convenient vehicle for coordinating the plan update with relevant state agencies. Each member of the SHMT was asked to complete an Agency Comment Form in addition to their participation in the SHMT meetings. The Rural Electric Association has worked with the Rural Electric Cooperatives (RECs) to identify relevant hazards and develop emergency restoration plans. The RECs were also asked to complete the Agency Comment Form. It is the State Hazard Mitigation Officer's (SHMO) responsibility to work with the local entities and support their mitigation planning efforts. Local representatives were invited to participate in an online Stakeholder Survey, as described in Section 2.2- Stakeholder Involvement and given an opportunity to review and comment on the complete draft plan.

Section 3 Risk Assessment
Based on past disaster history and population and property potentially at risk (numbers and dollars), the following hazards have emerged as the greatest concern statewide and are profiled in detail in this plan. The hazard ranking was based on the overall probability and impact on the state as a whole. When examining various regions of the state, the same ranking may not always apply. Section 3 details the process for developing the 2010 revised hazard prioritization and Table 0-1 presents a summary of the results.

Table 0-1: Hazard Ranking and Planning Consideration

Hazard Type and Ranking	Planning Consideration Based on Hazard Level
Flooding (flash, long-rain, snowmelt, and dam or levee failure)	Significant
Winter Storms	Significant
Wildfires	Significant
Drought	Significant
Tornadoes	Significant
Wind	Moderate
Agricultural Pests and Diseases	Moderate
Hazardous Materials	Moderate
Geological Hazards (Landslide, Mudflow, Expansive Soils, Earthquake)	Moderate

Agricultural Pests and Diseases Profile Summary
Agricultural hazards are divided into two categories: pests and diseases. For this plan, such events are defined as the naturally occurring infection of crops or livestock with insects, vermin, or diseases that render the crops or livestock unfit for consumption, sale or other use. South Dakota has a substantial agricultural industry and a significant infrastructure composed of related facilities and locations, so the potential for infestation of crops or livestock pose a significant risk to the economy of the state. The annual probability of occurrence for the state is 100 percent. The western portion of the state has a higher documented occurrence rate of trich and stem nematode afflictions of alfalfa crops. Counties along the river basins bore the brunt of the anthrax outbreaks in 2005. Eastern counties have higher documented rates of soybean cyst nematode, frogeye leaf spot, scab, and West Nile Virus in domestic fowl flocks.

Flood Hazard Profile Summary
Floods have a one percent chance of occurrence in any given year in identified special flood hazard areas. Smaller and more frequent damaging events occur in the state on an annual basis. Statewide there is the potential for $1.7 billion in flood losses from the 1percent annual chance flood. Nearly every county in South Dakota is vulnerable to floods. Potential losses are highest in Minnehaha, Union, Yankton, Pennington, Codington, Lawrence and Brown counties. Floods in these counties have the potential to displace at least a thousand persons in each county.

Winter Storm Hazard Profile Summary
According to the National Climatic Data Center, there were 863 winter storms (snow and ice events) in South Dakota between January 1993 and March 2010 (17 years). Total property damage for these events is estimated at $124.707 million. This suggests that South Dakota experiences 47.9 winter

storms and $6.93 million in winter storm losses each year. There were 16 deaths and 192 injuries in this time period, which averages out to approximately 1 death and 11 injuries each year. Of these storms, 11 resulted in major disaster declarations. Based on the frequency of events, South Dakota averages one major disaster-level winter storm every year and a half. Minnehaha has a very high vulnerability, while Brookings, Lincoln, Meade, Beadle, Brown, Butte, Davison, Hutchinson, Pennington, and Yankton have high vulnerabilities.

Wildfire Hazard Profile Summary
Wildfires have a 100 percent chance of occurrence somewhere in the state from early spring to late fall every year. Based on past fire history, Table 3-54 indicates the counties most vulnerable to wild land and prairie fires (from 2004 plan updated with 2010 HAZUS valuations and 2000 Census population data).

Drought Hazard Profile Summary
Based on the tree ring research, which spans a period of roughly 400 years, multi-year droughts as significant as the 1930's drought or worse occur on average every 57 years. Based on historical records (10 in the past 118 years, counting the 2003-2007 dry spell and other multi- year events as one event) notable droughts have occurred somewhere in the state on average about every 12 years, which is equivalent of an 8% chance any given year. Inadequate data on past impacts exists to calculate average annual losses, but it is assumed to be in the millions of dollars. The entire State of South Dakota is vulnerable to drought.

Tornado Hazard Profile Summary
According to the National Climatic Data Center, there were 1,592 tornadoes, of which 609 were F1 or higher, in South Dakota between 1950 and 2010 (61 years).Based on this information, the probability that at least one tornado will occur in South Dakota in any given year is 100 percent. Annualized losses are estimated at $3.9 million. While every South Dakota county is vulnerable to tornadoes, only Minnehaha County has a very high vulnerability. Beadle, Brown, Lincoln, McCook, Pennington, and Turner counties have high vulnerabilities. The remaining 59 counties (89%) have moderate vulnerabilities.

Wind Hazard Profile Summary
According to the National Climatic Data Center, there were 5,675 wind events (excluding events from October through March 31 and those associated with snow, see event description above) in South Dakota between 1950 and April 2010 (60 years). Based on this information, the probability that at least one wind event will occur in South Dakota in any given year is 100 percent. Annualized losses are estimated at $5.8 million. Every South Dakota county is vulnerable to windstorm but some counties have a higher risk than others. In addition, the severity of the windstorm event varies the vulnerability slightly. In both scenarios, only Minnehaha County has a very high vulnerability. In the total windstorm events vulnerability, Pennington, Brown, Meade and Lincoln have high vulnerabilities. When windstorm events of at least 70 knots are considered, Lincoln is rated as a moderate risk while Day and Hughes are added to this list of high vulnerabilities. The remaining counties have moderate vulnerabilities.

Hazardous Materials Hazard Profile Summary

- According to the U.S. Department of Transportation's (DOT) Hazardous Materials Information System, South Dakota experienced 709 transportation incidents involving hazardous materials between 1971 and 2010.The total cost of damage associated with these incidents was approximately $6,415,374. This suggests that South Dakota experiences 23.6

transportation incidents involving hazardous materials and $213,845 in related damage each year. Based on historic incidents more than half of the transportation incidents between 1971 and 2010 occurred in Minnehaha and Pennington counties, where the state's largest cities, Sioux Falls and Rapid City, are located.

- According to the U.S. Department of Transportation's Office of Pipeline Safety, there were 39 pipeline incidents in South Dakota between 1983 and 2010 (28 years). Based on this information, the probability that at least one pipeline incident will occur in South Dakota in any given year is 100 percent. The top ten counties with the most transmission lines are Lincoln, Minnehaha, Brown, Spink, Butte, Union, Clark, Harding, Duel, and Hutchinson, most of which are located in southeastern South Dakota.

- According to the U.S. Environmental Protection Agency's Toxic Resource Inventory, 7 million pounds of hazardous materials were disposed of or released in South Dakota in 2008. Based on this information, there is a 100 percent probability that a fixed facility will dispose of or release a hazardous material in South Dakota each year. Southeastern counties are more vulnerable to fixed facility incidents in general due to the number of facilities there.

Geologic Hazards

Although historical landslide/mudflow/subsidence/expansive soil occurrence data is limited it can be assumed that landslides will occur occasionally in the future, typically during wet climate cycles or following heavy rains, but in limited areas of the state.

South Dakota seems to be relatively geologically stable based upon the sparse data available. However, there is potential for larger earthquakes than the magnitude 4.4 earthquake that struck the Black Hills in 1964. The U.S. Geological Survey estimates this risk as only a 10 percent chance of exceeding a 5.1 magnitude in any one 50-year period. The counties with the highest building losses are Pennington ($110,000), Minnehaha ($59,000), and Lawrence ($26,000), with the remaining counties having $18,000 or less in annualized loss.

Growth and Development

In general, counties with growing populations and number of housing units have an increased vulnerability to hazards not defined by specific geographic areas. These hazards may include winter storms, tornadoes, wind, drought and earthquake.

Social Vulnerability

South Dakota's most socially vulnerable counties are:

- Shannon*
- Todd*
- Buffalo
- Ziebach
- Dewey
- Bennett
- Jackson
- Jerauld
- McPherson
- Tripp
- Charles Mix
- Mellette
- Corson

*These counties are among the 10 fastest growing counties in the state. The counties of Potter, Roberts, Gregory, Hamlin, Edmunds, Walworth, Faulk, Douglas, Day, Hand, and Hutchinson also rank in the top 20 percent in the nation in terms of social vulnerability.

Building Exposure

There are an estimated 406 thousand buildings in South Dakota with a total building replacement value (excluding contents) of $47,276,961,000. Approximately 92 percent of the buildings (and 70 percent of the building value) are associated with residential housing. In terms of a catastrophic event, the entire building inventory could be at risk to a hazard.

State Owned Facilities

Flood

A GIS overlay analysis was performed to determine vulnerability of critical facilities to flooding. Both the DFIRM (100 and 500 year) and HAZUS-MH modeled base flood extents were used. Figure 3-54 illustrates critical facilities and their relationship to floodplains. Table 3H-D in Appendix 3H illustrates the numbers of facilities in the floodplain. The results of the 2010 analysis found 258 critical facilities potentially at risk to flooding, based on both HAZUS and DFIRM mapping.

Wildfire

GIS was used to identify the critical facilities that lie within a high or moderate wildfire risk zone. The locations of these facilities are shown in Figure 3-56 and descriptions of the facilities are listed in Table 3H-E in Appendix 3H.

Tornadoes, Wind, Winter Storms

Eleven counties were identified to have either ‘very high’ or ‘high’ vulnerability to one or more of these hazards. The number of facilities in four state facility GIS layers (State Layer, Power, Natural Gas, and Fuel) was quantified in each of these counties. The results are displayed in Table 3-75. Due to the general nature of this exposure analysis individual facilities are not identified, but more detail can be referenced in the state’s GIS layers. The table also displays overlap in vulnerability to the three hazards, particularly in Minnehaha and Pennington counties. The mitigation strategies for these hazards often overlap as well, and this table indicates where multi-hazard critical facility protection opportunities may lie.

Section 4 Mitigation Strategies

Goals:

- Reduce injuries and loss of life from natural hazards
- Reduce damage to existing and future structures within hazard areas
- Reduce the losses to critical facilities, utilities, and infrastructure from natural hazards
- Reduce impacts to the economy, the environment, and cultural resources from hazards
- Support and assist local / tribal mitigation capabilities and efforts

The State Hazard Mitigation Team developed mitigation actions organized into the following 8 components to address the identified goals:

1. The problem statement,
2. A description of the proposed action including an action number comprised of the main plan objective the action addresses,
3. A level of priority compared to other actions listed here,
4. The hazards the action will address,
5. The goals the action will address,
6. Potential funding sources,

7. The department responsible for implementing the action, and
8. A target completion date.

The SHMT confirmed that the actions identified in 2007 are valid for the 2010 update. The mitigation actions that were formed in the 2007 plan have been updated to include a 2010 Status Report, which indicates the progress of each mitigation action, and to address the hazards identified in this plan that have changed since the 2007 plan.

The prioritized actions are detailed in Section 4.4

Section 5 Local Mitigation Planning Coordination
Funding and technical assistance provided by SDOEM includes provision of funds, plan development assistance, technical assistance for developing risk assessments, G318 trainings for hazard mitigation planning, benefit/cost analysis training, and tribal planning assistance.

The State Hazard Mitigation Officer (SHMO) works with every county throughout the state to support their development of a local mitigation plan. Section 3.1 discusses the consideration of the hazards identified in the local plans. Section 4.3 discusses the common capabilities identified in the local plans. The estimated losses, where provided, were integrated into the Risk Assessment (Chapter 3 of this plan). Table 3-27 in Section 3.3 summarizes the growth and development trends identified in the local plans. The funding sources identified in the local plans are presented in Section 4.5.

The State will continue to prioritize assisting communities in maintaining FEMA approved local mitigation plans and implementing diverse mitigation projects. The information gathered in this plan is available to the local communities for use and consideration.

Section 6 Plan Maintenance Procedures
The SHMT will continue to annually review applications for submittal for PDM grants. In addition the SHMT will continue to convene following every declared disaster event. At every meeting of the SHMT, the team will review the identified priorities in comparison to the already funded projects and discuss overall mitigation progress. This will inform ongoing prioritization decisions for funding additional projects. Every three years, as required by DMA 2000, the State will submit an updated Hazard Mitigation Plan to FEMA for review and approval.

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INTRODUCTION

Purpose

The purpose of the State of South Dakota Multi-Hazard Mitigation Plan is:

1. To guide South Dakota's mitigation program to reduce the impact of or eliminate destructive effects of significant hazards to the state e.g., threats to life and property.
2. To serve as a public and private sector reference document and management tool for mitigation activities throughout South Dakota.
3. To meet the state planning requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended by Public Law 106-390, October 30, 2000 UNITED STATES CODE Title 42. THE PUBLIC HEALTH AND WELFARE CHAPTER 68. DISASTER RELIEF [As amended by Pub. L. 103-181, Pub. L. 103-337, and Pub. L. 106-390] (Pub. L. 106-390, October 30,2000, 114 Stat. 15521575) hereafter referred to as the Disaster Mitigation Act of 2000 (DMA 2000).

FEMA published an Interim Final Rule (44 CFR Part 201) in the Federal Register on February 26, 2002 to implement the DMA 2000 planning requirements. This State of South Dakota Multi-Hazard Mitigation Plan includes the requirements set forth by this rule.

Background

South Dakota's first hazard mitigation efforts took place in the late 1800's. **Hazard Mitigation** is defined as *any action taken to reduce or eliminate the long-term risk to human life and property from hazards*. The term is sometimes used in a stricter sense to mean cost-effective measures to reduce the potential for damage to a facility or facilities from a disaster event (FEMA definition).

After the 1881 flood of the Vermillion and Missouri Rivers that wiped out the town of Vermillion, the town was relocated on the bluffs behind the former town to prevent another recurrence. This marks the first recorded hazard mitigation effort by a government entity in South Dakota. Following the 1972 Black Hills/Rapid City flood, development was prohibited from the floodway, marking the second recorded hazard mitigation effort in South Dakota.

A third example of South Dakota mitigation efforts involves mitigation of landslides. Since 1969, the South Dakota Department of Transportation (SDDOT) has created and implemented engineering and construction methods and procedures for mitigation of landslides. Over time, these measures were copied by other states and are still in use today. South Dakota has received national notoriety for their work in this area.

Currently, the South Dakota Office of Emergency Management oversees hazard mitigation grant funding available through FEMA's Hazard Mitigation Assistance programs and supports local implementation of various mitigation projects. These have included more than 1,000 miles of power line burial to prevent power outages and communication losses during winter storms.

The first State of South Dakota Multi-Hazard Mitigation Plan pursuant to the Disaster Mitigation Act of 2000 was completed and approved in June 2004. At that time, FEMA outlined several required and recommended areas for improvement to be integrated during the plan update. The State of South Dakota formed a State Hazard Mitigation Team in April 2007 and incorporated all of the required improvements in the 2007 updated plan. The SHMT continues ongoing collaboration to maintain and update this plan every three years.

INTRODUCTION

Organization

This plan demonstrates the State's current and future mitigation actions in an organized fashion similar to the guidance materials provided by FEMA. The reviewer will note that the section headings and subheadings follow the organization of the Standard State Hazard Mitigation Plan Review Crosswalk. Several appendices accompany this plan. They contain technical data, meeting minutes, and other relevant information that complements the content of this plan.

Section 1 demonstrates the legal authority of this plan through the Governor's adoption. Section 2 documents the planning process for developing this plan, including coordination with local mitigation planning efforts. Section 3 outlines the identified hazards South Dakota is vulnerable to and assesses the risk for each hazard on a per county basis. Section 4 details the State's mitigation strategy based on the local and state vulnerability analyses and risk assessments. Section 5 describes how the State provides funding to local governments as well as how the local assistance and project grants are prioritized. Section 6 outlines the plan maintenance process. Each section includes details on how this 2010 plan was updated from the previous 2007 plan.

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SECTION 1 PREREQUISITES

1.1 ADOPTION BY THE STATE

44 CFR Part 201 Requirement:
The plan must: • *Be formally adopted by the State prior to submittal to [FEMA] for final review and approval [and]* • *Include assurances that the State will comply with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with 44 CFR 13.11 (c). The State will amend its plan whenever necessary to reflect changes in State or Federal laws and statues as required in 44 CFR 13.11 (d).*

Governor M. Michael Rounds adopted the original (developed in 2004) State of South Dakota Multi-Hazard Mitigation Plan by letter dated February 28, 2005 and also adopted the updated 2007 Plan by letter dated April 22, 2008. These letters are included on the following pages.

On <INSERT DATE HERE> the State Hazard Mitigation Team, led by the director of the South Dakota Office of Emergency Management and charged by the governor with the responsibility of implementing a statewide Hazard Mitigation Program based upon Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 93-288, as amended), recommended that this 2010 revised and updated Multi-Hazard Mitigation Plan be adopted by the governor.

Governor M. Michael Rounds adopted the revised and updated (in 2010) State plan by letter dated <INSERT DATE HERE>.

The State will comply with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with § 13.11 (c). As reflected in Section 6 – Plan Maintenance Procedures, the State will amend its plan whenever necessary to reflect changes in State or Federal laws and statues as required in §13.11 (d).

STATE OF SOUTH DAKOTA
M. MICHAEL ROUNDS, GOVERNOR

February 28, 2005

David Maurstad
FEMA Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267

Dear David:

On behalf of the State of South Dakota, I am proud to adopt the South Dakota Multi-Hazard Mitigation Plan. This plan clearly outlines projects that will lessen the impacts of future disaster within our great state. This plan is a great planning tool for our state's entire emergency management community and will be an asset that can be utilized for years to come with noteworthy goals to accomplish.

With the submission of the 2004 State of South Dakota's Natural Hazards Mitigation Plan, the plan is hereby approved and adopted by the state of South Dakota, Office of the Governor.

Sincerely,

M. Michael Rounds

MMR:ls

STATE CAPITOL • 500 EAST CAPITOL • PIERRE, SOUTH DAKOTA 57501-5070 • 605-773-3212

STATE OF SOUTH DAKOTA
M. MICHAEL ROUNDS, GOVERNOR

April 22, 2008

Doug Gore
FEMA Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267

Dear Doug,

On behalf of the state of South Dakota, I am proud to adopt the South Dakota Multi-Hazard Mitigation Plan. This plan clearly outlines projects that will lessen the impacts of future disasters within our state. This plan is a great planning tool for our state's entire emergency management community and will be an asset which can be utilized for years to come with noteworthy goals to accomplish.

With the submission of the state of South Dakota Multi-Hazard Mitigation Plan, the plan is hereby approved and adopted.

Sincerely,

M. Michael Rounds

MMR:ls

STATE CAPITOL • 500 EAST CAPITOL • PIERRE, SOUTH DAKOTA 57501-5070 • 605·773·3212

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SECTION 2 PLANNING PROCESS

This section details the planning process conducted during 2010 to revise and update this State of South Dakota Multi-Hazard Mitigation Plan (last adopted on April 22, 2008). The planning process for this update began in November 2009, continued through adoption of the plan, and will remain in effect as the plan is maintained. This process has provided and continues to provide all relevant stakeholders the opportunity to actively participate in the development/revision of this plan.

2.1 PLANNING PROCESS UPDATE

Similar to the planning process conducted in 2007, the State Hazard Mitigation Team (SHMT) attended several milestone meetings to discuss revisions to the major components. This included reviewing and re-prioritizing the identified hazards, modifying the goals/objectives, and discussing the progress/prioritization of mitigation actions.

The SHMT recognized that the regional meetings conducted in 2007 (with the intent of facilitating face to face discussions with regional stakeholders in four locations throughout the state) were not productive. The limited attendance presented minimal input and minimal collaboration. The approach for receiving input from regional stakeholders was revised in 2010 to reach out via email and letter to identified stakeholders. This is described in more detail below. The identified stakeholders were asked to review a summary of the risk assessment and provide input through an online survey. They are also given an opportunity to review the complete draft plan and submit comments.

2.2 DOCUMENTATION OF THE PLANNING PROCESS

44 CFR Part 201 Requirement:
[The State plan must include a] description of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how other agencies participated.

The South Dakota Office of Emergency Management (SDOEM) oversaw and directed the planning process required to update and revise the 2007 Plan. SDOEM staff specifically responsible for coordinating the completion of the Plan update included Jason Bauder and Nicole Prince, with oversight by Kristi Turman and Tina Titze as necessary. SDOEM contracted with a consulting team comprised of Dewberry and AMEC for technical assistance throughout the process. Cynthia Maszk and Michelle Saxman who formerly served as the State Hazard Mitigation Officer (SHMO) and NFIP Coordinator, respectively, are no longer with SDOEM. Nicole Prince is currently acting as the SHMO and NFIP Coordinator.

State Hazard Mitigation Team

On April 4, 2007, Governor M. Michael Rounds signed Executive Order 2007-07 directing the establishment of the South Dakota Hazard Mitigation Team and authorizing this team to function in compliance with the responsibilities specified in the order. This order remains in effect for the purposes of the 2010 planning process. A copy of the executive order is included on the following page.

STATE OF SOUTH DAKOTA
OFFICE OF THE GOVERNOR
EXECUTIVE ORDER 2007-07

WHEREAS, Major disasters which struck South Dakota during the years of 2004, 2005 and 2006 caused tremendous physical and financial damages upon the citizens and governments of this state; and,

WHEREAS, There are sufficient opportunities to reduce the impact of future natural disasters through the Hazard Mitigation Grant Program and the pre-disaster mitigation program; and,

WHEREAS, Federal disaster assistance is tied to the establishment and maintenance of an effective State Hazard Mitigation Team; and,

WHEREAS, It is in the best interest of South Dakota that this state embarks upon a long-term effort to mitigate the effects of future disaster.

IT IS, THEREFORE, BY EXECUTIVE ORDER, Directed that the South Dakota Hazard Mitigation Team be established and authorized to function in compliance with the following sections of this order:

GENERAL PROVISIONS

Section 1. The governor of South Dakota will designate at least one person from each of the following departments and offices to form the core leadership of the South Dakota Hazard Mitigation Team:

- Office of the Governor
- Department of Tourism and State Development
  Governor's Office of Economic Development
  Historical Preservation Office
- Department of Agriculture
- Department of Game, Fish and Parks
- Department of Health
- Department of Public Safety, Office of Emergency Management
- Department of Transportation
- Bureau of Administration
  Risk Management

The governor may designate additional executive and non-executive branch personnel or quasi-governmental and non-governmental personnel to serve on the South Dakota Hazard Mitigation Team as the need for their expertise and counsel arises.

The core leadership of the State Hazard Mitigation Team consists of one representative from each of the departments and offices listed in the executive order. The names provided in Table 2-1 are the individuals who participated at the State Hazard Mitigation Team meetings in 2007 and 2010 and throughout development of this plan. The departments and offices are the same as 2007; however, some of the individual representatives have changed since the 2007 update. The executive order allows the Team to add specific members "as the need for their expertise and counsel arises". These members are listed with the precursor "As needed".

Table 2-1: South Dakota Hazard Mitigation Team Members 2010

Departments and Offices cited in Executive Order 2007-07	Individual Representative*
Office of the Governor	Dale Bertsch
Department of Tourism and State Development, Governor's Office of Economic Development, Historical Preservation Office	Paige Hoskinson Olson ~~Steve Harding~~
Department of Agriculture	Kevin Fridley
Department of Game, Fish, and Parks	Leslie Petersen Randy Kittle ~~Jayme Severyn (Parks and Rec)~~
Department of Health	Rick LaBrie
Department of Public Safety, Office of Emergency Management	Jason Bauder Nicole Prince Tina Titze ~~Cynthia Maszk~~ ~~Michelle Saxman~~
Department of Transportation	Laurie Schultz (new in 2010)
Bureau of Administration, Risk Management	Ian Paul
As needed: Office of Homeland Security	Michael Harmon August Geisinger ~~Daren Ketcham~~
As needed: Rural Electric Associations	Karla Steele ~~Audry Ricketts~~
As needed: Department of Environment and Natural Resources	Mark Rath
As needed: State Climatologist	Dennis Todey

*Names shown with a strikethrough participated in 2007, but were either no longer working for the state or have been replaced on the SHMT for the 2010 planning process.

In addition to assisting in the writing, preparation, and coordination of the State of South Dakota Multi-Hazard Mitigation Plan, the specific duties and responsibilities of the State Hazard Mitigation Team include:

- meeting periodically to review and update the State of South Dakota Multi-Hazard Mitigation Plan as needed or at least every 3 years,

- establishing statewide hazard mitigation goals and objectives,
- establishing priorities for categories of hazard mitigation projects, and
- reviewing and evaluating hazard mitigation grant applications for funding approval within the guidelines of the State of South Dakota Multi-Hazard Mitigation Plan.

Collaboration

The 2010 planning process involved two milestone meetings of the State Hazard Mitigation Team, many conference calls among team members and the contracted consulting staff, as well as, communication via e-mail and digital data sharing with regional stakeholders. A summary of the meetings and collaboration is presented in Table 2-2. Summary of Planning Process 2010.

Table 2-2: Summary of Planning Process 2010

November 30, 2009 – Internal Preparation Meeting prior to SHMT Kick Off Meeting
SDOEM and Dewberry began the planning process with an internal preparation meeting. Dewberry outlined a list of items for discussion. Dewberry asked for local plans that have been updated since 2007 so that they could be incorporated into the updated State Plan. SDOEM has access to HAZUS runs that have been completed for every county. SDOEM informed Dewberry that the SHMT met during the previous two years to prioritize projects following disaster declarations. Although meeting minutes were not collected during these meetings, the SHMT was expected to meet again in February and meeting minutes and attendance would be recorded during that meeting. SDOEM also informed Dewberry that many power line burial projects have been funded and completed throughout the state. During this meeting, ideas regarding a revised public outreach approach were outlined.
November 30, 2009 – SHMT Kick Off
One goal of the SHMT kick off meeting was to review recent hazard events (since 2007) and ensure that Dewberry/AMEC captured the significant events for updating the risk assessment section of this plan. The SMHT reviewed the hazard identification of the 2007 plan and re-prioritized hazards as appropriate. The SHMT reviewed the list of hazards provided in FEMA's "how to" guidance and decided to add expansive soils and agricultural pests/diseases for evaluation in the risk assessment. Due to the limited damage and occurrence of geological hazards the following were grouped together to be listed in the plan as geological hazards: landslide, mudflow, expansive soils, and earthquake. The hazard ranking from this meeting was placed on a project sharepoint site for review and comment by the SHMT. The SHMT discussed public outreach and hazard mitigation practices already underway. Additional stakeholders to be surveyed as part of the plan update were also discussed. The SHMT reviewed the current goals and objectives from the 2007 plan and made suggestions for modifications based on the addition of expansive soils and agricultural pests/diseases. FEMA's review crosswalk from the 2007 plan was also reviewed at this meeting. Members of the SHMT were asked to complete an updated version of the Agency Comment Form prepared by Dewberry to assist with the documentation of agency specific concerns and capabilities.
June 3, 2010 – SHMT Meeting #2
The SHMT was called together in June to review the preliminary risk assessment based on the identified hazards and updates to the 2007 risk assessment. AMEC presented the preliminary results of the risk and vulnerability assessment. The SHMT was encouraged to ask questions, provide feedback, and provide suggestions of additional data sources. The SHMT also developed a new mission statement that incorporated "economic impact" and "livelihood" concepts. The team reviewed and updated the plan goals and objectives during this meeting. The progress for each mitigation action from the 2007 plan was

also updated. The team was asked to think about new mitigation actions to help accomplish the new objectives and achieve the new goals. Ideas should be sent to SDOEM or Dewberry. Feedback on the risk and vulnerability assessment was integrated into the final Risk Assessment presented herein as Section 3. The mission statement and goals used in this plan are those developed at the second meeting of the SHMT. The Rural Electric Cooperatives (RECs) representative was active in this meeting and performed follow up actions to engage the local RECs.
September 8, 2010 – FEMA Preliminary Review of Risk Assessment
FEMA Region 8 conducted a pre-review of the Risk Assessment section and provided comments to Nicole Prince on September 8, 2010. AMEC addressed these comments in the final Risk Assessment presented herein as Section 3.
December 13, 2010 – January 7, 2010 SHMT and Public Review of Complete Draft
The State Hazard Mitigation Team reviewed a complete draft of this plan update and submitted comments/corrections to SDOEM. Concurrently, SDOEM made the complete draft available for public review.
January 14, 2010 - FEMA Review of Complete Draft
The State Hazard Mitigation Team submitted one hard copy and one electronic copy of this plan and accompanying crosswalk to FEMA for review and conditional approval.
Adoption by the State of South Dakota
to be determined
Bi-weekly conference calls
Throughout the duration of the planning process the project team (SDOEM, Dewberry, and AMEC) participated in bi-weekly conference calls. This enabled the team to update each other on progress as well as communicate data needs or questions pertaining to the update.
Project Team: Share Site
Dewberry provided a website environment for data sharing. SDOEM uploaded the collected data (from GIS data layers for the Risk Assessment to digital versions of the approved local plans) and Dewberry uploaded meeting documentation materials to this site as the planning process continued. All members of the SHMT and the Project Team were given access to this site to review and obtain materials relevant to the Multi-Hazard Mitigation Plan Update.

Meeting invitations, agendas, sign-in sheets, presentations, minutes, handouts, surveys used throughout the planning process, and digital communication records are provided in Appendix 2A.

Stakeholder Involvement

The SHMT revised the process for engaging stakeholders in the planning process since 2007. It was decided not to hold regional stakeholder meetings as was done for the 2007 plan update process. During the last plan update, an exhaustive list of stakeholders was invited to participate in one of four regional meetings. However, due to low attendance at these meeting, the SHMT agreed that a different approach would be more effective. For this plan update, the SHMT identified a list of stakeholders from state, regional, and local agencies to solicit input from. These stakeholders are listed in Table 2-3. The identified stakeholders include several of the suggestions noted in the 2007 plan such as Tribal governments, SD Housing Development Authority, SD Tribal Relations, SD State Climatologist, and Rural Waters. Future plan updates may reach out to SD Wildland Fire Suppression and Rural Telephones.

SDOEM issued email and letter notification inviting the stakeholders to review a Plan Update Summary document and respond to an online survey. Both the Plan Update Summary and online survey were accessible via SDOEM's website for public access. A copy of the Plan Update Summary document and stakeholder survey can be found in Appendix 2B.

Table 2-3: Identified Stakeholders 2010

Affiliation	Individual Representative
County and Tribal Emergency Managers	Tina Titze
County Governments	No email list available at this time
County Highway/Engineering	No email list available at this time
Floodplain Administrators	Nicole Prince (hard copy letter)
Housing Authority*	Nicole Prince
State Geologist*	Nicole Prince
Extensions*	Nicole Prince
Public Utility Commission*	Nicole Prince
Board of Regents*	Nicole Prince
Tribal Liaison from Governor's Office*	Nicole Prince
Red Cross*	Nicole Prince
Council of Governments*	Nicole Prince
Regional Coordinators*	Nicole Prince
Department of Health*	Nicole Prince
Department of Education*	Nicole Prince
VOADs*	Nicole Prince
Rural Electric Association (disseminated to all RECs)	Karla Steele
Rural Water System Association (disseminated to all RWSs)	Morris Elcock

Nicole Prince utilized a state government key planning contacts email list to reach the stakeholders noted with an *. Email lists were available for reaching the County and Tribal Emergency Managers, the Rural Electric Cooperatives, and the Rural Water Systems. The Floodplain Administrators were mailed hard copy letters. Disseminated emails and documentation of the website posting is included in Appendix 2B.

Results of the survey and summaries of the provided comments are presented in Section 2.3. This process was more successful than the regional meetings but can be improved by issuing a press release to encourage public input. The SHMT notes this as an action item for the next plan update.

Draft Plan Review

Based on the collaboration among SDOEM, the SHMT, and the contracted consultants, Dewberry was able to draft a complete updated State of South Dakota Multi-Hazard Mitigation Plan for review and edit by the project team, SHMT, and regional stakeholders. *The process for conducting this review and summary comments are forthcoming.*

2.3 Coordination among Agencies

44 CFR Part 201 Requirement:
The [state] mitigation planning process should include coordination with other State agencies, appropriate Federal agencies, interested groups, and ….

Coordination with federal agencies:

Dewberry and SDOEM maintained ongoing communication with Julie Baxter of FEMA Region VIII throughout the planning process. As noted above FEMA Region VIII reviewed the draft risk assessment prior to receiving the complete plan update. SDOEM and FEMA Region VIII discussed the integration of Rural Electric Cooperatives (RECs) as a stakeholder in this plan update so their mitigation project applications may be eligible through this approved plan. The guidance provided by FEMA Region VIII was followed to ensure eligibility for the RECs.

Coordination with state agencies:

The formation of the State Hazard Mitigation Team (SHMT) provides a convenient vehicle for coordinating the plan update with relevant state agencies. The State Hazard Mitigation Officer (Nicole Prince) communicated regularly via e-mail and follow-up phone calls with members of the SHMT. She ensured that everyone on the SHMT was given multiple opportunities to provide input during the planning process.

2.3.1 SHMT, REC, and Stakeholder Input

As discussed in Section 2.1 several categories of stakeholders were contacted for input into the planning process. This section presents the input provided by the SHMT, Rural Electric Cooperatives, and Identified Stakeholders. The SHMT and RECs were asked to complete an Agency Comment Form in addition to their active participation in the SHMT meetings. The Identified Stakeholders (Table 2-3) were invited to respond to an online survey designed for respondents from state, regional, and local agencies as well as interested members of the public. A copy of the Agency Comment Form and Public and Stakeholder Survey is provided in Appendix 2B along with complete responses from 2007 and 2010.

2.3.1.1 Respondents

The 2010 Agency Comment Form was modified since 2007 to target more specifically the risks, capabilities, concerns, and accomplishments of the state agencies represented on the SHMT. The eight agencies who responded are:

1) SD Office of Emergency Management,
2) SD Department of Agriculture,
3) SD Historical Society-State Historic Preservation Office,
4) SD Game, Fish, and Parks Department
5) SD Office of Risk Management
6) SD Department of Energy and Natural Resources
7) SD Department of Transportation
8) SD State Climate Office

Fifteen electric cooperatives completed the Agency Comment Form. These respondents were:

1) Bon Homme Yankton Electric
2) Central Electric Cooperative, Inc.
3) Charles Mix Electric Association, Inc.
4) Clay Union Electric Corp
5) Codington-Clark Electric Co-op
6) Douglas Electric Co-op
7) East River Electric Power Cooperative
8) FEM Electric
9) Kingsbury Electric Cooperative
10) Moreau-Grand Electric Cooperative
11) Oahe Electric Cooperative
12) Sioux Valley Energy
13) Southeastern Electric Cooperative
14) Traverse Electric Co-op
15) West River Electric Association

In 2007, hardcopy surveys were distributed at the regional stakeholder meetings. The SHMT agreed it was valuable to maintain the input from this 2007 survey since the respondents to the online 2010 Public and Stakeholder Survey are different entities. Eighteen local agencies responded to the Public and Stakeholder Survey in 2007. These respondents were:

1) Union County Emergency Management
2) Hughes County
3) Central Electric Cooperation
4) Rosebud Sioux Tribe
5) City of Wall
6) City of Hill City
7) Meade County
8) Pennington County Emergency Management
9) Charles Mix County Emergency Management
10) Moody County Emergency Management
11) Southeastern Electric Coop Inc.
12) Spink County Emergency Management
13) Brown County Emergency Management
14) SDOEM – Regional Coordinator
15) FEM Electric
16) Brule/Buffalo Emergency Management District
17) 28CES/CEX Ellsworth Airforce Base
18) Campbell County Emergency Management

In 2010, sixteen local agencies responded to the online Public and Stakeholder Survey. These respondents were:

1) Jerauld County Emergency Management
2) Marshall County Emergency Management
3) Tripp County Emergency Management
4) McCook County Emergency Management

5) Faulk County Emergency Management
6) Spink County Emergency Management
7) Turner County Emergency Management
8) Miner County Emergency Managment
9) CERT
10) South Dakota Division of Criminal Investigation
11) Central South Dakota Enhancement District (CSDED)
12) Sioux Valley Energy
13) Rosebud Electric Co-Op
14) Lacreek Electric Cooperative
15) Codington-Clark Electric Cooperative
16) Northern Electric Co-Op

Note: The only organization on this list that also participated in the 2007 stakeholder survey is Spink County Emergency Management. The rest of the organizations are new respondents for the 2010 plan.

2.3.1.2 Suggested Stakeholders

All surveys (2010 Agency Comment Form, 2010 Public and Stakeholder Survey, and 2007 Public and Stakeholder Survey) allowed respondents to suggest additional agencies for participation in the hazard mitigation planning process. Some of these suggestions have already been incorporated through the Identified Stakeholders (Table 2-3). The SHMT will review this list again (as documented herein) prior to the next plan update and reach out to the suggested agencies as appropriate.

In 2010, SHMT agencies made the following suggestions:

- State agencies that take an active role in protecting resources
- Local Emergency Operations Plans incorporate response within a County or Region
- All Cities, Towns, and Counties
- Electric Companies
- Internet Providers
- Schools
- Hospitals
- Utility Companies

In 2010, the RECs made the following suggestions:

- City of Vermillion
- Clay County
- City of Wakonda
- Yankton County
- Union County
- Rural Water Systems

In 2010, the following were suggested as additional organizations to complete the online Public and Stakeholder Survey:

- City of Parker Fire Chief
- Turner County Sheriff

- South Dakota Public Health Regional Coordinator
- Faulk County Auditor

In 2007, the following were suggested through the Public and Stakeholder Survey:

- Todd County LEPC
- National Weather Service
- Critical Utility Agencies
- Santee Sioux Tribe
- Cities – Townships
- Tourism
- Extended Care Facilities
- Weather Service
- Extension Service
- Department of Agriculture

2.3.2 Hazard Concern

Both the Agency Comment Form and the online Public and Stakeholder Survey asked respondents to indentify the hazards of concern to their agency. It is noted that the State Historical Society does not address any specific hazards through their normal operations.

Table 2-4 summarizes the hazards as they pertain to the solicited stakeholders. The SHMT (State) Agencies and RECs identified which hazards are addressed through their regular duties in the 2010 Agency Comment Form. In 2007, local agency respondents identified pertinent hazards, but this question was revised in the online 2010 Public and Stakeholder Survey (see Table 2-5).

Table 2-4: Hazards Addressed by State Agencies (2010), SD Electric Cooperatives (2010), and Local Agencies (2007)

Hazard	State Agencies (2010)	Electric Cooperatives (2010)	Local Agencies (2007)
Flood	7	13	16
Winter Storm	7	15	17
Tornadoes	7	12	16
Wind Storms	7	13	12
Wildfire	6	4	13
Summer Storms	5	8	11
Thunderstorms	4	11	14
Landslide and Mudflow	3	1	4
Hail	3	6	11
Drought	3	2	9
Wildland Interface Fire	3	1	9
Utility Mishap	3	4	7
Hazardous Materials	3	4	11

Hazard	State Agencies (2010)	Electric Cooperatives (2010)	Local Agencies (2007)
Aviation Incident	3	2	4
Railway Incident	3	5	6
Motor Vehicle Incident	3	5	8
Ground Transportation Incident	2	2	4
Epidemic	2	2	9
Urban Fire	2	2	3
Expansive Soils	2	0	1
Extreme Heat	1	2	5
Earthquake	0	6	2
Nuclear Event	0	1	2
Mass Casualty Incident	0	2	5
Other-Ice Storm/Buildup	0	4	0
Dam Break & Drinking Water Contamination	0	0	1

The 2010 online Public and Stakeholder Survey asked respondents to rate the identified hazards on a scale of 1 (low threat) to 3 (high threat), indicating the level of threat each hazard presents to the operation of their organization/residence. A 0 rating was given to hazards that were not applicable. For each listed hazard, the number of responses was multiplied by the corresponding level and totaled to produce a ranking of hazard threat. Table 2-5 below shows the number of responses and the total raking for each hazard. Winter Storms are the hazards that the respondents were most concerned with, followed by severe thunderstorms, tornadoes, wind storms, and power failure.

Table 2-5: Threat of Natural Hazards on Operation of Stakeholder's Organization or Public's Residence

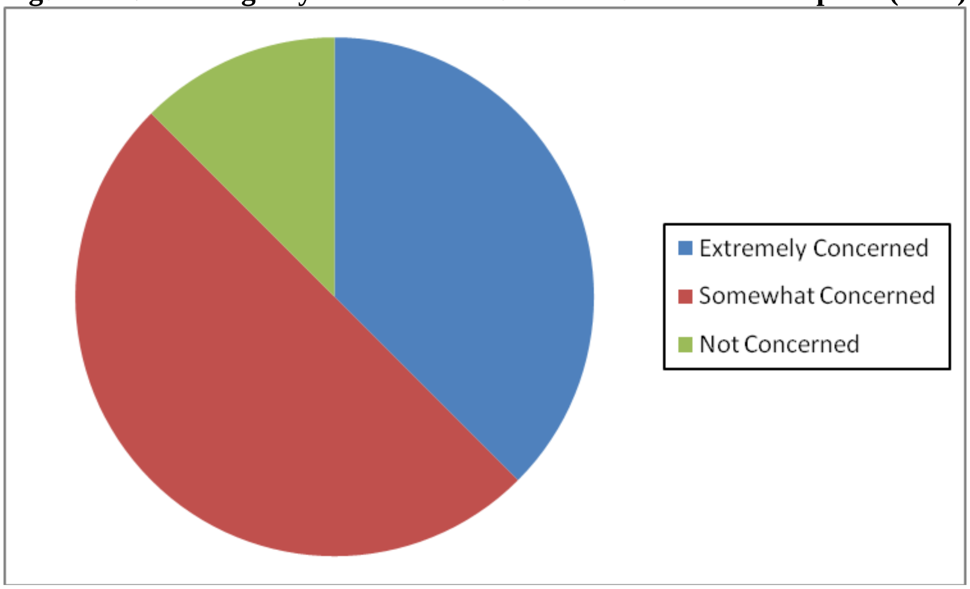
	Number of Responses				
Hazard	**High Threat (3)**	**Moderate Threat (2)**	**Low Threat (1)**	**No Response**	**Total Points**
Winter Storm	11	3	0	2	39
Severe Thunderstorms	10	3	1	2	37
Tornadoes	10	3	1	2	37
Windstorm	8	5	1	2	35
Power Failure	7	7	0	2	35
Fuel Shortage	6	6	3	1	33
Flooding	8	4	1	3	33
Lightening Strike	6	6	2	2	32
Communication Failure	3	11	0	2	31

	Number of Responses				
Hazard	**High Threat (3)**	**Moderate Threat (2)**	**Low Threat (1)**	**No Response**	**Total Points**
Hail	7	4	2	3	31
Utility Mishap	4	6	4	2	28
Drought	4	7	2	3	28
Communication Isolation	2	9	2	3	26
Motor Vehicle Transportation Incident	3	6	5	2	26
Agricultural Pests/Diseases	2	8	3	3	25
Bio-Terrorism	4	4	5	3	25
Hazardous Materials Incident	2	8	3	2	25
Infectious Disease/Epidemic	2	6	6	2	24
Structural Fires	1	8	5	2	24
Transportation Incidents	3	4	6	3	23
Explosion	1	8	3	4	22
Mass Casualty Incident	0	8	6	2	22
Wildland/Interface Fire	2	5	6	3	22
Natural Caused Mass Evacuation	1	7	5	3	22
Man-Man Hazards	0	8	5	3	21
Shortage of Critical Materials	1	6	6	3	21
National Security Emergency	0	7	6	3	20
Aviation Incident	1	4	8	3	19
Dam/Levee Failure	1	4	8	3	19
Acquifer/Water Supply Contamination	1	3	9	3	18
Structural Failure	0	4	9	3	17
Railway Incident	1	2	10	3	17
Expansive Soils	0	4	8	4	16
Hostage/Violence	0	3	10	3	16
Landslides	0	3	10	3	16
Natural Gas Failure	0	3	10	3	16
Terrorism	0	3	10	3	16
Earthquake	0	2	11	3	15
Mudflow/Debris Flow	0	3	9	4	15
Technological Hazards	0	3	9	4	15
Civil Disturbances	0	1	12	3	14

	Number of Responses				
Hazard	**High Threat (3)**	**Moderate Threat (2)**	**Low Threat (1)**	**No Response**	**Total Points**
Sewer Failure	0	1	12	3	14
Subsidence	0	2	10	4	14
Nuclear Incident	0	1	11	4	13
Seasonal Population Shift	0	1	11	4	13

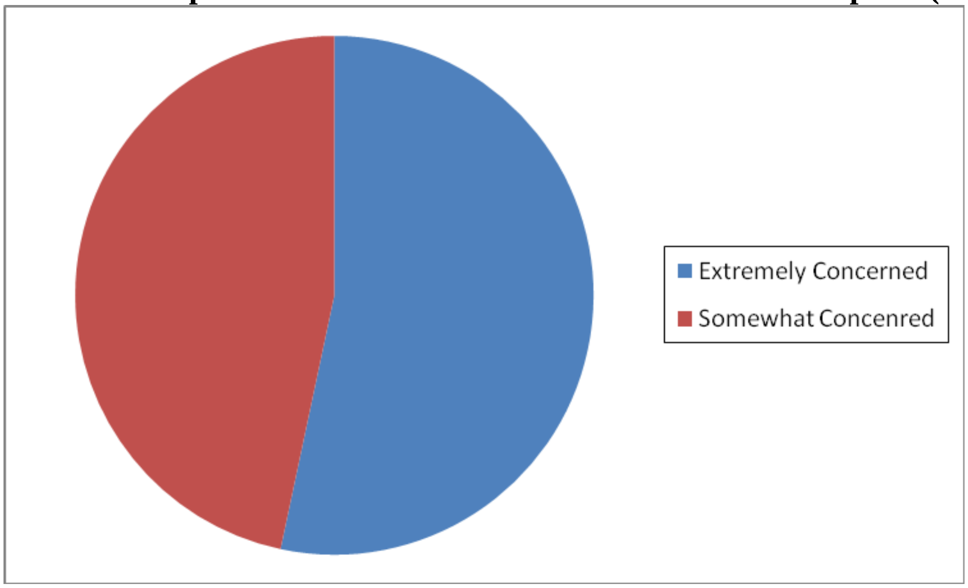
Three of the State Agency respondents to the 2010 Agency Comment Form indicated they are "Extremely Concerned" about the possibility of being impacted by a future natural hazard, while four respondents indicated they are "Somewhat Concerned". One respondent marked the "Not Concerned" option on the survey. Figure 2-1 demonstrates the distribution of the level of concern among the respondents.

Figure 2-1: State Agency Concern for Future Natural Hazard Impacts (2010)



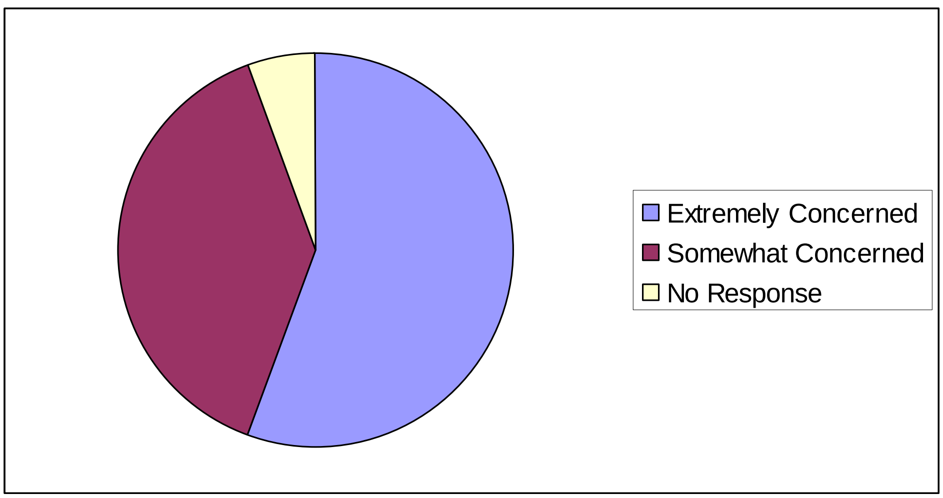
Eight of the REC respondents to the 2010 Agency Comment Form indicated they are "Extremely Concerned" about the possibility of being impacted by a natural hazard, while seven respondents indicated they are "Somewhat Concerned". No respondents marked the "Not Concerned" or "No Response" option on the survey. Figure 2-2 demonstrates the distribution of the level of concern among the respondents.

Figure 2-2: Electric Cooperative Concern for Future Natural Hazard Impacts (2010)



In 2007, more than half of the respondents to the Public and Stakeholder Survey indicated they are "Extremely Concerned" about the possibility of being impacted by a natural hazard. Figure 2-3 demonstrates the distribution of the level of concern among the respondents. No respondents marked the "Not Concerned" option on the survey.

Figure 2-3: Local Agency Concern for Future Natural Hazard Impacts (2007)



Organizations' most prominent concerns regarding disasters

Aside from ranking the hazards, the respondents were also asked what their organization's most prominent concerns were regarding natural or man-made disasters. The responses were:

- Fire
- Providing shelter and food for our citizens
- Criminal investigation behind man-made hazards

- Weather related incidents such as tornadoes, wind storms, blizzards and ice storms
- Hazard notification and cleanup
- Summer and winter storms
- Ethanol plant and railway tank car mishaps
- Power line outages
- Flooding
- Winter and spring ice storms
- Utility pole damage
- Crop damage
- Loss of power and utilities

2.3.3 Existing and Prior Mitigation Projects

2.3.3.1 Statewide Existing and Prior Mitigation Projects

Electric Cooperative Existing and Prior Mitigation Projects

Ten of the fifteen electric cooperatives have in the past or are currently replacing and constructing overhead utility wires with underground utility wires. Buried lines are not subject to wind storm, ice storm, and flood damage and are more resistant to natural disasters than the overhead system. Bon Homme Yankton Electric replaced 300 feet of cable that was washed out when the James River flooded. The cable was placed away from the river to avoid damage from future floods. Clay Union Electric Corporation tests and replaces poles to larger class poles so they are able to withstand strong winds. They also perform approximately 950 hours of tree trimming annually. East River Electric Power Cooperative has relocated electric transmission lines and distribution substations to locations free from future ground water accumulation. Moreau-Grand Electric Cooperative has improved pole construction to withstand high ice loads by placing poles closer together and with heavier construction.

The Rural Electric Association has continuously worked with the Rural Electric Cooperativess to identify relevant hazards and develop emergency restoration plans. SD Department of Environment and Natural Resources operates a dam safety program which determines the hazard ranking for dams across the state. Other ongoing statewide mitigation initiatives include the State Drought Task Force and the development and implementation of this Multi-Hazard Mitigation Plan.

In 2007, several existing or prior projects which resulted in or were intended to reduce risk and vulnerability to hazards were identified by the respondents. SD Game, Fish & Parks constructed severe weather shelters in parks and purchased pick up slip in water tanks for fire. The SD Department of Environment and Natural Resources worked with the public water system to relocate the intake so the water supply to the public would not be interrupted due to the drought. SDOEM identified raised road grades and detention ponds to prevent future flooding; supported power line burial, wind spoilers, and twisted lines to shed ice building to prevent winter and wind storm damage, and supported shelter construction for use in the event of a tornado.

In 2010, the state agencies identified additional existing or prior projects which resulted in or were intended to reduce risk and vulnerability to hazards. SDOEM activated outdoor tornado warning sirens and supplied generators for shelters during blizzards and extreme cold, as well as for rural water systems in an effort to sustain the pumping of water to citizens in the event that there is no power. SDOEM also continues to support burying power lines to prevent damage and power outages during high winds or winter storm ice buildup. The SD Game, Fish, and Parks Department (SDGFP) constructed bathrooms in campgrounds that are made of block and can also be used as storm shelters. They have also installed storm sirens in remote locations in parks to alert citizens of incoming severe weather. In addition, SDGFP has protected shorelines from erosion with rip-rap, constructed floating breakwaters to protect marina and boat docking facilities, and installed flashing beacons at busy boat ramps. Since SDGFP has water rights on most lakes in South Dakota, they have repaired/modified lake outlets to reduce the risk of flooding. The Department of Transportation (DOT) mitigates flooding by performing hydraulic analyses of new bridge or box culverts. In an effort to reduce snow drift, the DOT planted snow fences in vulnerable areas along the interstate. They have mitigated landslides by moving roads, reducing water infiltration, and building berms at the slide toes. DOT mitigates expansive soils by using drain tile and drainable gravels. To reduce traffic incidents during winter weather, the DOT has built gates at interstate interchanges to prevent vehicles from accessing the interstate.

2.3.3.2 Local Existing and Prior Mitigation Projects

In 2007, several existing or prior projects which resulted in or were intended to reduce risk and vulnerability to hazards were identified by the Public and Stakeholder Survey respondents. Union County cleaned a ditch to provide better water flows which in turn reduced flooding in a small community. The Central Electric Cooperation installed underground wire between Mitchell substation and Mt. Vernon substation. The Rosebud Sioux Tribe removed and/or relocated homes from a floodplain. The City of Wall linked a tornado warning system to 911. Meade County and Pennington County both have an active Flood Warning System. Charles Mix County has built storm shelters, is updating flood control insurance and bylaws, and participates in many collaborative efforts for wildfire and other emergency preparedness issues. Southeastern Electric Coop has shortened pole spans, upgraded pole classes, and installed underground facilities. Homes along Turtle Creek in Redfield (Spink County) were purchased after the October 15th floods. Brown County installed storm water holding ponds. FEM Electric is replacing overhead power lines with underground power lines in Faulk County.

Hughes County implements a floodplain ordinance, Subdivision Ordinance, Zone Ordinances, and Building Codes to prevent building in flood prone or other hazardous areas. The Rosebud Sioux Tribe implements a Zoning Ordinance to prevent building homes in floodplains. The Rosebud Sioux Tribe also maintains a GIS.

In 2010, online Public and Stakeholder Survey respondents were asked what their organization is doing to reduce risk of damage from natural and human-caused hazards. Table 2-6 below summarizes these findings.

Table 2-6: Actions Taken to Reduce Risk from Natural and Man-Made Hazards

Action Taken to Reduce Risk from Natural and Man-Made Hazards	Number of Respondents
Actions to prevent or minimize property damage	10
Actions to prevent loss of life	10
Conducts outreach activities to promote awareness of relevant natural and human-caused hazards	8

Action Taken to Reduce Risk from Natural and Man-Made Hazards	Number of Respondents
Implemented policies to prevent development in hazardous zones	6
Developed a continuity of operations plans to prevent business interruption	5
Would like to learn more about how my organization can help increase resiliency	2

Also, twelve of the sixteen respondents claim that they interact with SDOEM or other state agencies regarding mitigation actions.

Mitigation Actions Implemented in the Past 5 Years

The South Dakota Department of Criminal Investigation led the implementation of bomb technicians throughout the state to help reduce the effects of man-made hazards.

Sioux Valley Energy has implemented an Emergency Response Plan and conducts employee training addressing hazards and table top exercises with senior management to discuss response to hazardous incidents. They believe this will help them prepare for and respond to incidents and maintain operations if a hazardous event should occur. To prevent losses due to ice and wind damage, Rosebud Electric Co-op updates old utility lines, tests existing poles to make sure they can withstand weather damage, and replaces rotten poles. Lacreek Electric Cooperative moves or removes utility lines if they are in areas prone to hazards. They also trim trees in the summer to keep trees clear of the utility line right-aways. This is done to help ensure more reliable electricity services. Codington-Clark Electric Cooperative converts overhead power lines to underground power lines in an effort to reduce their exposure to weather related incidents. In another effort to reduce power outages, they have also installed a standby generator at the co-op headquarters.

Spink County has implemented floodplain planning to eliminate the threat to structures prone to flood damage. Turner County has installed weather radios and outdoor sirens to warn the public of incoming inclement weather. Their fire department and EMS also have more contact with the ethanol plants located in the County. In an effort to prepare for flood events, Turner County maintains a supply of sandbags and pumping equipment. Faulk County enacted a new paging/notification system to notify county residents of inclement weather and other hazards. The County created a Drainage Board to research flood mitigation planning and interacted with FEMA to gain assistance on how to mitigate future flooding.

Projects with Regards to Increasing Resiliency to Future Hazards

Turner County is currently reviewing PDM plans to increase resiliency to future hazard events. Central South Dakota Enhancement District (CSDED) is assisting three counties with their local hazard mitigation plan updates. Rosebud Electric Co-Op is replacing older, 3 phase utility lines with new, heavier lines that can withstand strong winds and ice. In addition to moving or removing utility lines from hazard prone areas and trimming trees in utility line right-aways, Lacreek Electric

Cooperative also provides safety demonstrations to all of the area schools. Codington-Clark Electric Cooperative is continuing to convert overhead power lines to underground as they are financially able to do so. Faulk County's new paging and notification system is designed to increase resiliency to future hazard events.

2.3.4 Integrating Hazard Mitigation into Statewide Existing Policies and Programs

State agencies have integrated hazard mitigation into their existing policies and programs. SDOEM requires counties to update their local mitigation plan before they lend grants to the county's emergency management offices. To mitigate damages due to flooding, the SDGFP is concerned with the types of park facilities that are developed in floodplains and near waterways. The SDGFP also monitors snowpack, snowmelt, and runoff into lakes to determine whether flooding on lakes may be a problem and to act accordingly to mitigate the potential for a flood. They have also developed Emergency Operations Procedures for each park so that seasonal employees have a tool to help them know who to contact during various emergency situations which may arise in a state park. The South Dakota Department of Agriculture implements planning education. The South Dakota Historical Society conducts a survey of historic properties so they are able to provide guidance to state and federal agencies that may need to take historic properties into consideration. The South Dakota Climate Office helps support other agency's programs by providing risk management information for planning purposes.

Many of the electric cooperatives incorporate mitigation projects into their short and long term construction work plans and file pre-mitigation plans with the county emergency management office. West River Electric can create a policy to shorten utility spans if a line is damaged by ice or frost. Another policy is to convert overhead lines to underground lines in an effort to mitigate the effects from a wind, ice/frost, and flood event.

2.3.5 Amending Laws, Regulations, or Policies

The SHMT agencies and RECs were asked which laws, regulations, and/or policies can be amended to incorporate hazard mitigation. One response indicated that a state law for floodplain zoning would be ideal. SDOEM has indicated the political feasibility of this happening is very low at this time.

An REC response indicated that zoning laws for subdivisions need to be more stringent so that multiple houses should be built at the same time rather than just a single home. Another response suggested that a policy allowing for the utilization of hazard mitigation funding statewide would be beneficial for all counties.

2.3.6 Effective Existing Programs, Policies, and Regulations

Several existing local, state, and federal programs, policies, and regulations are effective in reducing risk and damage to property due to a hazard event. At the local level, floodplain ordinances, county building codes, and county zoning ordinances are effective. Ground Water Quality, Surface Water Quality, Air Quality, and Waste Management requirements are effective in reducing risk. Legislation to restrict access to closed interstates during blizzard conditions and research for the Traffic Incident Management Plan help mitigate traffic and pedestrian incidents. For state parks, storm sirens have been an asset to warn campers in remote areas of potential risk. The construction of campground bathrooms has been effective in sheltering campers during severe thunderstorms. The development of Emergency Operations Procedures for each park has also helped in a variety of park emergency situations. The continuous monitoring and updating of local Emergency Operations Plans has also proven to be effective. Any Fiscal or Technical Assistance loan and grant programs that require mitigation actions as a prerequisite to acquiring the money is an effective incentive for localities to implement mitigation programs and projects. At the federal level, FEMA's public assistance and mitigation programs are effective in reducing the number of power outages by funding projects such as power line burials. In this same regard, the Emergency Management Performance grant is a useful source of funds to purchase generators for power outages.

The REC respondents indicated that existing local and federal programs, policies, and regulations are effective in reducing risk and damage to property due to a hazard event. At the local level, zoning ordinances for counties that define agricultural, commercial, and residential areas are thought to be effective. At the federal level, the FEMA hazard mitigation program is thought to be effective. The electric cooperatives also believe that their programs to replace overhead electrical and communication lines with underground utilities are very effective in reducing risk and damage to property due to a hazard event. Also, programs that reduce the span between two electric poles are effective in areas that could be affected by ice and frost. Any policies that assist with funding of these programs are considered to be effective as well.

2.3.7 Local Mitigation Capabilities Effectiveness

In 2007, the Public and Stakeholder Survey asked local agencies to rate a series of Local Mitigation Capabilities in terms of their effectiveness on hazard mitigation and risk reduction. Each respondent identified a level between 1 and 4, 1 representing Least Effective and 4 representing Most Effective. For each listed capability, the number of responses was multiplied by the corresponding level and totaled to produce a ranking of effective Local Mitigation Capabilities. Emergency Operations Plans were identified as the most effective capability. Wildfire Planning, Zoning Ordinances, Tornado Sheltering, and Public Information/Education followed respectively.

Table 2-7 shows the number of responses and the total ranking for each Local Mitigation Capability.

Table 2-7: Rating the Effectiveness of Local Mitigation Capabilities (2007)

	Number of Respondents					
Local Mitigation Capability	Least Effective (1)	(2)	(3)	Most Effective (4)	No Response	**Total Points**
Emergency Operations Plan	0	2	6	9	2	**58**
Wildfire Planning	1	3	5	7	3	**50**
Zoning Ordinance	0	4	7	4	4	**45**
Tornado Sheltering	1	3	7	4	4	**44**
Public Information / Education Programs	0	4	8	3	4	**44**
Geographic Information System (GIS) Program	3	3	7	3	3	**42**
Floodplain ordinance / NFIP	1	5	6	3	4	**41**
Local / Regional Emergency Planning Committee	2	2	5	5	5	**41**

Local Mitigation Capability	Number of Respondents: Least Effective (1)	(2)	(3)	Most Effective (4)	No Response	**Total Points**
Building Code	1	5	7	2	4	**40**
Subdivision Ordinance	2	2	7	3	5	**39**
Comprehensive Plan	2	4	7	2	4	**39**
Capital Improvements Plan	2	7	5	2	3	**39**
Stormwater Management Plan / Ordinance	0	6	6	1	6	**34**
Other: Early Warning Systems (high hazard dams)				2		**8**

In 2010, the SHMT agencies were asked to perform a similar rating. Public Information and Education Programs were identified as the most effective capability. Emergency Operations Plans, Floodplain Ordinances/NFIP compliance, Wildfire Planning, and Local and Regional Emergency Planning Committees followed respectively.

Table 2-8 shows the number of responses and the total ranking for each Local Mitigation Capability.

Table 2-8: Rating the Effectiveness of Local Mitigation Capabilities (2010)

Local Mitigation Capability	Number of Respondents: Least Effective (1)	(2)	(3)	Most Effective (4)	No Response	**Total Points**
Public Information / Education Programs	0	0	3	3	2	**21**
Emergency Operations Plan	0	1	2	3	2	**20**
Floodplain ordinance / NFIP	0	0	1	4	3	**19**
Wildfire Planning	0	1	3	2	2	**19**
Local / Regional Emergency Planning Committee	0	0	3	2	3	**17**
Geographic Information System (GIS) Program	1	1	2	2	2	**17**
Zoning Ordinance	0	1	1	3	3	**17**
Tornado Sheltering	0	1	4	0	3	**14**
Comprehensive Plan	0	2	2	1	3	**14**
Capital Improvements Plan	0	2	3	0	3	**13**
Subdivision Ordinance	0	3	1	1	3	**13**
Building Code	0	2	3	0	3	**13**
Stormwater Management Plan / Ordinance	0	1	2	1	4	**12**

In 2010, the REC respondents provided the following rating. Emergency Operations Plans were identified as the most effective capability. A Capital Improvement Plan, a Local/Regional Emergency Planning Committee, the Comprehensive Plan, and Geographic Information Systems (GIS) Programs followed respectively.

Table 2-9 shows the number of responses and the total ranking for each Local Mitigation Capability.

Table 2-9: Rating the Effectiveness of Local Mitigation Capabilities (2010)

	Number of Respondents					
Local Mitigation Capability	Least Effective (1)	(2)	(3)	Most Effective (4)	No Response	**Total Points**
Emergency Operations Plan	0	0	6	5	4	**38**
Capital Improvements Plan	0	2	3	5	5	**33**
Local / Regional Emergency Planning Committee	0	0	4	4	7	**28**
Comprehensive Plan	0	1	4	3	7	**26**
Geographic Information System (GIS) Program	1	1	5	0	8	**18**
Floodplain ordinance / NFIP	0	2	2	2	9	**18**
Building Code	1	1	3	1	9	**16**
Zoning Ordinance	0	3	2	1	9	**16**
Tornado Sheltering	1	2	1	2	9	**16**
Public Information / Education Programs	0	1	0	3	11	**14**
Wildfire Planning	2	0	4	0	9	**14**
Stormwater Management Plan / Ordinance	2	2	1	1	9	**13**
Subdivision Ordinance	2	3	1	0	9	**11**

2.3.8 Development Pressure in South Dakota 2010

The SHMT agencies were asked which counties, cities, or towns in South Dakota are under intense development pressure such that mitigation projects should be prioritized for those areas. The responses are listed below:

Minnehaha County
Lincoln County
Codington County
Brookings County
Davison County
Brown County
Meade County
City of Pennington
City of Sioux Falls
City of Watertown
City of Brookings
City of Aberdeen
City of Mitchell
City of Rapid City
Eastern Slope of the Black Hills

The REC respondents identified the following:

- Aberdeen County
- Brown County
- Roberts County
- Day County
- Marshall County
- Pennington County
- Yankton County
- Bon Homme County
- Minnehaha County
- Corson County-McLaughlin Area
- Dewey County
- Ziebach County
- City of Eagle Butte
- City of Timber Lake
- City of Isabel
- City of Dupree
- City of Lennox
- City of Tea
- City of Harrisburg
- Rapid City
- Area around Madison and Herman Lakes
- Areas West of Yankton along Lewis and Clark Lake

2.3.9 Suggested State Support and Mitigation Projects

In 2007, the Public and Stakeholder Survey respondents included recommendations for the State as to how they can assist with mitigation at the local level. These included:

- Working with local counties on planning,
- Continuing to bury power lines,
- Providing disaster mitigation training, table top, and on-site exercises,
- Making more funds available to local jurisdictions,
- Using an all hazards approach to mitigation planning,
- Reviewing the old documents and update to NIMS as required by homeland defense,
- Considering the impact to rail and agriculture in disaster situations,
- Knowing where the assets in each county are, and
- Disseminating information regarding the availability of resources.

The Rosebud Sioux Tribe noted that "Septic tanks are potential hazards to community drinking water. Pollution drains into creeks and into the Missouri River where many intakes are located for rural, municipal, and industrial water systems."

Charles Mix County has two towns without warning systems.

Brule/Buffalo Emergency Management District noted that the majority of South Dakota is rural and may require more face to face meetings to accomplish collaborative mitigation goals.

The following were identified through the 2010 online Public and Stakeholder Survey:

Actions organizations can take to reduce risk

Marshall County believes that planning and exercising for large scale disasters can help reduce the risk of property damage and injury from future hazard events. In this same respect, Turner County would like to be ready to respond to and aware of hazardous problems within their jurisdiction. Spink County believes that improving their notification system would help mitigate future hazards. Faulk County believes that training residents on how to respond to hazards and upgrading storm shelters can help reduce risk from future hazards. Rosebud Electric Co-Op will continue tree trimming and inspecting and replacing potentially dangerous utility poles. Like Rosebud, Lacreek Electric Cooperative also engages in utility pole testing. The cooperative also berms their substations to protect them from flood events. Codington-Clark Electric Cooperative will continue to install underground power lines in areas where there has been past ice storm damage.

State Priorities to Increase Resiliency

Marshall County, Faulk County, and Turner County all believe that the State should prioritize floodplain management as a way to increase resiliency. Marshall County also suggests that the State should participate in infrastructure bolstering. Turner County recommends that the State support burying power lines and creating a storm ready warning system. Spink County suggests that the State should continue and expand on public education. Faulk County regards that storm shelter plans and equipment should be a priority of the State to increase resiliency to future hazardous events. The Central South Dakota Enhancement District suggests that the State should prioritize protecting critical facilities and should also partake in mitigation actions that better protect the State from floods. Rosebud Electric Co-Op and Codington-Clark Electric Cooperative would like the State to prioritize making more resources available and/or to help secure grant money so they and other utility organizations are able to replace aging power lines and increase the number of miles of overhead power lines that can be converted to underground lines. Lacreek Electric Cooperative believes that the State should establish a warning and communication system to increase resiliency.

2.3.10 Funding for Hazard Mitigation Projects

SDOEM is able to provide Emergency Management Performance grant funds for limited mitigation projects. The SDGFP is able to provide Coast Guard, Dingell Johnson, and Title VI funding and is also able to apply for and distribute FEMA funds to help fund safety projects at parks. The DOT uses Transportation Enhancement funds to build the living snow fences along the interstate.

Federal loans through the Rural Utility Service (RUS) are provided for the electric cooperatives to implement hazard mitigation projects. East River Electric Power Cooperative provides funds to mitigate hazard impacts to its electric facilities and anticipates funding these projects through its annual electric plan budget. Other cooperatives also use their general funds toward the projects. Some cooperatives, like Traverse Electric Co-op and Kingsbury Electric Cooperative, match a percentage of funds from FEMA or other sources to complete hazard mitigation projects. Cooperative Finance Corporation and CoBank are also listed as potential funds for hazard mitigation projects.

2.3.11 Coordination with local mitigation planning efforts:

It is the State Hazard Mitigation Officer's (SHMO) responsibility to work with the local entities and support their mitigation planning efforts. The SHMO (Nicole Prince) has been actively reaching out to the counties and tribes to assist with their development of local hazard mitigation plans. The SHMO conducts regular hazard mitigation planning workshops with the local communities and makes a point to meet with each tribe on a regular basis to discuss hazard mitigation opportunities. FEMA Region VIII also supports these meetings as requested. A summary of recent trainings and briefings conducted by the SHMO can be found in Section 5.1- Recent Technical Assistance and Funding.

2.4 Integration of Mitigation Planning/Strategies

44 CFR Part 201 Requirement:
[The State mitigation planning process should] be integrated to the extent possible with other ongoing State planning efforts, as well as other FEMA mitigation programs and initiatives.

SDOEM's first priority for mitigation strategy implementation is to support local mitigation needs. This State of South Dakota Multi-Hazard Mitigation Plan update includes a review of the approved local mitigation plans at the time of the update in Section 4 – Mitigation Strategies. Understanding the needs and priorities set forth by the local communities allows the State to set consistent and supporting goals. This Plan serves as a tool for the State in prioritizing their actions to support local mitigation efforts.

2.4.1 Integration with State Programs

The State of South Dakota administers the Pre-Disaster Mitigation Competitive Grant Program, the Flood Management Assistance Program, the National Flood Insurance Program, and the Hazard Mitigation

Grant Program through the South Dakota Office of Emergency Management (SDOEM). Details on these programs are discussed in Section 4.2 State Capability Assessment. Projects submitted for funding through these programs are reviewed for eligibility and selected according to a prioritization process followed by SDOEM and the State Hazard Mitigation Team. Details on the prioritization process are discussed in Section 5.1 Local Funding and Technical Assistance.

Section 2.3.4 discusses additional examples of hazard mitigation being integrated into statewide existing policies and programs.

2.4.2 Public Outreach

During the preparation of the 2007 Plan update, SDOEM began several new methods of outreach to coordinate and integrate mitigation planning throughout the state. SDOEM (with assistance from FEMA) developed a mitigation brochure to advertise the idea of mitigation planning and encourage organizations of all types to partner with SDOEM in mitigating natural hazards. This brochure was distributed at the annual state fair in Huron in August, 2007 and subsequent applicant briefings. SDOEM continues to use this brochure in ongoing outreach efforts.

In addition, SDOEM has continued to partner with the Department of Health on a "bReady" campaign to educate the public on preparedness measures. A guidebook, brochures, and information available to the public as part of this campaign can be found at http://www.breadysd.com/. The Department of Health advertises this website and publicizes the campaign to schools, daycares, nursing homes, and at every meeting and exercise they operate (i.e. training exercises for the pandemic flu).

Since 2007, SDOEM has continued to use these outreach materials. Ongoing campaigns and efforts to improve public outreach include:

- b Ready,
- South Dakota Disaster Kits,
- Extension Disaster e Network (EDEN)
- Community Wildfire Protection Plans
- Rangeland Insurance (cropland insurance is strong)

SDOEM continues to provide mitigation materials at their State Fair booth annually. Outreach materials used in the efforts mentioned above are included as Appendix 2C.

2.4.3 Completed Mitigation Projects

During 2009 and 2010, the State of South Dakota received several disaster declarations. At the time of this plan update SDOEM was encouraging local governments to submit diverse project applications. Historically, HMGP funds have been used primarily to bury powerlines within South Dakota. With the recent funding SDOEM and the SHMT are encouraging alternative projects such as drainage improvements, detention ponds, shelters, buyouts, relocations, elevations, and fire mitigation.

The following table shows the most recent list of completed mitigation actions as funded by Hazard Mitigation Assistance programs. In future plan updates, SDOEM intends to track completed projects as they correspond to the identified mitigation action priorities outlined in Section 4.

Table 2-10: State Funded Projects

Program Area	Subgrantee	Disaster Number	Project Type	Project Title	Date Approved by FEMA
PDM	Aurora County	2008	91.1: Local Multi-hazard Mitigation Plan	AURORA COUNTY, SD PDM PLAN UPDATE	9/4/2008
HMGP	Beadle County	1620	400.1: Utility Protective Measures (Electric, Gas, etc.)	Powerline burial in Beadle County	7/18/2007
HMGP	Beadle County	1647	400.1: Utility Protective Measures (Electric, Gas, etc.)	BEADLE COUNTY - LINE I - POWERLINE BURIAL	8/29/2007
HMGP	Beadle County	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	BEADLE COUNTY PLB DAKOTA ENERGY LINE J, K, L	12/3/2008
HMGP	Beadle County	1759	Protective Measures	Beadle Cty Dak Energy Lines PBL - Q, S	
PDM	Beadle County	2008	91.1: Local Multi-hazard Mitigation Plan	Beadle County PDM Update	9/4/2008
HMGP	BON HOMME COUNTY	1774	601.1: Generators	BON HOMME COUNTY Generator Project	
PDM	Bon Homme County	2008	91.1: Local Multi-hazard Mitigation Plan	BON HOMME COUNTY, SD PDM PLAN UPDATE	9/4/2008
HMGP	Brown County	1620	400.1: Utility Protective Measures (Electric, Gas, etc.); 602.1: Other Equipment Purchase and Installation	BROWN COUNTY POWERLINE BURIAL	11/13/2007
PDM	Brown County	2008	91.1: Local Multi-hazard Mitigation Plan	Brown County Pre-disaster Mitigation Plan Update	9/4/2008
PDM	Brule County	2008	91.1: Local Multi-hazard Mitigation Plan	BRULE COUNTY, SD PDM PLAN UPDATE	9/4/2008
PDM	Buffalo County	2008	91.1: Local Multi-hazard Mitigation Plan	BUFFALO COUNTY, SD PDM PLAN UPDATE	9/4/2008
HMGP	Butte County	1702	601.1: Generators	Butte County Generator Project	6/16/2008
PDM	Butte County Emergency Management	2008	91.1: Local Multi-hazard Mitigation Plan	Butte County Pre-disaster Mitigation Plan Update	9/4/2008

Program Area	Subgrantee	Disaster Number	Project Type	Project Title	Date Approved by FEMA
PDM	City of Hot Springs	2008	200.3: Acquisition of Public Real Property (Structures and Land) - Riverine	Cold Brook Flood Channel Restoration	7/7/2006
PDM	Custer County Office of Emergency Services	2008	91.1: Local Multi-hazard Mitigation Plan	Custer County PDM update	9/4/2008
HMGP	Davison County	1759	Protective Measures	Electric PLB Line N, O	9/30/2009
PDM	Davison County	2008	91.1: Local Multi-hazard Mitigation Plan	DAVISON COUNTY, SD PDM PLAN UPDATE	9/4/2008
HMGP	Deuel County	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	DEUEL PLB HDELECTRIC	1/9/2009
PDM	Douglas County	2008	91.1: Local Multi-hazard Mitigation Plan	DOUGLAS COUNTY, SD PDM PLAN UPDATE	9/4/2008
PDM	Edmunds County	2008	91.1: Local Multi-hazard Mitigation Plan	Edmunds County Pre-disaster Mitigation Plan Update	9/4/2008
HMGP	Faulk County	1774	Protective Measures	FEM Elctric Faulk County PLB - Line B	
HMGP	Grant County	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	GRANT COUNTY PLB LINES C, D, & E	12/18/2008
HMGP	Grant County	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	GRANT CTY-WHETSTONE VALL PLB H,I,J,K	4/29/2009
PDM	Gregory County	2008	91.1: Local Multi-hazard Mitigation Plan	GREGORY COUNTY, SD PDM PLAN UPDATE	9/4/2008
HMGP	Haakon County	1774	Multi-hazard Mitigation Plan	Haakon County PDM Plan Update	
HMGP	Hand County	1774	Protective Measures	Hand Cty - Dakota Energy Lines PLB - N,O, P	
HMGP	Hanson County	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	HANSON COUNTY PLB CE LINE C	1/8/2009
HMGP	Hanson County	1774	Protective Measures	Hanson Cty Central Elec PLB - Q,R	
PDM	Hanson County	2008	91.1: Local Multi-hazard Mitigation Plan	HANSON COUNTY, SD PDM PLAN UPDATE	9/4/2008

Program Area	Subgrantee	Disaster Number	Project Type	Project Title	Date Approved by FEMA
HMGP	Harding County	1702	91.1: Local Multi-hazard Mitigation Plan	Harding County Pre-Disaster Mitigation Plan.	11/3/2008
HMGP	H-D ELECTRIC CO-OP INC	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	H-D ELECTRIC COOP POWER LINE BURIAL	1/9/2009
HMGP	Huron	1702	601.1: Generators	CITY OF HURON GENERATOR	6/16/2008
HMGP	Hutchinson County	1620	400.1: Utility Protective Measures (Electric, Gas, etc.)	HUTCHINSON COUNTY SE ELECTRIC POWERLINE BURIAL PROJECT	8/13/2007
PDM	Hutchinson County	2008	91.1: Local Multi-hazard Mitigation Plan	HUTCHINSON COUNTY, SD PDM PLAN UPDATE	9/4/2008
HMGP	Hyde County	1774	Multi-hazard Mitigation Plan	Hyde County PDM Plan Update	
HMGP	Jackson County	1620	91.1: Local Multi-hazard Mitigation Plan	Jackson County Hazard Mitigation plan	3/12/2007
PDM	Jerauld County	2008	91.1: Local Multi-hazard Mitigation Plan	JERAULD COUNTY, SD PDM PLAN UPDATE	9/4/2008
HMGP	Kingsbury County	1647	400.1: Utility Protective Measures (Electric, Gas, etc.)	PowerLines ABC	9/5/2007
HMGP	Kingsbury County	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	KINGSBURY COUNT PLB LINE D	11/3/2008
HMGP	Kingsbury County	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	KINGSBURY CTY ELECTRIC PLB F, G, H	4/8/2009
HMGP	Kingsbury County	1759	Protective Measures	KINGSBURY CTY ELECTRIC PLB - L, K	
HMGP	Kingsbury County	1759	Protective Measures	Kingsbury Cty Elcetric PBL - J, L	
HMGP	Miner County	1774	Protective Measures	Miner County Centeral Elec PBL - Line S	
HMGP	Moody County	1620	91.1: Local Multi-hazard Mitigation Plan	Moody County Pre-Disaster Mitigation Plan Project	3/12/2007
HMGP	Roberts County	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	ROBERTS COUNTY PLB LINE F	12/18/2008
HMGP	Roberts County	1759	Protective Measures	Roberts County Traverse Elect. PLB - Lines B,E,F, G	

Program Area	Subgrantee	Disaster Number	Project Type	Project Title	Date Approved by FEMA
HMGP	Roberts County	1759	Protective Measures	Roberts County Traverse Elect. PLB - Lines A, D	9/30/2009
HMGP	Spink County	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	SPINK COUNTY POWER LINE BURIAL PROJECT	12/18/2008
HMGP	Spink County	1774	Protective Measures	Spink Cty Northern Elec PLB - Line E	
HMGP	Spink County	1774	Protective Measures	Spink Cty Northern Elec PLB - Line D	
HMGP	Sully County	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	Sully County Oahe Electric Coop PLB	1/9/2009
HMGP	Sully County	1774	Multi-hazard Mitigation Plan	Sully County PDM Plan Update	
PDM	Tripp County	2008	91.1: Local Multi-hazard Mitigation Plan	TRIPP COUNTY, SD PDM PLAN UPDATE	9/4/2008
HMGP	Walworth County	1702	400.1: Utility Protective Measures (Electric, Gas, etc.)	WALWORTH COUNTY CAM-WAL LINES A, B, AND C	4/8/2009
HMGP	Walworth County	1759	Sanitary Sewer System Protective	City of Mobridge Storm Sewer Project	
PDM	Yankton County	2008	91.1: Local Multihazard Mitigation Plan	YANKTON COUNTY, SD PDM PLAN UPDATE	9/4/2008

Prior to 2007, the State of South Dakota provided funding through the Hazard Mitigation Grant Program for the following successful projects:

Hughes County Power Line Burial Project
Stanley County Power Line Burial Project
Brown County Detention Ponds
Day County Detention Ponds
Pennington County Acquisition/Flood Maintenance - Box Elder, SD
Pennington County Acquisition/Zoning Flood Zones
Pine Ridge Indian Reservation - Installation of Tornado/Safe Shelters
Custer State Park - Fire Break/Slash Piles Project
Beadle County Power Line Burial Project
Davison County Power Line Burial Project
Hanson County Power Line Burial Project
Douglas County Power Line Burial Project
Hutchinson County Power Line Burial Project
Brown County Power Line Burial Project
Hughes County Spoiler Project

Sully County Spoiler Project
Beadle County Acquisition/Flood Maintenance
GFP - Comfort Shelters
Beadle County Storm Sewer
Pennington County Detention Pond
Brown County Drainage Project
East River Substation Relocation
Hecla Power Line Burial Project
Day County Road Raise and Grade
Day County Acquisition Project

In 2007, FEMA informed SDOEM that efforts were underway, by FEMA, to document proven successes from some of these projects. SDOEM had not received a copy of this documentation prior to submitting this plan for review. Future plan updates may include further details on the benefits of the completed mitigation projects. For example, every power line that is buried will assuredly not fall during the next storm. Detention ponds drastically reduce, if not eliminate, flooding in the area surrounding the detention pond.

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3 RISK ASSESSMENT

The risk assessment lays the foundation for the South Dakota Multi-Hazard Mitigation Plan. It sets the stage for identifying mitigation goals and activities to help the state become disaster resilient and keep South Dakota residents safe. The major components of this risk assessment include a hazard identification/analysis and a vulnerability analysis that answer the following questions: What are the hazards that could affect South Dakota? What can happen as a result of those hazards? How likely is each of the possible outcomes? When the possible outcomes occur, what are the likely consequences and losses, and how does this vary across the state? This section attempts to answer these questions on a hazard by hazard basis based on best available data.

The Federal Emergency Management Agency (FEMA) defines risk assessment terminology as follows:

- **Hazard—**A hazard is an act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing.
- **Vulnerability—**Vulnerability is susceptibility to physical injury, harm, damage, or economic loss. It depends on an asset's construction, contents, and economic value of its functions.
- **Exposure—**Exposure describes the people, property, systems, or functions that could be lost to a hazard. Generally, exposure includes what lies in the area the hazard could affect.
- **Risk—**Risk depends on hazards, vulnerability, and exposure. It is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. It refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage.
- **Risk Assessment—**Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from hazards.

3.1 IDENTIFYING HAZARDS

44 CFR Part 201 Requirement:
[The State risk assessment shall include an] overview of the type…of all natural hazards that can affect the State…

The following resources were used to identify hazards that may affect the State of South Dakota:

- Federal disaster/emergency declarations (see Table 3-3)
- For the 2007 Plan, risk assessments of the 48 local hazard mitigation plans (covering 60 counties) submitted to the state prior to October 2007 were reviewed. The counties were entered into a risk rollup spreadsheet, which was designed to tally the hazards that localities are most concerned with and to recognize each localities hazard ranking system. For the 2010 update, current and updated local hazard mitigation plans covering 64 counties were reviewed and the risk rollup spreadsheet was updated.
- FEMA's Multi-Hazard Identification and Risk Assessment
- HAZUS-MH (see Sections 3.3–3.5)

The geography and climate of South Dakota are central to the hazards that affect the state. The following information is directly from NetState.com.

Geography

- **Longitude/Latitude**—Longitude: 98° 28’ 33"W to 104° 3’W/Latitude: 42° 29’ 30"N to 45° 56’N
- **Length x Width**—South Dakota is about 380 miles long and 210 miles wide.
- **Geographic Center—**The geographic center of South Dakota is located in Hughes County, 8 miles NE of Pierre (Longitude: 100° 28.7' W, Latitude: 44° 24.1' N).
- **Borders**—South Dakota is bordered by North Dakota on the north and by Nebraska on the south. On the east, South Dakota is bordered by Minnesota and Iowa. On the west, South Dakota is bordered by Montana and Wyoming.
- **Total Area**—South Dakota covers 77,121 square miles, making it the 17th largest of the 50 states.
- **Land Area**—75,898 square miles of South Dakota are land areas.
- **Water Area**—1,224 square miles of South Dakota are covered by water.
- **Highest Point**—The highest point in South Dakota is Harney Peak at 7,242 feet above sea level.
- **Lowest Point**—The lowest point in South Dakota is Big Stone Lake at 966 feet above sea level.
- **Mean Elevation**—The Mean Elevation of the state of South Dakota is 2,200 feet above sea level.
- **Major Rivers**—Cheyenne River, Missouri River, James River, White River, Big Sioux River
- **Major Lakes**—Lake Oahe, Lake Francis Case, Lewis and Clark Lake

The Missouri River runs through the central part of South Dakota. To the east of the river, lie low hills and lakes formed by glaciers. Fertile farm country covers the area. To the west of the Missouri River, the land consists of deep canyons and rolling plains.

South Dakota is comprised of four major land regions; the Drift Prairie, the Disected Till Plains, the Great Plains, and the Black Hills.

The **Drift Prairie** covers most of eastern South Dakota. This is the land of low hills and glacial lakes. This area was called Coteau des Prairies (Prairie Hills) by early French traders. In the north, the Coteau des Prairies is bordered on the east by the Minnesota River Valley and on the west by the James River Basin. The James River Basin is mostly flat land, following the flow of the James River through South Dakota from north to south.

The **Dissected Till Plains** lie in the southeastern corner of South Dakota. This area of rolling hills is crisscrossed by many streams.

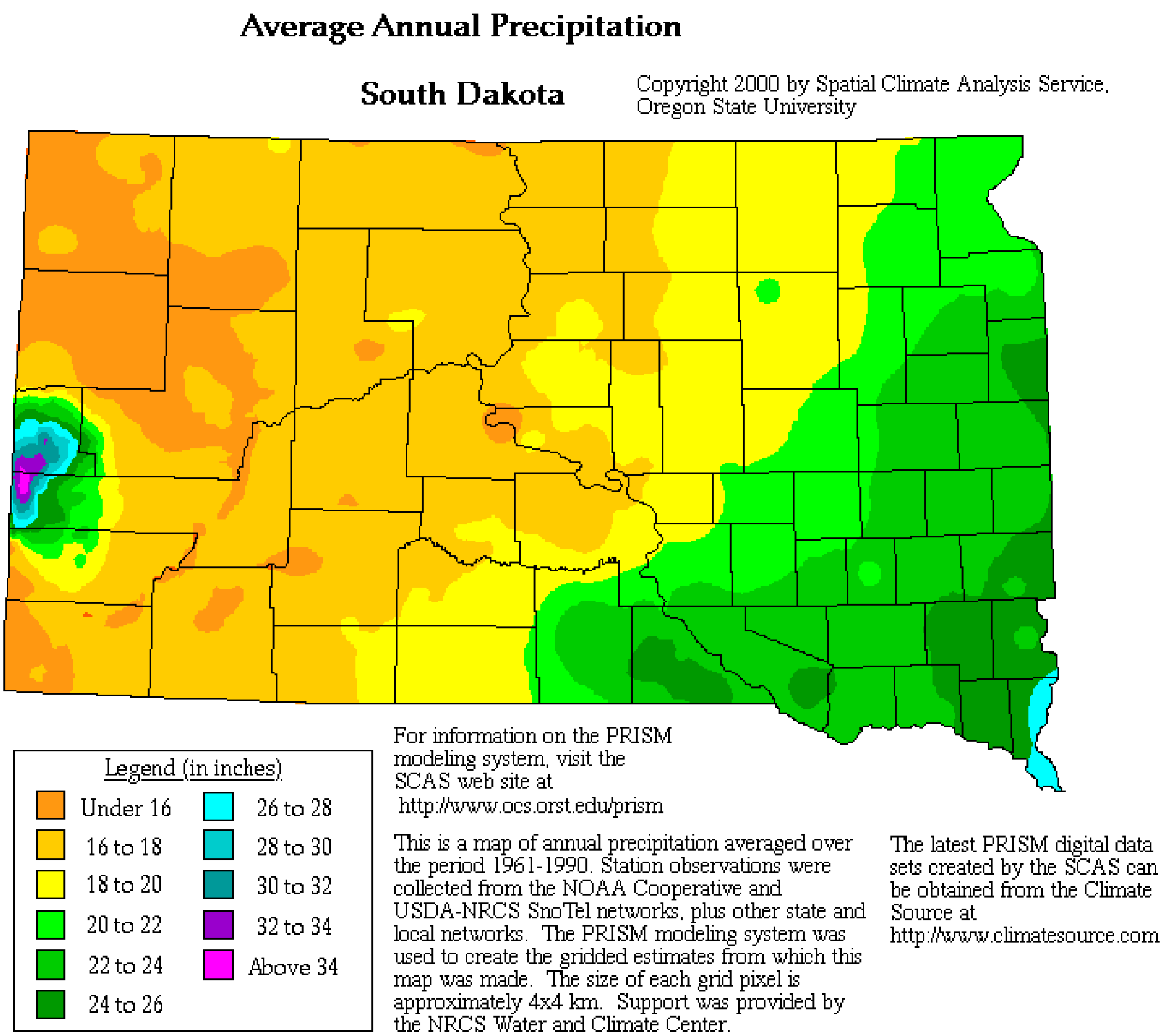
The **Great Plains** cover most of the western two thirds of South Dakota. The Coteau de Missouri hills and valleys lie between the James River Basin of the drift prairie and the Missouri River. West of the Missouri River much landscape becomes more rugged and consists of rolling hills, plains, canyons, and steep flat-topped hills called buttes. These buttes sometimes rise 400 to 600 feet above the plains. In the south, east of the Black Hills, lie the South Dakota Badlands. Badlands National Park is located here.

The **Black Hills** are in the southwestern part of South Dakota and extend into Wyoming. This range of low mountains covers 6,000 square miles with mountains that rise from 2,000 to 4,000 feet high. The highest point in South Dakota, Harney Peak (7,242 feet above sea level), is in the Black Hills. The Black Hills are rich in minerals such as gold, silver, copper, and lead.

Climate

- **Highest Temperature**—The highest temperature recorded in South Dakota is 120°F. This record high was recorded on July 5, 1936 at Gannvalley, and tied on July16, 2006 in Utsa.
- **Lowest Temperature**—The lowest temperature in South Dakota, -58°F, was recorded on February 17, 1936 at McIntosh.
- **Average Temperature**—Monthly average temperatures range from a high of 86.5°F degrees to a low of 1.9°F degrees.
- **Climate**—Average yearly precipitation for South Dakota, from 1961 to 1990, is shown in Figure 3-1.

Figure 3-1: South Dakota's Average Annual Precipitation



Methodology

Based on past disaster history and population and property potentially at risk (numbers and dollars), the following hazards have emerged as the greatest concern statewide and are profiled in detail in this plan:

- Agricultural Pests and Diseases
- Drought
- Floods (flash, long-rain, snowmelt, and dam failure or levee failure floods)
- Geological Hazards (Landslides, Mudflows, Expansive Soils, Subsidence, and Earthquakes)
- Hazardous Materials
- Tornadoes
- Wildfires
- Windstorm
- Winter Storm

During the 2009-2010 plan update, the State Hazard Mitigation Team reexamined the hazards that threaten South Dakota and added Agricultural Pests and Diseases, which was discussed as a potential hazard in the previous planning effort, but was not profiled. In addition, the profiles for earthquake and landslides and mudflows were combined into a single profile entitled 'Geological Hazards'. This profile is more detailed, as well, and includes a discussion on expansive soils and land subsidence. The only other changes in hazard identification from the 2007 plan were minor rewording of hazards to be consistent with FEMA hazard definitions and combinations of similar hazards into one hazard profile. Table 3-1 shows the changes made to the hazard identification.

Table 3-1: Changes Made to Hazard Identification in 2009-2010

2009-2010 Hazard Name	Change from 2007 plan
Floods	Incorporated levee failure considerations into the Flood profile
Geologic Hazards	Combines 2007 Earthquake, Landslides, and Mudflows profiles and adds Expansive Soils and Subsidence considerations
Drought	Addresses impacts of extreme heat
Wildfire	Changed from Major Fire Wildland
Windstorm	Changed from Wind
Winter Storm	Addresses impacts of extreme cold
Agricultural Diseases and Pests	Not addressed in 2007 plan

The following natural hazards are not included in this analysis because they do not threaten South Dakota: avalanches, coastal erosion, coastal storms, hurricanes, tsunamis, and volcanoes. While extreme heat, extreme cold, and hailstorms are recognized as hazards in South Dakota, their impacts tend to be limited and do not tax state resources or result in presidential disaster declarations; so they are not addressed as stand-alone hazards in this plan. Impacts from these hazards are addressed in appropriate hazard elements. The state does recognize that these hazards, particularly hailstorms, can inflict damages at the local level, but often the resulting property and agricultural losses are covered by insurance. During 2007 stakeholder meetings erosion problems, including silting of reservoirs and sediment dams along tributaries of the Missouri River as well as Badlands erosion affecting water quality of the White and Cheyenne Rivers were noted, but impacts are difficult to quantify. Manmade and biological hazards were also considered, but (with the exception of hazardous materials) were deemed appropriately addressed by the Department of Homeland Security (DHS). Generators, warning sirens, and shelters are funded by DHS.

Using the same hazard ranking exercise as the previous plan update, the State Hazard Mitigation Team identified the hazards of greatest significance to be flooding and winter storms (tied in importance), wildfires, drought, and tornadoes. Wind, agricultural pests and diseases, and geological hazards were ranked as moderate; Earthquake was ranked as a limited hazard when considered stand-alone but was included in the geological hazards profile.

Prioritization of the hazards that threaten the state was based on two separate factors: probability and potential impact. The likely geographical extent of the affected area, primary impacts of the event, and related secondary impacts all factor into the overall potential impact. While primary impacts are a direct result of the hazard, secondary impacts can only arise subsequent to a primary impact. For example, a primary impact of a flood event may be road damage due to submerged pavement or eroded surface. A possible secondary impact in these circumstances would be restricted access of emergency vehicles to citizens in a particular area due to the road closure.

A formula was developed to assign a value for probability and impact for each of the hazards considered. The probability of each hazard was determined by assigning a level, from 1 to 4, based on the likelihood of occurrence (which is based on historical data). Similarly, levels from 1 to 4 were assigned to each of the three impact factors mentioned above. Probability and impact factor levels assigned to each hazard were each then multiplied by an importance factor. The adjusted probability score was then multiplied by the sum of the adjusted impact factors to determine the total score for the hazard.

Based on the total calculated score, the hazards were separated into three categories that describe the relative risk level they pose to the state: significant, moderate, and limited. These terms relate to the level of planning analysis to be given to the particular hazard in the risk assessment process and are not meant to suggest that a hazard would have only limited impact. In order to focus on the most critical hazards, those assigned a level of significant or moderate were given more extensive attention in the remainder of this analysis (e.g., quantitative analysis or loss estimation), while those with a limited planning consideration were addressed in more general or qualitative ways.

The hazard ranking was based on the overall probability and impact on the state as a whole. When examining various regions of the state, the same ranking does not always apply. Table 3-2 indicates the ranking established by the state using the method described above.

Table 3-2: Hazard Ranking and Planning Consideration

Hazard Type and Ranking		Planning Consideration Based on Hazard Level
1	Flooding (flash, long-rain, snowmelt, and dam or levee failure)	Significant
1	Winter Storms	Significant
2	Wildfires	Significant
3	Drought	Significant
4	Tornadoes	Significant
5	Wind	Moderate
6	Agricultural Pests and Diseases	Moderate
7	Hazardous Materials	Moderate
8	Geological Hazards (Landslide, Mudflow, Expansive Soils, Earthquake)	Moderate

A Hazard Identification and Ranking Worksheet is included on the following page and contains the calculations and formulas utilized during the 2009-2010 update. Planning consideration rankings did not change from the 2007 plan.

HAZARD RANKING WORKSHEET - SOUTH DAKOTA

Hazard Type	Probability	Impact: Affected Area	Impact: Primary Impact	Impact: Secondary Impacts	Total Score	Hazard Planning Consideration
FLOODING (including Dam Failure)	4	4	2	3	48.80	Significant
WINTER STORMS	4	4	2	3	48.80	Significant
WILDFIRES	4	2	4	3	47.20	Significant
DROUGHT (including Extreme Heat)	4	3	2	4	46.40	Significant
TORNADOES	4	1	4	4	44.80	Significant
WIND	4	2	2	2	32.00	Moderate
AGRICULTURAL PESTS/DISEASES	3	3	1	4	30.60	Moderate
HAZARDOUS MATERIALS	4	1	1	3	24.00	Moderate
GEOLOGICAL HAZARDS (Landslide, Mudflow, Expansive Soils, Earthquake)	3	2	1	2	19.80	Moderate
EARTHQUAKE*	2	1	1	1	8.00	
EXPANSIVE SOILS*	3	UNK	UNK	UNK		

*Due to the minimal risk to earthquakes and unquantifiable impact of expansive soils these hazards were grouped with Landslide and Mudflow in a Geological Hazards profile

The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by it's importance factor times the sum of the impact level scores multiplied by their importance factors . Based on this total score, the hazards are separated into four categories based on the hazard level they pose to the communities: Significant, Moderate, Limited, None.

Probability Importance 2.0

Based on estimated likelihood of occurrence from historical data

Probability	Score
Unlikely	1
Somewhat Likely	2
Likely	3
Highly Likely	4

Affected Area Importance 0.8

Based on size of geographical area of community affected by hazard

Affected Area	Score
Isolated	1
Small	2
Medium	3
Large	4

Primary Impact Importance 0.7

Based on percentage of damage to typical facility in community

Impact	Score
Negligible - less than 10% damage	1
Limited - between 10% and 25% damage	2
Critical - between 25% and 50% damage	3
Catastrophic - more than 50% damage	4

Secondary Impacts Importance 0.5

Based on estimated secondary impacts to community at large

Impact	Score
Negligible - no loss of function, downtime, and/or evacuatio	1
Limited - minimal loss of function, downtime, and/or evacua	2
Moderate - some loss of function, downtime, and/or evacua	3
High - major loss of function, downtime, and/or evacuations	4

Total Score = Probability x Impact, where:

Probability = (Probability Score x Importance)

Impact = (Affected Area + Primary Impact + Secondary Impacts), where:

Affected Area = Affected Area Score x Importance

Primary Impact = Primary Impact Score x Importance

Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration

Total Score	(Range)	Distribution	Hazard Level
0.0	20.0	0	Limited
12.1	42.0	4	Moderate
42.1	64.0	5	Significant

The hazards identified in the local plans are consistent with those prioritized by the state. Not all of the counties prioritized the hazards, so it is impossible to compare how the hazards were ranked locally with the state's prioritization. Of the 64 counties with approved local mitigation plans, 63 identified winter storms, 61 identified floods (note related hazards: 11 identified dam failure, 7 identified flash flooding, and 3 identified snowmelt), 58 identified wildfires, 53 identified hazardous materials, 50 identified drought, 45 identified tornadoes, 30 identified windstorms, 24 identified earthquakes, 12 identified landslides and mudflows, and 2 identified agricultural pests and diseases as hazards for consideration in the local mitigation plan.

Several other hazards were identified by the local plans. Documentation of these hazards followed by the number of counties that identified each hazard is listed here for future reference by the State Hazard Mitigation Team, should these hazards become a statewide concern. While these are not explicitly profiled in this plan, the State Hazard Mitigation Team and the State Hazard Mitigation Officer will use this information to continue working with the local communities to understand the concerns these hazards pose, *how they are in part already addressed by the state plan*, and how they can be mitigated:

- Transportation Incidents (35)
- Urban Fire (32)
- Civil Disturbances (30)
- Summer Storms (23)
- Thunderstorms (19)
- Hail (19)
- Aviation Incident (19)
- Mass Casualty Incident (17)
- Lightening Strike (16)
- Utility mishap (14),
- Bio-Terrorism (14)
- Wildland interface fire (13) (see wildfires)

It must be noted that 51 of the 64counties identified terrorism as a risk. The State Hazard Mitigation Team recognizes this risk and feels that on a statewide level, terrorism is being mitigated to the best of their ability by the South Dakota Office of Homeland Security. This plan is not the appropriate vehicle for addressing the measures being taken in South Dakota to fight terrorism.

Presidential Declarations

Table 3-3 summarizes presidential disaster declarations, fire management assistance declarations, and emergency declarations for South Dakota since 1954. Twenty-seven presidential declarations in this 54-year period indicate that roughly every two years a disaster is declared. Since the early 1990's the state has had a presidential declaration on nearly an annual basis. From May 2008 to November 2010, South Dakota received 11 Presidential Disaster Declarations.

Table 3-3: Presidential Declarations

Declaration Number	Declaration Date	Incident Period Start	Incident Period End	Cost Share % (Federal/State)	Counties (#)	Disaster Type	FEMA Disaster Relief Costs[1]
Major Disaster Declarations							
FEMA-1947-DR	11/2/2010	9/22/2010	9/23/2010	75/25	4 Counties (including 1 reservation within designated counties)	Severe Storms and Flooding	Unknown
FEMA-1938-DR	9/23/2010	7/21/2010	7/30/2010	75/25	12 Counties	Severe Storms and Flooding	Unknown
FEMA-1929-DR	7/29/2010	07/16/2004	07/24/2010	75/25	3 Counties (including 1 reservation within designated counties)	Severe Storms, Tornadoes, and Flooding	Unknown
FEMA-1915-DR	5/13/2010	3/10/ 2010	Ongoing	75/25	31 Counties	Flooding	Unknown
FEMA-1914-DR	5/13/2010	4/2/2010	Ongoing	75/25	3 Counties	Severe Winter Storm	Unknown
FEMA-1887-DR	3/10/2010	1/20/2010	Ongoing	75/25	29 Counties (including 3 reservations within designated counties)	Severe Winter Storm	Unknown

Declaration Number	Declaration Date	Incident Period Start	Incident Period End	Cost Share % (Federal/State)	Counties (#)	Disaster Type	FEMA Disaster Relief Costs[1]
FEMA-1886-DR	3/9/2010	12/23/2009	Ongoing	75/25	12 Counties (including 2 reservations within designated counties)	Severe Winter Storm and Snowstorm	Unknown
FEMA-1844-DR	06/16/2009	04/11/2009	Ongoing (anticipated closing date of 07/09/2009 per amendment notice)	75/25	14 counties (including 2 reservations within designated counties and extending into North Dakota)	Severe Storms and Flooding	$3,551,885 (estimated)
FEMA-1811-DR	12/12/2008	11/05/2008	11/07/2008	75/25	13 counties (including four reservations within designated counties)	Severe winter storm and record and near record snow	$ 4,565,764 (estimated)

Declaration Number	Declaration Date	Incident Period Start	Incident Period End	Cost Share % (Federal/State)	Counties (#)	Disaster Type	FEMA Disaster Relief Costs[1]
FEMA-1774-DR	07/02/2008	06/02/2008	06/12/2008	75/25	26 counties (including portions of 3 reservations within designated counties)	Severe storms and flooding	$ 4,664,407 (estimated)
FEMA-1759-DR	05/22/2008	05/01/2008	05/02/2008	75/25	6 counties	Severe winter storm and record and near record snow	$7,551,320 (estimated)
FEMA-1702-DR	5/22/2007	5/4/2007	6/8/2007	75/25	24 counties (including 3 reservations within designated counties)	Severe Storms, Tornadoes, and Flooding	$8,373,536[2]
FEMA-1647-DR	6/5/2006	4/18/2006	4/20/2006	75/15/10 state	6 counties	Severe Winter Storm	$4,000,000[2]
FEMA-1620-DR	12/20/2005	11/27/2005	11/29/2005	75/15/10 state	26 counties	Severe Winter Storm	$28,000,000[2]
FEMA-1596-DR	7/22/2005	6/7/2005	6/8/2005	75/15/10 state	7 counties	Severe Storm (wind)	$840,159
FEMA-1531-DR	7/20/2004	5/28/2004	6/16/2004	75/15/10 state	9 counties, 1 reservation	Severe Storms and Flooding	$2,094,155
FEMA-1375-DR	5/17/2001	3/1/2001	4/30/2001	75/25	24 counties	Severe Storms (flooding)	$9,919,599
FEMA-1330-DR	5/19/2000	4/18/2000	4/20/2000	75/25	7 counties	Winter Storm	$2,877,023
FEMA-1280-DR	6/9/1999	6/4/1999	6/18/1999	75/25	2 counties	Severe Storms, Flooding, and Tornadoes	$17,848,761

Declaration Number	Declaration Date	Incident Period Start	Incident Period End	Cost Share % (Federal/State)	Counties (#)	Disaster Type	FEMA Disaster Relief Costs[1]
FEMA-1218-DR	6/1/1998	3/9/1998	3/12/1998	75/25	9 counties	Flooding, Severe Storms, and Tornadoes	$15,953,312
FEMA-1173-DR	4/7/1997	2/3/1997	5/24/1997	100 (A&B) 90/10 (C–G)	66 counties	Severe Storms, Flooding (high winds)	$82,490,180
FEMA-1161-DR	2/28/1997	11/13/1996	11/26/1996	75/25	10 counties	Severe Winter Storms	$2,526,209
FEMA-1156-DR	1/10/1997	1/3/1997	1/31/1997	75/25	66 counties	Severe Winter Storms/Blizzards	$18,431,301
FEMA-1075-DR	1/5/1996	10/22/1995	10/24/1995	75/25	26 counties	Ice Storms	$12,431,366
FEMA-1052-DR	5/26/1995	3/1/1995	6/20/1995	75/25	52 counties	Severe Storms, Flooding	$33,866,882
FEMA-1045-DR	3/14/1995	1/13/1995	2/10/1995	75/25	21 counties	Severe Winter Storms	$3,627,131
FEMA-1031-DR	6/21/1994	3/1/1994	7/29/1994	75/25	21 counties	Severe Storm, Flooding.	$7,789,915
FEMA-999-DR	7/19/1993	5/6/1993	6/10/1993	90/10	39 counties	Flooding, Severe Storms, Tornadoes	$50,202,256
FEMA-948-DR	7/2/1992	6/13/1992	6/23/1992	75/25	9 counties	Flooding, Severe Storms, Tornadoes (high winds)	$1,669,825
FEMA-764-DR	5/3/1986	n/a	n/a	n/a	25 counties	Severe Storms, Flooding	$4,893,611
FEMA-717-DR	7/19/1984	n/a	n/a	n/a	9 counties	Severe Storms, Flooding	$4,216,001
FEMA-511-DR	6/25/1976	n/a	n/a	n/a	4 counties	Flash Flooding, Mudslides	$4,439,769
FEMA-336-DR	6/10/1972	n/a	n/a	n/a	4 counties	Heavy Rains, Flooding	$111,907,010
FEMA-257-DR	4/18/1969	n/a	n/a	n/a	26 counties	Flooding	$4,369,737
FEMA-197-DR	5/26/1965	n/a	n/a	n/a	4 counties	Flooding	$3,771,780

Declaration Number	Declaration Date	Incident Period Start	Incident Period End	Cost Share % (Federal/State)	Counties (#)	Disaster Type	FEMA Disaster Relief Costs[1]
FEMA-132-DR	7/27/1962	n/a	n/a	n/a	23 counties	Floods, Tornadoes	$3,652,937
FEMA-99-DR	4/8/1960	n/a	n/a	n/a	16 counties	Floods	$933,934
FEMA-20-DR	7/31/1954	n/a	n/a	n/a	2 counties	Floods	$252,255
Emergency Declarations							
FEMA-3234-EM	9/10/2005	n/a	n/a	n/a	All counties	Hurricane Katrina Evacuation	n/a
FEMA-3015-EM	6/17/1976	n/a	n/a	n/a	n/a	Drought	n/a
Fire Management Assistance Declarations							
FEMA-2716-FSA	7/21/2007	7/21/2007	7/31/2007	75/25	Lawrence	Boxelder Fire	n/a
FEMA-2710-FSA	7/8/2007	7/7/2007	7/20/2007	75/25	Fall River	Alabaugh Canyon Fire	$2,659,373
FEMA-2658-FSA	7/27/2006	7/27/2006	8/7/2006	75/25	Pennington	East Ridge Fire	$1,973,107
FEMA-2569-FSA	7/16/2005	7/16/2005	7/17/2005	75/25	Pennington	Skyline #2 Fire	$18,975
FEMA-2565-FSA	7/10/2005	7/9/2005	7/19/2005	75/25	Meade	Ricco Fire	$573,581
FEMA-2513-FSA	11/20/2003	11/20/2003	11/21/2003	75/25	Pennington	Mill Road Fire	$62,852
FEMA- 2458-FSA	8/18/2002	8/16/2002	8/29/2002	75/25	Pennington	Battle Creek Fire	$1,816,503
FEMA-2434-FSA	6/29/2002	6/29/2002	7/17/2002	75/25	n/a	Grizzly Gulch Fire	n/a
FEMA-2369-FSA	7/31/2001	7/30/2001	8/8/2001	70/30	Custer	Elk Mountain Fire	$293,000
FEMA-2324-FSA	8/25/2000	8/24/2000	9/25/2000	100	Lawrence	Jasper Fire	$2,500,000
FEMA-2319-FSA	8/13/2000	8/11/2000	8/20/2000	70/30	Fall River	Flagpole Fire	$1,750,000
FEMA-2109-FSA	8/16/1994	n/a	n/a	n/a	n/a	Stagebarn Canyon Fire	n/a
FEMA-2076-FSA	9/14/1990	n/a	n/a	n/a	n/a	Swedlund Fire	n/a
FEMA-2068-FSA	7/26/1988	n/a	n/a	n/a	n/a	West Berry Trail Fire	n/a
FEMA-2061-FSA	7/22/1987	n/a	n/a	n/a	n/a	Battle Mountain Fire	n/a
FEMA-2057-FSA	7/15/1985	n/a	n/a	n/a	n/a	Flint Hill Fire	n/a
FEMA-2056-FSA	7/15/1985	n/a	n/a	n/a	n/a	Seven Sisters Fire	n/a
FEMA-2017-FSA	7/29/1975	n/a	n/a	n/a	n/a	Custer State Park	n/a

Declaration Number	Declaration Date	Incident Period Start	Incident Period End	Cost Share % (Federal/State)	Counties (#)	Disaster Type	FEMA Disaster Relief Costs[1]
FEMA-2016-FSA	7/8/1974	n/a	n/a	n/a	n/a	Argle & Booms Canyon	n/a

Sources: Federal Emergency Management Agency, South Dakota Office of Emergency Management, Public Entity Risk Institute
Notes:
[1]Costs include Public Assistance, Individual Assistance, and mitigation and are in constant 2006 dollars (with the exception disasters post-2006, which are year of event dollars). Fire costs are from the state, represent total outlays, and are not adjusted for inflation (with the exception of FEMA-2710-FSA, which is from InciWeb).
[2]Projects are not closed; costs are estimates from the state (FEMA-1702-DR is public assistance only).

Probability of Future Events

Predicting probability of future events is estimated by looking at the number of past damaging events, where possible (e.g. declared disasters), or using scientific estimates where available. Using the South Dakota information provided and the process as discussed in this section, one can conclude that it is probable that flooding, severe winter storms, tornadoes, wildfires, landslides/mudflows, and earthquakes will continue to occur in the future much as they have in the past. Some hazards are more likely to occur and cause more damage than others. This is discussed in more detail in the following hazard profiles.

What could reduce damage from future events? One way is to continue the process of identifying and implementing good mitigation measures that protect people and property. If people and property are not impacted by a hazard event when one occurs, then their vulnerability has been reduced. Hazard events will still occur, but people and property may not be impacted because they may no longer be vulnerable to the threat. The best example of this is when structures on repetitive flood loss properties are removed from the path of potential floods. Moving the structures reduces the potential risk to life and property. Therefore, lives and property are less vulnerable to the threat of flooding and loss of life and property is less probable.

3.2 Profiling Hazards

44 CFR Part 201 Requirement:
[The State risk assessment shall include an overview of the] location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate…

Information for the hazard profiles and at-risk facilities came from a variety of sources and organizations, including, but not limited to, the following:

- South Dakota Agencies and Departments
  - Office of Emergency Management
  - South Dakota Department of Environment and Natural Resources
  - South Dakota Department of Agriculture
  - South Dakota Department of Health
  - South Dakota Office of Homeland Security
  - Northern State University, Aberdeen, South Dakota
  - South Dakota State University, Brookings, South Dakota
- Federal Emergency Management Agency
  - HAZUS-MH
- Public Entity Risk Institute
- University of South Carolina Hazards and Vulnerability Research Institute
  - Spatial Hazard Events and Losses Database for the United States (SHELDUS)
  - Social Vulnerability Index for the United States
- National Oceanic and Atmospheric Administration
  - National Climactic Data Center
  - National Weather Service
- U.S. Army Corps of Engineers
- U.S. Geological Survey
- Literature and written and oral communications from state and national hazard experts
- Input given at stakeholder meetings during the 2007 update

Agricultural Pests and Diseases

Description

Agricultural hazards are divided into two categories: pests and diseases. For this plan, such events are defined as the naturally occurring infection of crops or livestock with insects, vermin, or diseases that render the crops or livestock unfit for consumption, sale or other use. South Dakota has a substantial agricultural industry and a significant infrastructure composed of related facilities and locations, so the potential for infestation of crops or livestock pose a significant risk to the economy of the state. In order to profile each element adequately, this hazard profile focuses on events that primarily affect livestock (primarily disease) and crops (disease and pests). In some cases, pests may also serve as the vector of disease for livestock. For clarity, the profile examines livestock and crop impacts separately, following the same evaluation criteria of location, past events, and probability demonstrated in other profiles.

Small losses caused by agricultural pests and diseases are normal for South Dakota farmers and ranchers. Concerns arise when the level of an infestation escalates suddenly and overwhelms normal control efforts, a new type of infestation occurs, diseases decimate animal populations, or when diseases pose a risk to humans. The levels and types of such events vary based on many factors, including cycles of heavy rains and drought, feeding practices, cross contamination or exposure, or inadequate infection control measures.

While Zoonotic diseases (those transmissible to humans from animals or via an animal vector) are a concern, those events are best addressed in a pandemic or contagious disease plan, in order to address the variability and magnitude the events entail. To some extent, the control of insects and rodents also addresses the mitigation of Zoonotic disease, but for the purposes of this plan, that is an extra factor, rather than a primary focus. This hazard profile focuses on the diseases which impact the population of domesticated livestock or crops, which in turn damages the economic return on these valuable assets.

The following evaluation of crop hazards is reproduced from the Plant Sciences at South Dakota State website discussing crop production problems:

> Farmers endure a number of problems during the growing season which can curtail yield. Some of these problems occur because best management practices are not applied. The lack of a good stand, crop-nutrient deficiencies, insect infestations, weed population increases, poor field drainage, and salinity problems can to some degree be managed. However, there are some weather related natural events that are beyond the farmer's control. High humidity and strong southerly breezes can carry windborne pathogens from Mexico and the southern states to infect crops. Violent storms from May to August can bring hail can reduce crop yield potential or damage crops beyond recovery. Lack of timely precipitation can wither crops and reduce yields. Late frost in the spring can kill crops and early frost in the Fall can curtail the grain filling period of fall harvested crops.[1]

[1]http://plantsci.sdstate.edu/woodardh/Soils_and_Ag/Eastern/Crop_Production_Problems/crop_production_problems.htm

Weeds that infest fields may cause problems during harvest. The weeds may clog small-medium size combines, so alternative harvesting techniques are required. The cut-and-swathing technique is not preferable as it may encourage grain loss and requires a greater investment of time and/or manpower.[2]

Rodent infestations threaten crops, which is one of the primary industries in the planning area. Mice, rabbits, and other pests damage crops in all stages of the production process. Young plants are vulnerable to the rodents who feed on them. Harvested and stored crops may be contaminated by rodents burrowing into storage units, either to feed on the materials or create nests during winter months, or become contaminated by fecal matter. The nature of such infestations makes tracking statistical data nearly impossible. Variables include the geographic distribution of the rodents and the crops, the number of rodents in the area, the presence and proliferation of natural predators, and the reproduction rates relative to the amount of natural food resources available. As such, while this is an acknowledged element of the agricultural hazards, it is not a primary focus in this profile.

Insect plagues also cause significant damage to crops in South Dakota. The last major grasshopper infestation in the United States occurred in the 1930s. Following this disaster, it was decided that local control of grasshopper outbreaks was insufficient and that regional coordination was required. The 1934 Congress charged the U.S. Department of Agriculture (USDA) with controlling grasshoppers on federal rangeland. Later, in 1987, the Animal and Plant Health Inspection Service (APHIS), which is part of the USDA, created the Grasshopper Integrated Pest Management (GHIPM) Project to develop new technologies for managing grasshopper populations. Subsequent grasshopper infestations in the 1950s, 1980s, and predicted infestations for the early 2000s further underscore the importance of mitigating this insect-driven hazard. Similar insect hazards include locusts, aphids, and bark beetle plagues. In early March 2010, USDA designated Ziebach County as a primary natural disaster area due to weather and grasshopper problems in 2009. Federal disaster assistance, such as low-interest emergency loans, is available for producers in Ziebach and the contiguous counties of Corson, Haakon, Pennington, Stanley, Dewey, Meade and Perkins.

Location

Since diseases and pests are profiled in a compilation, instead of examining each potential hazard individually, the geographic location of the hazards is somewhat general. It is recognized that the individual occurrences of the hazards contained in this profile will exert unequal pressures and impacts. In general, it is important to know where the hazards *may* occur in order to determine the severity of the hazard when compared to other hazards in this plan. Specific vulnerabilities may be best addressed in county or local mitigation plans.

Livestock diseases are possible anywhere that livestock are present. In addition, humans who come into contact with contaminated livestock or byproducts may also be exposed to livestock diseases. 23,025,294 acres in South Dakota are devoted to pastureland, which accounts for 47.4% of the total land area of the state. Pastureland is primarily located in bands that stretch from north to south in the eastern half of the state, and in the grasslands that dominate the western area of the state. In Figure 3-2, pastureland areas are indicated in yellow, while grasslands are indicated in beige.

[2] http://plantsci.sdstate.edu/woodardh/Soils_and_Ag/Eastern/Crop_Descriptions/crop_desciptions.htm

Similarly, crop diseases are possible in any cultivated cropland environment. While some crop varieties are engineered for resistance to specific diseases or pests, the overall location of any pest or disease hazard corresponds to the cropland extent in the state. Specific variances to general distributions are noted in Table 3-5 and Table 3-6. 19,095,318 acres in South Dakota are designated as cropland, which accounts for 39.3% of the total land area of the state.

Cultivated crops are heaviest in the eastern half of the state, though significant areas of cropland interspersed with grasslands also exist in the west. In Figure 3-2, these areas are indicated by brown shading.

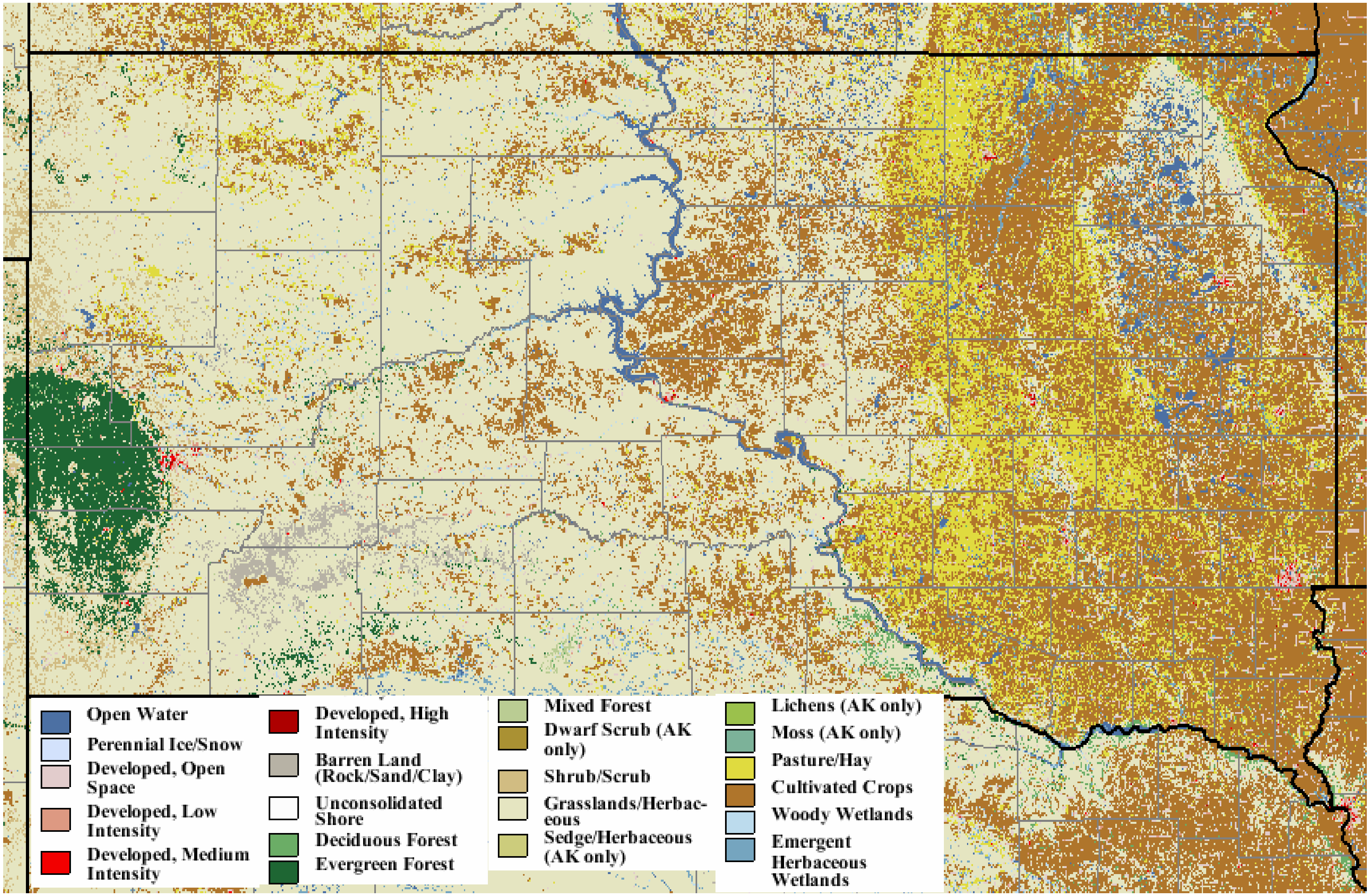
Rodents such as mice, rats, and rabbits, are found across the entire planning region, as are insects. The presence of the rodents and insects is a consistent feature, with normal population density flows following the seasonal patterns. However, when density of these populations exceeds the capacity of the ecosystem, agricultural industries such as crops and the health of livestock are threatened. As discussed above, the ability to model these trends is difficult and inconsistent.

Grasshoppers are a historical insect hazard impacting agricultural production of crops. Figure 3-3shows the adult grasshopper density for South Dakota measured in October 2008. While the map indicates that the majority of the density ratings are in western South Dakota, outside of the majority of cultivated cropland, this is due to the fact that the USDA does not survey in the eastern part of the State. The impacts of grasshoppers on cattle have also been significant. The prediction for 2009, based on the density ratings, indicated that food supplies for cattle in the western portion of the state would be severely impacted by the grasshoppers. This proved accurate in August of 2009, when the Associated Press reported that grasshopper infestations forced ranchers to sell livestock because food supplies were unavailable.[3] South Dakota, specifically Ziebach County, was named in USDA Secretarial Disaster Declaration S2916 for damages done by grasshoppers. Figure 3-4 predicts the grasshopper hazard for the western United States (outbreaks have historically occurred in the 17 states that lie west of the 100th meridian[4]), including South Dakota. Depending on weather conditions in May, June, and July, the 2010 growing season may be affected by a large grasshopper population. Wet conditions in the spring/summer of 2010 are being tracked in hopes that it will mitigate some of the grasshopper issues.

3 Carson Walker, Associated Press. "Grasshopper Infestation forces livestock sales". http://www.mnn.com/food/farms-gardens/stories/grasshopper-infestation-forces-livestock-sales

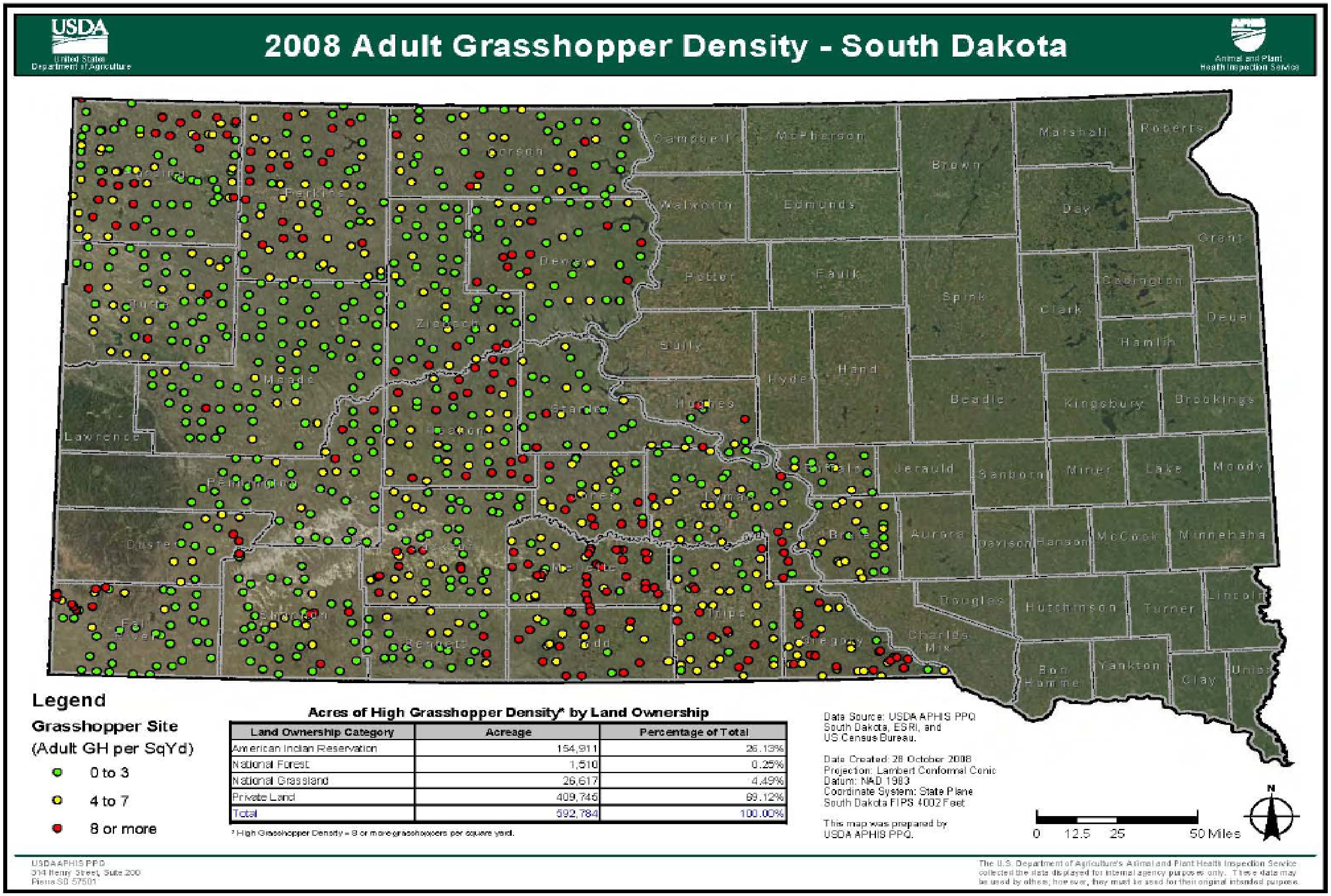
4 USDA APHIS. http://www.aphis.usda.gov/plant_health/plant_pest_info/grasshopper/index.shtml

Figure 3-2 Land Cover in South Dakota



Source: The National Map Seamless Server hosted by the USGS, using NLCD 2001 Land Cover data.

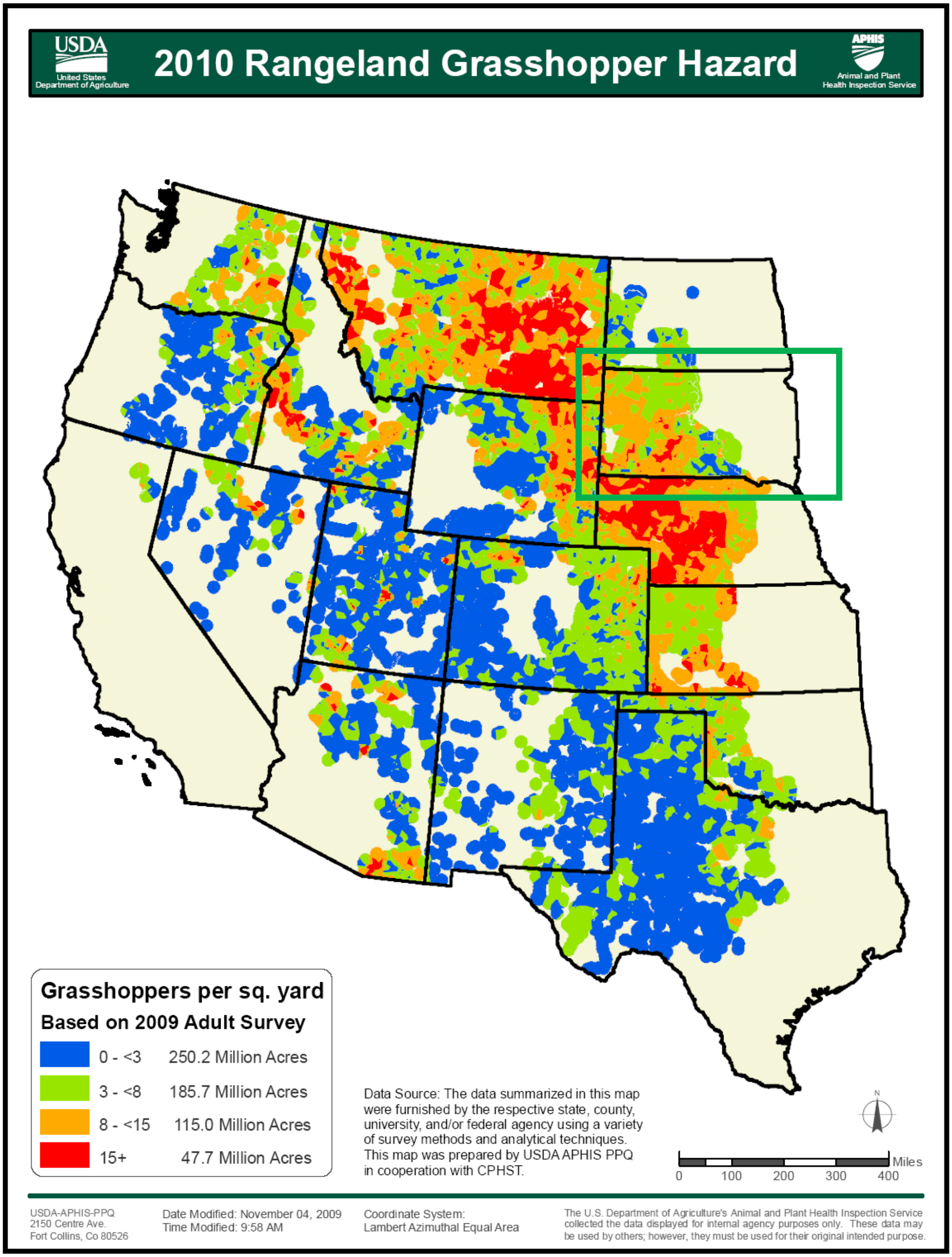
Figure 3-3 2008 Adult Grasshopper Density for South Dakota



Land Ownership Category	Acreage	Percentage of Total
American Indian Reservation	154,911	26.13%
National Forest	1,510	0.25%
National Grassland	26,617	4.49%
Private Land	409,745	69.12%
Total	592,784	100.00%

Source: USDA

Figure 3-4 South Dakota Grasshopper Hazard



Source: USDA APHIS

Past Events

Past events are detailed differently in this section compared to other hazard profiles. While previous occurrences are listed, where applicable, it is also important to recognize the potential devastating diseases or pests for which the State constantly monitors. The use of vaccines (in livestock) and fungicides, pesticides or resistant seeds have mitigated some previously severe hazards, while other potentially devastating hazards have not yet appeared in South Dakota and appropriate preventative measures are in place to help inhibit their introduction. As such, monitored diseases or infestations are as equally important as known events.

The information presented in Table 3-4 is a summary of the information presented on the South Dakota Animal Industry Board Disease Control Website with additional information drawn from the USDA and other resources. Only diseases for cattle, pigs, poultry and wildlife are profiled here due to their respective importance in the South Dakota economy. However, additional information on sheep and horses is also available on the website. In addition, diseases with minimal impact on humans and a low incidence rating in animals are not included in this profile.

There are many common crop diseases that impact the production, yield, and overall quality of harvests. Some crops are sold as a commodity, while others are used to support the livestock industry. As with livestock disease, tracking every occurrence is unwieldy because, to some level, crop disease is omnipresent. This section (Table 3-5 and Table 3-6) shows the occurrence rate of common crop hazards for the top commodities groups grown in South Dakota- that is, small grains, oilseeds, dry beans and dry peas (ranked 9th in the nation for value of sales), corn for grain (ranked 6th in the nation for production), soybeans (ranked 8th in the nation for production), sunflowers (ranked 2nd in the nation for production), and forage (ranked 3rd in the nation for production). Note that commodities are grouped by disease vulnerability, rather than by commodities group. The information is drawn from an issue of "Extension Extra" published by the College of Agricultural and Biological Sciences at the South Dakota State University, which discusses the recognition and management of common crop diseases in South Dakota.[5]

Some highlights of the events listed below, or events of particular significance, include:

- In 2009, the State experienced combined effects of severe storms with hail, high wind, flooding, and grasshopper infestation in 35 counties. This led to the release of USDA Secretarial Disaster S2916.
- In 2005, the state experienced an unusually high outbreak of anthrax, with 56 positively confirmed cases in 18 counties.
- Trichomoniasis (trich) cases have been steadily increasing in recent years. The highest number of cases also occurred in FY 2005, with 45 positive cases in 11 counties.
- Asian soybean rust is still not documented and confirmed in the state, but extensive scouting efforts are underway, particularly in the southeast counties.

[5] http://sdces.sdstate.edu/ces_website/hit_counter.cfm?item=ExEx8005&id=1246

Table 3-4 South Dakota Livestock Diseases

Disease Name	Incidents, history, and other reporting measures	Human Vulnerability
Cattle		
Brucellosis, also known as Bangs Disease or Bangs	U.S. states are free from Brucellosis in domestic cattle herds due to extensive vaccination and testing requirements. Buffalo and Elk in the Greater Yellowstone Area remain natural carriers of the disease and present the largest risk to domestic cattle herds. Documented cases include far-reaching impacts and tremendous costs for movement restrictions, testing requirements, indemnities, and epidemiology.	Yes, if ingested or directly exposed to the bacteria. Human-to-human transmission is possible, but rare.
Tuberculosis, also known as TB.	South Dakota has maintained a "TB Free" status by the USDA since 1982, however, all intact dairy cattle imported to the state must reflect a 'negative' result in official TB testing within 60 days prior to entering South Dakota. The bovine strain of bacteria is distinct from the most common forms that impact humans. However, the strain may be passed between cattle, from humans to cattle, and from cattle to humans. In both human and cattle patients, TB may be fatal if untreated or neglected.	Yes, if ingested (particularly from untreated milk). Sustained human-to-human transmission is possible but rare.
Bovine Spongiform Encephalopathy (BSE), also called 'Mad Cow Disease'	First surfacing in Great Britain in 1986, BSE is a chronic degenerative disease of the central nervous system. There is no method for testing for the disease in live cattle, so suspected cases pose an extreme cost impact on ranchers. There have been sporadic cases in Canada and the United States. Strict regulations prohibit the feeding of ruminant derived proteins to ruminants. The disease is not passed between cows except via consumption. According to the Center for Disease Control, the first confirmed domestic case of BSE disease was reported in Washington state in 2003. Two subsequent diagnoses were confirmed for a 2004 case in Texas (confirmed in 2005) and in 2006 in Alabama. Luckily, these cases have resulted in minimal impact on domestic cattle herds, but monitoring remains a key component.	Suspected yes, if ingested. The link is suspected between VSE and certain cases of CJD, which is a chronic degenerative central nervous disease in humans.
Anthrax	Anthrax is a spore-forming bacteria that causes acute infections. In 2005, South Dakota experienced a serious anthrax outbreak, with 55 herds with confirmed losses to the disease in the space of four months. Mitigation and response measures helped contain the outbreak, with efforts to vaccinate over 1 million cattle during the summer months. The State Veterinarian reported that the effects of drought, contributed to the severity of the 2005 outbreak. Since South Dakota is located in the 'anthrax belt', potential losses and vulnerability remain high and vigilance remains critical. Previous cases include 1infected herd in 2009, 3 in 2008, 2 in 2007, and 2 in 2006.	Yes, if spores are inhaled, ingested, or infected materials are improperly handled. The disease is not known to be peer-to-peer transmissible.
Johne's Disease (pronounced Yo-nees), also called Paratuberculosis	Johne's disease is a chronic infection that causes diarrhea and wasting, which primarily impacts cattle over the age of 2 years, and is also found in other ruminant animals such as goats and sheep. The disease is closely related to tuberculosis, but grows very slowly. The disease causes wasting of the inflicted animals and may be spread via fecal matter, nursing from infected dams or contamination of the udder with manure, or en vitro. The disease may cause early death or culling losses, decreased milk production, decreased slaughter weights, loss of show, sale and breeding animals, and incurred veterinary costs. There is no effective vaccine. Johne's disease cases are reported at a rate of approximately 4.4% and appear to be increasing. Dairy cows seem to demonstrate a higher occurrence rate than beef cows.	There does not appear to be a transmission of this disease to people. Crohn's disease is a similar infliction in human populations.

Disease Name	Incidents, history, and other reporting measures	Human Vulnerability
Foot and Mouth Disease (FMD)	FMD is a fast-spreading virus which impacts all cloven-footed animals and causes blisters on feet, in mouths, and on mammary glands, resulting in lameness, the inability to eat or drink, and mastitis in dairy animals. In all cases, animals rapidly lose weight and may die. Transmission rates are nearly 100% of exposure, and young animals may die. FMD poses huge economic risks to livestock owners and consumers. In February 2001, the UK was forced to destroy over 9% of the national food animal production industry, and over 11 months to eradicate the disease.	FMD is distinct from Hand, food and mouth disease that impacts humans though the symptoms are similar. People cannot contract FMD.
Vesicular Stomatitis (VS)	VS is a virus that causes similar symptoms as FMD and is highly contagious, though it demonstrates a lower mortality rate. The disease may lead to serious restrictions on the movement, marketing, and exportation of animals from affected areas, which has a significant economic impact on livestock-driven economies. While no cases have been diagnosed recently in South Dakota, cases in nearby states underscore the need for vigilance and close reporting requirements.	Humans may contract the disease from sand flies or improper handling of infected animals and animal byproducts. Symptoms are flulike.
Trichomoniasis, also called 'trich'	Trich is a venereal disease that causes infertility and occasional abortions in cows. Bulls, once infected, carry the disease for life but cows seem to spontaneously recover after a period of infection, in some cases. During the FY 2005 breeding season, South Dakota experienced an unexpected resurgence of the disease in 45 confirmed cases, all west of the Missouri river. The known endemic qualities of the disease and the presence of the disease in states west and south of South Dakota, increased cases and magnified losses. Regulations for controlling and reporting Trichomoniasis were effected on June 1, 2005. Additional cases include 13 in FY 2009, 7 in FY 2008, 10 in FY 2007, and 9 in FY 2006.	Humans may contract the disease and spread it from person to person via sexual contact. The disease may be contracted from livestock through improper hygiene when handling infected animals.
Swine		
Psuedorabies (PRV), also known as Aujesky's Disease or mad itch in cattle.	PRV is a viral disease that causes abortion, high mortality of piglets, and may cause other symptoms in adult pigs. In addition, cattle, dogs, bears, cats, sheep, rabbits and raccoons may contract the disease, which often proves fatal in these secondary hosts. The disease is spread via nasal secretions and saliva. On April 16, 2003, South Dakota was granted Stage V-Free status. Though domestic swine herds have been PRV-free since 2003, the disease remains in feral herds, which pose the greatest risk to domesticated animals. Positive animals must be destroyed to limit the spread and in some cases the entire herd must be destroyed. The disease is considered one of the most economically devastating diseases of swine herds and the potential for a reintroduction of the virus from feral pig exposures remains a concern.	Humans are not potential hosts.
Porcine Reproductive and Respiratory Syndrome (PRRS)	PRRS is a virus that attacks the respiratory system and leads to an overall weakened immune system. The disease is highly contagious and spreads rapidly, but seems to impact different herds with varying degrees of severity for unknown reasons. First identified in the U.S. in North Carolina in the 1980s, the disease spread rapidly across the continent. All breeds and ages of pigs are susceptible, though there is some indication that some breeds demonstrate less vulnerability than others. The impacts of this disease are still under evaluation, but losses to pig herds have economic ramifications for sale for slaughter and breeding.	There is no known human susceptibility to the disease. Humans may serve as mechanical vectors of the disease without proper infection control practices.

Disease Name	Incidents, history, and other reporting measures	Human Vulnerability
Poultry		
Avian Influenza	While Avian Influenza is not currently documented in the state, the concern remains that exposure could result in the infection of domestic avian flocks, including turkeys, geese, chicken, and other fowls, that may contribute to the crossover between birds and people. A detailed response and containment plan has been developed and is a factor in mitigation should a quarantine and/or subsequent destruction of flocks be required. A surveillance project went into effect in FY 2007.	Currently humans may contract the disease through extensive exposure to avian carriers. The concern is that the influenza serotype could genetically alter to sustain peer-to-peer transmission.
West Nile Virus	The first identified domesticated cases of WNV occurred in FY 2006, identified in geese at a production site in northeastern South Dakota.	Though mosquitoes remain the primary vector for human transmission, close contact with birds also increases the risk of exposure and may contribute to an alteration of the virus for sustained peer-to-peer transmission.
Wildlife		
Chronic Wasting Disease	The first case of CWD in farmed elk or deer in the U.S. was identified in a private South Dakota herd in late 1997. On February 5, 1998, a mandatory Cervid Chronic Wasting Disease Surveillance Identification (CCWDSI) Program was enacted. This monitoring program has become the model program for numerous other state CWD monitoring programs as well as the federal interim CWD monitoring plan.	No known human transmissions exist at this time. The disease is a variant of the same family that houses BSE, however, so appropriate precautions are appropriate.
Rabies	Rabies in the wildlife population remains at a high level. Skunks are the reservoir of the disease and they represent the largest number of positive diagnoses at the laboratory. Bats have also been recognized as a significant reservoir of rabies. For FY 2009, thirty-two (32) animals were reported infected with rabies, compared to twenty-nine (29) in FY 2008, twenty-five (25) in FY 2007; fifty-three (53) in FY 2006; eighty (80) in FY 2005; one hundred five (105) in FY 2004.	Yes, if exposed through bites or handling of infected animals.

Source: South Dakota Animal Industry Board Disease Control Website and the Center for Disease Control http://aib.sd.gov/diseasecontrol.shtm

Table 3-5 Small Grains

Disease	Winter Wheat	Spring Wheat	Barley	Oats	Rye	Occurrence
Barley Yellow Dwarf (Red Leaf of Oats)	X	X	X	X		Common
Common Root Rot	X	X	X	X	X	Widespread
Covered Smut & Common Bunt	X	X	X	X	X	Fairly Common
Dryland Root & Crown Rot	X	X	X	X	X	Widespread, most serious on winter wheat
Leaf Rust	X	X	X	X		Widespread
Loose Smut	X	X	X	X		Common (>2% In Given Field)

Disease	Winter Wheat	Spring Wheat	Barley	Oats	Rye	Occurrence
Scab (Fusarium Head Blight)	X	X	X	X	X	East River Counties: Common West River Counties: Rare
Stem Rust	X	X	X	X	X	Rare
Stripe Rust	X	X				Frequent, Severity Varies By Year
Take All	X					Rare
Tan Spot, Septoria Leaf Blotch & Other Leaf Spot Diseases	X	X	X	X		Widespread
Vomitoxin	X	X	X	X	X	Fairly Common
Wheat Streak Mosaic	X	X				Frequent

Table 3-6 Sunflowers, Oilseeds, Dry Beans, Dry Peas and Soybeans, Corn, Alfalfa and Flax

Disease	Sun-flowers	Canola	Safflower	Field Pea	Chick-pea	Lentil	Dry Bean	Soy-beans	Corn	Alfalfa	Flax	Occurrence
Alternaria Leaf &Stem Spot, Leaf Blight	X		X*									Annually in late summer *common
Anthracnose						X	X		X*	X	X*	Rare *Occasional
Apical Chlorosis	X											Infrequent
Ascochyta Blight					X	X						Common
Asian Soybean Rust								X				Not yet reported in the state
Aster Yellows		X									X	Infrequent, no control
Bacterial Blight & Wilt[$]				X			X*	X		X[$]		Widespread, *Occasional [$]Rare
Bean Pod Mottle								X				Widespread
Black Leg		X										Common
Blackspot		X										Common, no control
Brown Spot								X				Widespread
Brown Stem Rot (BSR)								X				Occasional
Charcoal Rot								X				Occasional, extreme southeast counties
Common Leaf Spot										X		Common

Disease	Sun-flowers	Canola	Safflower	Field Pea	Chick-pea	Lentil	Dry Bean	Soy-beans	Corn	Alfalfa	Flax	Occurrence
Damping-Off			X						X	X		Common
Downy Mildew	X							X				Common
Eyespot									X			Occasional
Frogeye Leaf Spot								X				Rare in state, observed in extreme southeast counties
Fusarium Root Rot and Wilt$^{\$}$				X	X	X	X	X		$X^{\$*}$	$X^{\$*}$	Occasional *Common
Goss's Bacterial Wilt & Blight									X			Rare
Gray Leaf Spot									X			Fairly common
Holcus Spot									X			Annual in early summer
Maize Dwarf Mosaic									X			Common, typically low incidence
Northern Stem Canker								X				Frequent
Nothern Corn Leaf Blight									X			Occasional
Pasmo											X	Occasional
Phoma Black Stem	X											Annually in late summer
Phomopsis Stem Canker	X											Annually in late summer
Pod & Stem Blight								X				Widespread
Pythium Damping Off & Seed Decay				X	X	X	X	X		X		Widespread
Pytophthora Root & Stem Rot								X		X*		Widespread *Fairly Common
Rhizoctonia Seedling Blight$^{\$}$ & Root Rot								X			$X^{\$*}$	Widespread *Common
Root & Crown Rot Complex										X		Common
Sclerotinia Wilt, Stalk Rot & Head Rot	X											Annually in late summer
Soybean Cyst Nematode								X				Widespread in south-eastern counties, scattered in other areas
Soybean Mosaic								X				Rare

Disease	Sun-flowers	Canola	Safflower	Field Pea	Chick-pea	Lentil	Dry Bean	Soy-beans	Corn	Alfalfa	Flax	Occurrence
Spring Black Stem & Leaf Spot										X		Widespread
Stalk Rot Complex									X			Annual in fall
Stem Nematode										X		Rare, restricted to western counties
Sudden death syndrome (SDS)								X				Rare: only in Clay County
Summer Black Stem & Leaf Spot										X		Common
Verticillium Wilt										X		Common
White Mold		X	X	X	X	X	X					Common

Probability

To some extent, the probability of these events is guaranteed on an annual basis, particularly when evaluated on a statewide scale. The determination of probability becomes most valuable when areas of particular occurrence rates, or when events of unusual severity, are recorded. Many times, extreme events are documented concurrently with other hazard event occurrences, such as the outbreak of high anthrax levels in 2005, which was attributed to drought, the grasshopper plagues of the 1930s, also attributed to drought, or the recurrence of certain crop molds which correspond to unusually wet growing periods.

If the general annual probability of occurrence for the state, overall, is near 100%, some general probabilities for regions or specific counties may also be drawn.

In general, the western portion of the state (counties lying to the west of the Missouri River) have a higher documented occurrence rate of trich and stem nematode afflictions of alfalfa crops. Counties along the river basins bore the brunt of the anthrax outbreaks in 2005. Eastern counties have higher documented rates of the soybean cyst nematode, frogeye leaf spot, scab, and West Nile Virus in domestic fowl flocks. Areas with a primarily cultivated crop land use are more susceptible to crop diseases, and thus have a predicted higher probability rating than areas devoted to rangeland. Areas where wildlife interaction is more common among livestock have higher exposure probabilities to diseases like rabies and brucellosis.

A South Dakota State University Extension entomologist said that "based on the high grasshopper count late last summer (2009), there is potential for another year of grasshopper infestation in counties in western South Dakota" (see Figure 3-4). Dangerously high levels of grasshopper populations seem to follow a cycle of 7 to 10 years. Drought or periods of higher-than-average temperatures, particularly in the winter, increase the severity of grasshopper population numbers, because more eggs survive to hatch. Based on historical data, South Dakota has experienced four grasshopper plagues in 122 years (1887 to 2009) for an annual chance of 3.2%. Smaller infestations, which still exert significant economic impact, may be predicted at the cycle of ten years, or a 10% annual chance.

Flood

Description

Throughout the United States, flooding is recognized as the most prominent disaster-producing phenomenon, generating annual losses in the billions of dollars. Floods are among the most serious, devastating, and costly natural hazards that affect South Dakota. The greatest impact of these phenomena has been to the eastern half of the state, principally, the Big Sioux, Vermillion, and James river basins, which have recurring problems.

The following is extracted from "Flooding in South Dakota," a fact sheet written by Stan F. Pence from the South Dakota Department of Environment and Natural Resources.

> #### What Is a Flood?
> A flood occurs when water rises to flow over land that is normally dry. Floods happen in low-lying areas, such as valley bottoms, lake basins, and coastal areas. In South Dakota, flooding occurs mainly in valley bottoms, deep canyons, and lake basins when the

amount of water moving through a river, or entering a lake, is so great that the natural or artificial banks can no longer contain all of the water. Therefore, the water overflows the banks of the river or lake and spreads out onto low-lying areas that are not normally covered with water.

What Causes A Flood?

In South Dakota, there are two main climatological causes of flooding: runoff from rainfall and runoff from melting snow. The water from rainfall or melting snow flows overland until it reaches a nearby river or lake. If the river or lake cannot hold all of the water that is entering it, some of the water will begin to overflow the banks of the river or lake, causing flooding. The size of the flood is commonly influenced by such factors as the intensity of the rainfall, length of the rainfall, melting rate of the snow, and the infiltration rate of the water into the ground.

In addition to climatological reasons for flooding in South Dakota, floods can also result from the failure of dams. Dam failure can result from defective construction or a poor foundation. Many small dams in South Dakota fail because their spillway is not big enough. Often, failure occurs as a result of extremely heavy rainfall that causes a large increase in the amount of water held by the dam. This increase in water behind the dam could place more stress (pressure) on the dam than it was designed to handle, causing the dam to fail.

What Types of Floods Occur in South Dakota?

Four types of floods can occur in South Dakota. The first type is commonly called a flash flood. A flash flood is the result of several inches or more of rain falling in a very short period of time, often tens of minutes. This high intensity rainfall is commonly caused by powerful thunderstorms that cover a small geographic area. Because so much water is falling onto the ground very rapidly, there is little time for the water to soak in, and most of the water runs off into nearby rivers or lakes. The flood that occurs as a result of this runoff happens very rapidly, hence the term “flash.” This type of flood is generally very destructive, affecting a fairly small, localized area, commonly several tens of square miles or less. The flash flood often ends almost as quickly as it started. Probably the best-known flash flood in South Dakota occurred when Rapid Creek left its banks on June 9, 1972, in Rapid City. Fifteen inches of rain that fell in less than 6 hours caused the flooding. This flood was devastating both in terms of loss of human life and property damage. Two hundred thirty-eight people lost their lives in this flood and about $150 million (in 1972 dollars) of property damage occurred.

The second type of flooding is sometimes termed the long-rain flood, and is the most common cause of major flooding. This type of flood results after several days or even weeks of fairly low-intensity rainfall over a widespread area, often hundreds of square miles. As a result, the ground becomes "water logged," and the water can no longer infiltrate into the ground; therefore, the water begins to flow toward rivers or lakes. The flooding that can result is often widespread, covering hundreds of square miles, and can last for several days or many weeks. Much of the flooding that occurred in eastern South Dakota during the summer of 1993 was this type of flooding.

The third type of flood in South Dakota is the result of melting snow in the spring. This type has characteristics that are almost a combination of the flash flood and long-rain flood. The area covered by this type of flood is generally not as large as that covered by the long-rain flood, but is typically larger than that covered by the flash flood. Generally, the flood lasts for several days, occurring when large amounts of snow melt rapidly due to warm temperatures. The flooding can be made worse if the ground remains frozen while the snow is melting; this causes all of the melt water to run off to nearby rivers and lakes rather than infiltrate into the ground.

Some of the largest floods that have occurred in South Dakota were the result of melting snow and ice. These large floods have occurred along the entire length of the Missouri River. The Great Flood of 1881 is probably the most well known of all the floods to take place in South Dakota. Ice jams on the river caused the flooding to become extremely devastating, destroying large amounts of property and causing many lives to be lost. Towns such as Yankton, Vermillion, Burbank, Meckling, and Pierre were all severely damaged by the flooding.

The fourth type of flood results from the failure of dams or levees. The four largest dams in South Dakota—Oahe at Pierre, Big Bend at Fort Thompson, Fort Randall at Pickstown, and Gavins Point at Yankton—are all located on the Missouri River. Large dams in the Black Hills are the Deerfield, Pactola, Sheridan, and Angostura dams. If any of these large dams were to fail, flood damage could be very great. Fortunately, all of these dams are considered to be properly constructed and have been designed to hold back very large amounts of water; therefore, they are considered to be very safe, and the likelihood of failure is extremely small. Except for these Missouri and Black Hills dams, the majority of the dams in South Dakota are very small, and if they were to fail, flooding would likely be minimal. Levees protect many areas in South Dakota; however, many of these levees protect small areas from flooding (see Figure 3-7).

Dam Failure

South Dakota has approximately 2,500 dams in the National Inventory of Dams (see Figure 3-6 in Location section below). The state defines a dam as follows: "a structure is a dam if the height to the dam crest is greater than or equal to 25 feet and the storage at the dam crest (not at the spillway elevation) is greater than 15 acre feet or if the height to the dam crest is greater than 6 feet and the storage at the dam crest (not at the spillway elevation) is greater than or equal to 50 acre feet. The height of the dam is the difference in elevation between the natural bed of the watercourse or the lowest point on the toe of the dam, whichever is lower, and the crest elevation of the dam."

Of the roughly 2,500 dams, approximately 84 are high hazard dams. Sixty six of these high hazard dams, of which 31 are state regulated, have emergency action plans. This is an improvement since 2007, when 21 dams had no emergency action plan. All high hazard dams are required to have emergency action plans. According to the South Dakota Department of Environment and Natural Resources, the majority of the 18 high hazard dams that do not have plans are privately owned, and the owners, who live below the dams, are the only people at risk should they fail. Of the total dams, approximately 155 are significant hazard dams. Because of South Dakota's low population and low density, most of the state's dams are low hazard dams. In *Federal Guidelines for Dam Safety: Hazard Potential Classification Systems for Dams* (FEMA 2004), dams are classified as follows:

- **Low Hazard Potential**—Dams assigned the low hazard potential classification are those where failure or misoperation result in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
- **Significant Hazard Potential**—Dams assigned the significant hazard potential classification are those dams where failure or misoperation result in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- **High Hazard Potential**—Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life as well as economic, environmental, and lifeline losses.

Levee Failure

In addition to these dams, South Dakota also has levees that can pose a flood risk as well. Levees are earth embankments constructed along rivers and coastlines to protect adjacent lands from flooding. Floodwalls are concrete structures, often components of levee systems, designed for urban areas where there is insufficient room for earthen levees. When levees and floodwalls and their appurtenant structures are stressed beyond their capabilities to withstand floods, levee failure can result in loss of life and injuries as well as damages to property, the environment, and the economy. In South Dakota, there are numerous levees ranging from small agricultural levees that protect farmland from high-frequency flooding to large urban areas that protect people and property from larger-less frequent flooding events such as the 100-year and 500-year flood levels. For purposes of this discussion, levee failure will refer to both overtopping and breach of a levee as defined in FEMA's Publication ―So You Live Behind a Levee (http://content.asce.org/ASCELeveeGuide.html).

- **Overtopping** occurs when floodwaters exceed the height of a levee and flow over its crown. As the water passes over the top, it may erode the levee, worsening the flooding and potentially causing an opening, or breach, in the levee.
- **Breaching** - A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach may occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. The resulting torrent can quickly swamp a large area behind the failed levee with little or no warning.

Location

According to the National Oceanic and Atmospheric Administration, flash floods are the deadliest natural disaster in South Dakota. They are caused by stationary or slow-moving thunderstorms that produce heavy rain over a small area. The Black Hills are especially vulnerable to flash floods, where steep terrain and narrow canyons can funnel heavy rain into small creeks and dry ravines, turning them into raging walls of water. Even on the prairie, normally dry draws and low spots can fill with rushing water during very heavy rain.

Critical to the mission of disaster identification and risk assessment is the ability to statistically log and compare various types of flood and demographic data. Through the use of modern GIS technologies, multiple analyses of structures, historical sites, city boundaries, airports, and schools can be performed and then compared to the floodplains in which they are located. Based on numbers of people and property at risk, i.e., the vulnerability of people and property at risk, the South Dakota Office of Emergency Management has determined that the cities of Aberdeen, Pierre, Rapid City, Sioux Falls, and Watertown are at the greatest risk from flood events.

South Dakota is divided into 14 river drainage basins (See Figure 3-5). These basins extend beyond the political boundary of the state. Although not discussed or included in this plan, an interstate understanding of water policy is required to fully analyze and comprehend South Dakota water systems.

Figure 3-5: Drainage Basins of South Dakota

Source: USDA Natural Conservation Resources Service South Dakota (www.sdconservation.org/files/SDWatershedsQ.pdf)

Missouri River Basin

The following description of the Missouri River Basin is from Microsoft Encarta Online Encyclopedia:

> Considered as a separate river, the Missouri is the longest in the United States. In combination with the Mississippi River into which it flows at St. Louis, it is the longest river system in the United States. The river begins where the Gallatin River, Jefferson River, and Madison River come together in the foothills of the Rockies in Montana. It flows through Montana, North Dakota, and South Dakota before forming the boundary between Iowa and Nebraska. It forms the extreme northeast border of Kansas before turning almost due east through the state of Missouri.

South Dakota is drained almost entirely by the Missouri River and its tributaries. The only sections that are not lie in the extreme northeast and northwest. The Missouri flows southward and then southeastward across the state, in a deep, wide channel. It forms part of the South Dakota–Nebraska state line. Much of the South Dakota section of the river is now made up of a chain of four reservoirs impounded by large dams. These dams include Fort Randall, Gavins Point, Big Bend, and Oahe dams which were built for flood control and to provide water for irrigation and the generation of hydroelectricity. Lake Oahe is formed by Oahe Dam at Pierre. The James River, the Vermillion River, and the Big Sioux River, all in the eastern half of the state, flow southward in roughly parallel courses to join the Missouri. In the western part of the state the Grand, Moreau, Cheyenne, Bad, and White rivers flow generally eastward to join the Missouri.

South Dakota cities on the river include Pierre, Mobridge, Oacoma, Chamberlain, Pickstown, Fort Thompson, and Lower Brule. The interstate effects of water policy are evident in the capital city of Pierre, where national policy objectives produce an ever-rising Missouri River to offset flooding in down river states.

The largest natural lake in South Dakota is Lake Thompson in the east-central part of the state. Other natural lakes of significant size in South Dakota are lakes Traverse and Big Stone, both in the northeastern corner of the state. In addition, there are the Waubay Lakes Chain and adjoining closed basins (discussed further in this section) located in the northeastern part of the state, which have continuous ongoing flooding issues. Numerous small lakes and sloughs dot the landscape of northeastern South Dakota, as well. The largest lakes are the reservoirs behind dams on the Missouri River, all of which were constructed as part of the Missouri River Basin Project.

Big Sioux River Basin

The Big Sioux River Basin is the eastern most major river pattern in South Dakota. It is formed within a topographic feature known as the Coteau de Prairie Highlands. This glacial formed feature rises about 800 feet above the bordering Red River lowlands of Minnesota. It is also bordered on the west by the James River lowland. The Coteau has what is known as a flatiron shape lying in a general northwest to southeast direction. It is about 200 miles long and 80 miles wide at the widest point. It has a variation in elevation from 2,050 feet at the highest point to 1,090 feet at the lowest point.

The northern part of the Coteau has geologically developed features of potholes, sloughs, and lakes. During periods of low precipitation, these features tend to hold backwater and do not contribute to the drainage of the Big Sioux River. Conversely, during wet years, this area can accumulate enough moisture to greatly increase the water supply to the drainage basin. There are about 1,970 square miles of land within the basin that is designated as noncontributing to the drainage system. The portion of the basin that does contribute to the Big Sioux River is about 7,280 square miles. A total of 4,280 square miles of the figure is located in South Dakota

The headwaters for the Big Sioux River are found in the Coteau Lake Region of Roberts and Day counties. The river flows in a southerly direction to its junction with the Missouri River near Sioux City, Iowa. The variation in elevation from the headwaters to the mouth greatly influences the movement of water through the basin. The elevation decreases from 1,826 feet near Waubay to 1,281 at Sioux Falls.

The Granite Falls formation of Sioux Falls has a 100-foot drop in elevation. Below the falls, the elevation varies from 1,281 feet to 1,098 feet at the river's mouth near Sioux City, Iowa.

Associated with the elevation is the slope profile of the river. The slope varies from 1.83 feet per mile near Watertown, 1.50 feet per mile at Sioux Falls, and 0.5 feet per mile at the junction with the Missouri River. The Big Sioux River has a steeper gradient than the James or Vermillion rivers. This steep slope causes water to move quickly down the drainage system and thus shortens the time of peak flooding in any given portion of the basin.

James River Basin

The James River Basin is the largest of the East River Basin Systems. It is bordered on the east by highlands of the Coteau de Prairie and on the west by the high ground of the Coteau de Missouri. The valley is a nearly flat stretch of land about 216 miles long and averaging 60 miles wide. It is only in the southern portion that the topography becomes steeper. There is little variance in the elevation of the basin. At Columbia, where the river basin forms in South Dakota, the elevation is 1,290 feet. At the southern terminus of the basin near Yankton, the elevation is 1,162 feet.

The James River drainage area encompasses all or part of 23 counties. It drains 12,609 square miles or over eight million acres of land in South Dakota. This represents 16.3 percent of the total land in the state. The river valley is about 400 miles long, 25 to 75 feet deep, and varies in width from a few hundred feet to three miles. The slope of the valley is .493 feet per mile and the average slope of the river is .280 feet per mile.

There are seventeen contributing streams within the James River Valley. These streams drain 10,606 square miles. The majority of the basin lacks good drainage features. This is due to the slight variance in elevation and limited slope of the river. Much of its drainage is noncontributing and remains in small swales and basins.

Vermillion River Basin

The Vermillion River Basin is the smallest of the East River systems. It has its headwaters in the lake country of Kingsbury County. The river flows through McCook, Turner, and Clay counties to join with the Missouri River near Burbank, South Dakota. The west branch originates in Miner County and connects with the main stem near Parker in Turner County.

The Vermillion River Basin is formed in the Dakota Valley or what is more commonly called the James River Lowland. This area is more than 200 miles long and about 60 miles wide and occupies a portion of the lower half of the basin. The gradient of this river system is approximately 400 feet throughout the length of the river. The east branch elevation is 1,518 feet and the elevation near Vermillion is 1,119 feet. The slope profile is approximately four feet per mile.

The drainage system is supplied with water from both the east and west portion of the basin. The major tributaries are the Little Vermillion River, Turkey Ridge Creek, and Saddle Creek. There are also a number of very small tributaries contributing to its drainage pattern.

Black Hills Region

The western most drainage system is found in the Black Hills region. The Black Hills lie within the states of Wyoming and South Dakota with the majority in western South Dakota. The region is 125 miles long and 60 miles wide. The general shape of the Black Hills is elliptical. This formation presents a startling contrast to the surrounding topography. Its eastern side rises from the prairie to a height from 2,600 to 3,500 feet. The western part of the Black Hills varies in elevation from 3,500 to 7,200 feet at Harney Peak.

The major drainage creeks of Alkali, Battle, Bear Butte, Beaver, Box Elder, Elk, French, Rapid, Spearfish, Spring, and Whitewood are all capable of causing heavy flooding and flood-related damage. These eleven creeks drain about 7,500 square miles of land.

Waubay Lakes Chain and Adjoining Closed Basins

The Waubay Lakes Chain is part of a 409 square mile closed basin area in the Big Sioux River Basin in northeastern South Dakota (mostly in Day County). The 10 major lakes in this chain are glacial in origin and include Bitter Lake, Blue Dog Lake, Enemy Swim Lake, Hillebrands Lake, Minnewasta Lake, Pickerel Lake, Rush Lake, Spring Lake, Swan Pond, and Waubay Lake. In closed basins, under most circumstances, water does not have a direct drainage path to a river outside the closed basin and the water would have to evaporate into the atmosphere for lake levels to recede. The northeastern area of South Dakota is much like a giant bathtub. Water fills the basin until it overflows the sides. Because the area is atop a flat area of high ground, the sides of the tub are higher than the normal drainage routes (e.g., the Big Sioux and the James Rivers), leaving the accumulated runoff without a natural outlet.

Rising waters have inundated portions of Day County and the surrounding areas in the past. Significant increases in lake levels within the Waubay Lakes Chain have occurred mainly due to greater-than-normal precipitation along with less-than-normal evaporation. Several presidential declarations allowed for funding to be used to address the immediate problems of inundated roads and structures for emergency access purposes. As of 1999, the federal government had spent over $71 million in northeastern South Dakota for response and recovery efforts and emergency measures. However, because a major storm event or flash flood did not cause the damage (it was caused by an accumulation of annual runoff and a lack of evaporation), established FEMA disaster programs could not adequately address the situation.

Rising water levels in the Waubay Lakes Chain have resulted in substantial damage to public and private properties in the basin. Numerous public roads and highways have been damaged or closed because of high water, and some have been raised at great cost. Many parks and recreational facilities have been adversely affected as well. The available data show that the greatest impacts from flooding have been to agriculture and transportation.

In September 1998, FEMA issued a mission assignment to the U.S. Geological Survey to provide oversight, coordination, and hydrologic expertise for a study of the Waubay Lakes Chain and the adjoining closed basins. This study, including pertinent maps, is on file with the SDOEM and FEMA Region VIII. The U.S. Army Corps of Engineers also provided technical expertise and analysis for the study as well as possible structural mitigation solutions. The Natural Resource Conservation Service provided soils data.

This study found that from 1991 until the report was published in 1999, the Waubay Lakes Chain experienced a wet climatic period that can be expected to occur less than once every 100 years, on average. Due to periods of above normal precipitation and below normal evaporation, significant increases in lake levels and inundation areas within closed basins in northeastern South Dakota have been observed.

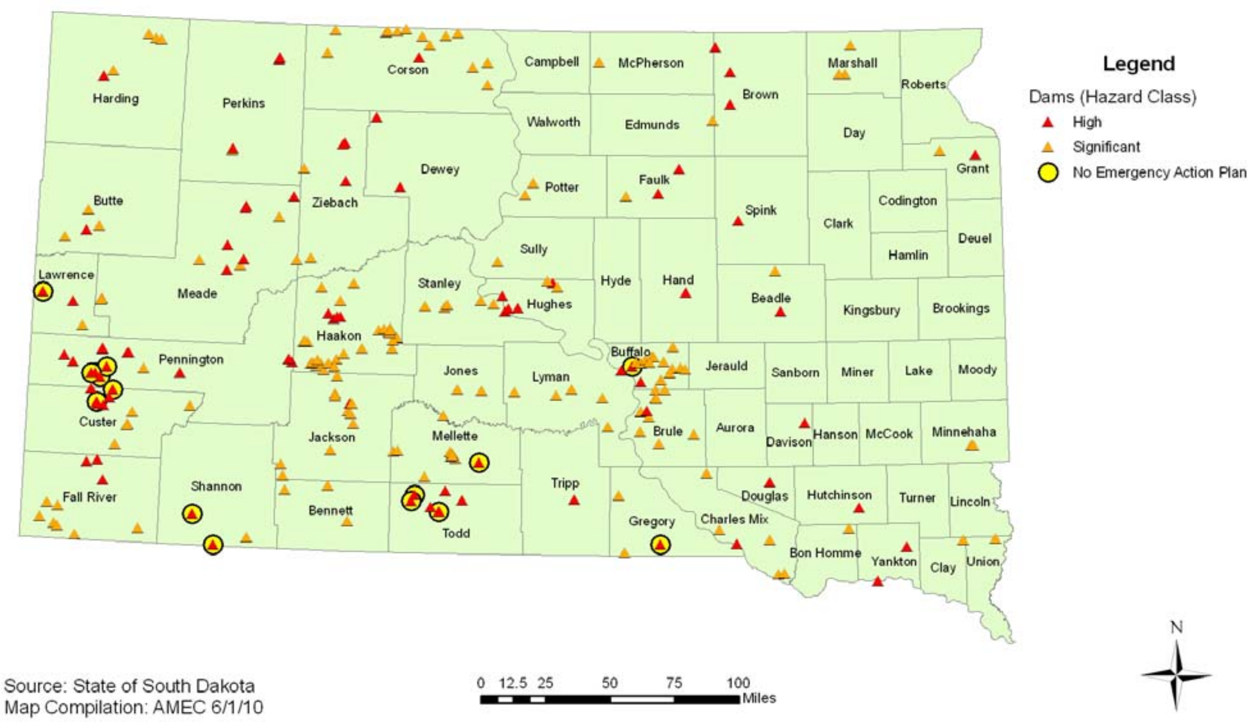
In the Waubay Lakes Chain, the lake levels for Bitter, Hillebrands, Minnewasta, Rush, Spring, and Waubay lakes and Swan Pond have significantly increased. The total surface area of the 10 major lakes increased by 74 percent between 1991 and 1998. The water levels for Bitter, Hillebrands, Spring, and Waubay lakes and Swan Pond increased between 15 and 18 feet from 1991 to 1998. Blue Dog, Enemy Swim, and Pickerel lakes have concrete weir outlet structures and experienced lake level increases of 2.7, 1.8, and 0.1 feet respectively between fall 1991 and fall 1998. Minnewasta and Rush lakes experienced lake level increases of 9.2 feet and 3.9 feet respectively.

At the time the study was published, the U.S. Army Corps of Engineers' hydrologic model simulation suggested that flooding problems would persist in the region for the next few years, regardless of whether the climate was wet or dry. As of 2007 problems continue. It would take at least a decade of drought similar to that experienced in the 1930s to return the lakes to pre-1992 conditions. If relatively wet climate conditions persist, the lakes would continue to climb until Bitter, Blue Dog, Rush, and Waubay lakes form a single lake that will inundate over 60,000 acres and the natural drainage divide south of Bitter Lake could overflow and spill to the Big Sioux River. This scenario, however, would require nearly 15 years of wet conditions.

South Dakota Dams

As mentioned previously, the four largest dams in South Dakota are Oahe at Pierre, Big Bend at Fort Thompson, Fort Randall at Pickstown, and Gavins Point at Yankton. These are all U.S. Army Corps of Engineers Dams on the Missouri River. Large dams in the Black Hills are the U.S. Department of the Interior Bureau of Reclamation's Deerfield, Pactola, and Angostura dams and the U.S. Forest Service's Sheridan Lake dam. Figure 3-6 shows the locations of the high and significant hazard dams in South Dakota.

Figure 3-6: South Dakota High and Significant Hazard Dams



More location information is in the following section on past events and Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction.

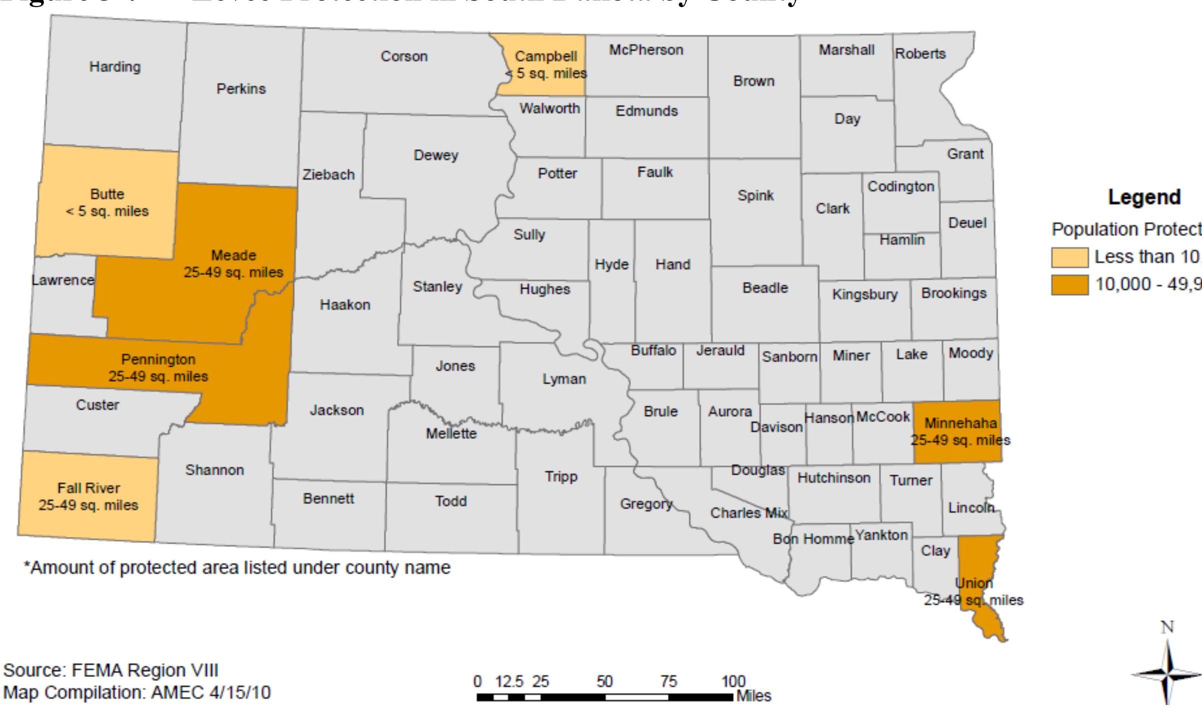
South Dakota Levees

As mentioned previously, South Dakota contains numerous levees ranging from small agricultural levees that protect farmland from high-frequency flooding to large urban areas that protect people and property from larger-less frequent flooding events such as the 100-year and 500-year flood levels. Table 3-7 shows the location of the US Army Corp of Engineers Levees, as well as detail about each levee. These are also graphically depicted on Figure 3-7. The following table is not a comprehensive inventory of levees in the State. The SHMT noted that there are several levees along the James River in Spink and Brown counties that are not certified and frequently overtopped. Although these are not represented in the FEMA database of levees, the James River Water Development District (JRWDD) commissioned a LiDAR survey of the floodplain and now owns GIS data of all of the levee locations along the James River. This information is being used by the JRWDD to identify specific mitigation actions within the watershed. JRWDD and Brown County are exploring opportunities to commission LiDAR for the entire county.

Table 3-7 US Army Corp of Engineers Owned Levees by County in South Dakota

County	City	River	Construction Date	Population Protected	Protection Description	Level of Protection
Butte	Belle Fourche	Belle Fourche	1-Jan-39	Less than 10,000	Less than 5 square miles	100-500 year
Campbell	Herreid	Herreid	19-Oct-53	Less than 10,000	Less than 5 square miles	50 - 99 year flood
Fall River	Hot Springs	Fall River	25-Jul-49	Less than 10,000	25 - 49 square miles	50 - 99 year flood
Meade	Meade	Dead Man's Gulch	16-Apr-80	10,000 - 49,999	25 - 49 square miles	50 - 99 year flood
Minnehaha	Sioux Falls	Big Sioux	1-Jan-61	10,000 - 49,999	25 - 49 square miles	50 - 99 year flood
Pennington	Rapid City	Rapid Creek	26-Nov-78	10,000 - 49,999	25 - 49 square miles	100-500 year flood
Union	North Sioux City	Missouri	26-Nov-78	10,000 - 49,999	25 - 49 square miles	50 - 99 year flood

Figure 3-7 Levee Protection in South Dakota by County



According to the National Climatic Data Center Storm Events database, there were 735 floods in South Dakota between 1993 and April 2010. Total property and crop damage for these events is estimated at $275 million in 2009 dollars. This suggests that South Dakota experiences 43.2 floods and $16.2 million in flood losses (property and crop) each year. There were two deaths and three injuries in this time period. Table 3-8 describes some of the floods that have occurred in South Dakota. See Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction for more information about how floods affect individual counties.

South Dakota is remarkable in that as early as the late 1800s, flood mitigation efforts were pursued and implemented. The first effort was after the 1881 flood of the Vermillion and Missouri rivers that wiped out the town of Vermillion. The town was relocated on the bluffs behind the former town to prevent another recurrence. This was the first recorded hazard mitigation effort by a government entity in South Dakota and possibly the nation.

The second effort followed the 1972 Black Hills/Rapid City flood. This flood stands out in South Dakota history as the deadliest and most expensive in terms of damage. Following the flood, Rapid City refused to allow rebuilding in the floodway, effectively launching federal government efforts to create a hazard mitigation program.

While there have been failures of low hazard dams in recent years, no deaths or injuries were reported, and property damage was minimal. The only significant failures of high hazard dams are the breach of Canyon Lake Dam in 1972 (Rapid City flood) and the failure of Menno Dam in 1984 (see event descriptions below).

Table 3-8: South Dakota Flood Events

Date	Comments
July 21-30, 2010	**Flooding (FEMA-2328-DR)** A powerful storm dumped heavy rain causing flash flooding in South Dakota. As much as nine inches of rain fell in the southeastern part of the state, flooding homes and neighborhoods. The heavy rain also forced Sioux Falls officials to discharge untreated wastewater into the Big Sioux River. The storms in late-July hit counties where soils already were saturated and roads, bridges and culverts had been damaged from the earlier flooding and storms. Rain gauge readings ranged from 3.69 inches to 4.15 inches. The National Weather Service says the previous July 21 record at Mitchell was 2.32 inches in 1907. Total damage to public infrastructure in those counties is estimated to be more than $4 million from heavy rains and severe storms during the period between July 21 and July 30, 2010.
March 10, 2010	**Flooding (FEMA-1915-DR)** Floodwaters closed roads, filled basements, and soaked agricultural fields in southeastern South Dakota in late March 2010. A combination of snowmelt, ice jams, and heavy rains drove the Vermillion, Big Sioux, and James Rivers over their banks. Some residents described the flooding as the worst in living memory, according to the Associated Press. This event also resulted in a presidential disaster declaration.
April, 2009 through June	March flooding of the James River continued throughout April. The James River went above flood stage at Redfield on April 18th and continued through the end of

Date	Comments
2009	the month. The James River at Redfield rose to 25.7 feet on April 30th, almost 6 feet above the flood stage of 20 feet. The James River from Columbia to Ashton was from 6 to as much as 10 feet above flood stage throughout the month. The James River continued to cause major issues throughout Brown and Spink counties for roads, fields, cropland, along with some homes. State Highway 34 was closed for about two weeks at the state border near Hecla. The flooding washed away the highway base. The James River west of Hecla became a 3 mile wide lake. Some people near Hecla said this was the highest the James River had been near Hecla in several decades. The high water forced the evacuation of people from two homes near Hecla. Many roads along the James River throughout Brown and Spink counties were closed. Also, several bridges along the river were overtopped. Many outbuildings along the river were flooded and damaged with over 100 livestock deaths attributed to the flooding. At the Sand Lake National Wildlife Refuge, both the Sand and Mud Lakes hit record levels on the morning of April 17th. Sand Lake's elevation was 1,292.58 feet, breaking the previous record of 1,292.39 feet in 1997. Mud Lake's elevation was 1,293.36 feet, breaking the previous record of 1,293.29 feet. The elevation of the river remained above flood levels through June though waters began receding in early June. This event also resulted in a presidential disaster declaration.
March 20, 2009	Rapid snowmelt and ice jamming caused the Elm River near Westport to rise above flood stage on March 20th. The Elm River reached an all time record level of 22.69 feet on March 25th almost 9 feet above flood stage. The previous record was 22.11 feet set on Apri1 10th, 1969. The flood stage for the Elm River at Westport is 14 feet. The city of Westport was evacuated with the flood waters causing damage to many homes and roads in and around Westport. Also, many other roads and agricultural and pastureland along the river were flooded. The Elm River slowly receded and fell below flood stage on March 30th. The flood waters from the Elm River flowed south and into the northern portion of Moccasin Creek. Subsequently, the Moccasin Creek rose as the water flowed south into the city of Aberdeen. Flooding became a concern for Aberdeen and for areas along the creek north of Aberdeen. The Governor signed an emergency declaration which allowed the state to help with flood response efforts, including sending 50,000 sandbags to the area. Also, the National Guard was activated to move a variety of heavy equipment. Some sandbagging and a falling Elm River kept the Moccasin Creek from causing any significant flooding in and north of Aberdeen. Although, some township and county roads were flooded from the creek.
June 1 – June 6, 2008	A series of intense storms impacted more than twenty counties across the state over a period of five days, incurring several million dollars worth of damage and causing flash flooding, hail and wind damages to livestock, wildlife, property and cropland, and resulting in a presidential disaster declaration. Periodic flash flooding continued for another four days, incurring several hundred thousand dollars more of damage.
August 17, 2007	An intense summer thunderstorm dropped rainfall in the foothills of the Black Hills ranging from four to seven inches that caused flash flooding in and around Hermosa. The flash flooding resulted in widespread catastrophic damage to homes and businesses. Some houses were moved off their foundations and destroyed; other homes and businesses received significant flood damage. Critical utilities were also nonfunctional.
May–June	**Severe Storms, Tornadoes, and Flooding (FEMA-1702-DR)**

Date	Comments
2007	Flooding brought on by record-setting rainfall on May 4 and 5 caused widespread damage to homes, businesses, farmland, infrastructure, and utilities across eastern South Dakota. Houses were destroyed; with basement walls collapsing, and critical utilities were nonfunctional. Thousands of acres of farmland were flooded that could not be planted, resulting in financial impacts to the individual operations as well as businesses dependant on the farming community. State and local governments also sustained damage to infrastructure. www.state.sd.us/news/showDoc.aspx?i=8468 www.state.sd.us/news/showDoc.aspx?i=8437
May–June 2004	**Severe Storms and Flooding (FEMA-1531-DR)** Thunderstorms developed from northern Turner County to western Yankton County on May 29. These storms produced large hail and strong winds across the area and saw very little movement over an eight-hour period. As a result, three to six inches of rain fell in portions of Yankton, Turner, and Minnehaha counties, including Sioux Falls and the towns of Parker, Hartford, Crooks, and Marion. Urban flooding resulted with rapid runoff from streets across Sioux Falls. Willow Creek in Crooks and Skunk Creek in Hartford rose several feet in only a couple of hours. In western Sioux Falls, Skunk Creek reached its highest level in 20 years. River flooding continued the following two days. On June 16, strong thunderstorms developed in western Sioux Falls and moved east. As the storms moved east, new storms developed just west of Sioux Falls, resulting in repeated episodes of heavy rain in the Sioux Falls metropolitan area. Rainfall amounts were similar to May 29, but the rate of rainfall was much higher. Over two inches of rain fell in one hour at the Sioux Falls airport, and multiple locations around the city received more than three inches of rain in two hours. The highest amount of rainfall reported in Sioux Falls was 7.79 inches. There were numerous reports of three to six inches across the city. The large amount of rainfall in a short period of time produced excessive runoff across the city and Skunk Creek and the Big Sioux River rose rapidly as a result. At the time, the 31 days up to and including June 16 marked the wettest 31 day period on record for Sioux Falls (12.74 inches at Joe Foss Field). Source: NWS Sioux Falls
April 2001	**Severe Storms (Flooding) (FEMA-1375-DR)** This presidentially declared disaster was precipitated by an onset of flooding that began during a spring thaw in early March 2001. On April 6, a series of rainstorms that dropped from two to six inches of rain resulted in flooding of the James, Vermillion, and Big Sioux rivers. According to the National Weather Service, the James River, at Huron, reached its highest crest of 18.1 feet (flood stage of 11 feet) on April 10, the second highest crest on record. On April 11, a second similar weather system produced more heavy rains in the Aberdeen, Huron, Watertown, and Brookings areas. Flooding of the James River occurred in and around Huron and Mitchell. The west fork of the Vermillion River caused flooding around Parker and Centerville. The Big Sioux River flooded in and around Watertown, Dells Falls, and Sioux Falls. At Mitchell, the James River reached its highest crest of 21 feet (flood stage of 14 feet) on April 11, the second

Date	Comments
	highest crest on record according to the National Weather Service. Peak crests on the Vermillion and West Vermillion rivers were two to four feet above flood stage. The Big Sioux River in Sioux Falls crested at 22 feet (flood stage of 16 feet) on April 24. A third major system passed through South Dakota on April 21-22. The Black Hills, in the western part of the State, received up to 22 inches of heavy wet snow and the eastern portion of the state received 4-8 inches. Beadle, Brookings, Brown, Buffalo, Clark, Codington, Day, Deuel, Edmunds, Grant, Gregory, Hamlin, Hanson, Jerauld, Kingsbury, Marshall, Mellette, Moody, Roberts, Sanborn, Spink, Todd, Turner, and Tripp counties were included in the disaster declaration. The major impact was to public infrastructure. Due to ice and wind damage to utility poles and lines, electrical services to some areas were interrupted. Numerous bridges and roads were impacted as well. There was damage to county and township roads in the eastern and northeastern portion of the state that had previously not been affected by floodwater. Some of the damaged roads included school bus, mail, and farm-to-market routes. Travel on these roadways involved significant risk. Several roads were temporarily impassable, requiring residents to travel greater distances because of detours. Many farmers were unable to access their fields to begin spring planting. In Mellette County, ice jam fluctuations substantially damaged a bridge, which caused the county to close the bridge to through traffic, resulting in a 40-mile detour for residents needing to cross the White River. This disaster also heavily impacted South Dakota's agricultural and livestock community.
February–May 1997	**Severe Storms/Flooding (FEMA-1173-DR)** This disaster had its roots in past flooding events. Beginning in 1992, the state had a series of weather-related events of sufficient magnitude and impact to warrant eight presidential disaster declarations prior to this event; five for flooding, four for ice/snow; and one for just snow. These events kept the water table saturated, which prevented much of the winter snow melt and the spring/summer rains from soaking into the ground, thus contributing to flooding. The first significant winter storm of 1996 hit the eastern part of the state in mid-November, dumping up to 10 inches of snow across the northeast and producing a major ice storm with widespread damage across the southeast (see Winter Storms). In 1997, major winter storms were fairly frequent throughout January with several blizzards, mostly in the northeast part of the state (see Winter Storms). From mid-November to mid-February, the general weather across the eastern part of the state was cold and wet with below normal temperatures (in excess of 30°F below zero) and record-setting above normal snowfall. The persistent cold greatly limited snowmelt between storms, allowing up to 48 inches of snow to accumulate across much of the northeastern part of the state. Mid-February snow depths elsewhere across eastern South Dakota ranged from 10 to 24 inches. The National Weather Service snow water equivalent measurements of February 12 ranged from approximately two inches near the Missouri River to over six inches in Marshall County. Snow water equivalent values from 4 to 5 ½ inches were common over the central and northern portions of the James and Big

Date	Comments
	Sioux river basins. Seasonably cool and relatively dry weather prevailed across the eastern part of the state from mid-February to early April. An early April blizzard added to the remaining snow pack, which gradually melted south to north by the end of April. Heavy rain and snowstorms in April, compounded by severe winter blizzards and existing saturated soil conditions, resulted in persistent flooding throughout the state. Many people were evacuated from their homes and farms, while others had limited or no access or escape. Heavy snowmelt and pounding rains turned prairie potholes into lakes, pushed people from their homes, and prevented farmers from planting thousands of acres of land. The James River Water Development District estimated that five years of flooding destroyed or severely damaged approximately 75 percent of the forested areas in the James River Valley. Riverine flooding destroyed or damaged many homes and businesses, impacted water and sewage treatment plants, and damaged or destroyed many roads and bridges. All counties were included in the presidential disaster declaration. This flood caused approximately $82.5 million in damage (2006 dollars) and two deaths.
March–May 1995	**Severe Storms, Flooding (FEMA-1052-DR)** The entire state had above normal precipitation between January and May, ranging from about one to two inches above normal in the southwest to five to nine inches above normal in the east. This is up to 200 percent of normal. Many official reporting stations, including Huron, Mitchell, and Sioux Falls, experienced their all-time wettest springs on record. Most damage to public facilities was caused by ground saturation and flooding due to very high residual groundwater tables from 1994, heavy winter snow and spring rain, and rapid snowmelt. Many roads were under water or unusable due to high groundwater saturation of the subgrade, causing interruption of emergency services. Damage to power transmission and distribution facilities owned by rural electric cooperatives was also reported. Preliminary damage surveys identified over 3,000 homes with some type of damage. The vast majority of damage was from one to three inches of groundwater seepage into basements. In many areas, the water table rose to near land surface levels, saturating septic drain fields and preventing proper treatment of residential sewage. Preliminary damage surveys estimated $9.3 million in damage to infrastructure of public facilities. Roads and Bridges and Utilities incurred the most damage with almost $5.7 million and $2.6 million in estimated damages, respectively. Federal aid system roads received $7.1 million in damage.
March–July 1994	**Severe Storm/Flooding (FEMA-1031-DR)** Flooding in northeastern South Dakota began in mid-February 1994, as a result of very high residual groundwater tables from 1993's extremely high levels of precipitation (snow and rain) and rapid melting of the snowpack. Flooding continued into late March 1994 and then subsided. Rain continued throughout the spring and summer months, but the remainder of the snowmelt was gradual and did not significantly contribute to flooding. On July 6, a significant storm system passed through central and northeastern South Dakota. Severe winds caused damage in the Pierre area, and the town of Milbank in Grant County received approximately six inches of rain in a two to three hours. The thunderstorm in Milbank caused the town's storm and sanitary sewer systems to overload and water backed into basements of several homes. Damage was estimated at approximately $4 million. The vast majority of damage was to county and township roads (which

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	had significantly deteriorated because of saturation from near ground-level water tables), culverts, and bridges. Many roads remain under water, as once-small (or dry) glacial lakes with no drainage outlets, grow in size and encroach upon nearby roadways. In 1995, total damages were estimated to be $36.5 million.
March–September 1993	**Flooding, Severe Storms, Tornadoes (FEMA-999-DR)** Early and rapid snowmelt resulted in localized flooding along portions of the three eastern river basins. Major problems began in May when severe weather spawned tornadoes and floods in five eastern counties, injuring 12 and killing 1. Heavy rains continued throughout May, June, and July, which included a 6.5 inch deluge in Sioux Falls on May 23 that backed up sewage into 190 basements and damaged city streets. By the end of June, the Big Sioux River was over a mile wide in places, flooding many communities along its banks. During early July, the swollen Vermillion and James rivers inundated thousands of acres of farmland and surrounding communities. Heavy July rains developed flash flood torrents on small drainages in Madison and Yankton, while rising lake levels flooded numerous communities on lake shores. Overall, the disaster heavily impacted 39 counties in South Dakota, over half the state, and contributed to four deaths, approximately $2 million damage to business, $12 million damage to public facilities, $10 million to private residences, and $204 million to agriculture. Federal aid system roads received $3 million.
June 1992	**Flooding, Severe Storm, Tornadoes (FEMA-948-DR)** On June 13 and 14, a major spring storm resulted in severe weather in Harding County. Golf ball size hail and 10 ½ inches of rain occurred in a three-hour time span. Crops were destroyed and over 500 sheep were killed. On the afternoon and evening of the June 16, several violent thunderstorms (super cells) produced large amounts of rain and several large, damaging tornadoes. Heavy rain was experienced in the Davison, Miner, Kingsbury, Lyman, Buffalo, Moody, Brookings, Deuel, Minnehaha, and Hamlin counties. The heavy rains occurred in an area already saturated by previous rains. Over a two to three day period, 15 to 20 inches of rain fell in the Clear Lake/Watertown area resulting in widespread flooding of the Big Sioux River. The rains subsided late in the week. Some flooding was experienced by South Dakotans as far south as Sioux Falls.
May 1986	**Severe Storms, Flooding (FEMA-764-DR)** The above average fall rains and heavy winter storms during 1985-86 created a condition of supersaturated ground and record water levels in the lakes and Big Sioux River Basin in the northeast part of the state. The snowmelt run-off into the numerous lakes forced the already full lakes to overflow and seriously impact residences, cottages, resort business, and agribusiness. A severe winter storm covered the entire state the week of April 14, adding one to three inches of precipitation to the area. Flood damage was estimated at approximately $25.9 million, $20.6 million of which was to agriculture.
Spring 1984	**Severe Storms, Flooding (FEMA-717-DR)** The winter of 1983-84 was the third snowiest on record (75 inches of snow at Sioux Falls). The heaviest snows occurred in November 1983 and in March 1984. Severe snowmelt flooding began March 20 and after the fourth wettest April on record, caused near record flooding on the Big Sioux, Vermillion, and lower James rivers in April. These rivers did not go below flood stage until the end of April.

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	Numerous reports of water damage were recorded in the communities of Mt. Vernon, Parkston, Tabor, and Volin. June was the wettest June on record in southeast South Dakota and was the sixth wettest month on record at Sioux Falls. Between June 4 and June 22, many large storms crossed the region and dumped approximately 30 inches of rain, which caused repeated flash floods. Numerous roads and bridges were heavily damaged. Many areas had severe urban flooding, because sewers and storm drains were unable to handle the load. As a result, many basement walls collapsed. The Lake Menno Dam (Hutchinson County) collapsed on June 12, killing 450 hogs, destroying one car and damaging two, moving a farmhouse 75 feet off its foundation, scattering and destroying farm machinery, and completely sweeping away grain bins. On June 16, three feet of water was flowing through downtown Davis (Turner County). Vermillion Lake Dam (McCook County) and many smaller dams sustained severe erosion. The Fulton Lake Dam (Hanson County) was severely weakened and in imminent danger of failing, but held. On June 18, a train was derailed at Parker (Turner County) due to washed out tracks. On June 20, Lake Dimock Dam (Hutchinson County) gave way, destroying the dam and causing flooding in Milltown. A 400-yard sandbag dike saved the Lake Carthage Dam (Miner County) from destruction. Widespread flash flooding caused severe erosion; washed out or weakened many roads, bridges, and culverts; and washed away crops in low lying areas. Many small stock dams collapsed, washing out roads, bridges, and culverts beneath them. In Mt. Vernon (Davison County), there was three to four feet of water in homes. Twenty homes were evacuated along Dry Run Creek in Mitchell (Davison County). Sewage was five to six feet deep in parts of Mitchell. Estimates by the U.S. Geological Survey place the flooding on the Big Sioux River drainage at about a 10 to 30 year recurrence interval, the Vermillion River at about a 100–500 year recurrence interval, and the lower James River at about a 100–300 year recurrence interval. By June 22, over one million acres of cropland in the region were under water. Total damage was estimated at $289 million.
Spring 1983	The winter of 1982–83 was the fourth snowiest on record and led to severe snowmelt flooding on the lower Big Sioux and Vermillion rivers from late February to mid March (March '83 was the fifth wettest on record). Heavy rains through April and into early May prolonged flooding and high stages on these rivers through the middle of May. Very heavy rains again in mid and late June caused flash flooding in the area and again caused severe flooding on the lower Big Sioux River and near record flooding on the lower Vermillion River. The flash flooding in June caused widespread erosion and crop damage and there was severe agricultural land flooding on the mainstems of the lower Big Sioux and Vermillion rivers.
Spring 1979	Big Sioux River—A minor flood in North Sioux City was caused by an ice jam. Lake Kampeska—A minor flood affected property on the lake shore.
June 1976	**Flash Flooding, Mudslides (FEMA-511-DR)** In a 24-hour period on June 13-14, 3 to 10 inches of rain fell in the northern Black

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	Hills. And additional two to three inches of rain plus heavy snow was recorded over this area on the June 15 and 16. The run-off from this precipitation did considerable damage in the counties of Lawrence, Meade, Butte, and Harding. Physical structures, streets, roads, sewers, and water systems sustained about $1.5 million in damage. Deadwood, Spearfish, Belle Fourche, Sturgis, and Galena received most of this damage. Throughout the region, a number of bridges and culverts were washed out and many of the roads suffered water erosion. Debris damage was not as great as in 1972, however, there was considerable movement of rocks and gravel. There was also a problem with mudslides and landslides. One death resulted from this flood.
June 1972	**Heavy Rains, Flooding (FEMA-336-DR)** On June 9-10, 1972, extremely heavy rains over the eastern Black Hills of South Dakota produced record floods on Rapid Creek and other streams in the area. Scattered showers had occurred throughout the Black Hills area on several days prior to the heavy rains that began on June 9. Near Pactola Dam, these earlier showers left the soil saturated, which increased the amount of runoff for the flood of June 9-10. Rainfall began in the Black Hills area on the afternoon of June 9, when a group of almost-stationary thunderstorms formed over the eastern Black Hills. Precipitation totals for June 9-10 ranged from 4 inches to more than 12 inches in the Rapid Creek watershed between Pactola Dam and Rapid City. In the Boxelder Creek watershed, 15 inches of rain during a six-hour period was measured at Nemo. The heaviest rainfall averaged about four times the six-hour amounts that are to be expected once every 100 years in the area. The resulting runoff produced record floods (highest peak flows recorded) along Battle, Spring, Rapid, and Boxelder creeks. Smaller floods also occurred along Elk Creek and Bear Butte Creek. The floods struck quickly and forcefully, but they did not last long nor did they make much impact farther downstream in the basins. Nonetheless, the Black Hills region sustained millions of dollars of damage to roads, streets, and bridges (very few bridges were left standing). Rapid City—Evacuation of residents along Rapid Creek was ordered by 10:15 p.m. Flood and debris-laden water flowed into Canyon Lake and clogged the dam's chute spillway. This caused a 300-foot breach in the dam and sent a wall of water and debris pouring down on residents below the dam. The effect of this dam failure on the subsequent flood wave into urban Rapid City has been difficult to assess because the amount of water coming down Rapid Creek and several tributaries (accounting for 86 percent of the peak flow) far overshadowed the amount of water in the small lake. The peak flow was carried through Rapid City via Rapid Creek at about midnight on June 9, while many people were asleep and unaware of the impending flood. The stage of Rapid Creek (measured above Canyon Lake) rose more than 13 feet in five hours during the flood. The toll of the flood-produced carnage was staggering. At least 238 people died (including 5 listed as missing and presumed dead). Thousands of people barely escaped death and hundreds of people were forced to climb, stand, or cling to objects which saved them from being swept away. Property damage exceeded $79

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	million. 436 houses were destroyed and 930 houses damaged. 710 mobile homes were either damaged or destroyed. 36 businesses were wiped out and 236 more sustained damage. About 5,000 cars were reported lost to the flood. Keystone—Motels, shops, bars, and restaurants, which cater to tourists were either damaged or destroyed. Many campgrounds located along the creeks were washed away. At least 10 campers died. Total damage was set at $1.4 million. Black Hawk and Box Elder—These cities incurred $2 million in damage as the flood destroyed or damaged 75 homes and 180 mobile homes along Box Elder Creek. Sturgis—Sturgis sustained over half a million dollars in damage; 275 houses and 25 businesses were affected.
Spring 1969	**Flooding (FEMA-257-DR)** Big Sioux River—This flood surpassed the flood of 1881 in magnitude with water discharge rates more than twice those of 1962. It resulted from a large buildup of snow. Snow fell in December (1968) in normal amounts, but the accumulations for January and February set a record. The temperatures during March were below the seasonal average, so little run-off occurred. The entire basin was ice free by April 6. The upper part of the basin received an inch of rain on April 7 and compounded the flood. One-eighth of Watertown was under water. Dempster, Estelline, and Castlewood had flood damage as did the lower portion of Dell Rapids. Fifty families were evacuated from Moody County, and fifty people had to be removed from Renner. Sioux Falls was more fortunate as they had developed a flood control system, which was credited with preventing more than $12 million in flood damage. Vermillion River—This flood was greater than the 1962 flood. The town of Centerville was surrounded by water. Within the town, the sewers backed up and the disposal plant was flooded. In the surrounding country, the damage was about the same as in the previous floods. Three bridges were washed out and numerous roads damaged. 450 feet of one highway was completely washed away. The dike system did not contain the water and the lowlands flooded. The U.S. Geological Survey placed the damage to the basin at $1 million. James River—The river was in flood during all of April. The creeks in the lower portion of the basin started flooding early in the month. Their discharge of water started breaking up ice on the main stem of the James. The massive flow of the smaller tributaries caused a backing up of water along the James and increased the problem of flooding. Huron recorded a flood crest of 16.7 feet, almost one foot higher than registered in the previous 30 years. In that area, damage was estimated at $750,000. In the northern part of the state, Moccasin Creek flooded from water coming out of Richmond Lake. This caused some flooding in Aberdeen, as well as extensive flooding in the surrounding countryside. Total damage to the basin was over $16 million. Most of the damage was incurred by farm land, bridges, and roads.
May 18, 1965	**Flooding (FEMA-197-DR)**

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	Black Hills—Flash flooding brought widespread damage to Deadwood, Spearfish, and Sturgis. Heavy snows in excess of 30 inches and 7 inches of rain triggered an avalanche of water shooting down the creeks and gullies. Some houses were swept away in the Spearfish-Sturgis area while others sustained major damage. One resident whose home was near a creek lost everything. He reportedly had a 70 ton concrete retaining wall between the house and the creek—this was completely washed away. Flood damage to the Black Hills area was estimated at over $2 million.
Summer 1962	**Flooding, Tornadoes (FEMA-132-DR)** Black Hills—A summer storm dumped more than three inches of rain on Rapid City. The resulting damage: 120 mobile homes, 2 motels, and over 400 homes had water damage. Bridges, roads, sewer systems, streets, and recreation areas along Rapid Creek were also damaged. Total damage to Rapid City alone was over $800,000. Sturgis, Deadwood, and Whitewood received extensive damage to roads and bridges. Road equipment lost during this flood was estimated at $200,000.
Spring 1962	Big Sioux River—Snow and ice were the cause of the devastation. Ice jams were a serious problem as they held back the run-off. From Brookings to Sioux Falls, ice caused problems. Flandreau and Renner also had flooding because of the ice. Farther north, flooding also occurred. Watertown received flooding from Willow Creek, Lake Kampeska, and the Big Sioux River. The U.S. Army Corps of Engineers estimated damage by the Big Sioux River to be $2.5 million. The interstate bridge near Sioux City collapsed—replacement cost was $600,000. Vermillion River—One of the worst for the southern segment of the basin. This flood resulted from snow melt and ice buildup. The towns of Centerville and Davis reported minor flooding. The majority of the flooding impacted the farm country. Thousands of acres of land were submerged. The highway system received heavy damage. Five bridges in Turner County were washed out and many roads were closed. The damage to the roads and bridges was estimated at $60,000.
April 1960	**Floods (FEMA-99-DR)** Vermillion River—Between 10 and 15 thousand acres were flooded when the dikes were unable to retain the rapid run-off. Many fences were destroyed due to ice and debris pile up. Also, county road systems were damaged due to erosion. The town of Davis received about one foot of water.
March 1960	Big Sioux River—Flooding occurred from the Brookings area south to the junction with the Missouri. Deer Creek and Medary Creek caused flooding in Aurora. Bruce and Sioux Falls also experienced flooding. Damage was heavy and estimated at $2.3 million. Approximately half of this was incurred in the lower basin. About 86,000 acres of land were flooded, and 41,000 of these were between Sioux Falls and Sioux City. James River—The U.S. Geological Survey reported that severe flooding occurred north of Huron with flood water lingering in the area. Tributaries in the Mitchell area also presented flood problems. Pony Creek, which flows through Parkston, rose to flood stage in three hours. People living along its banks had to be evacuated. A number of culverts and bridges in the town were jammed with debris. North of Mitchell, Dry Run Creek flooded, causing at least five families to be

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	evacuated.
June 17, 1957	General Comments: Rated as a 10 to greater than a 100-year event. Five deaths. Attributed solely to rain. Big Sioux River—An estimated seven inches of rain fell in the Flandreau and Sioux Falls area. The Skunk and Marne creeks as well as the Big Sioux River were in flood stage. The towns of Flandreau, Egan, Baltic, Trent, Sioux Falls, and Canton were all impacted by the flood. Sioux Falls had flood damage to the north and southern parts of town as well as heavy flooding in the business district along the river. Damage was estimated to be over $1 million in the city and $4 million over all. Of this amount, $980,000 was sustained in the southern half of the Big Sioux River Basin—over 62,000 acres of land were flooded. Families were forced from their homes, and many of the houses were flooded. Most of the crops in the area were destroyed by the water and there was little or no chance to replant because of the short growing season. Vermillion River—The sudden rain that fell during the middle of June dropped between three and eight inches of precipitation throughout Turkey Ridge Creek and the Vermillion River north of Centerville. The citizens and National Guard filled sandbags to be used in and around Centerville. An estimated 50,000 sandbags were placed on the lowland dike system south of the town to help contain the water. An estimated 80 square miles were flooded. James River—The southern portion of the basin was also affected. The tributary of Marne Creek erupted with a flash flood which brought considerable water and debris to Yankton. Several homes and businesses adjacent to the creek received water and mud damage.
May 1952	Rapid City—Heavy flooding through the Canyon Lake area of west Rapid City. Damage was very much like that sustained in the 1972 flood. Sturgis/Deadwood—Heavy rains brought flash flooding that tore up streets and gas pipelines in Sturgis. Bridges were washed out and water erosion caused rock slides. Water damage and landslides also occurred in Deadwood.
April 8, 1952	Big Sioux River—Warm weather brought on another rapid snow melt and flooding conditions. Watertown had flooding starting at Lake Kampeska. There was also heavy flooding in the southern part of the town. Farther downstream at Estelline, the river was about one mile wide. Flooding occurred in the towns of Flandreau, Trent, and Dell Rapids. There was also heavy flooding around the Sioux Falls Air Base (Joe Foss Field). Pictures of the locality gave it the appearance of a large lake. From Watertown to Sioux Falls, about 99,000 acres were flooded and $4.5 million of damage sustained. Below the falls to the mouth of the river, an additional 30,000 acres of land were covered and about $1 million damage done to the area. James River Basin—The tributaries of the Elm and Maple rivers delivered snowmelt run-off over thousands of acres of farmland. Ice jams on the Elm and Maple rivers forced the water over land. Hundreds of farm families were isolated

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	by the water, while other families in the area were still snowbound. The end result was an enormous amount of water standing on frozen ground, causing the Elm River to spread to one mile in width. This water washed out a number of culverts and roads and isolated farms.
Spring 1951	Big Sioux River—Heavy flooding originated in the Brookings area. An accumulation of snow throughout February and an additional six to fourteen inches during March served as the flood source. High temperatures in late March brought about rapid melting and the flood condition. The Big Sioux was ½ mile wide in Moody County, 1 ½ miles wide around Baltic and Sioux Falls, and 2 miles wide below the Rock River. The area from Brookings to below the falls of Sioux Falls had about 73,400 acres of land flooded and damage of nearly $2.25 million. The area from Sioux Falls to Sioux City, Iowa, had an estimated 29,000 acres flooded and $600,000 in damage. Vermillion River—The combination of snow melt run-off and ice dams brought extensive water to the town of Davis. The entire main street of the town had water damage. One portion of town had three inches of water, which caused a number of families to evacuate. Elsewhere, the towns of Centerville and Montrose received some water. At least three bridges were washed away, lowlands were flooded, and some stored grain destroyed.
Apr/May 1950	Grand, Moreau, and James rivers—10- to 25-year flood event. Much of the damage was the result of water lingering over the fields. Parts of Brown County and adjacent counties had flood conditions for more than a month. More than 40,000 acres of cropland were submerged and damage was greater than $900,000. Flooding also created heavy damage to road surfaces and caused the loss of some grain and livestock. Total damage was estimated at $5 million.
May 1922	Cheyenne and James river basins—25-50-year flood event: Caused by snowmelt and rain.
May 1920	Rapid City—Homes were flooded, bridges were washed out, and utility systems disrupted. Hat Creek and James River—25-50-year flood event: Caused by snowmelt and rain. Deaths: 7.
Jun 12, 1907	Rapid City—Caused by more than five inches of rain throughout the Black Hills in one six-hour period. The flood destroyed five bridges, damaged roads and power lines, and washed out about ½ of Canyon Lake Dam. The entire downtown area along Rapid Creek was under water. Four people died, and the railroad system sustained heavy damage.
May 1883	Rapid City—Similar flood to 1878: bridges, buildings, and homes received heavy water damage.
Spring 1881	Big Sioux River—Winter began in mid-October 1880. The total winter was very cold and an accumulation of two to four feet of snow covered the state. When the ice broke up in March, the Big Sioux River Basin was flooded. Sioux Falls was especially hit hard. The river was recorded as rising 16 feet in 24 hours on March 20, 1881. The rapid rise brought widespread destruction throughout the Sioux Falls area. Approximately 100 buildings in north Sioux Falls were washed away. Three major bridges were also washed out in a 15-minute period. Estimated damage was $150,000 to the Sioux Falls area. Below the falls, farms along the river suffered heavy flood damage. Large amounts of grain, livestock, and personal possessions

Date	Comments
	were lost to the flood. Many of the railroad bridges and wagon bridges were washed away. The only means of travel was by foot or horseback. No lives were lost. Vermillion River—The town of Vermillion was located on the banks of the Missouri and Vermillion Rivers. Almost all the homes and stores were located along or near the shoreline. The heavy accumulation of winter snow started melting, which caused the Missouri River to flood. Associated with the flood was ice blockage, which not only backed up the water into the Vermillion River but also formed an ice dam that prevented normal run-off. The tributary run-off added to the back water until the river became one to two miles wide in places. Mills, houses, and stables were washed away. When the Vermillion River finally broke through the ice blockage, the impact was devastating. A wall of water entered the town of Vermillion and covered it in depths ranging from 3 to 10 feet of water. The combined forces of the Missouri and Vermillion rivers resulted in the town literally floating away. An estimated 132 buildings were destroyed and many others were damaged by the ice and water. The end result was ¾ of the town was totally destroyed and about $142,000 in damage was sustained. This destruction was so total and severe that the town was relocated on the bluffs behind the former town to prevent another recurrence.
1878	Rapid City—Rapid Creek rose 20 feet in one hour. Streets were under water, buildings flooded, and bridges washed out.

Source: If not otherwise sourced in the table, the NCDC is the information source.

Probability

Floods have a one percent chance of occurrence in any given year in identified special flood hazard areas. Smaller and more frequent damaging events occur in the state on an annual basis. Floods result in $16.2 million per year in average annualized losses to the state.

Winter Storm

Description

Winter storms are not limited to one portion of the state and historically occur from late fall to the middle of spring. They vary in intensity from mild to severe. Winter storms regularly destroy property and kill livestock. They can immobilize a region, blocking roads and railways and closing airports, which can disrupt emergency and medical services, hamper the flow of supplies, and isolate homes and farms, possibly for days. Heavy snow can collapse roofs and knock down trees and power lines. Unprotected livestock may be lost. Economic impacts include cost of snow removal, damage repair, and business losses.

The National Weather Service describes different types of snow events as follows:

- Blizzard—Winds of 35 mph or more with snow and blowing snow reducing visibility to less than ¼ mile for at least 3 hours.

- Blowing Snow—Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
- Snow Squalls—Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
- Snow Showers—Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
- Snow Flurries—Light snow falling for short durations with little or no accumulation.

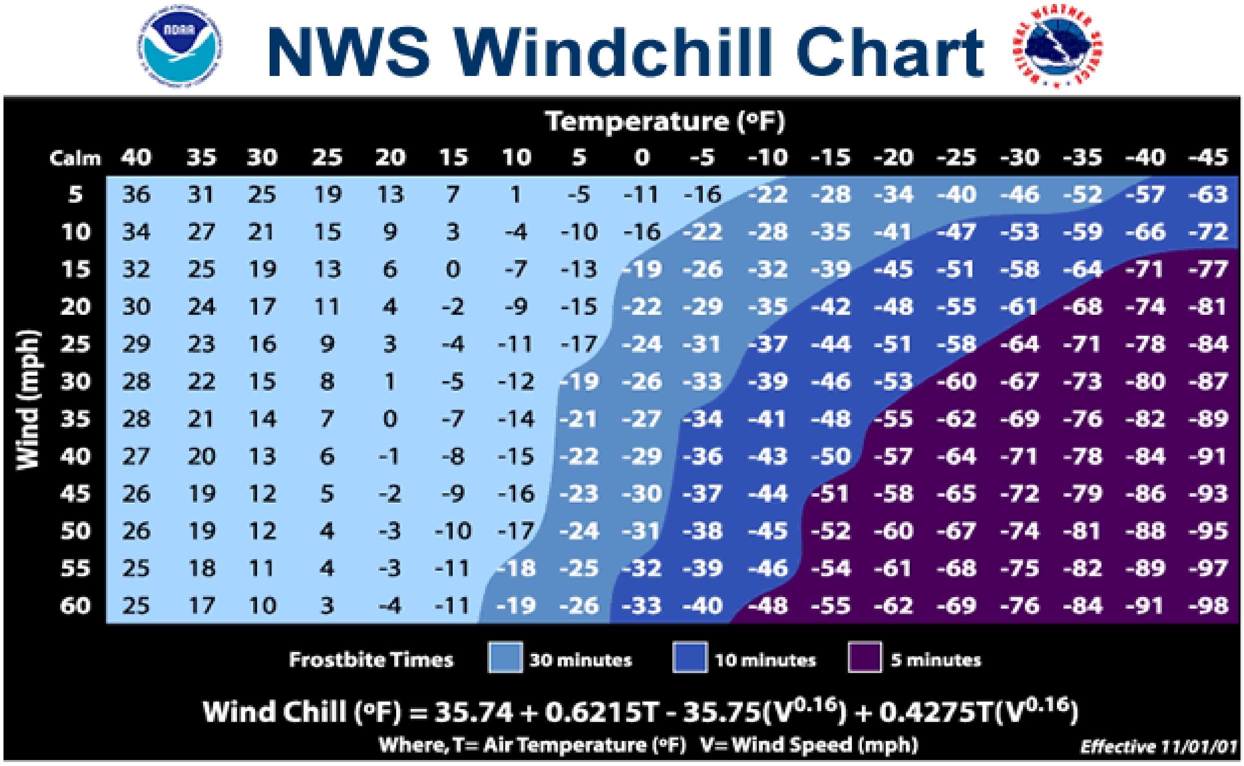
Also associated with winter storms are ice, freezing rain, and sleet. Freezing rain coats objects with ice. This ice coating on sidewalks, roads, etc., creates dangerous conditions. Sleet does not generally cling to objects like freezing rain, but it does make the ground very slippery. Heavy accumulations 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 extensive damage. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Winter storms can also generate flooding, usually as a result of ice jams or snowmelt, which can cause significant damage and loss of life. Ice jams form when long cold spells cause rivers and lakes to freeze and a rise in water level or a thaw breaks the ice into large chunks that become jammed at obstructions (e.g., a bridge). Water backs up at the jam, which is acting as a dam, and flooding results. The snowmelt hazard is defined as a sudden thaw of a heavy snow pack that often leads to flooding. Both snowmelt and ice jam floods are common in South Dakota.

Extreme cold often accompanies a winter storm or is left in its wake. It is most likely to occur in the winter months of December, January, and February. Prolonged exposure to the cold can cause frostbite or hypothermia and can become life-threatening. Infants and the elderly are most susceptible. Pipes may freeze and burst in homes or buildings that are poorly insulated or without heat. Extreme cold can disrupt or impair communications facilities.

In 2001, the NWS implemented an updated Wind Chill Temperature index (see Figure 3-8). This index was developed to describe the relative discomfort/danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure 3-8 National Weather Service Wind Chill Chart



NWS Windchill Chart

Temperature (°F)

Wind (mph)	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

Source: National Weather Service

Location

The topography of South Dakota is such that no one area is immune from effects of winter storms. The inherent nature of temperature hazards makes them a regional threat, impacting most or all of the planning area simultaneously as well as extending the effects into the surrounding jurisdictions. Prairie lands, which cover most of the state, offer little resistance to high winds and drifting snow. Even the Black Hills region, which presents some resistance to wind conditions, is not excluded from blizzard conditions. Blizzards in this region are often less severe than elsewhere in the state, but they can still produce heavy drifting shows. Early blizzards were so devastating that South Dakota had the dubious distinction of being called the Blizzard State.

According to the National Weather Service, most of South Dakota has an annual mean snowfall of 24.1 to 36 inches. Some areas in the northeast, northwest, and southwest have an annual mean snowfall of 36.1 to 48.0 inches, and a small area in the southwest has an annual mean snowfall greater than 72 inches.

More location information is in the following section on past events and Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction.

Past Events

According to the National Climatic Data Center Storm Events database, there were 867 winter storms (snow and ice events) in South Dakota between January 1993 and April 2010, and 57 extreme cold events from January 1994 to April 2010. Total property damage for these events is estimated at $124.7 million dollars. This suggests that South Dakota experiences 54 winter storms and $7.3 million in winter storm losses each year, as well as 3.6 extreme cold events each year. 16 deaths and 194 injuries were attributed to these events. This suggests that South Dakota can expect approximately 1 death and 12 injuries each year. See Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction for more information about how winter storms affect individual counties.

Figure 3-9 South Dakota Winter Storm Events 1993 – November 2009

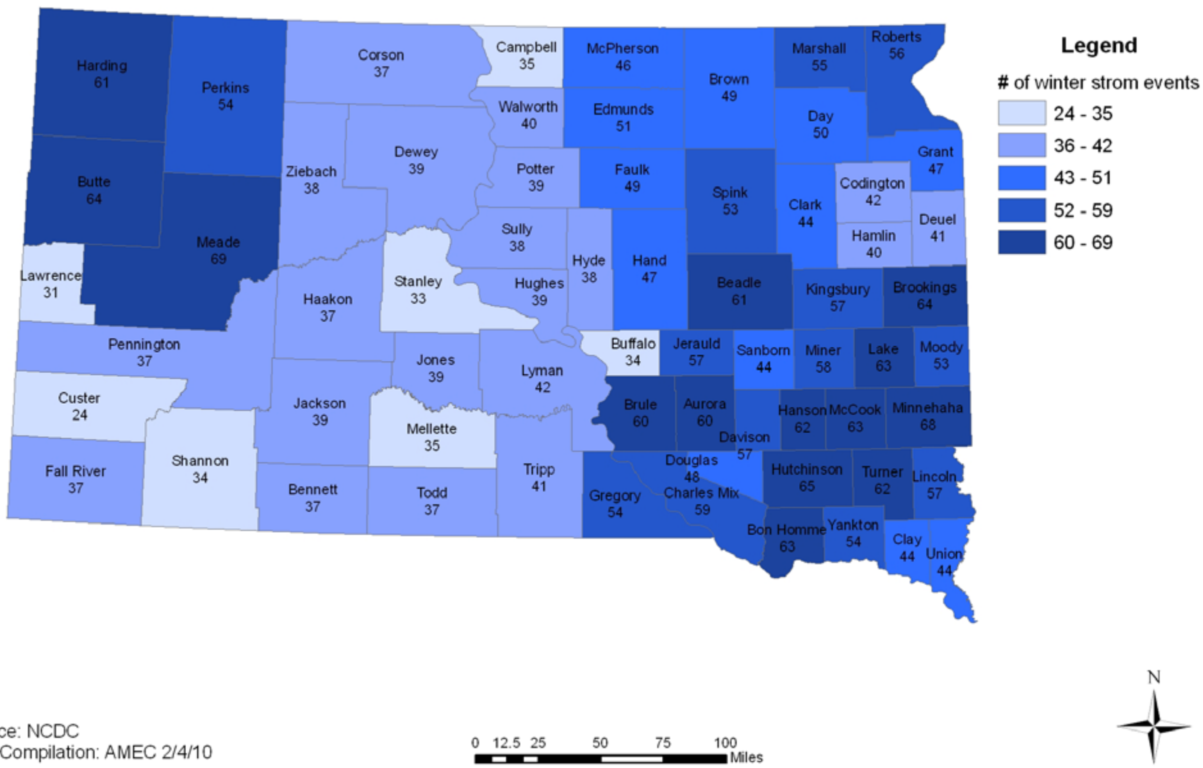


Table 3-9: South Dakota Winter Storm Events

Date	Comments
April 2, 2010	**Severe Winter Storm (FEMA-1914-DR)** The April 2, 2010, blizzard caused an estimated $1.6 million in damage in the three-county area. A band of heavy snow set up across Corson and Dewey counties during the early morning hours of April 2nd. Along with heavy wet snow, northwest winds gusting up to 40 mph developed. By the time the snow ended in the late morning hours, 6 to 8 inches of snow had fallen. The heavy snow, combined with the strong winds, downed many power poles across the region along with making travel treacherous. Some snowfall amounts included; 4 inches at Eagle Butte; 6 inches at Timber Lake, McLaughlin, and 14 miles north of Isabel; 7 inches at Isabel and 6 miles southeast of McIntosh; 8 inches southwest of Keldron. Heavy snow and strong winds knocked down power lines and poles, cutting off electricity to more than 1,500 rural electric customers. More than 400 poles were lost to the heavy snow leaving approximately 800 people without power. Eighty lineman worked through the Easter weekend in the snow and mud. McLaughlin and Keldron were the hardest hit. Several hundred people were still without power on April 5th.

Date	Comments
	Corson, Perkins, and Ziebach Counties were also among those struck by a late-January ice storm that qualified them for an earlier Presidential Disaster Declaration. Some of the power lines damaged by the April storm had just been repaired from damage caused by the January ice storm.
January 20-26, 2010	**Severe Winter Storm (FEMA-1887-DR)** A powerful storm struck the northeast half of the state. The storm began with rain, turning to sleet, followed by heavy snow. Winds of up to 60 mph accompanied the storm. Power lines burdened by ice after several days of heavy fog began snapping and falling. High winds and blizzard conditions across the eastern and north central regions of the state stalled traffic and further complicated relief efforts. Interstate 90 was closed from Chamberlain to the Minnesota border. Interstate 29 was closed from Sioux Falls to the North Dakota border. An estimated 7,600 customers across South Dakota were without power. Some phone systems also experienced outages. At least 31 emergency shelters were open across the hard hit regions. Indian reservations were hit especially hard. The Cheyenne River Sioux Tribe had a breakdown at the water treatment plant as a result of the storm that left many residents without potable water.
December 23-27, 2009	**Severe Winter Storm (FEMA-1886-DR)** A powerful winter storm blanketed the entire state. The entire Interstate highway systems were shut down for an extended period across South Dakota. Winds gusted as high as 76 mph in western South Dakota Preliminary storm totals from the State Climatologist across the state from the Christmas blizzard indicated that the large majority of the state received over 10" of snow in the storm with 20" or greater amounts in the southeast (Marion-Vermillion-Yankton), northeast (Sisseton and Clear Lake), central (Kennebec and Murdo) and northwest (Perkins County). The northern Black Hills recorded 40-50". The statewide average was 15.4". This would place it as one of the top few storms for snowfall totals statewide.
March 23-34, 2009	A powerful spring storm brought rain, snow, and very strong winds to western South Dakota. Precipitation started as rain, then changed to snow, and blizzard conditions developed. The heaviest snow fell over the northern Black Hills, where 18 to 48 inches of snow was measured. Ten to 20 inches of snow fell across far northwestern South Dakota, with drifts as high as ten feet. Most other locations received at least six inches of snow. Sustained winds of 30 to 55 mph, with gusts over 80 mph, were reported. Interstate 90 and other highways were closed for more than 24 hours. Some power outages were reported, mainly across the northern Black Hills and northwestern South Dakota. Tens of thousands of livestock perished. Damage estimates were slated in the millions.
November 5-7, 2008	An intense fall storm brought heavy snow and gusty winds to much of the Black Hills. The heaviest snow fell across the northern Black Hills as upslope-enhanced snow fell for many hours. Snowfall amounts ranged from only a few inches across the southeastern slopes of the Black Hills to near five feet from Cheyenne Crossing to Lead and Deadwood in the northern Black Hills. The next day, a strong area of low pressure moving across South Dakota and into Minnesota brought widespread rain, freezing rain, and snow to central, north central, and northeast South Dakota. Much of the freezing rain fell across central and north central South Dakota west of the Missouri River. As the freezing rain changed over to snow and the winds increased, the ice and snow buildup on the

Date	Comments
	power lines and poles caused hundreds of power poles to break across Jones, Stanley, Dewey, and Corson counties. East of the Missouri River, the colder air and stronger winds moved in changing the rain over to snow. Strong winds of 30 to 45 mph with gusts near 60 mph brought widespread blizzard conditions to all of the area. Ice buildup from the freezing rain ranged from a tenth to as much as an inch for counties west of the Missouri River. Snowfall amounts across the entire area generally ranged from 2 to 8 inches with a 15 inch amount recorded in southwest Corson County. Some of the snowfall amounts included: 3 inches at Eagle Butte, Blunt, Kennebec, Mission Ridge, and Onida; 4 inches at Pollock, Gettysburg, and Bowdle; 5 inches south of Harrold, Iona, and near McIntosh; 6 inches at Mobridge; 7 inches at Murdo; 8 inches at McLaughlin, and 15 inches southwest of Keldron. All 4,600 customers of the Moreau-Grand Electric company lost power due to the storm. The last time this occurred was during the winter of 1967-68. The monetary loss to this cooperative and other electric cooperatives for Jones, Stanley, Corson, and Dewey counties was in the hundreds of thousands of dollars. There were over 100 line workers working countless hours with crews coming from as far away as Nebraska and Iowa to assist in the power recovery. Over 1,000 customers were without power for an extended period of time. Cell phone coverage was also knocked out for parts of the West River area due to downed towers. The blizzard resulted in numerous school, business, and road closures along with flight cancellations. Interstate-90 was shut down from Mitchell, South Dakota to the Wyoming border from Thursday the 6th until Friday evening of the 7th. Many semi trucks and cars were stranded along the Interstate with many people being rescued. Many travelers took shelter in Murdo, Chamberlain, and Pierre until the Interstate reopened Friday evening. There were also several accidents across the area with a serious accident in Walworth county on Highway 83 near the Potter county line. In the early afternoon hours of Friday the 7th, slippery roads, high winds, and low visibilities contributed to the rollover of a passenger van carrying seven students. The passenger van rolled several times causing serious injuries to three of the students. Also, a semi truck rolled over on an icy and snowy Highway 45 south of Miller in the late afternoon hours of the 6th. The driver received minor injuries. The Governor declared a state of emergency on the 7th, and President Bush declared South Dakota a disaster area.
April 25-26, 2008	A strong low pressure area brought widespread heavy snow of 6 to 20 inches to most of northeast South Dakota for much of the 25th and into the early morning hours of the 26th. The precipitation began as light freezing rain in the early morning across parts of the area before changing to all snow by mid morning. As the low pressure area intensified, snowfall rates and the north winds also increased. The heavy snow combined with the strong winds created widespread visibility problems along with large snowdrifts. Snowfall amounts included, 6 inches at Andover, Britton, Gann Valley, and 15 miles south of Miller, 8 inches at Roy Lake, 9 inches at Clark, Big Stone City, Hillside Colony, and Sisseton, 10 inches 7 miles south of Bristol, and 11 inches at Hayti. Locations with a foot or more of snowfall included, 12 inches at Wilmot, Webster, and Waubay, 13 inches at Milbank, 15 inches at Castlewood, 16 inches near Victor, and near Summit, 17 inches at Clear Lake, 19 inches at Watertown, and 20 inches at Bryant. There were a number of automobiles

Date	Comments
	that went into the ditch along with many other automobiles damaged in accidents. Many stranded motorists had to abandon their vehicles in the hardest hit areas. Travel was not advised across the entire area. A school bus slid into a ditch east of Castlewood with no injuries occurring. Interstate-29 was closed from 3 pm the 25th until 3 pm on the 26th from Brookings north to the North Dakota border. In addition, South Dakota State Highway 12 was closed from Webster to the Minnesota line from the afternoon of the 25th until the late morning of the 26th. Most counties affected by the storm opened emergency shelters when Interstate 29 was closed to house stranded motorists. Also, many schools were closed across the area. The very heavy snow set several records across the area. The 19 inches at Watertown broke its all time 24 hour snowfall record of 16 inches. Both Victor and Clear Lake had their second highest snowfall ever recorded in a 24 hour period. Watertown, along with several other locations in northeast South Dakota, received near record or record snowfall for the month of April. In fact, Watertown's 29.5 inches of snow for the month of April was almost their seasonal normal snowfall. This event was also declared a disaster by the President.
March 1, 2007	In southeast South Dakota, four to eight inches of snow was accompanied by sustained winds of over 30 mph at times with gusts over 40 mph. The combination of new snow, wind, and existing fresh snow cover resulted in a blizzard with widespread near zero visibilities. Drifting snow made travel extremely difficult to impossible. As a result, some who did attempt to travel became stuck or slid off roads. Schools and school activities were cancelled and numerous businesses closed. Source: National Climatic Data Center
April 18-20, 2006	**Severe Winter Storm (FEMA-1647-DR)** The strongest storm of the 2005-2006 winter brought heavy, wet snow to northwestern South Dakota and the Black Hills and heavy rain across southwestern and south central South Dakota. Reported snow totals included 10 to 24 inches in northwestern South Dakota, 16 to 30 inches in the Bear Lodge Mountains, 40 to 70 inches in the northern Black Hills, 74 inches in Lead, and 55 inches in Deadwood. Fifteen-foot drifts were reported on the plains of northwestern South Dakota. Source: NWS Rapid City
November 27-29, 2005	**Severe Winter Storm (FEMA-1620-DR)** This storm brought snow and ice to the state. It was one of the worst ice storms in the state's history. Snowfall accumulations in central South Dakota ranged from 2 to 20 inches. Strong northwest winds of 30 to 50 mph with gusts to 70 mph caused widespread blizzard conditions. Visibilities were reduced to zero across the area with snowdrifts of 5 to 10 feet high in some places. Freezing rain occurred before the snow in some areas coating objects with up to three inches of ice and causing power outages. Some power lines were also brought down by snow accumulation and high winds. Tens of thousands of households and businesses lost power from one day to up to two to three weeks in some rural areas. One electric cooperative said it was the worst damage they had in their 65 years of existence. Many roads, including Interstates 90 and 29 were closed due to the treacherous travel conditions. Several accidents occurred during the storm, killing two and injuring others. Many motorists were stranded. Several people had to be rescued. Air traffic was also brought to a halt across much of the area. Schools, businesses, government offices, and many other organizations were closed. Minor damage was caused to homes and vehicles by the strong winds and by wind blown debris, mainly from trees. A

Date	Comments
	79-year old man died from exposure in Douglas County. Source: National Climatic Data Center
April 2000	**Winter Storm (FEMA-1330-DR)** From April 19-20, a severe spring storm consisting of rain, heavy snow, and very high winds struck seven western counties of South Dakota. The storm's greatest impact was on the electrical power system. One to three feet of heavy, wet snow coupled with ice and high winds caused significant damage to three rural electric cooperatives, resulting in widespread power outages to homes and businesses. The power providers reported that over 1,500 power poles were damaged or destroyed. Eligible damage to public infrastructure was estimated at approximately $2,500,000.
January 1997	**Severe Winter Storms/Blizzards (FEMA-1156-DR)** All counties were declared disaster areas. Twice in a seven-day period in early January, cold Arctic air swept down and "froze" the state. The governor closed the interstates for public safety. More than 36,000 head of cattle perished. Roads were blocked or covered by 20-foot drifts of snow. Fifteen days after the storm ended, some roads were still blocked by snow. The Day County highway superintendent reported 20- and 40-foot vertical drifts blocking the highway. Livestock losses, damaged buildings, and feed shortages occurred in an area called the "red zone." This is an area of 4,722 cattle operations, 1,200 sheep operations, 1,000 hog farms, and 515 dairies along the northern third of the state west to east. The storm caused more than $30 million in damage/cleanup efforts. Three people died while trapped in vehicles along the highways. The snowmelt from this record-breaking storm was a major contributor to the flood disaster a few months later.
December, 1996	Extreme cold struck portions of South Dakota. A Summit man died from exposure to the extreme cold after his vehicle became stuck in the snow. The man attempted to walk for help and was found about one mile from his car in the driveway of a home about a mile and a half west and one mile south of Summit.
November 13-26, 1996	A slow moving winter storm with severe snow and freezing rain entrenched itself over much of the state. The effects of the storm were felt primarily in the Black Hills and southeastern portions of the state. The storm was a result of a strong system of cold air, hovering close to the ground, with a system of warm air above. This combination made for rain, fog, and snow that quickly turned to damaging ice. The snow and ice formed and amassed on roadways, trees, electric transmission lines, and power poles. Some power lines were swollen by ice to five inches in diameter. The excessive weight and severe wind conditions snapped lines and flattened poles. Thousands of polebraces, crossarms, and anchors cracked under the heavy stress. Six rural electric cooperatives, affecting approximately 10,700 customers, experienced serious outages due to the loss of poles, braces, lines, crossarms, anchors, and substation failures. Customers were without power in subfreezing temperatures for several hours to several days. The force of the storm caused major delays on Interstates 90 and 29. Portions of state and county highways and roads were closed for an extended period of time due to heavy ice and snow accumulation and extremely poor visibility.
October 22-24, 1995	**Ice Storms (FEMA-1075-DR-SD)** Between October 22 and 24, 1995, a severe autumn snow and ice storm caused widespread damage in South Dakota. Effects of this storm were felt first in the Black Hills. Portions of the hills received up to 22 inches of snow. As the storm moved across South Dakota, ice and 5 to 15 inches of wet snow covered trees and

Date	Comments
	electric lines and poles. Winds associated with the storm caused lines to slap together and poles to fail, producing widespread power outages to large portions of rural South Dakota. Tree damage also led to significant damage to electrical utilities. Thirteen rural electric cooperatives reported damage from this storm. The cooperatives lost nearly 9,500 poles and 170 transmission lines. Damage was estimated at $10 to $10.3 million to rural electric infrastructure only. Approximately 30,290 households were affected by the power outages. Crews from electric cooperatives in South and North Dakota, Minnesota, Iowa, and Nebraska assisted local cooperatives with line repairs. The power outages also caused several rural water system pumping stations to go off-line, causing a loss of water utilities to members of rural water systems. The National Guard provided generators to power these pumping stations to restore water service. This storm also forced major transportation delays as portions of Interstates 90 and 29 had to be closed because of the snow accumulation on the roadway and poor visibility. One of these interstate closings led Davison and Codington counties to initiate their sheltering plans for travelers who could not find rooms at local motels. The storm also caused numerous cancellations and delays in school openings because of travel conditions or the lack of power. Interstate traffic was restored by early October 24. Twenty-eight counties were included in the disaster declaration: Aurora, Beadle, Bon Homme, Brookings, Brule, Buffalo, Charles Mix, Clark, Codington, Davison, Day, Deuel, Douglas, Grant, Gregory, Hamlin, Hanson, Hutchinson, Jerauld, Kingsbury, Lake, McCook, Marshall, Miner, Roberts, Sanborn, Spink, and Tripp Counties.
January–February 1995	**Severe Winter Storms (FEMA-1045-DR)** Damage to electric power lines in 21 counties was caused by an unusually foggy January weather. Continuous fog in many areas resulted in a heavy crust of ice forming on many of the power lines in central South Dakota. The fog-crust was reported to be three to five inches in diameter. The addition of high winds caused power poles to snap. Deep drifts of snow made it difficult for power company linemen to gain access to the damaged power lines, and in many areas, county snow removal equipment was required to provide access. According to reports, 13,435 households were without power for varying periods of time. The maximum time without power was 12 days. Early damage was estimated at more than $3.2 million. More than 1,700 power poles had to be replaced.
November–December 1983	Weeks of subzero temperatures preceded the actual blizzard and set the stage for the deadly combination of cold, blizzard conditions, and loss of electrical power. A series of winter storms struck South Dakota in late November and throughout December. The impact was felt statewide, but it was particularly heavy on the Rosebud and Pine Ridge reservations. Cheyenne River, Lower Brule, and Crow Creek reservations were also affected, but to a lesser degree. Many of the Rosebud and Pine Ridge communities had propane fueled/heated homes. At the height of the storms, reservation roads were drifted closed and became impassible. A fuel shortage occurred when the weeks of subzero temperatures drained propane tanks faster than normal. Tribal governments opened community shelters for those who could make it to the shelters. As conditions worsened, fuel contractors could not start their delivery vehicles and roads were increasingly impassible. County and

Date	Comments
	tribal government snowplows were overwhelmed by the enormity of the task. One death resulted from these storms.
October 9, 1981	The entire Black Hills area was virtually paralyzed by three to six feet of heavy snow and 40 to 70 mph winds. Roads were totally blocked, trees and power lines broken, and some homes sustained heavy damage. Not only were the northern hills residents isolated, but some were also without water and power for at least three days, causing food spoilage.
March 29, 1981	A winter storm front created a tornado near Martin, which destroyed a mobile home and injured one occupant. By 3:00 a.m. on March 30, the storm was generating 50 to 80 mph winds and dumping up to 10 inches of heavy, wet snow in the northwest. Power lines and at least 1,500 poles in the northwest were snapped after being coated with one to six inches of ice. Strong winds also snapped power lines and poles in south central South Dakota. These winds overturned trucks and cars along Interstate 29. The winds also overturned a railroad tank car, spilling phosphoric acid. This accident forced the evacuation of part of Garretson.
January 1981	A series of storms blocked the majority of roads in eastern South Dakota, overturned vehicles, and stranded hundreds of motorists. The severity of these storms caused four deaths in vehicles stalled in the deep snow.
1977	February, March, and November were especially active months for winter storms. Many rural roads were blocked with snow drifts six to eight feet high. Interstate 90 was often blocked and up to 100 cars were stranded. Six people died as a result of these storms. In addition to power outages reported in various part of the state, the March storm dropped over an inch of rain in the eastern part of the state and generated walnut size hail in Grant County. In November, a winter storm toppled a 1,400 foot television tower and derailed six freight cars.
January 1975	Of the two blizzards in 1975, the one on January 11 and 12 was the worst. High winds exceeding 60 mph, subzero temperatures, and heavy snow combined to produce killer conditions. Several people died and thousands of head of livestock perished in eastern South Dakota.
March 1969	Heavy snowfall and high winds knocked out power in the Aberdeen area. Rural residents were hard hit as blocked roads prevented early power line repair. The Belle Fourche area also sustained loss of power and phone service as hundreds of poles were knocked down.
March 1966	This storm moved into eastern South Dakota and remained stationary for 12 hours. Winds of 60 to 70 mph were common. Gettysburg had gusts up to 100 mph. The driving wet snow clung to the mouths of livestock and they suffocated. Cattle and sheep loss approached 100,000 animals with a value of nearly $20 million. Many towns suffered physical damage from the storm. A total of 380 people in Pierre had to be evacuated as the result of a power failure. Many towns lost phone service, and some communities had windows shattered by high winds, allowing snow to drift into buildings. A 121-car train was completely stopped by snow drifts. This storm killed 10 people.
December 1965	An ice storm destroyed an estimated 3,500 telephone poles in the Aberdeen area. Damage was nearly $650,000. Total damage to light and power systems approached $1 million. At the time, this was the worst ice storm experienced in 40 years.
January 1952	The temperature dropped from 40°F to -8°F in a short period of time. The wet, driving snow clung to everything. Cattle were blinded and suffocated as snow covered their mouths and noses. Young country school children lost their way

Date	Comments
	home and died of hypothermia. A few ranchers died when they tried to gather their livestock. Snow piled up to a point that people could walk along tops of power lines. In some isolated areas, people were snowed in for four months off and on throughout the winter. Planes were used to deliver mail, groceries, fuel, and feed for livestock. Snow track vehicles were used to transport doctors to isolated farm areas.
January 1949	A blizzard affected the entire state. Blizzard conditions existed for weeks rather than days. The general weather conditions were low temperatures (-2°F to -8°F), heavy snows (24 inches for the month), and winds from 40 to 73 mph. Towns and rural areas were completely isolated as the snow blocked up everything. Roads, railroad tracks, and buildings were buried under tons of snow. People were lost in the storm and many cattle were frozen. Airplanes were used to deliver food, fuel, and medicine to stranded people. Snow was very deep in western South Dakota. Pictures of the area showed drifts 35 feet high and several thousand feet long.
1943	A blizzard killed a large number of cattle.
1927	A blizzard killed a large number of cattle.
May 1905	A blizzard hit western South Dakota counties in May. Cattle wandering around in the blizzard walked off the bluffs in the Badlands area and fell to their death. Estimated cattle loss exceeded 16,000.
January 12, 1888	A blizzard was preceded by 10 days of cold, snowy weather, 8 to 10 inches of new snow, and a low temperature of -28°F. The weather warmed on January 11 and 12; it was foggy and about 32°F. The temperature dropped on the afternoon of January 12 to -20°F in five minutes. The wind blew so strongly that it knocked people off their feet. Many children, sent home from school, did not make it home. The blizzard was so withering that people lost their sense of direction and wandered about until they died of hypothermia (exposure). Thousands of head of livestock and wild animals perished. Many buildings were covered with snow or destroyed, and all transportation stopped. Although the storm lasted less than one day, an estimated 400 people died throughout the Dakotas, 174 of which were in South Dakota.

Probability

According to the National Climatic Data Center, there were 867 winter storm events in South Dakota between 1993 and April 2010 (17 years). Total property damage for these events is estimated at $212 million in 2009 dollars. Based on this information, the probability that at least one winter storm will occur in South Dakota in any given year is 100 percent. South Dakota can expect approximately $12.5 million in winter storm losses each year.

Wildfire

Description

Wildfires are uncontrolled conflagrations that spread freely through the environment. Wildfires near populated areas pose threats, not only to natural resources, but also to human life and personal property. Natural causes, such as lightning, or human acts may ignite wildfires. Lightning remains a fixed element of the ecosystem, and human-caused fire risks continue to increase as more and more people move to and recreate in fire-prone wildland areas.

South Dakota has a history of damaging wildfires. The state's susceptibility to wildfire was recognized nationally in 1897 when, prompted by a series of large forest fires in 1893, President Grover Cleveland established the Black Hills Forest Reserve to protect the forests from fires (as well as wasteful lumbering practices).

More recently, years of drought along with extremely low percentages of normal snowpack in the Black Hills has created the potential for catastrophic wildfires in South Dakota. Compounding this situation is the impact of the mountain pine beetle on pine trees in South Dakota. The most common host is the ponderosa pine. This tree occurs on more than 1 million acres of forestland in South Dakota. When the beetle population is very low only stressed or weakened trees, such as those struck by lightning, are colonized. However, approximately every ten years the beetle population increases and the beetles begin colonizing healthy as well as stressed trees. The South Dakota Department of Agriculture reported in 2009 that beetle populations are increasing and are expected to continue to increase during the next five years. Consequently, there is great concern for wildfires in the wildland-urban interface and also for agricultural and rural wildfires. Fires involving grass, prairie, or timber can cause mass destruction of property and vegetation.

South Dakota's semi-arid climate, highly flammable native vegetation, rugged terrain, and populated wildland-urban interface make up its wildfire hazard.

Topography—The Black Hills are an outcropping of the Rocky Mountains, lying in an ellipse 100 miles long and 50 miles wide along the state's western edge. In the Black Hills, terrain varies from broad, open valleys; rolling topography; mountainous terrain up to 7,242 feet in elevation; and steep, narrow canyons.

Fuels—Fuels are generally conducive to high rates of spread, represented by National Fire Danger Rating System fuel models "L," "K," and "C." Grass predominates in the broad valley bottoms. Ponderosa Pine grows on all aspects, and extensive pure forests of Ponderosa grow in the Black Hills. Mixed grass and timber stands occur in many areas depending on aspect. Fuel loading is lightest in the southern Black Hills and heaviest in the northern Black Hills.

Weather—During the summer months, temperatures are often in the 90s and low 100s with relative humidity in the teens. The average annual precipitation is approximately 17.5 inches. Some of this precipitation comes in association with thunderstorms that bring lightning during the fire season.

Lightning fires burn more acreage than human-caused fires, in part, because 1) multiple lightning fire ignitions often occur at the same time; 2) lightning fires can occur throughout the protection area, while most human-caused fires occur in accessible areas; 3) people often detect and report human-caused fires quickly due to their proximity to inhabited areas; and 4) lightning producing thunderstorms typically occur during the hottest portion of the fire season, while many human-caused fires start during spring or fall.

Conditions—The Black Hills ecosystem is fire adapted, having evolved with fire and fire dependent plant species. The forests of the Black Hills are very different from pre-settlement times when frequent, low-intensity fires maintained a healthy forest structure. Ponderosa Pine is adapted to benefit from frequent, low-intensity fires started in summer by lightning. Historically, these fires killed smaller plants that competed with the pines for moisture and released nutrients from litter on the forest floor. These fires also prevented accumulation of fuels that feed severe fires, which can destroy the thick-bark defense of the trees.

Today, the forest contains many more trees per acre and much more undergrowth, needle litter and deadwood than it did historically. Under these circumstances, when wildfires occur under dry, warm, and windy conditions, they will frequently develop into uncontrollable crown fires that destroy the forest and any homes within it.

Mountain pine beetle attacks in Ponderosa Pine often coincide with abundant weak trees resulting from drought and overgrown conditions. These circumstances have been common throughout the Black Hills and have allowed a mountain pine beetle infestation to become epidemic.

Wildland-Urban Interface—Wildfires destroy hundreds of structures throughout the western United States every year. These fires can and will occur anywhere that humans and their development meet or intermix with wildland fuels. This wildland-urban interface fire problem exists in every state, including South Dakota, and worsens each year. People continue to develop residential properties in fire-prone environments, increasingly exposing themselves and their personal property to the risks of wildfire. Fire and resource management professionals know that wildland-urban interface development can draw the efforts of firefighters away from protecting the natural resources, whose stewardship they are charged with.

Location

Early writings by explorers, trappers, and settlers often describe South Dakota as a sea of waving grass. The descriptions would not be valid today for the eastern half of the state. The more fertile and climatically desirable prairie of the eastern portion is now used for crop production. But, the wild prairie still exists in the western part of the state. South Dakota's portion of the Great Plains now exists from the foothills of the Black Hills to the western boundary of the Missouri River. This amounts to nearly 35,000 square miles of land, which is used primarily for livestock grazing and some wheat cultivation. For most of the year, this area is at risk to wildfires because of the nature of the ground cover and the limited precipitation.

Although wildfires occur throughout the state, the grass and forestland areas west of the Missouri River represent the area most prone to large wildfires. This area remains vulnerable due to the large areas of continuous fuels and the extreme burning conditions that occur in the area. The area of the state known as the Black Hills has the highest potential for loss of lives and personal property from wildfire. After years of fire suppression, the landscape of the Black Hills has become a dense forest. High fuel loads, years of drought, and mountain pine beetle infestation have combined to make the area particularly susceptible to wildfire. Between 2000 and 2002, 10 percent of the Black Hills National Forest burned (see Past Events) (U.S. Forest Service, Spearfish, South Dakota, and the Northern Black Hills: Steps to Improve Community Preparedness for Wildfire).

The Black Hills National Forest encompasses 1,524,164 acres of land in South Dakota and Wyoming (see Figure 3-10). Over one million acres of the forest are exclusively in South Dakota (Custer, Fall River, Lawrence, Meade, and Pennington counties). Of the one million acres, about 80 percent is federally controlled. The remaining 20 percent is controlled by the state and private citizens.

Figure 3-10: Map of Black Hills National Forest

Source: U.S. Forest Service, www.fs.fed.us/r2/blackhills/maps/bhmap.shtml

The land ownership pattern in the Black Hills includes a mix of private, Black Hills National Forest, State of South Dakota, Bureau of Land Management, and National Park Service lands. A "checkerboard" ownership pattern in the Black Hills National Forest produces a condition where private, residential structures are scattered throughout much of the National Forest. The U.S. Forest Service has reduced, through land exchanges, the number of individual property inholdings and the land area they cover within the Black Hills National Forest. However, the number of occupied developments on the remaining inholdings increases constantly. This rural residential growth continually and dramatically increases private property exposure within U.S. Forest Service's fire jurisdiction.

The state primarily maintains fire protection responsibility on private and state lands, but protects a relatively small amount of Federal land as well. Since a large portion of the state's fire protection area is private land, single-family dwellings exist throughout the state's protection area. However, there are existing pockets with no dwellings due to the roughness of the terrain in some areas.

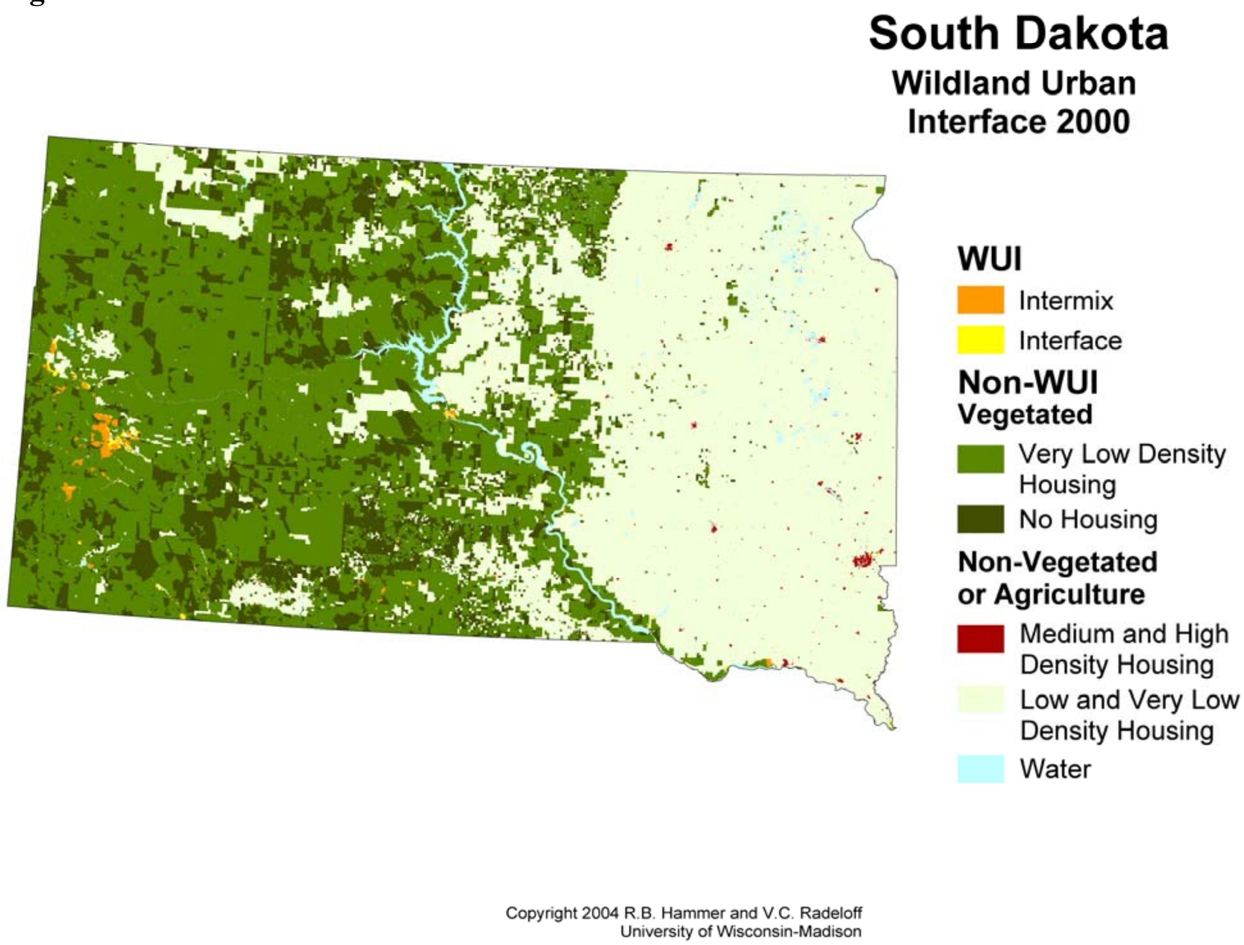
The greatest concentration of structures is located in and around the towns and cities in the Black Hills, including subdivisions within a few miles of the town and city limits. Rapid City and bedroom communities within a five-mile radius of the city represent the greatest concentration of structures located in the forested areas of the Black Hills. The population of new residents is growing, and there are far more individual property owners to deal with than in the past.

Many new residents are unfamiliar with the realities and responsibilities of living in a fire dependent ecosystem such as the Black Hills, are unaware of the natural role of fire, the concept of defensible space, and the capabilities of local government services. Many homeowners seem to value aesthetics more than safety and resist the concept of defensible space, believing that they will spoil the environment for which they came.

In addition to the Black Hills National Forest, there are lesser size timber stands in Harding County, the Pine Ridge Reservation of Shannon County (unorganized), and the Rosebud reservation of Todd County (also unorganized). These three counties are in western South Dakota.

Figure 3-11 illustrates South Dakota's wildland-urban interface. Wildland-urban interface, as illustrated in this figure from the SILVIS Lab at the University of Wisconsin–Madison, is composed of both interface and intermix communities. In both interface and intermix communities, housing must meet or exceed a minimum density of one structure per 40 acres. Intermix communities are areas where housing and vegetation intermingle and vegetation exceeds 50 percent. Interface communities are areas with housing in the vicinity of contiguous vegetation, have less than 50 percent vegetation, and are within 1.5 miles of an area that exceeds 1,325 acres and are more than 75 percent vegetated.

Figure 3-11: South Dakota's Wildland-Urban Interface



Source: SILVIS Lab, Forest Ecology and Management, University of Wisconsin–Madison

Past Events

The South Dakota Department of Agriculture's Division of Resource Conservation and Forestry database indicates that lightning represents the single largest ignition source in its jurisdiction, causing 35 percent of fires and burning 41 percent of the acreage lost between 1996 and 2000. While debris burning caused slightly more fires, these fires burned only about one third of the acreage lost to lightning-caused fires. Table 3-10 contains information about wildfires in the Black Hills between 1977 and 2000. Table 3-11 shows the large fire history for the South Dakota, with emphasis on the Black Hills National Forest, between 1879 and 2010 from South Dakota Wildland Fire Suppression. Figure 3-12 indicates the communities at risk for a wildfire, updated in 2008.

There have been no major fires that qualified for a Fire Management Assistance Declaration since 2007. The NCDC does not have any wildfire events on record. The State has a "South Dakota Fire History" page on the Wildland Fire Suppression Division website (http://www.state.sd.us/doa/wfs/Firehistory.htm) that also does not record any significant fire events since 2007.

Figure 3-12 South Dakota Communities at Risk to Wildfire

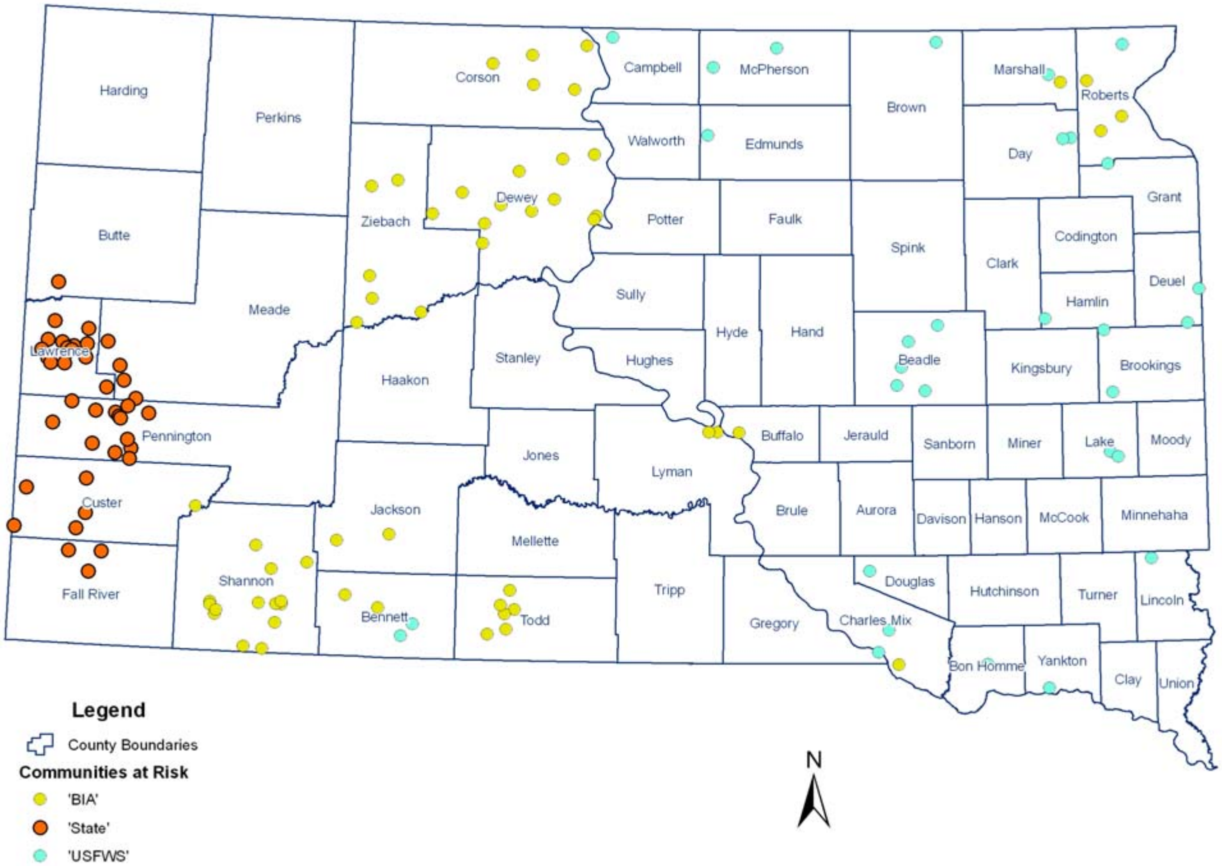


Table 3-10: Black Hills Fire Occurrence for 24 years, 1977 – 2000

Total number of fires	3,971
Total acres burned	679,293
Average number of fires per year in the Black Hills:	166
Average acres burned per year in the Black Hills	28,304
Lightning-caused	398 fires (35 percent)
Human-caused	2,573 fires (65 percent)

Source: South Dakota Department of Agriculture Division of Resource Conservation and Forestry

Table 3-11: South Dakota Wildfire Events

Date	Comments
July 2007	**Boxelder Fire (FEMA-2716-FSA)** At the time of the state's request, the fire had burned approximately 700 acres and had resulted in the evacuation of 100 residents from the town of Nemo in Lawrence County.
July 2007	**Alabaugh Fire (FEMA-2710-FSA)** This fire near Hot Springs in Fall River County was started by lightning on July 7 and was contained on July 12. It burned 10,324 acres. The fire killed one man and destroyed 33 homes. It also forced the evacuation of about 600 residents in about

Date	Comments
	300 homes. Fire suppression costs were estimated at $2.7 million. A state official said the blaze was the most intense wildfire ever recorded in the Black Hills. Sources: InciWeb, Rapid City Journal, National Public Radio
2006	2,000 fires burned 230,000 acres Source: John Thune Press Release, March 23, 2007
July 2006	**East Ridge Fire (FEMA-2658-FSA)** 3,204 acres burned, $1,973,107 total outlay
July 2005	**Skyline #2 Fire (FEMA-2569-FSA)** 42 acres burned, total outlay: $18,975 (FEMA share: $14,231)
July 2005	**Ricco Fire (FEMA-2565-FSA)** 3,939 acres burned in Meade County, started by lightning, total outlay: $573,581 (FEMA share: $428,064)
April 2005	**Camp Five Fire (FEMA-2557-FSA)** 775 acres burned. Request for assistance withdrawn because event did not meet fire cost thresholds.
November 2003	**Mill Road Fire (FEMA-2513-FSA)** Total outlay: $62,852 (FEMA share: $45,685)
August 2002	**Battle Creek Fire (FEMA-2458-FSA)** On August 16, 2002, the Battle Creek Fire ignited on private land near Keystone. High temperatures, low relative humidity, and strong winds created conditions that led to intense fire behavior with long-range spotting. The fire burned actively for four days and burned 12,450 acres (9,120 acres of national forest system lands, 3,330 acres of private lands) before it was fully contained on August 25. Over 600 structures and the town of Keystone were threatened, but thanks to firefighters, losses were limited to three residences near Hayward. Source: U.S. Forest Service, Battle Creek Fire Rapid Assessment (www.fs.fed.us/r2/blackhills/fire/history/battlecreek/index.shtml) Total outlay: $1.8 million
June–July 2002	**Grizzly Gulch Fire (FEMA-2434-FSA)** This fire near Deadwood and Lead burned 10,801 acres and destroyed 7 homes and 20 other structures. Source: Jerome Harvey, "Historic Wildfire in the Black Hills" (www.nfpa.org/assets/files/PDF/blackhills.pdf)
July–August 2001	**Elk Mountain #2 Fire (FEMA-2369-FSA)** Total outlay: $293,000
August–September 2000	**Flagpole Fire Complex (FEMA-2319-FSA) and Jasper Fire (FEMA-2324-FSA)** The Flagpole fire complex started on August 11, 2000, in Fall River County in southwestern South Dakota. The wildfire was actually three different starts, the Flagpole Mountain, Green Canyon, and Chilson II fires in the southern hills area. The fires were attributed to lightning. The Flagpole Mountain fire burned in ponderosa pine; the Green Canyon fire burned in grass, scrub, and juniper. The terrain was extremely rocky and steep, making access and fire-fighting difficult. Pushed by shifting winds, the Flagpole fire immediately threatened structures, including two homes, and destroyed one outbuilding. The Flagpole and Chilson II fires burned more than 6,000 acres by the evening of August 12. The Flagpole fire threatened 30 homes on the north, south, and east sides of the fire and prompted officials to call for voluntary evacuations in the Shep's Canyon area, where there was only one access road. One residence was lost on the north side of the fire. The fires eventually burned 7,386 acres.

Date	Comments
	The Jasper Fire was located in Custer County in the Southwest Black Hills. It was the largest fire to occur in the Black Hills in at least a century. The fire started at about 2:30 p.m. on August 24, 2000, and was contained on September 8, 2000. The cause of the fire was arson. The weather was very hot and dry, vegetation moisture was at record low levels, and atmospheric conditions were very unstable. The conditions caused extreme fire behavior and the fire spread rapidly, doubling in size every hour on the day it started. Almost immediately after ignition, the fire spread into the tops of the trees and blowing embers began causing spot fires ahead of the main fire. The fire created its own weather pattern as it burned. Lightning from the storm created by the fire was a big concern. The fire completely blackened some areas, leaving scorched, dead trees and ash-covered ground in its wake. Other areas experienced only a light ground burn. Large areas within the fire perimeter remained green, either lightly burned or completely undamaged. Firefighting efforts continued for a month, and firefighters declared the fire controlled on the evening of September 25, 2000. The Jasper fire burned 83,500 acres and was the largest fire in Black Hills history. It destroyed one summer cabin and three outbuildings, burned acreage at the Jewel Cave National Monument, and threatened more than 100 other structures and the communities of Custer and Hill City. Fire losses included approximately 244 million board feet of timber, 150 miles of range fence, 65 livestock water tanks, 20 miles of range water lines, 17 wildlife water developments, 59 wooden power line structures, and 2,738 feet of above ground telephone line. Total outlay for both fires: $4.25 million
1997	69 fires burned 1,353.65 acres.
1994	201 fires burned 2,663 acres [includes Stagebarn Canyon].
August 15, 1994	**Stagebarn Canyon Fire (FEMA-2109-FSA)** Stagebarn Canyon near Indian Hills subdivision northwest of Rapid City. Fire started by lightning. 112 acres burned; cost in excess of $159,000.
1993	44 fires burned 678 acres.
1992	958 fires burned 20,367 acres.
1991	815 fires burned 43,782 acres.
September 1990	**Swedlund Fire (FEMA-2076-FSA)**
1990	860 fires burned 11,725 acres.
1989	911 fires burned 14,779 acres.
1988	1,171 fires burned 69,512 acres.
July 1988	**Galena Fire** 16,788 acres burned in Custer State Park (http://thune.senate.gov/public/index.cfm?FuseAction=PressReleases.Detail&PressRelease_id=427&Month=3&Year=2007)
Jul 25, 1988	**Westberry Trail Fire (FEMA-2068-FSA)** Suspected arson fire and was located in a subdivision on the western edge of Rapid City. Burned 14 homes and 3,980 acres.
Jul 20, 1987	**Battle Mountain Fire (FEMA-2061-FSA)** Started by lightning in the game production area, two miles from Hot Springs. Burned 2,200 acres.
1987	1,638 fires burned 52,277 acres.
1986	478 fires burned 3,572 acres.

Date	Comments
July 1985	**Flint Hill Fire (FEMA-2057-FSA)**
July 1985	**Seven Sisters Fire (FEMA-2056-FSA)**
1985	1,229 fires burned 110,669 acres.
1984	651 fires burned 28,230 acres.
1983	950 fires burned 18,613 acres.
1982	403 fires burned 6,886 acres.
1981	1,556 fires burned 24,537 acres.
1980	1,349 fires burned 42,077 acres.
1979	485 fires burned 14,214 acres.
1978	479 fires burned 48,290 acres.
1977	535 fires burned 6,952 acres.
1976	582 fires burned 9,130 acres.
July 1975	**Custer State Park (FEMA-2017-FSA)**
1975	851 fires burned 30,671 acres
July 1974	**Argle & Booms Canyon (FEMA-2016-FSA)**
1974	1,022 fires burned 38,864 acres.
1973	704 fires burned 36,252 acres.
1972	452 fires burned 13,638 acres.
1971	815 fires burned 20,890 acres.
1970	477 fires burned 6196 acres.
1969	211 fires burned 3254 acres.
November 21, 1962	Burned an area that stretched from Harrold to Highmore (20 miles long) and consumed 30,000 acres of hay and cropland. No loss of life.
September 8, 1959	This human-caused fire nearly destroyed the town of Deadwood. The fire burned 4,500 acres (1,971 federal, 2,560 private) around the town and did more than $1 million (1959 dollars) in damage. More than 60 structures (businesses, residences, utilities, etc.) were destroyed and damage to infrastructure was severe. Nearly 4,000 people were evacuated from the town in less than 30 minutes. Source: Jerome Harvey, "Historic Wildfire in the Black Hills" (www.nfpa.org/assets/files/PDF/blackhills.pdf)
March 1879	This fire burned for at least one week in an area from Brookings County to Union County. The path was over 100 miles long and 20 miles wide.

Probability

As shown in the differences in fires reported in Table 3-10 and Table 3-11, wildfire reporting in the State varies regionally. Given the data in Table 3-10, between 1977 and 2000 the Black Hills area averaged 167 fires per year, averaging 170 acres per fire. Table 3-11 focuses on major fires in the State. Using the data in Table 3-11 (excluding the outlier of the 1879 fire), there were 51 wildfire events in South Dakota between 1959 and 2007 (48 years). Given both sets of data, wildfires, including those of a significant size, have a 100 percent chance of occurrence somewhere in the state from early spring to late fall every year.

Drought

Description

According to the National Weather Service, "Drought is a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage causing adverse impacts on vegetation, animals, and/or people. It is a normal, recurrent feature of climate that occurs in virtually all climate zones, from very wet to very dry. Human factors, such as water demand and water management, can exacerbate the impact that drought has on a region." Four common types of drought are defined below.

- Meteorological drought is most often described in terms of dryness and the duration of the dry period. Other types of drought typically begin with a meteorological drought.
- Hydrological drought usually occurs as a result of precipitation shortfalls that negatively impact water supply.
- Agricultural drought links impacts on agriculture to meteorological or hydrological drought with a focus on precipitation shortages, soil water deficits, reduced water levels needed for irrigation, etc.
- Socioeconomic drought refers to the situation that occurs when physical water shortages begin to affect people.

South Dakota is vulnerable to the social, economic, and environmental impacts of drought. Specifically, drought in South Dakota means limited water availability for people, agriculture, and recreation. The demand for water for multiple uses also impacts water availability. Rural water systems designed largely to supply water for people are now also being used for cattle and to fight wildfires, taxing the limits of the systems. These problems are only expected to get worse in the years to come as populations grow.

Drought in South Dakota is often accompanied by periods of extreme heat. According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Heat kills by taxing the human body beyond its abilities. In a normal year, about 175 Americans succumb to the demands of summer heat. According to the National Weather Service (NWS), among natural hazards, only the cold of winter—not lightning, hurricanes, tornadoes, floods, or earthquakes—takes a greater toll. 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 heat wave of 1980, more than 1,250 people died.

Heat 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 heat gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise and heat-related illness may develop. Elderly persons, small children, those with chronic illnesses, those on certain medications or drugs, and persons with weight and alcohol problems are particularly susceptible to heat reactions, especially during heat waves in areas where moderate climate usually prevails. The chart below illustrates the relationship of temperature and humidity to heat disorders.

Figure 3-13 National Weather Service Heat Index

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

Source: National Weather Service

Note: Heat Index (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.

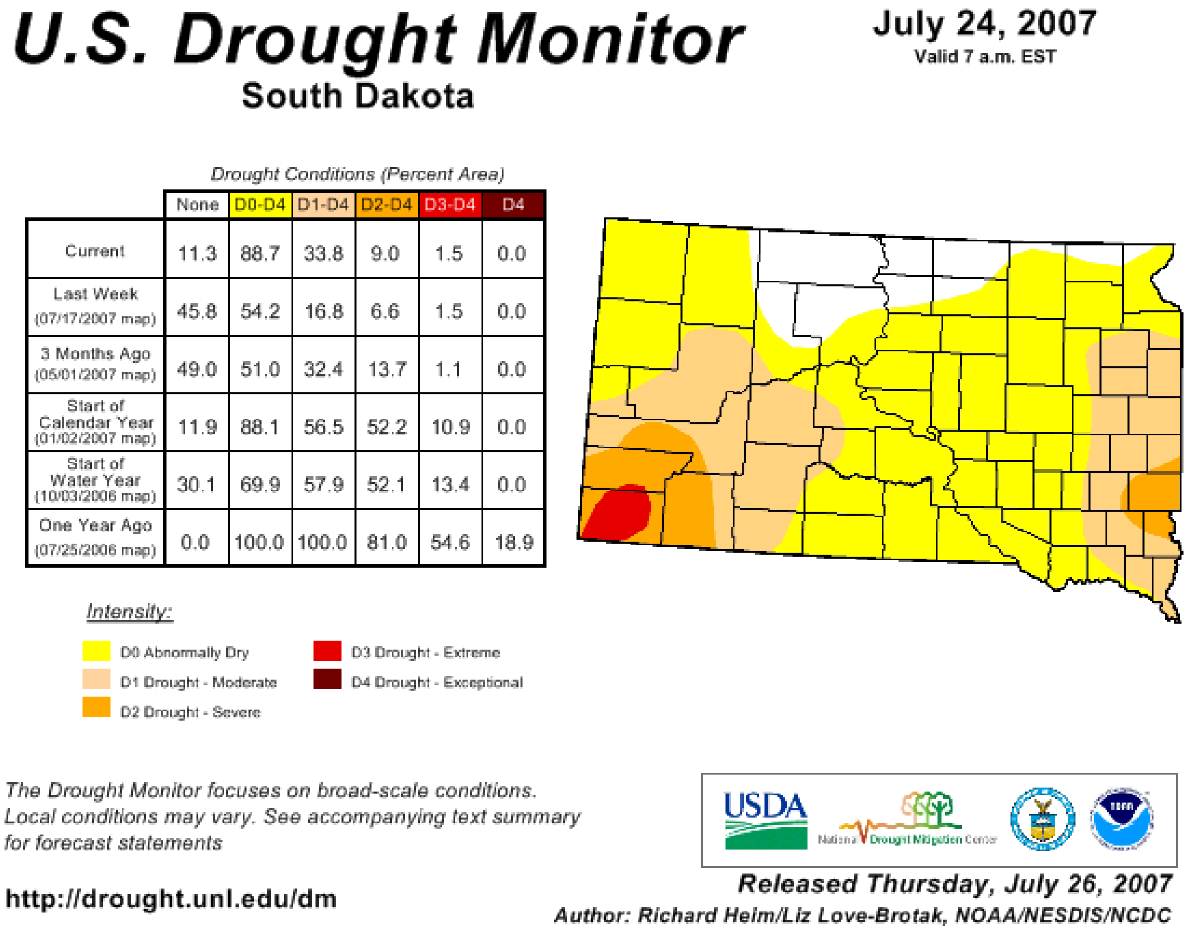
The NWS has in place a system to initiate alert procedures (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for the issuance of excessive heat alerts is when the maximum daytime high is expected to equal or exceed 105°F and a nighttime minimum high of 80°F or above is expected for two or more consecutive days.

Location

The whole state of South Dakota is susceptible to drought, but there is a difference in how. Drought in the eastern part of the state is largely an issue for row crops. Water availability in Sioux Falls, and other areas that get their water from the Big Sioux River, is also becoming an issue as population grows. In the west, the concern is the need for water for people and rangeland. Rapid City, in the Black Hills, is also experiencing water availability issues related to growth that is exacerbated by years of below average rain and snowfall. Periods of drought can vary region by region in terms of length and severity.

South Dakota had been experiencing some level of drought between 2002 and 2007. Some years have been worse than others, and some areas have been harder hit than others, but there has not been any real wet periods until recent years. The U.S. Drought Monitor summarizes current drought conditions, and also allows comparison of current drought conditions to past drought conditions. It is produced collaboratively by the U.S. Department of Agriculture, NOAA, and the National Drought Mitigation Center at the University of Nebraska–Lincoln based on multiple drought indicators. South Dakota's drought status for July 24, 2007 is shown in Figure 3-14. This was the most recent drought to affect South Dakota.

Figure 3-14: South Dakota Drought Status, July 24, 2007

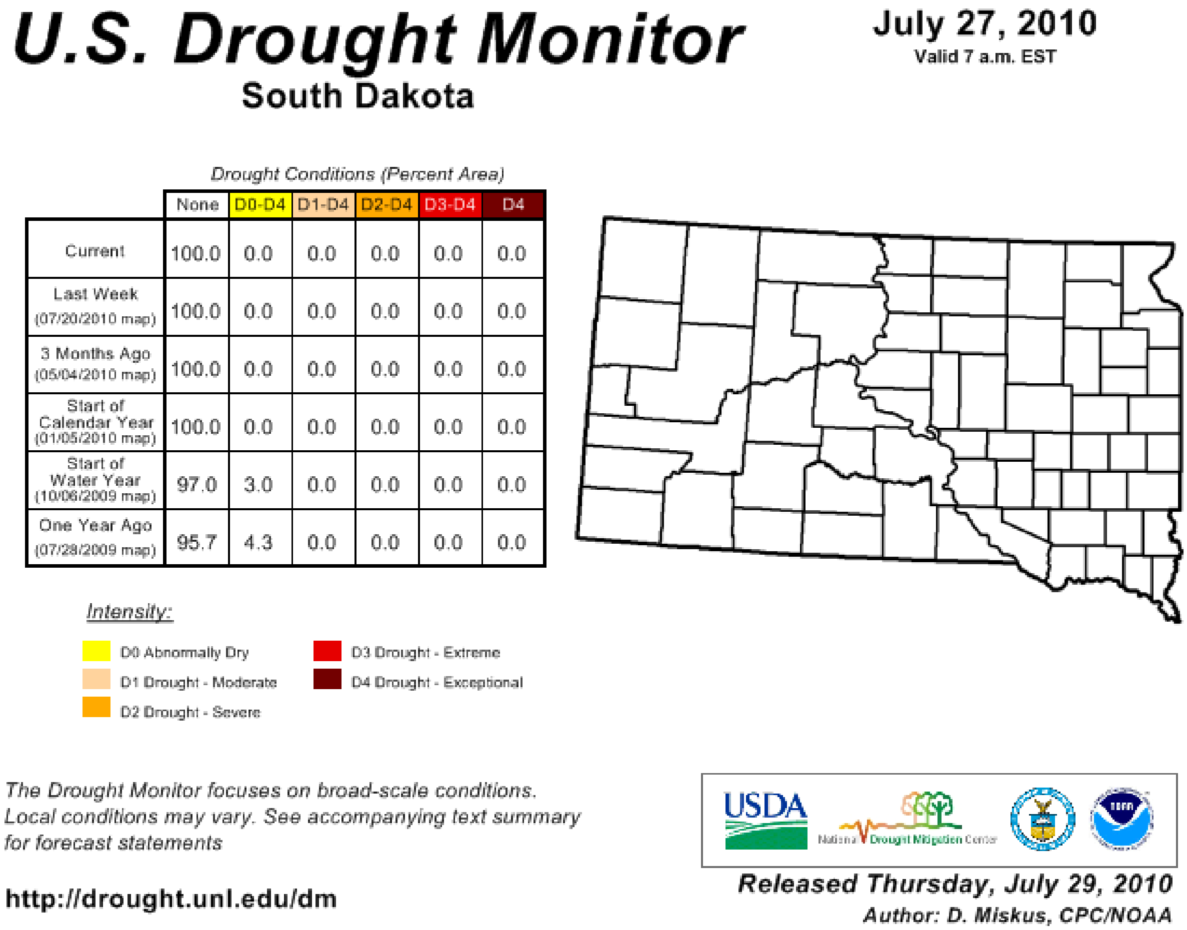


	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	11.3	88.7	33.8	9.0	1.5	0.0
Last Week (07/17/2007 map)	45.8	54.2	16.8	6.6	1.5	0.0
3 Months Ago (05/01/2007 map)	49.0	51.0	32.4	13.7	1.1	0.0
Start of Calendar Year (01/02/2007 map)	11.9	88.1	56.5	52.2	10.9	0.0
Start of Water Year (10/03/2006 map)	30.1	69.9	57.9	52.1	13.4	0.0
One Year Ago (07/25/2006 map)	0.0	100.0	100.0	81.0	54.6	18.9

Source: University of Nebraska–Lincoln National Drought Mitigation Center
http://drought.unl.edu/dm/DM_state.htm?SD,HP

The Drought Monitor graphic in Figure 3-14 illustrates South Dakota's drought status as of July 24, 2007. Figure 3-15 shows the state's drought status as of July 27, 2010. Together the two graphics show how intensity and coverage varies over time, and how drought conditions have improved since 2007.

Figure 3-15: South Dakota's Drought Status, July 27, 2010



Source: University of Nebraska–Lincoln National Drought Mitigation Center
http://drought.unl.edu/dm/DM_state.htm?SD,HP

Historical drought information for South Dakota is difficult to find. An article in the *Proceedings of the South Dakota Academy of Science* suggests that South Dakota has seen droughts worse than the 1930's Dust Bowl. The article is based on a study of tree core data conducted to learn more about historical drought in South Dakota. The results of the study are illustrated in Table 3-12. According to the National Drought Monitor, South Dakota is not in a drought and has not been for the summers of 2008 and 2009.

Table 3-12: Duration and Magnitude Estimates of 15 Dry and 15 Wet Spells in South Dakota

	Dry Periods			Wet Periods		
Rank	**Years**	**No. Years**	**% of Max**	**Years**	**No. Years**	**% of Max**
1	1531-1551*	21	100.0	1429-1448*	20	100.0
2	1325-1344*	20	90.8	1284-1297*	14	80.3
3	1859-1873	15	82.5	1559-1574*	16	66.0
4	1397-1411*	15	73.0	1609-1617	9	53.6
5	1710-1725	16	65.8	1762-1769	8	35.7
6	1780-1791	12	51.3	1882-1892	11	31.5

	Dry Periods			Wet Periods		
Rank	Years	No. Years	% of Max	Years	No. Years	% of Max
7	1933-1942	10	50.0	1683-1695	12	30.0
8	1753-1761	9	43.5	1792-1806	15	28.1
9	1660-1668	9	44.7	1903-1910	8	27.2
10	1580-1598*	9	32.2	1962-1969	8	26.1
11	1852-1857	6	29.7	1773-1779	7	24.4
12	1956-1961	6	29.6	1832-1842	11	21.1
13	1467-1472*	6	27.0	1726-1733	8	21.0
14	1377-1388*	12	26.3	1943-1947	5	20.6
15	1637-1640	4	24.8	1641-1645	5	19.5

Source: Bunkers, M.J., L.R. Johnson, J.R. Miller, and C.H. Sieg. 1999. Old Black Hills Ponderosa Pines Tell a Story. *Proceedings of the South Dakota Academy of Science*, Vol. 78.
Note: *Sample size <5 trees and is likely not adequate to reliably infer precipitation patterns.

The National Drought Mitigation Center's Drought Impact Reporter contains information on 288 drought impacts from droughts that affected South Dakota between January 1, 1980 and July 2010. Most of the impacts, 93, were classified as "agriculture." Other impacts include "water/energy" (50), "social" (29), "fire" (37), "environment" (20), and "other" (59). These categories are described as follows:

- **Agriculture**—Impacts associated with agriculture, farming, and ranching. Examples include damage to crop quality, income loss for farmers due to reduced crop yields, reduced productivity of cropland, insect infestation, plant disease, increased irrigation costs, cost of new or supplemental water resource development, reduced productivity of rangeland, forced reduction of foundation stock, closure/limitation of public lands to grazing, high cost/unavailability of water for livestock, and range fires.
- **Water/Energy**—Impacts associated with surface or subsurface water supplies (i.e., reservoirs or aquifers), stream levels or streamflow, hydropower generation, or navigation. Examples include lower water levels in reservoirs, lakes, and ponds; reduced flow from springs; reduced streamflow; loss of wetlands; estuarine impacts; increased groundwater depletion, land subsidence, reduced recharge; water quality effects; revenue shortfalls and/or windfall profits; cost of water transport or transfer; cost of new or supplemental water resource development; and loss from impaired navigability of streams, rivers, and canals.
- **Environment**—Impacts associated with wildlife, fisheries, forests, and other fauna. Examples include loss of biodiversity of plants or wildlife; loss of trees from urban landscapes, shelterbelts, wooded conservation areas; reduction and degradation of fish and wildlife habitat; lack of feed and drinking water; greater mortality due to increased contact with agricultural producers, as animals seek food from farms and producers are less tolerant of the intrusion; disease; increased vulnerability to predation; migration and concentration; and increased stress to endangered species.
- **Fire**—Impacts associated with forest and range fires that occur during drought events. The relationship between fires and droughts is very complex. Not all fires are caused by droughts and serious fires can result when droughts are not taking place.
- **Social**—Impacts associated with the public, or the recreation/tourism sector. Examples include health-related low-flow problems (e.g., cross-connection contamination, diminished sewage flows, increased pollutant concentrations, reduced fire fighting capability, etc.), loss of human life (e.g., from heat stress, suicides), public safety from forest and range fires, increased respiratory ailments;

increased disease caused by wildlife concentrations, population migrations, loss of aesthetic values; reduction or modification of recreational activities, losses to manufacturers and sellers of recreational equipment, and losses related to curtailed activities.

- **Other**—Drought impacts that do not easily fit into any of the above categories.

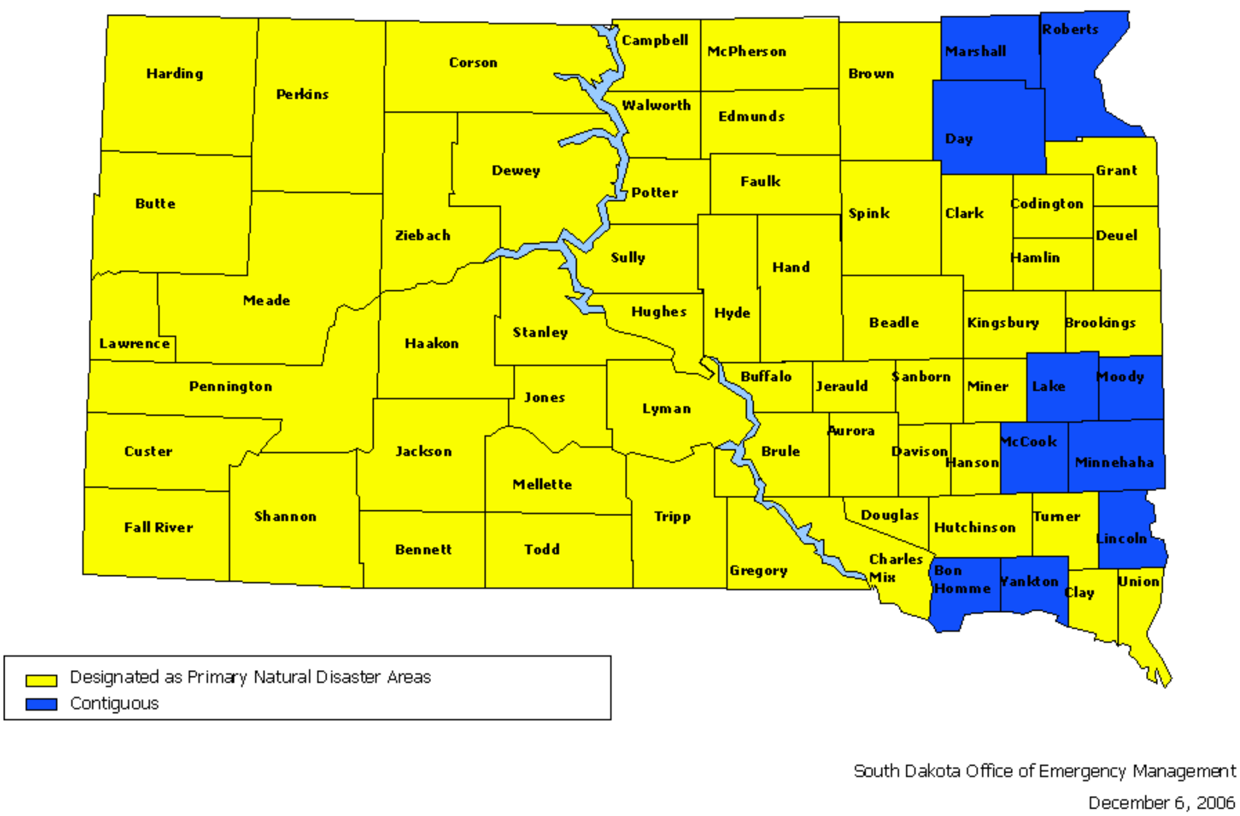
Table 3-13: South Dakota Droughts

2007	Drought continued in some areas of South Dakota. The July 24, 2007, Drought Monitor for South Dakota (Figure 3-15) showed that drought encompassed most of the state. Most of Fall River County was experiencing severe drought conditions that also reached north into southern Custer County.
2006	Fifty-six counties designated primary natural disaster areas by the USDA. The other 10 were contiguous to primary natural disaster areas and thus also eligible for assistance. For many areas, this was their seventh consecutive year of drought. The National Weather Service cooperative observer 8 miles north-northwest of Usta in Perkins County recorded a maximum temperature of 120 degrees on July 15th, which tied the previous all-time record high in South Dakota, first set on July 5th, 1936 in Gann Valley. A woman died of heat exhaustion while hiking in the Badlands National Park on July 16th.
2005	Fifteen counties designated primary natural disaster areas by the USDA. Twenty nine were contiguous to primary natural disaster areas and thus also eligible for assistance. In 2005, the Missouri River basin had experienced five consecutive years of below normal runoff. System storage was at a record low due to the combined impact of the drought and water allocation decisions made during the drought. Impacts included reduced hydropower production, loss of fish production, unusable boat ramps, and irrigation water supply problems. Source: South Dakota Engineer Society
2004	Thirty-four counties designated primary natural disaster areas by the USDA. Eighteen were contiguous to primary natural disaster areas and thus also eligible for assistance.
2003	Forty-three counties designated primary natural disaster areas by the USDA. Twenty were contiguous to primary natural disaster areas (in South Dakota or neighboring states) and thus also eligible for assistance.
2002	Many areas in South Dakota were devastated by drought in 2002. After a dry winter and spring, below normal rainfall for June brought severe drought conditions to the area. Much of the rainfall for June was below 50 percent of normal with much of the area receiving 20 to 40 percent of the normal rainfall. Some locations were at 10 to 15 percent of normal rainfall. Central and north central South Dakota were the hardest hit with the drought conditions. As a result of the severe dryness, a lot of grazing land and stock ponds dried up, and ranchers had to buy additional feed for their animals, transport them to healthier pastureland for grazing, or sell their herds prematurely. Crops suffered with much having to be cut up for hay or replanted. Water levels on lakes and rivers were also way down. Burn bans and voluntary or mandatory water restrictions were implemented across much of the area. All counties were declared drought disasters.
May/July 1992	Twenty-eight counties declared by governor as drought disaster areas: Aurora, Bon Homme, Buffalo, Butte, Campbell, Charles Mix, Corson, Dewey, Douglas, Edmunds, Haakon, Hand, Harding, Hughes, Hyde, Jackson, Jerauld, Jones, Lawrence, Lyman, Meade, Perkins, Stanley, Sully, Todd, Tripp, Walworth, and

	Ziebach.
1988	Statewide. Regional impact varied.
1985–1987	Western half of state during 1985; continued in Black Hills during 1986 and 1987. Rated as a 10- to 25-year event.
1980–1982	Statewide. Rated as a 10- to 25-year event. Most severe in 1981.
1973–1977	Statewide, except Black Hills. Rated as a 10- to 25-year event. Most severe in 1976. Includes drought emergency declaration (FEMA-3015-EM) in 1976.
1954–1962	Statewide. Rated as a 25-year event. Regional variations. Most severe in 1956 and 1959, except in the Black Hills where it was most severe in 1961.
1929–1942	Statewide. Rated as greater than a 25-year event. Dust Bowl years. Regional impact varied a little. Most severe in 1931, 1933, 1934, and 1936. Included in this period was a "plague" of grasshoppers.
1910–1914	Western half of state. Regional impact varied. Most severe in 1911.
1889–1905	Statewide. Regional impact varied. Most severe between 1894 and 1896 and 1898 and 1901.

Source: NCDC

Figure 3-16: South Dakota Counties Declared in 2006 by U.S. Department of Agriculture for Drought Assistance



Probability

Based on the tree ring research, which spans a period of roughly 400 years, multi-year droughts as significant as the 1930's drought or worse occur on average every 57 years. Based on historical records

(10 in the past 118 years, counting the 2003-2007 dry spell and other multi- year events as one event) notable droughts have occurred somewhere in the state on average about every 12 years, which is equivalent of an 8% chance any given year. Inadequate data on past impacts exists to calculate average annual losses, but it is assumed to be in the millions of dollars.

Tornado

Description

The National Oceanic and Atmospheric Administration (NOAA) defines a tornado as a violently rotating column of air extending from a thunderstorm to the ground. The most violent tornadoes are capable of tremendous destruction with wind speeds of 250 mph or more. Damage paths can be in excess of one-mile wide and 50 miles long. In an average year, about 1,000 tornadoes are reported across the United States, resulting in approximately 80 deaths and more than 1,500 injuries.

Though climate data is available to explain a predisposition to tornadoes, there is no accurate way of predicting when or where a tornado may occur. Tornado systems have been linked to the development of temperature and wind flow patterns in the atmosphere, which can cause moisture, instability, lift, and wind shear (NOAA). Expert predictions of these conditions begins first by modeling in the long term and relying on critical analysis of satellite data, weather stations, balloon packages, airplanes, wind profilers, and radar-derived winds to pinpoint storm activity for the short term (NOAA).

Tornadoes typically occur in South Dakota in May, June, and July, but they can occur in any month. The greatest period of tornado activity (about 82 percent of occurrence) is from 11 a.m. to midnight. Within this time frame, most tornadoes occur between 4 p.m. and 6 p.m.

Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis, better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado. Table 3-14 shows the wind speeds associated with the original Fujita scale ratings and the damage that could result at different levels of intensity. Table 3-15 shows the wind speeds associated with the Enhanced Fujita Scale ratings. The Enhanced Fujita Scale's damage indicators and degrees of damage can be found online at www.spc.noaa.gov/efscale/ef-scale.html.

Table 3-14: Original Fujita Scale

Fujita (F) Scale	Fujita Scale Wind Estimate (mph)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/f-scale.html

Table 3-15: Enhanced Fujita Scale

Enhanced Fujita (EF) Scale	Enhanced Fujita Scale Wind Estimate (mph)
EF0	65-85
EF1	86-110
EF2	111-135
EF3	136-165
EF4	166-200
EF5	Over 200

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/ef-scale.html

Location

Tornado disasters are often associated with Tornado Alley (the area from the Gulf to the Northern Great Plains that has high tornado incidence). South Dakota sits in the northern region of Tornado Alley and is susceptible to the specific conditions to which the formation of tornadoes has been attributed: warm Gulf air coming in contact with cool Canadian air fronts and dry air systems from the Rocky Mountains. The intersection of these three systems produces thunderstorm conditions that can spawn tornadoes. According to NOAA, tornadoes can occur at any location and from a wide variety of conditions. Western South Dakota, though not in the Tornado Alley, is still vulnerable to tornadoes of different strengths.

Figure 3-17 illustrates the number of F3, F4, and F5 tornadoes recorded in the United States per 3,700 square miles between 1950 and 1998. Figure 3-18 illustrates the wind zones in the United States. By noting the South Dakota data from these two maps and matching them up in Table 3-16, it appears that approximately 90 percent of South Dakota has a high tornado risk and 10 percent has a moderate tornado risk. A very small area in the northwest corner of the state has a low tornado risk.

Figure 3-17: Tornado Activity in the United States

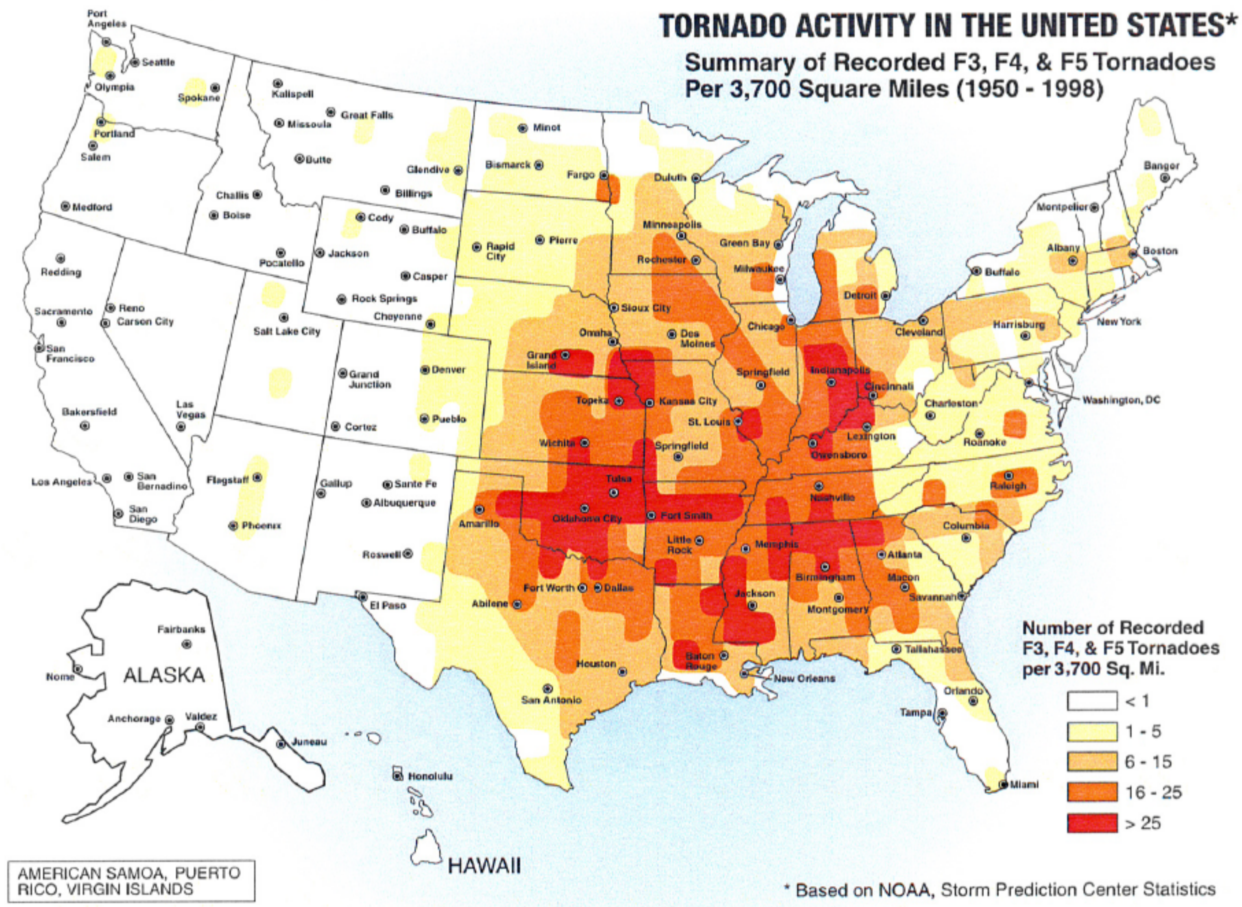
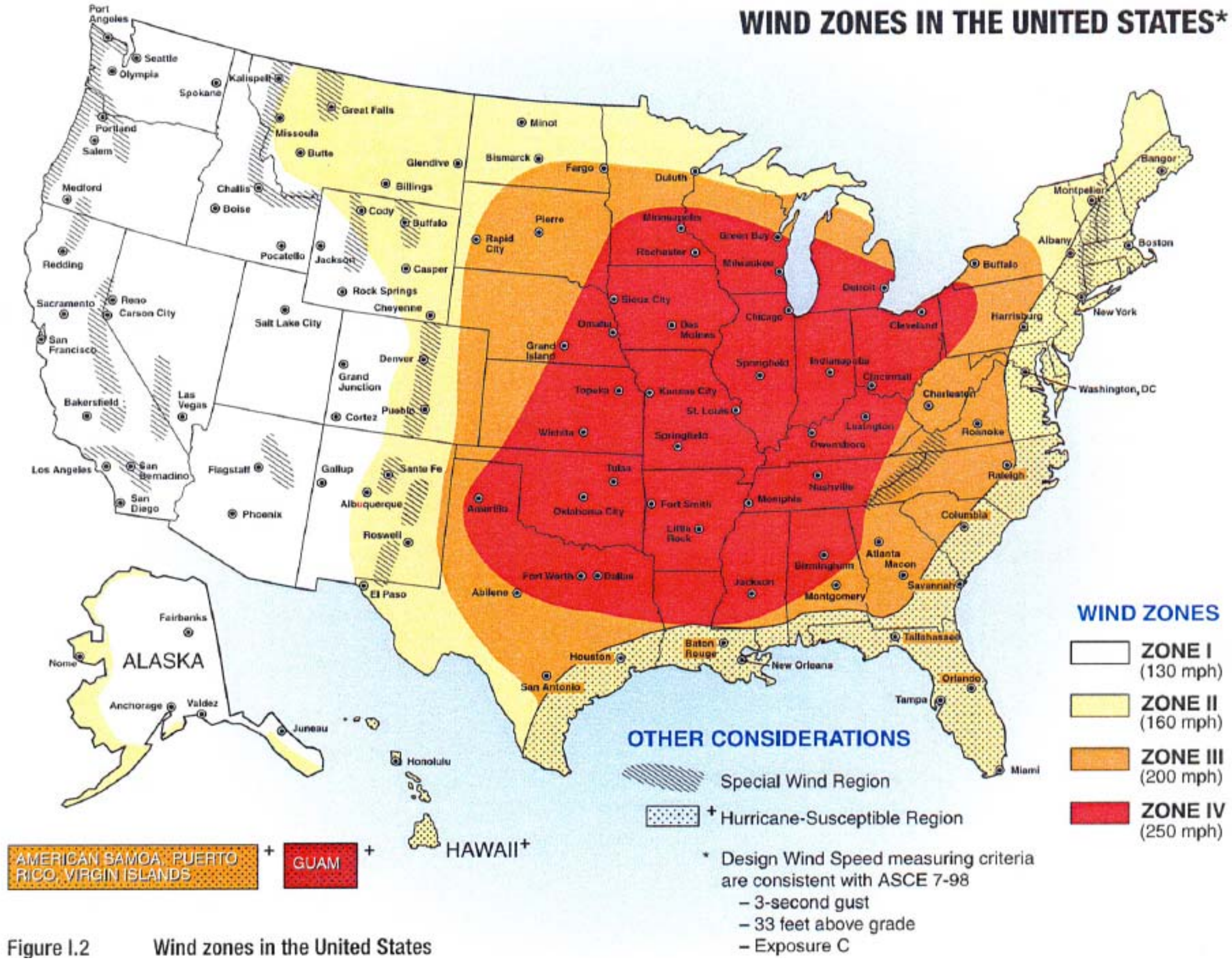


Figure I.1 The number of tornadoes recorded per 3,700 square miles

Source: Taking Shelter from the Storm (FEMA 2004)

Figure 3-18: Wind Zones in the United States



Source: Taking Shelter from the Storm (FEMA 2004)

Table 3-16: Wind Zones

Number of Tornadoes Per 3,700 square miles (See Figure 3-17)	Wind Zone (See Figure 3-18)			
	I	II	III	IV
<1	Low Risk	Low Risk	Low Risk	Moderate Risk
1-5	Low Risk	Moderate Risk	High Risk	High Risk
6-10	Low Risk	Moderate Risk	High Risk	High Risk
11-15	High Risk	High Risk	High Risk	High Risk
>15	High Risk	High Risk	High Risk	High Risk

Source: Taking Shelter from the Storm (FEMA 2004)

According to the National Climatic Data Center (NCDC) Storm Events database, there were 609 tornadoes in South Dakota between 1950 and April 2010 rated as an F1 or higher. Tornadoes reported in the database are in segments. One tornado can have multiple segments as the NCDC counts a new segment when county boundaries are crossed. So, the number of past occurrences is really a reflection of the number of past tornado segments. Total property damage for these events is estimated at $647.5 million in 2009 dollars. There were 17 deaths and 441 injuries in this time period. This number increases to 18 deaths and 450 injuries if all tornado events, including those smaller than an F1, are recorded. This suggests that South Dakota experiences 10 tornadoes of F1 intensity or greater, $3.9 million dollars in tornado property losses, and eight injuries each year. See Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction for more information about how tornadoes affect individual counties. Figure 3-19 shows the number of tornadoes by county between 1950 and 2008. Figure 3-20 shows tornado paths of individual tornadoes where data was available.

Figure 3-19: South Dakota Tornadoes by County, 1950-2008

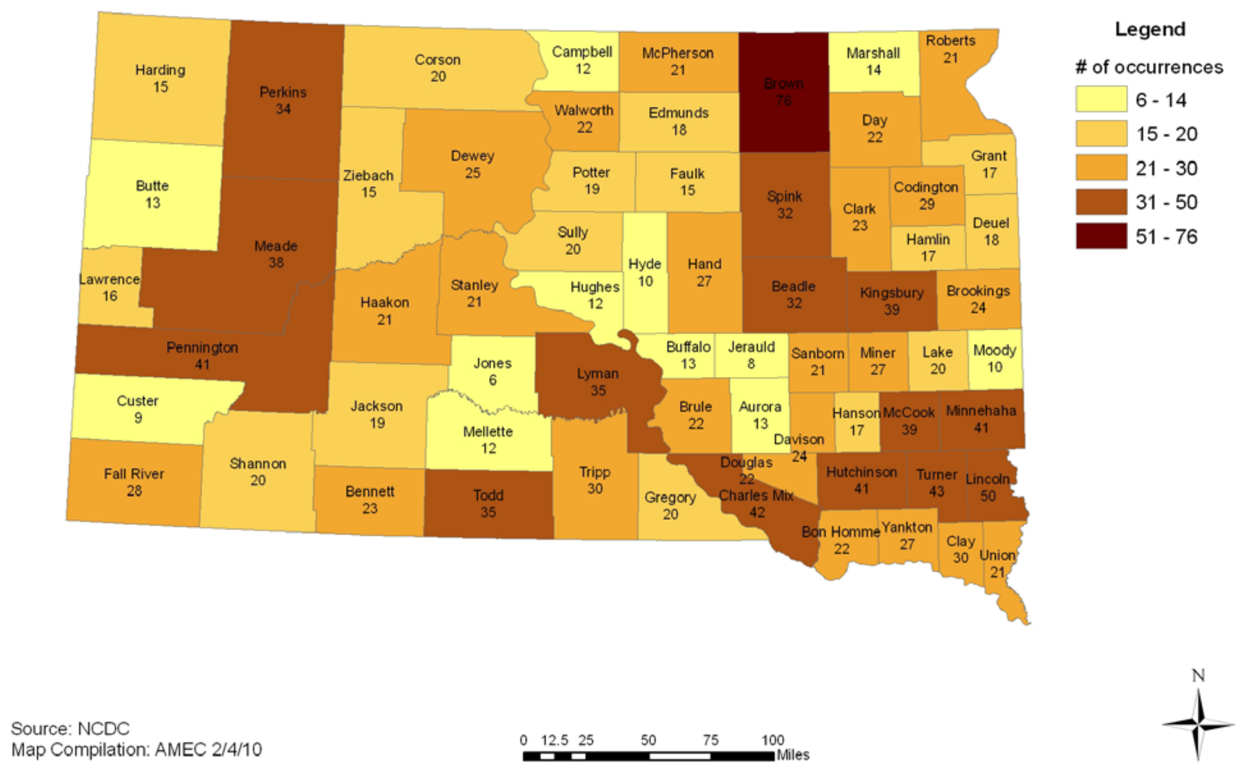


Figure 3-20 Tornado Paths in South Dakota 1953-2009

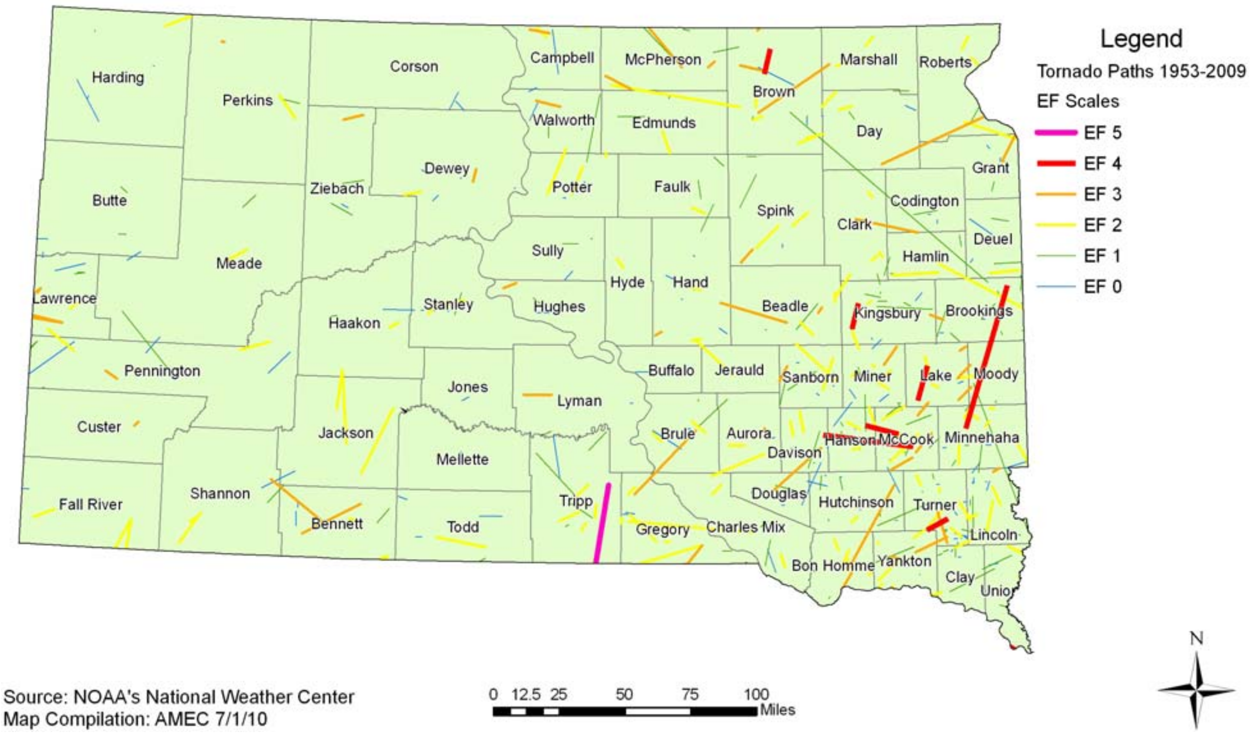


Table 3-17: South Dakota Tornadoes

Date	Comments
June 16, 2010	**FEMA-1929-DR** An intense low pressure system developed across the northern Plains states and impacted the region on June 17. At least 61 tornadoes were reported that afternoon and evening across North Dakota, South Dakota, and Minnesota. A supercell around Dupree and Faith spawned 16 or more tornadoes, with 4 and possibly 5 on the ground at the same time.
May 22, 2010	Severe weather shifted north as a low pressure system tracked across the northern Plains states on May 22. Isolated tornadoes were reported across portions of central South Dakota that afternoon. The most intense supercell produced a long-lived wedge tornado in and around Bowdle, South Dakota where numerous houses and farm buildings were destroyed and cars were thrown into the air. It was rated as an EF4, but fortunately remained in rural areas and no injuries were reported
July 9, 2009	Severe storms developed over Fall River County and moved eastward across southwestern and south central South Dakota. The storms produced large hail and strong wind gusts. Two tornadoes were observed in Todd County and two tornadoes touched down in southern Tripp County. A small tornado touched down on a farm west of the intersection of 286th Street and 313th Avenue. The tornado blew a garage off its foundation, tipped over a combine, and snapped large cottonwood trees.
May 12, 2009	An F1 tornado travelled for eight miles with a width of 200 yards. The tornado touched down west of Dupree and tracked eastward before dissipating northeast of Dupree. It dented several grain bins, blew over a small mobile home and semi

Date	Comments
	trailer truck, tore sheet metal off sheds, and toppled a large communications tower.
June 5, 2008	An F1 tornado 100 yards wide damaged a path ten miles long. The tornado severely damaged a home, destroyed outbuildings, and damaged storage bins at a farm near Ravinia. The tornado also caused tree damage along its path. An F2 tornado caused damage to silos, farm buildings, power lines, and numerous trees southeast of Baltic.
May 29, 2008	An F-1 Tornado two miles long and 100 yards wide destroyed a barn, damaged or destroyed several outbuildings, scattered lumber across a field, and damaged trees and power lines. Damages were estimated at $100, 000.
May 5, 2007	**Severe Storms, Tornadoes, and Flooding (FEMA-1702-DR)** Twenty-five tornadoes were recorded in southeast South Dakota. It was the most significant tornado outbreak in southeast South Dakota since June 24, 2003. The strongest tornado, an EF-3, occurred in Aurora County. On the ground for five miles, it did its most significant damage to a pheasant hunting lodge/preserve, where numerous buildings and trees were severely damaged and numerous adult and chick pheasants were lost. Winds were estimated at around 140 mph. In Bon Homme County, an EF-2 tornado was on the ground for six miles, severely damaging many homes, barns, out-buildings, and trees. An EF-2 tornado traveled through both McCook and Hanson Counties and was observed to be very large before it dissipated. Most of the damage was to trees and a junk yard. In western Hanson County, an EF-1 tornado damaged trees and took a roof off a building. In Yankton County, a tornado began at the Lewis and Clark Recreation Area and resulted in considerable tree damage and damage to homes. It was on the ground for approximately four miles. For a while, it was joined by a second tornado. These tornadoes were determined to be EF-1s based on the damage homes. Source: NWS Sioux Falls
September 16, 2006	Seven tornadoes touched down over southeast South Dakota. The strongest, an F2, was in McCook County and damaged several buildings and killed several cattle. An F1 tornado in Minnehaha County damaged some buildings and downed power lines. There was no damage reported from the other storms (F0s). Source: NWS Sioux Falls
August 26, 2006	Severe weather in east central South Dakota produced at least three tornadoes. In Beadle County, two tornadoes did considerable damage to farmsteads, power lines, and crops. One was a 24.5 mile long-track F2/F3 tornado with winds up to 200 mph that measured between 400 and 500 yards at its widest. Another tornado touched down in Kingsbury County, but did little to no damage. Source: NWS Sioux Falls
May 2, 2006	An F1 tornado touched down in Kingsbury County. While the tornado was generally F0, there were a couple of periods where it approached F1 intensity. It hit a hog operation, destroying a barn and two other outbuildings, downing several trees, and killing numerous hogs. Source: NWS Sioux Falls
June 24, 2003	Sixty seven tornadoes touched down in South Dakota on this day. This rare occurrence tied the U.S. record at the time for the most tornadoes within a state in a 24-hour time period. However, the 67 tornado touchdowns recorded that day occurred in a period of less than eight hours. The strongest of the 67 tornadoes was an F4,

Date	Comments
	which destroyed the town of Manchester and injured five people. Winds were estimated to be between 207 and 260 mph. The tornado warning issued by the National Weather Service in Sioux Falls provided the residents of Manchester with 28 minutes of advance warning. The National Weather Service offices in Aberdeen and Sioux Falls issued more than 350 warnings, statements, and storm reports on the evening of June 24. The 67 tornado touchdowns recorded that day represented a significant portion of the 85 total tornado touchdowns recorded for all of 2003. Despite the historic events of this day and the destruction of the town of Manchester, no presidential disaster declarations were issued.
June 23, 2002	Four separate tornado tracks and two satellite tornadoes were confirmed across McPherson and Brown counties. The first was an F0, the second an F1, the third an F3, and the fourth an F4. This was the first F4 tornado recorded in Brown County. Source: NWS Aberdeen
July 27, 2001	In Lincoln County, an F1 tornado downed numerous trees and damaged storage sheds and buildings along Main Street in Lennox, including the VFW (Veterans of Foreign Wars). Source: NWS Sioux Falls
July 11, 2000	An F2 tornado hit Lake County and damaged the Lake County Speedway. Source: NWS Sioux Falls
June 4, 1999	**Severe Storms, Flooding, and Tornadoes (FEMA-1280-DR)** A deadly tornadic storm moved across southwest South Dakota during the late afternoon and evening of June 4. Multiple tornadoes (F1 and F2) were observed from several supercells that moved toward the northeast from west of Chadron, Nebraska, to near Kyle, South Dakota, between 5:30 and 8:00 p.m. The most severe damage occurred where the paths of these storms passed near the community of Oglala in Shannon County, South Dakota. Oglala was heavily impacted by the tornadoes as were other smaller communities on the Pine Ridge Indian Reservation. The Red Cross estimated that 123 homes sustained major damage and an additional 139 sustained minimal damage. FEMA deemed 49 homes beyond repair and demolished them. In one area, all of the telephone poles were snapped and tossed, mobile homes were thrown over 100 yards with debris strewn over a quarter of a mile, and a newly framed house was leveled with wood projectiles in the ground 100 yards downwind. The total Public Assistance damage for the disaster was $1,029,000. One person was killed and over 40 were injured; 22 required medical attention at area hospitals. The fatality was the first from a tornado in western South Dakota since 1939 and only the third ever recorded in western South Dakota. Very large hail was also reported in the area. Grapefruit-sized hail was observed two miles west of Oglala with golf ball and baseball-sized stones reported in Oglala itself.
May–June 1998	**Flooding, Severe Storms, and Tornadoes (FEMA-1218-DR)** By late afternoon of May 30, 1998, the atmosphere over the north central United States had become favorable to a significant outbreak of severe weather. At approximately 8:40 p.m., following a series of thunderstorm warnings and numerous funnel sightings in the area, a violent tornado struck the town of Spencer, South Dakota, approximately 45 miles west northwest of Sioux Falls in extreme western McCook County. Deemed the deadliest tornado in recorded South Dakota history, the F4 tornado killed 6 people, injured more than one-third of the town's 320 residents, and destroyed most of the town's 190 buildings, including all public and numerous private facilities. Only 12 structures were left standing in the entire town of Spencer.

Date	Comments
	An assisted living center was destroyed, and since it had no basement, there was no protection from the tornado. Most of the fatalities were residents of the center. In addition to the town of Spencer, some farms in Hanson and McCook Counties were heavily damaged. Total damage was estimated at $18 million. During the storm, electrical service was out. Survivors reported that the warning siren system lost power prior to the touchdown of the tornado.
June 14, 1993	Pierre—Three homes damaged. No deaths. Arlington—Minor damage.
March 29, 1981	A winter storm front created a tornado near Martin, which destroyed a mobile home and injured one occupant.
May 12, 1984	Clark and Codington counties—18 to 20 farmsteads and homes were directly affected and ten homes severely damaged.
June 19, 1979	Watertown—Damage to trees, roofs, and power lines. Bon Homme, Turner, Yankton, Hanson, Sanborn counties—Tornado damage. Letcher—Tornado caused minor injuries with numerous reports of tree and building damage. Springfield—Tree damage.
June 1978	Aberdeen—On June 15 and 16, Aberdeen and Marshall County experienced tornadoes, hail, and some flooding. Five trailers were damaged by tornadoes. Marshall County had crop and building damage from hail and tornado winds.
Summer 1977	Arlington—Minor damage.
July 23, 1973	Ft. Pierre/Pierre—The tornado began in Ft. Pierre where it did minor damage; one grain elevator and a few mobile homes were affected. It jumped the Missouri River and then “skipped” through Pierre. Houses and businesses were damaged and a few homes were completely destroyed. Many mobile homes were either scattered about or piled upon one another. No deaths. Ten people were injured. Damage amounted to over half a million dollars.
June 18, 1967	Rapid City—One motel suffered heavy structural damage along with several other buildings in the city. No deaths. Three people were injured. Over $2 million in damage was done.
May 21, 1962	Gregory County—Several homes were destroyed as was farm equipment, automobiles, and livestock. Many miles of power poles and lines were also knocked down. Damage exceeded $500,000. Mitchell—Damage was estimated at about $2 million to Mitchell and the surrounding countryside.
July 31, 1949	Beresford and Elk Point—A series of tornadoes struck the countryside between Beresford and Elk Point in the southeast corner of the state. Property damage exceeded $1 million.
June 29, 1947	Howard and Carthage—Occurred in the rural area of Howard and Carthage. Damage was light. A barn and airplane hangar were damaged. One death resulted.
June 12, 1947	Turner/Yankton counties—The rural area of Turner/Yankton counties was struck by a tornado that did hundreds of thousands of dollars in damage. Barns, houses, and sheds were destroyed, and crop damage was listed as heavy. There were no recorded deaths or injuries.
July 9, 1932	South of Sioux Falls (Minnehaha County)—One person died, 11 were people injured, and damage was estimated at $150,000. A number of horses and cattle were killed or injured, buildings were knocked down, and telephone and power lines were destroyed. This tornado was from a storm that also dropped baseball-sized hail throughout the area.

Source: NCDC, unless otherwise noted.

Probability

According to the National Climatic Data Center, there were 1,592 tornadoes, of which 609 were F1 or higher, in South Dakota between 1950 and 2010 (61 years). Based on this information, the probability that at least one tornado will occur in South Dakota in any given year is 100 percent. Annualized losses are estimated at $3.9 million.

Windstorm

Description

Straight-line winds are generally any thunderstorm wind that is not associated with rotation (i.e., is not a tornado). It is these winds, which can exceed 100 mph, that represent the most common type of severe weather and are responsible for most wind damage related to thunderstorms. Since thunderstorms do not have narrow tracks like tornadoes, the associated wind damage can be extensive and affect entire (and multiple) counties. Objects like trees, barns, outbuildings, high-profile vehicles, and power lines/poles can be toppled or destroyed, and roofs, windows, and homes can be damaged as wind speeds increase. One type of straight-line wind is the downburst, which can cause damage equivalent to a strong tornado and can be extremely dangerous to aviation.

Thunderstorms over the Northern Plains typically happen between late April and early September, but, given the right conditions, they can develop as early as March. They are usually produced by supercell thunderstorms or a line of thunderstorms that typically develop on hot and humid days.

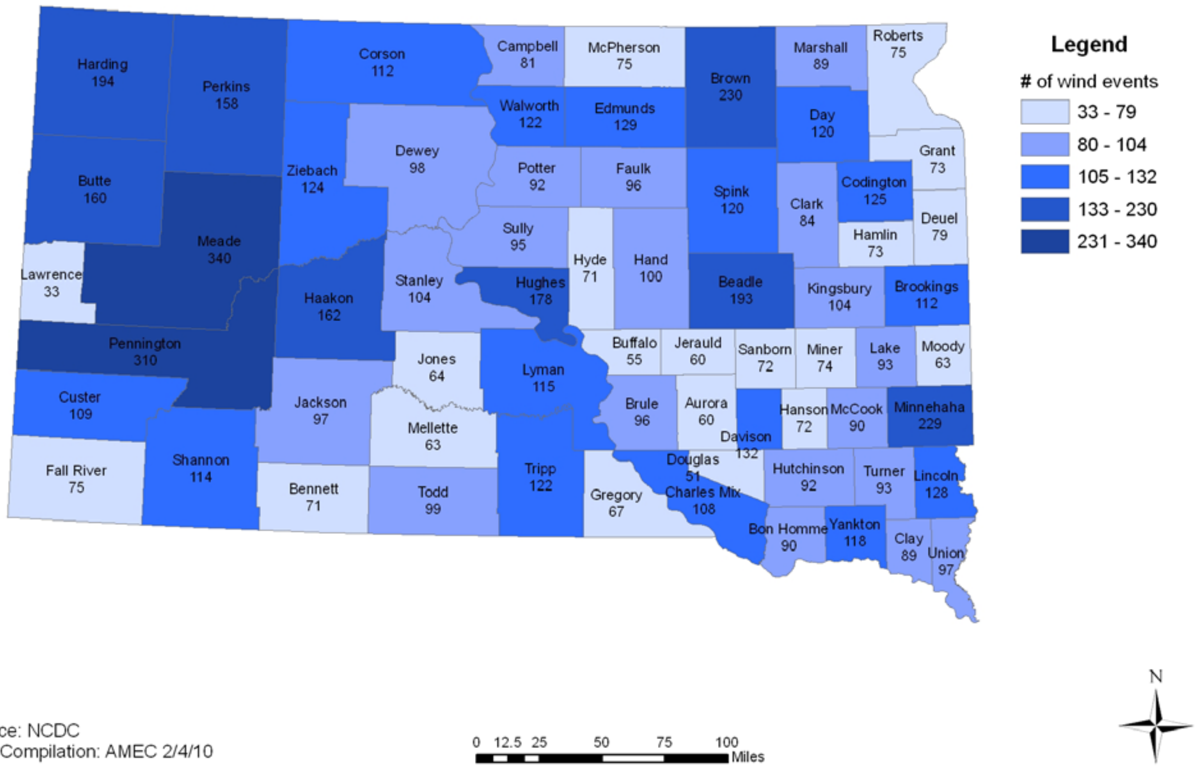
Location

All of South Dakota is susceptible to high wind events. Figure 3-18 in the tornado section above illustrates the wind zones in the United States. Most of South Dakota is in Zone III, which is susceptible to winds up to 200 mph. The westernmost part of the state is in Zone II, which is susceptible to winds up to 160 mph.

Past Events

According to the National Climatic Data Center Storm Events database, there were 5,675 windstorm events (5,263 thunderstorm wind, 407 high wind, and 5 strong wind events) in South Dakota between 1950 and April 2010. There were 9 deaths and 156 injuries in this time period. Total property and crop damage for events between 1993 (when damage figures began being kept) and 2010 is estimated at $97.9 million dollars. This suggests that South Dakota could experience 95 wind events, $5.8 million in wind losses, and approximately three injuries each year. See Section 3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction for more information about how wind affects individual counties. Figure 3-21 shows the number of wind events by county between 1955 and 2009.

Figure 3-21: South Dakota Wind Events by County, 1955 – 2009



Source: NCDC
Map Compilation: AMEC 2/4/10

Table 3-18: South Dakota Wind Events

August 7, 2009	A supercell thunderstorm developed across the northern Black Hills and moved eastward across the Sturgis area, southern Meade County, northeastern Pennington County, Haakon County, and northeastern Jackson County. The storm produced baseball sized near Sturgis, then strong winds of 61 knots and hail larger than baseball sized developed as the storm moved across the plains. The storm hit Sturgis during the annual motorcycle rally and caused extensive damage to motorcycles, vehicles, and property. Minor injuries from the hail were also reported.
July 13, 2009	High winds developed behind an exiting area of thunderstorms causing damage along with some injuries. Wind gusts to 50 to 70 mph were estimated or measured across parts of north central and northeast South Dakota. As a result, A mobile home was rolled twenty feet and destroyed by gradient winds associated with a wake low pressure area. The mobile home was not tied down and caught fire as it rolled into a propane tank. The three people inside the mobile home at the time all escaped with minor injuries.
October 26, 2008	Strong northwest winds reached sustained speeds of 40 mph or more with gusts to around 60 mph over all of southeast South Dakota during the morning and afternoon of October 26th.High winds sustained at 40 to 45 mph and gusting to over 60 mph caused damage to trees, shingles, and road signs. The tree damage included one very large weeping willow tree blown down in De Smet.

July 31, 2008	In the early morning hours of July 31st, a line of storms originating in North Dakota began to expand and surge southeast into northeast South Dakota. As the storms moved southeast, they began to tap into warmer, more humid air and rapidly evolve into a line of severe thunderstorms. Widespread damage occurred in a wide swath extending from Long Lake in McPherson County all the way into eastern Grant County and southern Big Stone County in Minnesota. The most extensive damage was generally found along and near US Highway 12 from Aberdeen to Milbank. Several observing stations in the path of this system measured wind speeds ranging from 70 mph to over 115 mph. Estimated wind speeds from damage surveys indicated even stronger winds with peak speeds of 120 mph. Over fifty communities in northeast South Dakota and the surrounding rural areas received minor to major tree and structural damage as straight line winds from 70 to 120 mph raced across the area. Webster and Waubay received the most extensive damage from the storms. Thousands of trees were snapped or uprooted, hundreds of grain bins were damaged or destroyed, hundreds of homes, businesses, and outbuildings were damaged or destroyed along with many power poles and miles of power lines downed. Many mobile homes, campers, and boats were damaged or destroyed along with many road and business signs. Countless homes, vehicles, and campers were also damaged by fallen trees. Thousands of acres of crops were also damaged or completely destroyed by the winds and hail. The greatest crop damage occurred in the Roslyn, Grenville, Eden, and Pickeral Lake areas in Marshall and Day counties. Many acres of corn were blown down and not able to come back. The large hail combined with the strong winds also broke out countless windows in homes and vehicles along with damaging the siding on homes. Thousands of people were left without power for up to several days. Large hay bales were moved up to 700 yards by the high winds. A semi was overturned on Highway 12 near Webster, injuring the driver. Near Milbank on Highway 12, two other semis were blown off the road resulting in injuries to both drivers. A State Forestry Specialist said it was one of the worst tree damage events he has ever seen in the Webster area. A fifty-eight year old man died two miles north of Waubay during the cleanup after the storms when he was pinned between a backhoe and a tree.
June 26, 2008	On the evening of 26 June 2008, a compact upper level low pressure system tracking through the Northern Plains interacted with a very moist and unstable airmass over western and central South Dakota resulting in a widespread severe weather outbreak. Three confirmed tornadoes occurred briefly in western Dewey County. Little or no damage was reported and all three tornadoes were rated EF-0. In addition to the tornadoes, multiple reports of large hail were received over Corson and Dewey Counties, including some to the size of

	baseballs near the communities of McLaughlin and Isabel. The large hail broke out many home and vehicle windows and damaged many roofs in Dewey, Corson, and Sully Counties. Significant wind damage occurred over sections of Sully County. There were multiple reports of wind gusts in excess of 70 mph, with the most concentrated swath of damaging winds extending from near Sutton Bay, eastward to the city of Onida, then southeast to the community of Harrold. The storm survey began near Sutton Bay on Lake Oahe, where a wind gust of 92 mph was recorded. The most significant property damage was found further east near the community of Agar where multiple grain bins were either damaged or destroyed. Nine miles west of Agar, a barn was destroyed and a large pine tree was snapped in half. Winds in this area were estimated to range from 80 to 100 mph. Near the intersection of Highways 1804 and 175th Street, several Western Area Power Administration (WAPA) electrical transmission towers were completely collapsed. This is consistent with wind speeds ranging from 130-140 mph. In the city of Onida a bank roof was damaged and the city was without power until the next day. Four miles north of Onida, a feed wagon was tossed nearly 40 feet. In Harrold, several railroad cars were tipped over. Also of great significance during the event was the peak wind speed of 124 mph recorded at the Onida airport. This wind speed is the strongest wind gust ever measured in the Aberdeen County Warning Area (CWA) and the 4th strongest wind speed ever reported in South Dakota
January 27, 2008	Strong southwesterly winds developed across the Black Hills during the afternoon and persisted through much of the night. Wind gusts of 60 to 70 mph were common across the higher terrain of the Black Hills and the northern and eastern foothills. The strongest winds were noted in the Spearfish and Hermosa areas, where a few gusts exceeded 90 mph. The strong winds caused a semi-trailer to jack knife on interstate 90 in Spearfish. Downed tree branches, signs, and damage to roofs were also reported around Spearfish.
July 9, 2007	Severe storms produced wind gusts to 80 mph across south central South Dakota. Roofs were torn off two houses and a trailer house was rolled three times. No injuries were reported. Damage estimates were reported at $75,000.
November 19, 2006	Strong southwest winds developed during the evening across parts of the northern Foothills. Winds gusted near 80 mph just west of Spearfish, while gusts over 50 mph were recorded in the Sturgis area. Several power poles and lines were downed in the Spearfish area, with minor damage around Sturgis.
August 18, 2006	Damaging winds associated with a line of thunderstorms moved through Lincoln County and were estimated between 50 and 80 mph. A downburst caused significant damage, especially to crops, which were shredded by wind-blown hail. Source: NWS Sioux Falls
May 23, 2006	Eighty mph straight-line winds damaged a Union County farm. Two outbuildings were destroyed and a third building lost its roof. A fourth building was also

	damaged, and debris was strewn along a ¼ mile stretch. Tree damage was also documented in the area. Source: NWS Sioux Falls
April 17, 2006	Severe thunderstorms. The earliest reports of large hail and strong winds on record for northwestern South Dakota. Source: NWS Rapid City
June 7-8, 2005	This was one of the most damaging severe thunderstorm events of the past several years for central and northeast South Dakota. In the late afternoon of June 7, a line of thunderstorms developed across western South Dakota and moved east across the state and into west central Minnesota. Widespread damage was reported. Hundreds of grain bins and countless buildings were damaged or destroyed and numerous trees, power lines, and poles were downed. Winds of 60 to over 100 mph were reported. It illustrated the fact that extreme straight-line winds can do as much damage as tornadoes. NWS Aberdeen
March 10, 2005	Sustained winds of 40 to 45 mph with gusts above 60 mph persisted from mid morning until late afternoon. The winds caused widespread tree damage with branches and smaller tree debris broken off. Several power lines were knocked down by the wind or by wind blown debris. This resulted in several power outages, especially between the Missouri and James Rivers. Damages to buildings was mostly to shingles and gutters. However, a metal storage building was blown over at Mitchell. Also at Mitchell, construction barriers were blown over, and windows were broken in two vehicles by blowing rocks. An aluminum recycling cage was blown away at Woonsocket. A window was blown out at a school in Freeman. In Sioux Falls, there was damage to the airport tower.
July 3-4, 2003	A line of severe thunderstorms developed in Montana and moved into and across North Dakota, South Dakota, and Minnesota. It brought large hail and winds over 80 mph at times to Brown, Marshall, and Roberts counties, which resulted in widespread property and crop damage. Approximately 30 percent of Marshall County's 227,000 acres of crops were damaged or destroyed. Trees, branches, and power lines and poles were downed; roofs and siding were damaged from hail and fallen trees; farm outbuildings were damaged or destroyed; and many windows were broken out of homes and vehicles. A crop spraying plane at the Sisseton airport was thrown 450 feet and a 55,000 bushel grain bin in Claire City was blown off of its foundation and flattened. On the opposite side of the state, a supercell thunderstorm developed over Lawrence County and moved into Meade County. It moved through Rapid City with 60 to 70 mph winds and moved quickly east-southeast across southwestern and south central South Dakota producing 60 to 80 mph winds. The strong winds downed many trees and power lines from Rapid City to the Winner area. Source: NCDC, NWS Aberdeen
June 9, 2001	A severe windstorm struck portions of western South Dakota with gusts estimated to 80 mph. The greatest damage occurred in Philip and Wanblee. The damage was consistent with strong straight-line winds.

	Source: NWS Rapid City
August 1, 2000	A powerful thunderstorm moved into western South Dakota from northeast Wyoming. Winds in the Spearfish area, estimated at 90-110+ mph, were particularly devastating, causing a considerable amount of damage and several injuries. Strong downburst winds were responsible for most of the observed damage. As the storm approached Sturgis, it evolved into a bow echo with winds estimated at 65-80 mph that toppled and blew away merchandise tents that had been set up for the Sturgis Rally. Strong winds in excess of 70 mph were also noted in the Black Hawk, Piedmont, Rapid City, and Ellsworth AFB areas. Source: NWS Rapid City
June 3-4, 2000	Two severe thunderstorms brought strong straight-line winds to Clay and Union counties. The first storm had wind gusts of 70-75 mph. The second storm had 60-65 mph wind gusts. Trees were damaged and a picnic shelter was destroyed Source: NWS Sioux Falls
August 6, 1999	Downburst wind event in Meade County. Winds were estimated up to 70 mph at 8:05 p.m. as the front passed through the area. Numerous trees were damaged and a few were blown down. The worst of the storm hit Ellsworth Air Force Base at 8:18 p.m. where they gusted to 89 mph. Between that time and 8:30 p.m., the wind speed did not drop below 50 mph at the base. Sensors measured gusts of 129 mph and 165 mph. Damage was minimal due the rural location. Source: NWS Rapid City
June 20, 1997	These severe thunderstorms brought strong straight-line winds, estimated at 80-90 mph, that caused widespread tree, crop, power line, and building damage and destruction in Davison County and injured eight people. The damage path was at least 15 miles wide by 50 miles long. Many people believed the damage was caused by a tornado, but the damage assessment proved otherwise. Source: NWS Sioux Falls

Source: NCDC, if not otherwise sourced

Probability

According to the National Climatic Data Center, there were 5,675 wind events (excluding events from October through March 31 and those associated with snow, see event description above) in South Dakota between 1950 and April 2010 (60 years). Based on this information, the probability that at least one wind event will occur in South Dakota in any given year is 100 percent. Annualized losses are estimated at $5.8 million.

Hazardous Materials

Description

A hazardous materials incident can occur during production, storage, transportation, use, or disposal of material. South Dakota's Codified Law Chapter 33-15 Emergency Management defines "hazardous material" as "any material, including but not limited to, explosives, flammable liquids, flammable compressed gas, flammable solids, oxidizing materials, poisons, corrosive materials, and radiological materials, the loss of control or mishandling of which could cause personal injury or death to humans or damage to property or the environment." These substances are most often released as a result of transportation accidents or chemical accidents in plants and can be caused and complicated by a different type of hazard event (e.g., flood, earthquake). They affect humans through inhalation, ingestion, and direct contact with skin. South Dakota is concerned about transportation, fixed facility, and pipeline hazardous materials incidents.

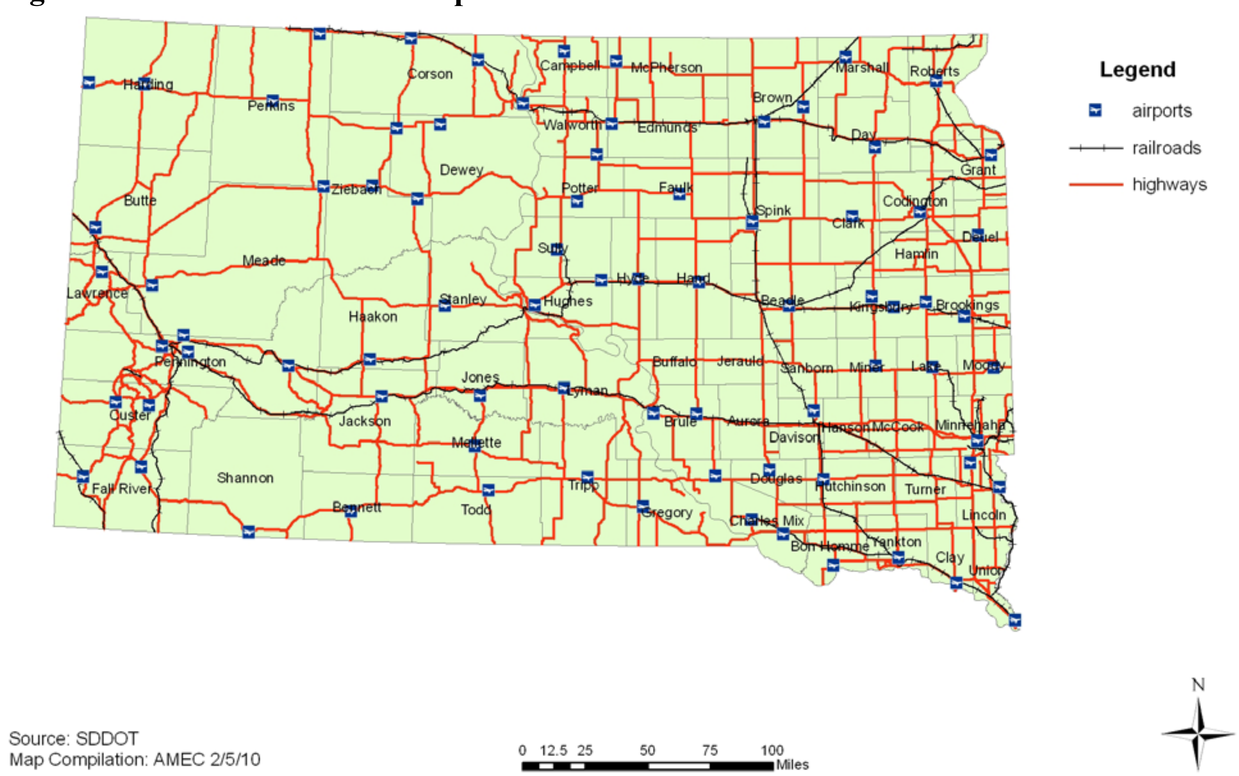
Location

Hazardous materials incidents can happen throughout the state. Localities where hazardous materials are fabricated, processed, and stored as well as those where hazardous waste is treated, stored, and disposed of are most at risk for hazardous materials incidents. Additionally, localities along transportation corridors that carry these materials to their final destinations are also at risk. More than half of the transportation incidents between 1971 and 2006 occurred in Minnehaha and Pennington counties, where the state's largest cities, Sioux Falls and Rapid City, are located (see the discussion on past events in the following section).

Transportation

Figure 3-22 illustrates South Dakota's transportation infrastructure.

Figure 3-22: South Dakota Transportation Infrastructure.



According to the U.S. Department of Transportation's Office of Pipeline Safety, South Dakota's pipeline system is as follows:

- Hazardous liquid line mileage: 420
- Gas transmission line mileage: 1,651
- Gas gathering line mileage: 0
- Gas distribution mileage: 4,293*
- Total pipeline mileage: 6,364

All mileages are for 2006 and are approximate as some data sources may not have contained a complete record of state pipeline mileage.
*Gas distribution service lines (the connection between the distribution line and the end user) are not included in the gas distribution mileage. The total number of such services is 183,182.

Table 3-19 shows the breakdown of gas transmission line and hazardous liquid line mileage by county.

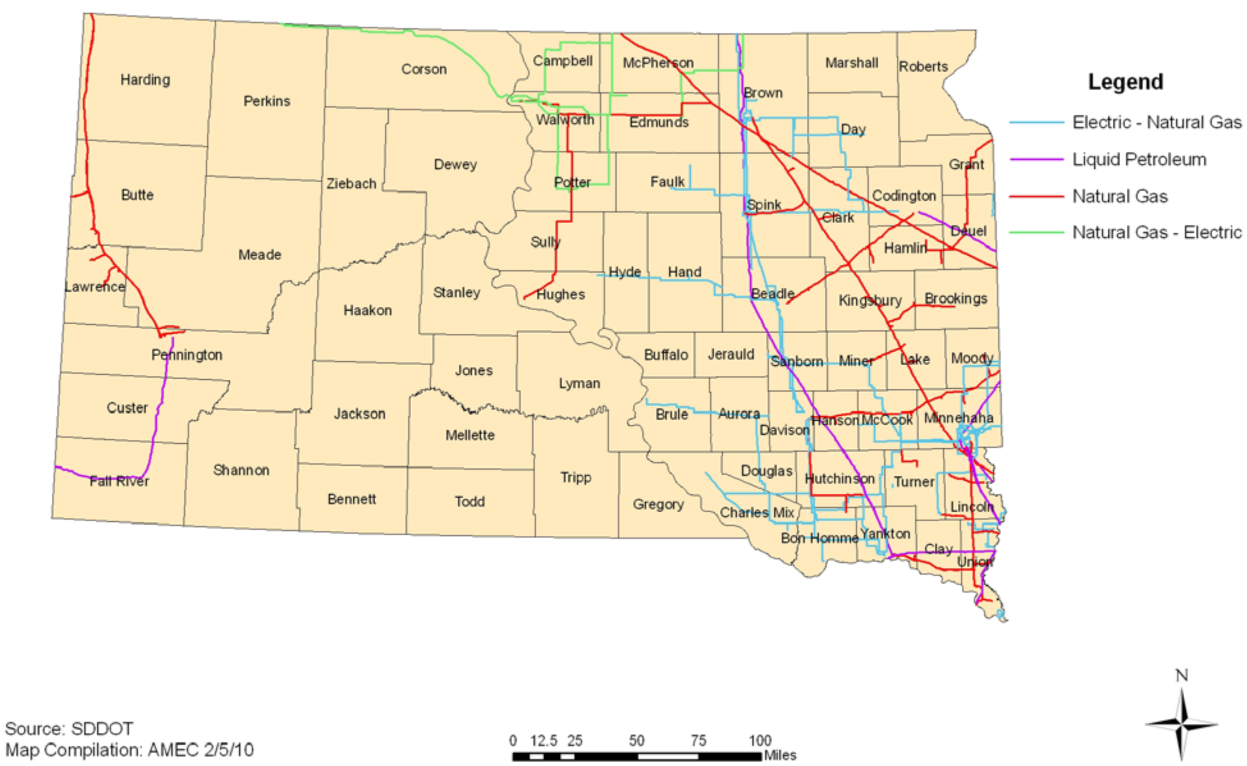
Table 3-19: Gas Transmission Line and Hazardous Liquid Line Mileage by County (ranked by percent of total)

County	Gas Miles	Liquid Miles	Percent of Total
Lincoln	110	69	8.6
Minnehaha	102	31	6.4
Brown	69	50	5.7
Spink	70	43	5.4
Butte	96	0	4.6
Union	75	20	4.5
Clark	88	0	4.2
Harding	79	0	3.8
Deuel	53	25	3.7
Hutchinson	47	26	3.5
Kingsbury	67	0	3.2
Meade	60	0	2.9
Edmunds	59	0	2.8
Yankton	23	35	2.8
Clay	38	18	2.7
Walworth	55	0	2.6
Beadle	20	32	2.5
Hamlin	51	0	2.4
Sully	48	0	2.3
Lawrence	47	0	2.2
McCook	44	0	2.1
Hanson	21	22	2.0
Codington	29	11	1.9
McPherson	41	0	1.9
Lake	39	0	1.8

County	Gas Miles	Liquid Miles	Percent of Total
Grant	30	0	1.4
Sanborn	0	28	1.3
Turner	28	0	1.3
Moody	22	3	1.2
Davison	16	7	1.1
Pennington	23	0	1.1
Potter	24	0	1.1
Day	21	0	1.0
Hughes	19	0	0.9
Brookings	16	0	0.7
Roberts	12	0	0.5
Miner	8	0	0.3
Bon Homme	1	0	0.0
Fall River	0	0	0.0
Jerauld	0	0	0.0
Totals	**1,651**	**420**	**100**

Source: Pipeline and Hazardous Materials Safety Administration, http://primis.phmsa.dot.gov/comm/reports/safety/SD_detail1.html

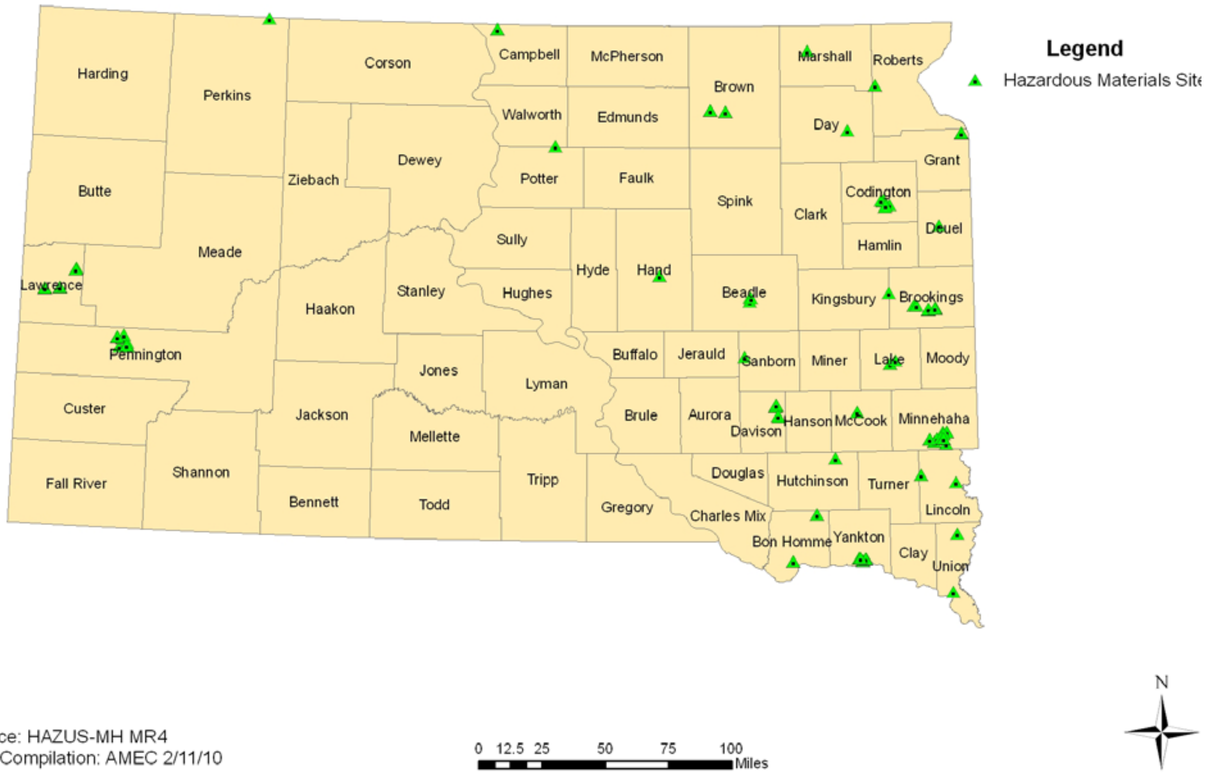
Figure 3-23: South Dakota Hazardous Materials Transmission Lines



Fixed Facility

HAZUS-MH defines hazardous material facilities as those that contain substances that can pose significant hazards because of their toxicity, radioactivity, flammability, explosiveness, or reactivity. Facilities that meet this definition are mapped in Figure 3-24.

Figure 3-24: South Dakota Hazardous Material Site Locations



Past Events

Transportation

The Hazardous Materials Incident Report Subsystem (HMIRS) of the Pipeline and Hazardous Materials Safety Administration (PHMSA) Hazardous Materials Information System was established in 1971 to fulfill the requirements of the federal hazardous materials transportation law. Unintentional releases of hazardous materials or the discharge of any quantity of hazardous waste must be reported. The federal law defines hazardous material as "a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has designated as hazardous … The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table (see 49 CFR 172.101)."

According to the U.S. Department of Transportation's (DOT) Hazardous Materials Information System, South Dakota experienced 709 transportation incidents involving hazardous materials between 1971 and 2010 (see Table 3-20). The total cost of damage associated with these incidents was approximately $6,415,374. This suggests that South Dakota experiences 23.6 transportation incidents involving hazardous materials and $213,845 in related damage each year. Among these incidents there were 3 deaths and 15 injuries. In total, 357 people were evacuated. 14 of the incidents were rail related, 19 were air, and the remaining 676 were highway.

Table 3-20: Transportation Hazardous Materials Incidents, 1971-2010

County	# of Events	Fatalities	Total Injuries	Damages ($)	Evacuations
Minnehaha	290	0	3	456,392	213
Pennington	104	1	1	86,396	0
Lincoln	50	0	1	71,154	21
Brown	34	0	2	286,470	0
Codington	29	0	0	7,402	0
Brookings	14	0	0	207,419	1
Davison	16	0	0	53,573	5
Lawrence	15	0	0	3,366	0
Hughes	13	0	0	1,150	0
Beadle	11	0	3	9,090	40
Meade	12	0	0	84,915	0
Fall River	10	0	0	0	0
Butte	9	0	1	100	0
Tripp	9	0	0	0	0
Custer	6	0	1	0	0
Grant	9	0	0	297,345	75
Haakon	7	0	0	575	0
Hand	6	0	0	165,665	0
Yankton	5	0	0	2,500	2
Perkins	4	0	0	0	0
Shannon	4	0	0	12,347	0
Brule	3	0	2	0	0
Clay	6	0	0	135,500	0
Hutchinson	4	0	0	0	0
Lake	4	0	0	34,000	0
Aurora	2	2	1	4,000,000	0
Day	2	0	0	0	0
Jackson	2	0	0	83,000	0
Kingsbury	2	0	0	0	0
Mccook	2	0	0	0	0
Potter	2	0	0	115,000	0
Spink	2	0	0	0	0
Union	4	0	0	128,650	0
Walworth	2	0	0	0	0
Ziebach	2	0	0	0	0
Bon Homme	1	0	0	3,828	0
Buffalo	1	0	0	100	0
Clark	1	0	0	0	0

County	# of Events	Fatalities	Total Injuries	Damages ($)	Evacuations
Corson	2	0	0	1,230	0
Edmunds	1	0	0	0	0
Hyde	1	0	0	600	0
Marshall	1	0	0	5,000	0
McPherson	1	0	0	0	0
Moody	1	0	0	89,387	0
Stanley	1	0	0	64,840	0
Sully	1	0	0	8,380	0
Todd	1	0	0	0	0
Total	709	3	15	6,415,374	357

Source: DOT's Hazardous Materials Information System, http://hazmat.dot.gov/pubs/inc/hmisframe.htm

Pipeline

Reports from the DOT's Office of Pipeline Safety provide detail and significant incident history for the pipeline systems in the State of South Dakota between 1983 and 2010. Table 3-21 lists these incidents. Significant incidents are those incidents reported by pipeline operators with any of the following conditions met: 1) fatality or injury requiring in-patient hospitalization; 2) $50,000 or more in total costs, measured in 1984 dollars; 3) highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more; 4) liquid releases resulting in an unintentional fire or explosion.

Table 3-21: Details of South Dakota Pipeline Incidents, 1983 – 2010

County	Date	Fatalities	Injuries	Damage ($)	Gross Barrels Lost	Barrels Recovered	Type of Incident
Pierre	04/02/2009	0	0	150,000	0	0	Natural Gas Transmission
Pierre	02/20/2008	0	0	152,979	0	0	Natural Gas Distribution
Beresford	03/29/2007	0	0	499,705	0	0	Natural Gas Distribution
Mitchell	03/08/2007	0	0	505,216	0	0	Natural Gas Transmission
Minnehaha	10/14/2006	0	0	25,100	n/a	n/a	Natural Gas Distribution
Minnehaha	6/16/2006	0	0	14,400	n/a	n/a	Natural Gas Transmission
Sanborn	12/28/2004	0	0	192,102	193	154	Hazardous Liquid
Pennington	10/11/2004	0	0	107,577	n/a	n/a	Natural Gas Distribution
Clark	4/28/2003	0	0	75,027	n/a	n/a	Natural Gas Distribution
Beadle	2/26/2001	0	0	62,642	n/a	n/a	Natural Gas

County	Date	Fatalities	Injuries	Damage ($)	Gross Barrels Lost	Barrels Recovered	Type of Incident
							Distribution
Lincoln	10/4/2000	0	0	0	n/a	n/a	Natural Gas Distribution
Custer	8/10/1998	0	0	37,083	123	0	Hazardous Liquid
McCook	5/30/1998	0	0	92,707	n/a	n/a	Natural Gas Distribution
Union	4/4/1998	0	0	49,444	195	0	Hazardous Liquid
Lawrence	3/19/1997	0	0	0	n/a	n/a	Natural Gas Transmission
Pennington	9/12/1994	0	0	68,027	147	30	Hazardous Liquid
Walworth	10/22/1993	0	1	69,735	n/a	n/a	Natural Gas Distribution
Pennington	4/9/1993	0	0	7,601	300	250	Hazardous Liquid
Pennington	3/2/1993	0	0	174,338	n/a	n/a	Natural Gas Distribution
Minnehaha	1/13/1992	0	0	0	7,200	1,849	Hazardous Liquid
Brown	5/14/1991	0	1	0	n/a	n/a	Natural Gas Distribution
Union	4/8/1991	0	0	184,911	2,881	0	Hazardous Liquid
Watertown	2/18/1990	0	0	10,802	332	101	Hazardous Liquid
Minnehaha	12/25/1989	0	0	40,650	1	1	Hazardous Liquid
Minnehaha	12/24/1989	0	0	40,650	6	6	Hazardous Liquid
Yankton	7/5/1989	0	0	0	n/a	n/a	Natural Gas Distribution
McCook	3/21/1989	0	1	0	n/a	n/a	Natural Gas Transmission
Pennington	1/9/1989	0	0	0	0	0	Hazardous Liquid
Pennington	1/9/1988	0	0	0	n/a	n/a	Natural Gas Distribution
Lincoln	12/10/1987	0	0	0	100	0	Hazardous Liquid
Pennington	4/9/1987	0	1	13,321	n/a	n/a	Natural Gas Distribution
Minnehaha	4/8/1987	0	0	444,050	25	0	Hazardous Liquid
Minnehaha	3/11/1987	0	0	888,099	200	5	Hazardous Liquid
Minnehaha	2/16/1987	0	0	7,104,796	715	19	Hazardous Liquid
Brown	9/25/1986	2	0	551,471	n/a	n/a	Natural Gas Distribution
Pennington	12/20/1985	0	0	93,633	n/a	n/a	Natural Gas Distribution
Kingsbury	6/17/1985	0	0	0	n/a	n/a	Natural Gas

County	Date	Fatalities	Injuries	Damage ($)	Gross Barrels Lost	Barrels Recovered	Type of Incident
							Transmission
Decatur	5/7/1984	0	0	6,796	n/a	n/a	Natural Gas Distribution
Beadle	2/13/1983	0	0	n/a	n/a	n/a	Natural Gas Transmission

Source: DOT's Office of Pipeline Safety, http://ops.dot.gov/stats/IA98.htm
Notes:
The costs in the years prior to 2006 are in 2006 dollars, years after 2006 are shown in that years dollars/.
For years 2002 and later, property damage is estimated as the sum of all public and private costs reported in the 30-day incident report. For years prior to 2002, accident report forms did not include a breakdown of public and private costs, so property damage for these years is the reported total property damage field in the report.

Fixed Facility

The U.S. Environmental Protection Agency maintains a database on toxic chemical releases and other waste management activities, which are reported annually by certain covered industry groups as well as federal facilities: the Toxics Release Inventory. In 2008, the most recent data available, 7 million pounds of hazardous materials were disposed of or released in South Dakota. Table 3-22 ranks chemical releases by county for 2008. Table 3-23 and Table 3-24 show the top 10 releasing facilities and the top 10 chemicals released in 2008.

Table 3-22: Chemical Releases* by County, 2008 (all figures are in pounds)

County	Total On-site Disposal or Other Releases	Total Off-site Disposal or Other Releases	Total On- and Off-site Disposal or Other Releases
Minnehaha	2,294,886	73,180	2,368,066
Grant	1,224,533	266,481	1,491,014
Lawrence	2,369,603	305	2,369,908
Brookings	508,078	1,541	509,619
Pennington	69,916	250,757	320,673
Yankton	107,587	2,703	110,290
Lincoln	107,827	0	107,827
Codington	94,550	9,713	104,263
Roberts	48,999	0	48,999
Brown	48,260	155	48,415
Davison	12,755	18,839	31,594
Edmunds	31,581	0	31,581
Turner	31,119	0	31,119
Bon Homme	12,268	0	12,268
Spink	19,677	0	19,677
Lake	15,242	531	15,773
Day	13,709	0	13,709
Union	540	1,029	1,569

County	Total On-site Disposal or Other Releases	Total Off-site Disposal or Other Releases	Total On- and Off-site Disposal or Other Releases
Hamlin	3,850	0	3,850
Deuel	0	1,362	1,362
Beadle	500	0	500
Charles	0	460	460
Douglas	0	429	429
Jackson	190	0	190
Hutchins	62	0	62
Perkins	3	0	3

Source: U.S. Environmental Protection Agency, Toxics Release Inventory, www.epa.gov/tri/
*Includes releases to land, air, and water

Table 3-23: Top 10 South Dakota Facilities with Greatest Total Releases,* 2008 (all figures are in pounds)

Facility	County or Parish or County Equivalent	Total On-site Disposal or Other Releases	Total Off-site Disposal or Other Releases	Total On- and Off-site Disposal or Other Releases
John Morrell & Co.	Minnehaha	2,149,211	73,142	2,222,353
Wharf Resources	Lawrence	2,355,847	4	2,355,851
Otter Tail Corp (DBA Otter Tail Power Co)	Grant	1,096,567	265,662	1,362,229
South Dakota Soybean Processors LLC	Brookings	437,528	0	437,528
Black Hills Corp Ben French Power Plant	Pennington	704	250,757	251,461
Sapa Extrusions Inc	Yankton	107,079	34	107,113
Starmark Cabinetry	Minnehaha	100,334	0	100,334
Northern Lights Ethanol LLC	Grant	92,663	0	92,663
Glacial Lakes Energy LLC	Codington	76,358	0	76,358
Sioux River Ethanol	Lincoln	74,348	0	74,348

Source: U.S. Environmental Protection Agency, Toxic Resources Inventory, www.epa.gov/tri/
*Includes releases to land, air, and water

Table 3-24: Top 10 Chemicals Reported Released* in South Dakota, 2008 (all figures are in pounds)

Chemical	Total On-site Disposal or Other Releases	Total Off-site Disposal or Other Releases	Total On- and Off-site Disposal or Other Releases
Nitrate Compounds	2,300,792	2,120	2,302,912
Lead Compounds	2,096,572	3,702	2,100,274
Barium Compounds	655,928	355,346	1,011,274
N-Hexane	483,213	0	483,213
Zinc Compounds	261,841	151,046	412,887
Ammonia	212,834	71,760	284,594
Xylene (Mixed Isomers)	174,295	0	174,295
Acetaldehyde	99,199	0	99,199
Hydrogen Flouride	86,000	0	86,000
Toluene	72,014	0	72,014

Source: U.S. Environmental Protection Agency, Toxic Resources Inventory, www.epa.gov/tri/
*Includes releases to land, air, and water

Probability

Transportation

According to the U.S. Department of Transportation's Hazardous Materials Information System, there were 709 transportation incidents involving hazardous materials in South Dakota between 1971 and 2010 (40 years). Based on this information, the probability that at least one transportation incident involving hazardous materials will occur in South Dakota in any given year is 100 percent.

Pipeline

According to the U.S. Department of Transportation's Office of Pipeline Safety, there were 39 pipeline incidents in South Dakota between 1983 and 2010 (28 years). Based on this information, the probability that at least one pipeline incident will occur in South Dakota in any given year is 100 percent.

Fixed Facility

According to the U.S. Environmental Protection Agency's Toxic Resource Inventory, 7 million pounds of hazardous materials were disposed of or released in South Dakota in 2008. Based on this information, there is a 100 percent probability that a fixed facility will dispose of or release a hazardous material in South Dakota each year.

Geologic Hazards

A multitude of geologic hazards affect the State of South Dakota. For purposes of this plan, the geologic hazards profiled consists of landslides, mudflows, expansive soils, subsidence, and earthquakes

Description

What Is a Landslide?

Landslides are a serious geologic hazard common to almost every state in the United States. It is estimated that nationally they cause up to $2 billion in damage and 25 to 50 deaths annually. Globally, landslides cause billions of dollars in damage and thousands of deaths and injuries each year.

Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. Gravity is the force driving landslide movement. Factors that allow the force of gravity to overcome the resistance of earth material to landslide movement include saturation by water, steepening of slopes by erosion or construction, alternate freezing or thawing, earthquake shaking, and volcanic eruptions.

Landslides are typically associated with periods of heavy rainfall or rapid snow melt and tend to worsen the effects of flooding that often accompanies these events. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides.

The Columbia Electronic Encyclopedia, 6th ed. Copyright @ 2003, Columbia University Press defines landslides as rapid slipping of a mass of earth or rock from a higher elevation to a lower level under the influence of gravity and water lubrication. More specifically, rockslides are the rapid downhill movement of large masses of rock with little or no hydraulic flow, similar to an avalanche. Water-saturated soil or clay on a slope may slide downhill over a period of several hours. Earthflows of this type are usually not serious threats to life because of their slow movement, yet they can cause blockage of roads and do extensive damage to property.

Earthquakes also may cause landslides by shaking unconsolidated or weathered material from slopes. Rockslides triggered by an earthquake in Montana in 1959 caused an entire mountainside to slide into the Madison River Gorge, killing 27 people in its path, damming the gorge, and forming a new lake. Humans have triggered a number of tragic landslides that have caused great damage and loss of life. In the Los Angeles area of California, extensive real estate development carried out on hillsides has resulted in widespread mudflows after winter rains have saturated the over-steepened embankments of soil. In some areas, slow-moving earthflows have been initiated by the lubrication of certain types of underlying clays by septic tank effluent. Submarine slides, or a sliding mix of seawater and mud, are called turbidity currents. Undersea landslides can travel several hundred miles across very gradual slopes, riding on a thin film of water that reduces friction.

What Is a Mudflow?

Mudflows (or debris flows) are rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt, changing the earth into a flowing river of mud or “slurry.” A slurry can flow rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds. A slurry can travel several miles from its source, growing in size as it picks up trees, cars, and other materials along the way. In hilly or mountainous areas for years after a wildfire, heavy rainfall creates mudflow and landslide risks to people, structures, and infrastructure located below such areas.

Mudflows are covered under the National Flood Insurance Program; landslides are not.

What is Expansive Soil?

Expandable soils are referred to by many names. “Expandable soils,” “expansive clays,” “shrink-swell soils,” and ‘heavable soils” are some of the many names used for these materials. Expansive soils contain minerals such as smectite clays that are capable of absorbing water. When expansive soils are present, they will generally not cause a problem if their water content remains constant. The situation where greatest damage occurs is when there are significant or repeated moisture content changes. When they absorb water they increase in volume. The more water they absorb the more their volume increases. Expansions of ten percent or more are not uncommon. This change in volume can exert enough force on a building or other structure to cause damage. The force of expansion is capable of exerting pressures of 15,000 pounds per square foot or greater on foundations, slabs, and other confining structures. Cracked foundations, floors and basement walls are typical types of damage done by swelling soils. Damage to the upper floors of the building can occur when motion in the structure is significant. Expansive soils will also shrink when they dry out. This shrinkage can remove support from buildings or other structures and result in damaging subsidence. Fissures in the soil can also develop. These fissures can facilitate the deep penetration of water when moist conditions or runoff occurs. This produces a cycle of shrinkage and swelling that places repetitive stress on structures.

Expansive soils are present throughout the world and are known in every US state. Every year they cause billions of dollars in damage. The American Society of Civil Engineers estimates that 1/4 of all homes in the United States have some damage caused by expansive soils. In a typical year in the United States they cause a greater financial loss to property owners than earthquakes, floods, hurricanes and tornadoes combined. Even though expansive soils cause enormous amounts of damage most people have never heard of them. This is because their damage is done slowly and cannot be attributed to a specific event. The damage done by expansive soils is then attributed to poor construction practices or a misconception that all buildings experience this type of damage as they age.

What is Subsidence?

Land subsidence is the sinking of the land over manmade or natural underground voids. Subsidence occurs naturally and also through man-driven or technologically exacerbated circumstances. Natural causes of subsidence occur when water in the ground dissolves minerals and other materials in the earth, creating pockets or voids. When the void can no longer support the weight of the earth above it, it collapses, causing a sinkhole depression in the landscape. Often, natural subsidence is associated with limestone erosion, but may also occur with other water-soluble minerals. Man-driven or technology-exacerbated subsidence conditions are associated with the lowering of water tables, extraction of natural gas, or subsurface mining activities. As the underground voids caused by these activities settle or collapse, subsidence occurs on the surface.

Location

Landslides

Areas that are generally prone to landslide hazards include existing old landslides, the bases of steep slopes, the bases of drainage channels, and developed hillsides where leach-field septic systems are used. Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas away from sudden changes in slope, and areas at the top or along ridges, set back from the tops of slopes.

In certain areas of South Dakota landslides do occur. Over the years, many landslides have been dealt with by the State of South Dakota and in particular the South Dakota Department of Transportation (SDDOT). The SDDOT has spent a lot of time stabilizing landslides throughout the state. Two of the larger slides were the US 12 Missouri River Crossing at Mobridge and the US 212 Missouri River crossing at Forest City. At Mobridge, stone columns were used for the first time in the United States to stabilize a clay-shale landslide. Forest City also used stone columns and also incorporated the use of massive concrete shear pins installed by slurry wall process to stabilize the approach berm. This was the first time in the United States that this technique was used to mitigate a landslide of this magnitude. A civil engineer, who was head of the SDDOT Geotechnical Activity Section from 1969 to 2001, achieved national recognition and notoriety for his innovative work with these two landslides.

Subsidence

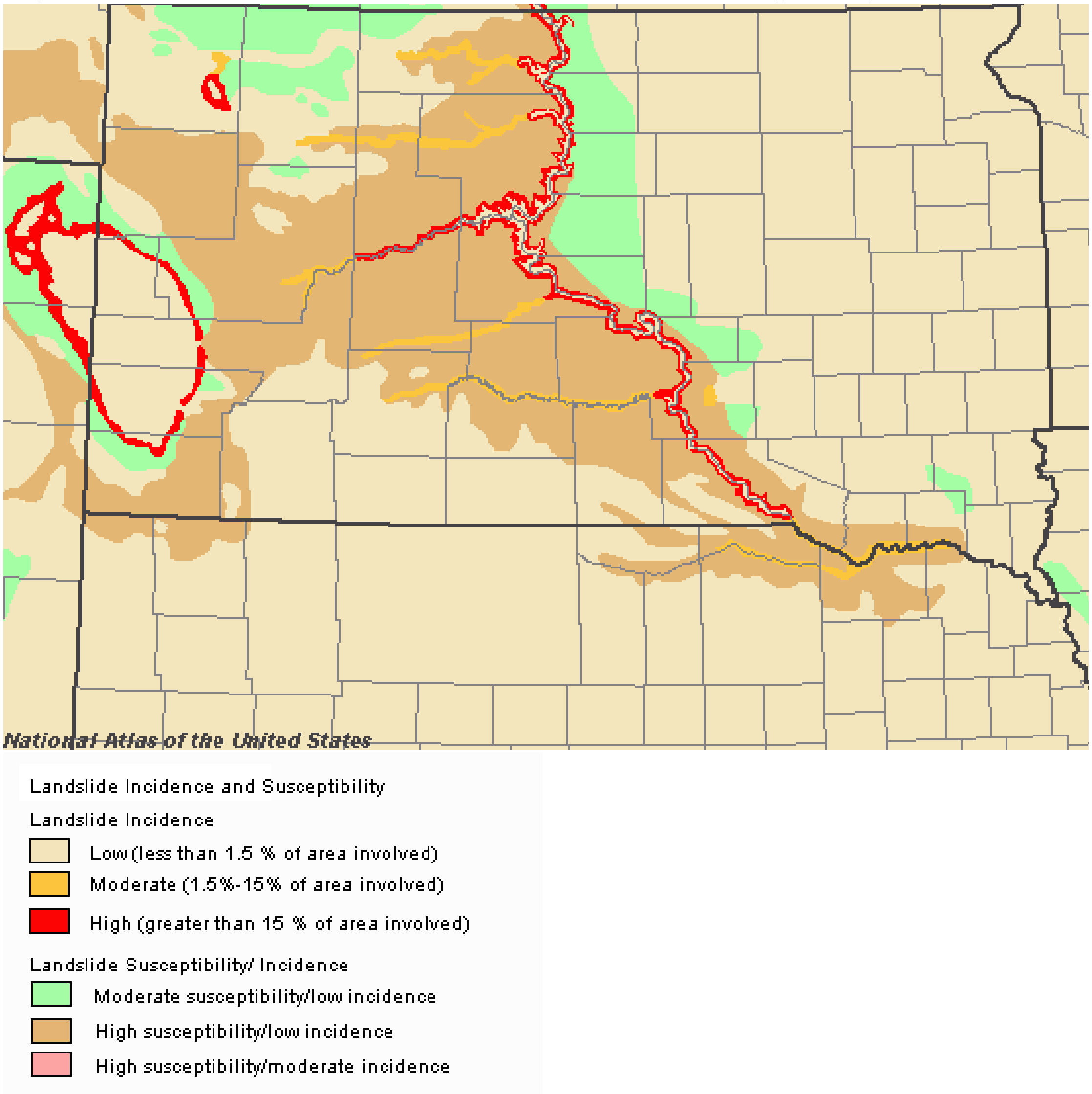
There are certain areas in South Dakota at risk to subsidence (see Figure 3-24). The Niobrara Formation (Upper Cretaceous) and its equivalents are the most widespread carbonate rocks in western Kansas, eastern Nebraska, and southeastern South Dakota. The Niobrara is generally covered by more than 50 ft (15 m) of younger sediments. Small fissures, less than 1,000 ft (300 m) long and up to 100 ft (30 m) deep, are present, but they are not common and are generally irregularly spaced with 1,000 ft (300 m) or more of solid rock between fissures.

In western South Dakota and adjacent parts of Wyoming and Montana, Paleozoic and Cretaceous carbonate rocks, arched steeply upwards, encircle the structural dome that forms the Black Hills. Caves and open fissures are common in the Paleozoic carbonate rocks. A few caves contain many miles of passages but most of the cave passages and fissures in the Black Hills area only extend up to 3,000 ft (900 m) in length and are generally less than 150 ft (45 m) in depth. Closely spaced solution joints also are prevalent.

Expansive Soils

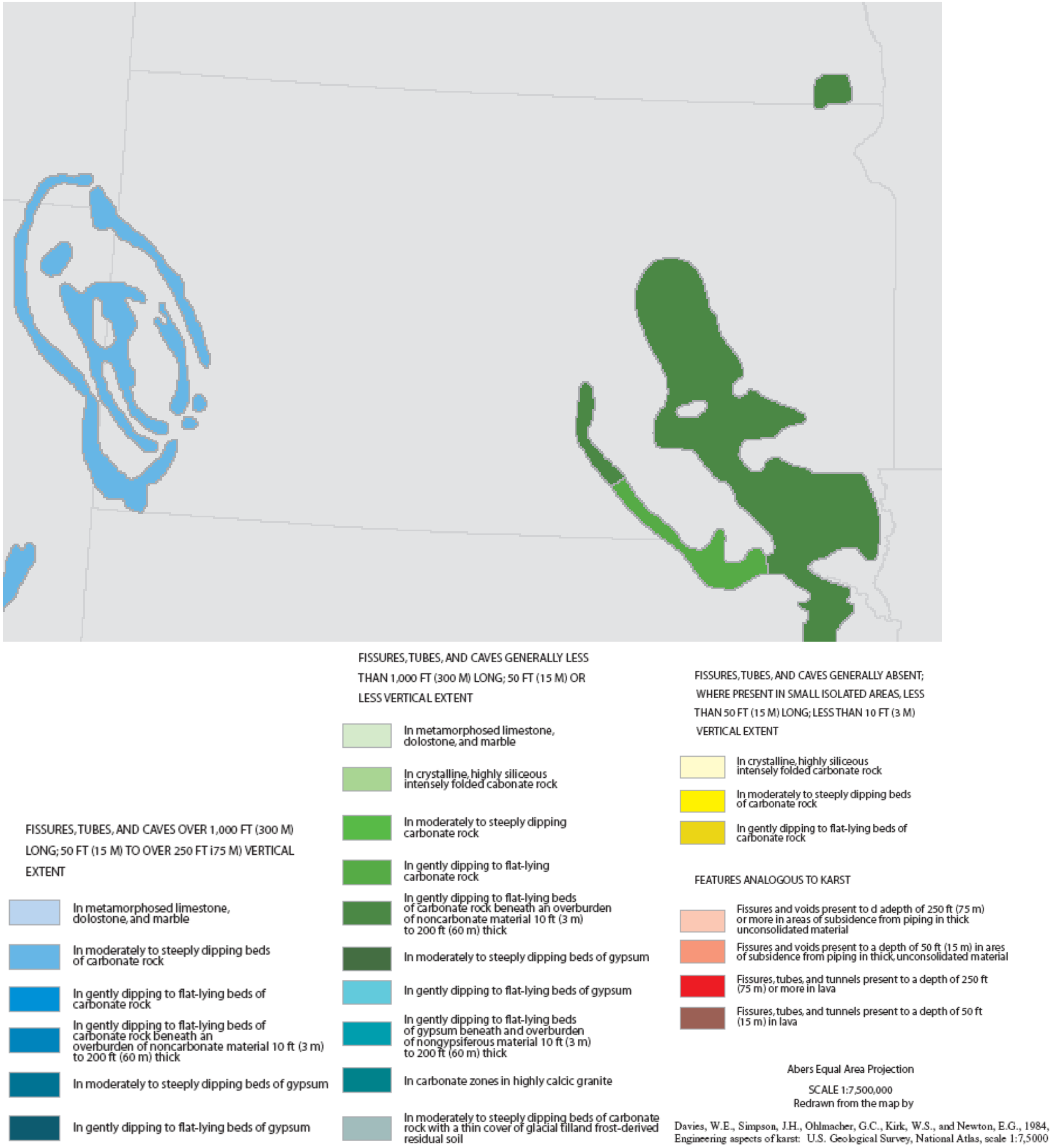
There are certain areas of South Dakota at risk to expansive soils. The map in Figure 3-27 below shows the geographic distribution of soils which are known to have expandable clay minerals which can cause damage to foundations and structures. It also includes soils that have a clay mineral composition which can potentially cause damage. The map is meant to show general trends in the geographic distribution of expansive soils. It is not meant to be used as a property evaluation tool. It is useful for learning areas where expansive soils underlie a significant portion of the land and where expansive soils might be a localized problem. According to this map, the majority of the State has the potential for expansive soils.

Figure 3-25: South Dakota Landslide Incidence and Susceptibility



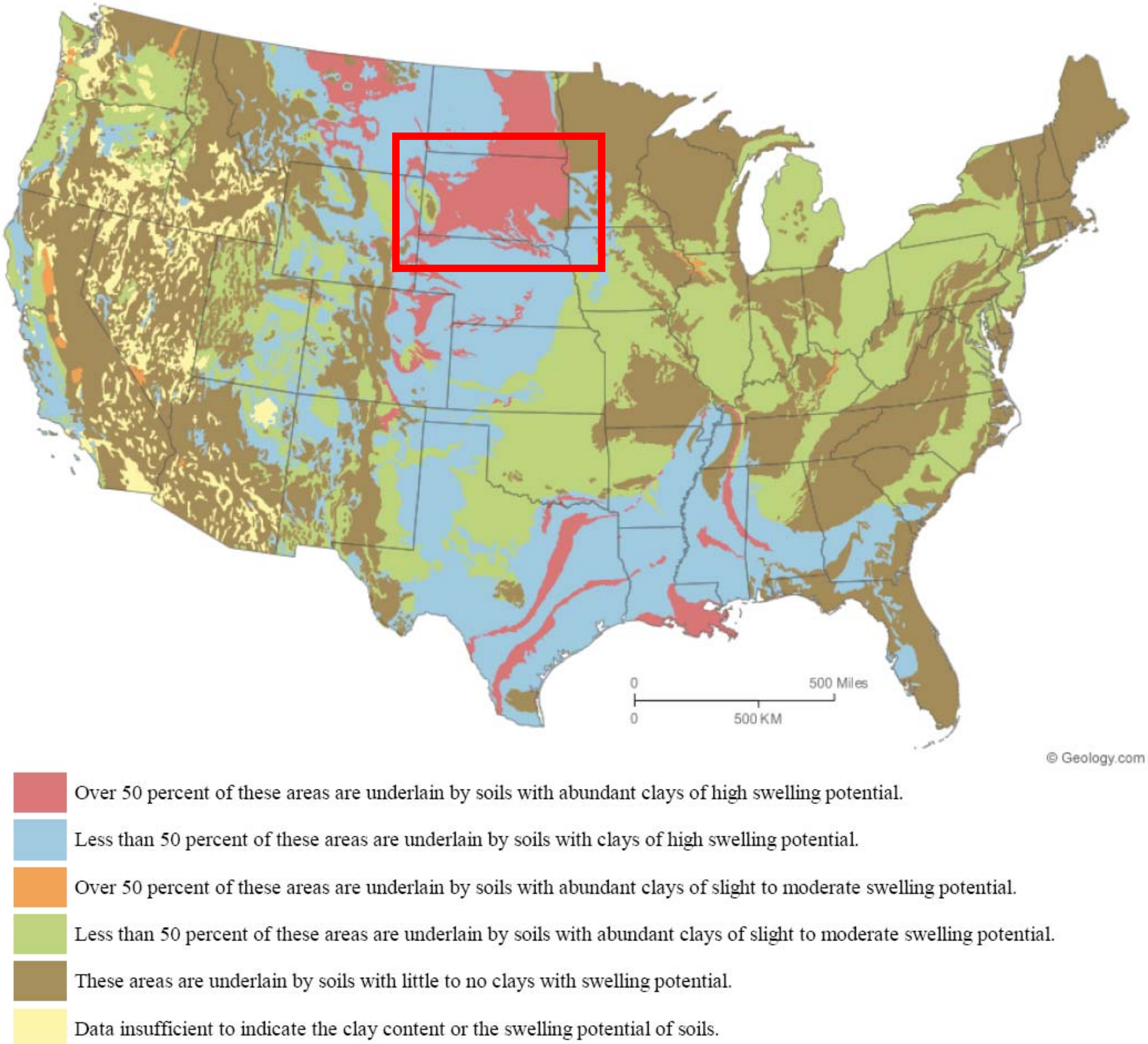
Source: U.S. Geological Survey, map generated by www.nationalatlas.gov

Figure 3-26: State of South Dakota Subsidence Risk



Source: The National Karst Map http://www.nature.nps.gov/nckri/map/maps/engineering_aspects/davies_map_PDF.pdf

Figure 3-27: South Dakota Expansive Soils



Source: The map above is based upon "Swelling Clays Map of the Conterminous United States" by W. Olive, A. Chleborad, C. Frahme, J. Shlocker, R. Schneider and R. Schuster. It was published in 1989 as Map I-1940 in the USGS Miscellaneous Investigations Series. Land areas were assigned to map soil categories based upon the type of bedrock that exists beneath them as shown on a geologic map. In most areas, where soils are produced "in situ", this method of assignment was reasonable. However, some areas are underlain by soils which have been transported by wind, water or ice. The map soil categories would not apply for these locations.

Past Events

Table 3-25 provides information regarding past landslides, mudflows, subsidence, and expansive soils.

Table 3-25: South Dakota Landslides and Mudflows

2006	A landslide near Wasta in Pennington County took the water system out for a week.
August 8, 2004	A heavy rain at the rate of about one inch per hour fell over the area burned by the Grizzly Gulch fire in Lawrence County just six weeks before. The result was that the steep hillsides lost most of their topsoil, which flowed down into Deadwood. Hardest hit was the area of the Northern Hills General Hospital where a retaining wall was damaged, Whistler's Gulch Campground and Mile High Mobile Home Park, and properties along Sherman Street in Deadwood. Cleanup would have been well over one million dollars, but the use of a state prison work crew and volunteers reduced the out of pocket expense to property owners.
2001	A mudflow caused by heavy rain occurred after the Black Hills Grizzly Gulch Fire in 2001. The mudflow caused damage to many homes in the burn area or below.
June 1976	**Flash Flooding, Mudslides (FEMA-511-DR)** In a 24-hour period on June 13-14, 3 to 10 inches of rain fell in the northern Black Hills. And additional two to three inches of rain plus heavy snow was recorded over this area on the June 15 and 16. The run-off from this precipitation did considerable damage in the counties of Lawrence, Meade, Butte, and Harding. There was also a problem with mudslides and landslides.
May 1952	Sturgis/Deadwood—Heavy rains brought flash flooding that tore up streets and gas pipelines in Sturgis. Bridges were washed out and water erosion caused rock slides. Water damage and landslides also occurred in Deadwood.

Limited information was available regarding past impacts from swelling soils. Modern building practices often take this hazard into account and incorporate mitigation. The Department of Transportation does normal maintenance and accounts for this hazard in their construction practices.

Probability

Although historical landslide/mudflow/subsidence/expansive soil occurrence data is limited it can be assumed that landslides will occur occasionally in the future, typically during wet climate cycles or following heavy rains, but in limited areas of the state.

Earthquake Description

Earthquakes east of the Rocky Mountains are less frequent than in the western United States and are typically felt over a much broader region. Most of North America east of the Rocky Mountains has infrequent earthquakes. Most of the enormous region from the Rockies to the Atlantic can go years without an earthquake large enough to be felt, and several U.S. states have never reported a damaging earthquake. The earthquakes that do occur are typically small and occur at irregular intervals.

East of the Rockies it is difficult to determine the specific fault that is responsible for an earthquake since this vast region is far from plate boundaries, which are in the Atlantic Ocean, the Caribbean Sea, and in California and offshore from Washington and Oregon. Known faults do exist in this "stable continental region," but numerous smaller or deeply buried faults remain undetected, and even most of the known faults are poorly located at earthquake depths. Thus, few earthquakes east of the Rockies can be linked to named faults. Also, it is difficult to determine if a fault is still active and capable of generating an earthquake. Unfortunately, in most areas east of the Rockies, the best guide to earthquake hazards is the earthquakes themselves.

South Dakota is somewhat more seismically active than other areas in the Northern Great Plains, although the earthquake magnitudes have been relatively minor to date. At least two mechanisms may be important in generation of the earthquakes. These include initiation of movement along preexisting fractures due to crustal plate movements or movements due to glacial rebound. Ground motion accelerations can be calculated based upon historical seismic records, but the poor quality of the database does not allow great confidence to be placed in those calculations. These calculations show highs in ground motion acceleration that correspond reasonably closely with areas of greater earthquake frequency.

Location

A zone of higher earthquake frequency extends from the northeastern corner of the state and a generally higher frequency of earthquakes is recorded along the eastern flank of the Black Hills and in the southwestern corner of the state. The earthquakes occurring in South Dakota appear to be concentrated along the Great Lakes Tectonic Zone and possibly along the boundaries of the structural provinces in the Precambrian, crystalline basement.

The Black Hills, being a structural dome, is full of faults and joints dating to the uplift some 50 million years ago. Very little strain now accumulates along them, so only small, rare earthquakes have occurred in the region during historic times. Work by several geologists during the last decade or so have shown that much of the region has widely spaced joints and faults breaking the earth's crust into blocks, each a township size in area. The good news is that there is very little strain to release as earthquakes in South Dakota. In the south central part of the state, the South Dakota Geologic Survey have mapped some of these blocks and have identified individual block-bounding faults that have moved 40 feet or more vertically and a few hundreds of feet horizontally in very small increments during the last 50 million years.

Past Events

According to the USGS, no major earthquakes have been reported in South Dakota since 1967. However, earthquakes have historically caused relatively minor damage in South Dakota. Documented damages include cattle stampedes, shaking buildings, falling or rattling dishes and pictures, stuck doors and windows, cracked window glass, foundations heaving or cracking, wall and ceiling plaster cracks, furniture moving, etc.

The following is excerpted directly from an abridged version of Carl A. von Hake's "South Dakota History" in Earthquake Information Bulletin, Volume 9, Number 1, January-February 1977:

> The first earthquake reported in the region occurred on October 9, 1872, 17 years before South Dakota was admitted to the Union. This shock was apparently centered near Sioux City, Iowa. Severe effects were noted at Sioux City, at Yankton and White Swan, South Dakota, and elsewhere in the Dakota Territory. Two strong tremors 45 minutes apart caused some damage in eastern Nebraska on November 15, 1877. The large felt area (over 350,000 square kilometers) included all or most of South Dakota.

On December 29, 1879, a mild earthquake produced rumbling noises at Yankton (V). Two shocks, estimated at intensity IV-V, occurred in the Black Hills region on October 11, 1895. The first was reported strongest at Rochford; the latter was strongest at Keystone and Hill City.

The earthquake of June 2, 1911, was reported from Huron (V) and other places in South Dakota, Iowa, and Nebraska, an area covering approximately 100,000 square kilometers. It was apparently centered in the James River valley. A shock on October 23, 1915, near Kadoka, was accompanied by loud noises. Some cracks in the ground were reported (V). The Black Hills region experienced another earthquake on November 16, 1928. At Custer and Rochford there was a deep rumbling sound (V).

Buildings were jarred, dishes rattled, and loose objects swayed (V) at Sioux Falls from an October 11, 1938, tremor. Police stations received more than 50 calls from alarmed residents. The total felt area affected was about 7,500 square kilometers in South Dakota and one town in Minnesota. A strong, localized shock on July 23, 1946, caused several cracks in water mains (VI) at Wessington. The earthquake, which occurred about 12:45 a.m., also awakened sleepers at Huron. The small felt area extended from Pierre to De Smet and from Wessington to Redfield. A similar disturbance occurred on December 31, 1961, causing slight damage at Pierre. Reports of cracked plaster and a cracked cement floor were received. Also, buildings shook and loose objects rattled. Newspaper and police switchboards were swamped with calls from alarmed residents (VI). Fisherman along the Missouri River reported that many fish leaped into the air at the time the earthquake occurred. The felt area extended from Midland on the west to Huron on the east.

An earthquake with an abrupt onset and a short duration (3-5 seconds) was felt by all at Wind Cave National Park. The March 24, 1964, tremor caused small rocks to fall in the cave. Buildings creaked, and a slight trembling motion was noticed at Hot Springs (V). Three days later (March 27), another shock was reported from the same area. The epicenter was apparently located near Van Tassell, Wyoming, although no instrumental records were available for this event owing to the proximity in time of its occurrence to the occurrence of the great Alaska earthquake. There was no connection between the shocks, although many persons within the felt area thought effects from the Alaskan earthquake had been observed. Maximum intensity (V) was noted at Van Tassell; felt reports were received from Harrison and Hyannis, Nebraska, and Edgemont, Hot Springs, Keystone, Pine Ridge, and Provo, South Dakota.

The strongest tremor in this series (measured at magnitude 5.1) occurred at 3:08 a.m. CST, March 28, 1964. The instrumental epicenter was near Merriman, Nebraska, where broken goods were reported in stores; also, dishes were broken in homes, and stucco under windows cracked. Sixteen kilometers south, 75 cracks were noted in the highway, and some steep banks tumbled along the river (VII). Plaster fell at Rushville, and part of a chimney toppled at Alliance, Nebraska. Slight damage also occurred in southwestern South Dakota - a retaining wall was damaged at Deadwood, there were a few slight cracks in ceiling plaster at Interior, a glass container broke in a market at Martin, and wall and ceiling plaster cracked at Pine Ridge. Several farms near Martin also reported broken glass. The total felt area, including several places in Wyoming, covered approximately 230,000 square kilometers. One town in Montana (Alzada) reported this tremor.

An earthquake on June 26, 1966, near Rapid City, caused slight damage over a small area. A patio and concrete steps were cracked at Rapid City; well water was muddied and could not be used for several hours at Keystone (VI). The magnitude 4.1 shock produced intensity V effects at Deadwood and Silver City. It was also felt at Black Hawk, Hill City, Lead, Piedmont, Pine Ridge, and Shannon.

A magnitude 4.4 shock on November 23, 1967, was felt over a small area of southern South Dakota and northern Nebraska. Press reports indicated that houses shook and dishes fell from shelves in the Winner - Rosebud - White River areas (V). Many residents were frightened at Gregory, where furniture was shifted and some windows were cracked. Livestock stampeded through fences on some farms. Felt reports were also received from Carter, Chamberlain, Colome, Martin, Mission, and Stephan, South Dakota, and Ainsworth and Dunning Nebraska. One isolated report stated the shock was felt by a few people at Douglas, Wyoming.

Figure 3-28 Earthquakes in South Dakota 1872-2010

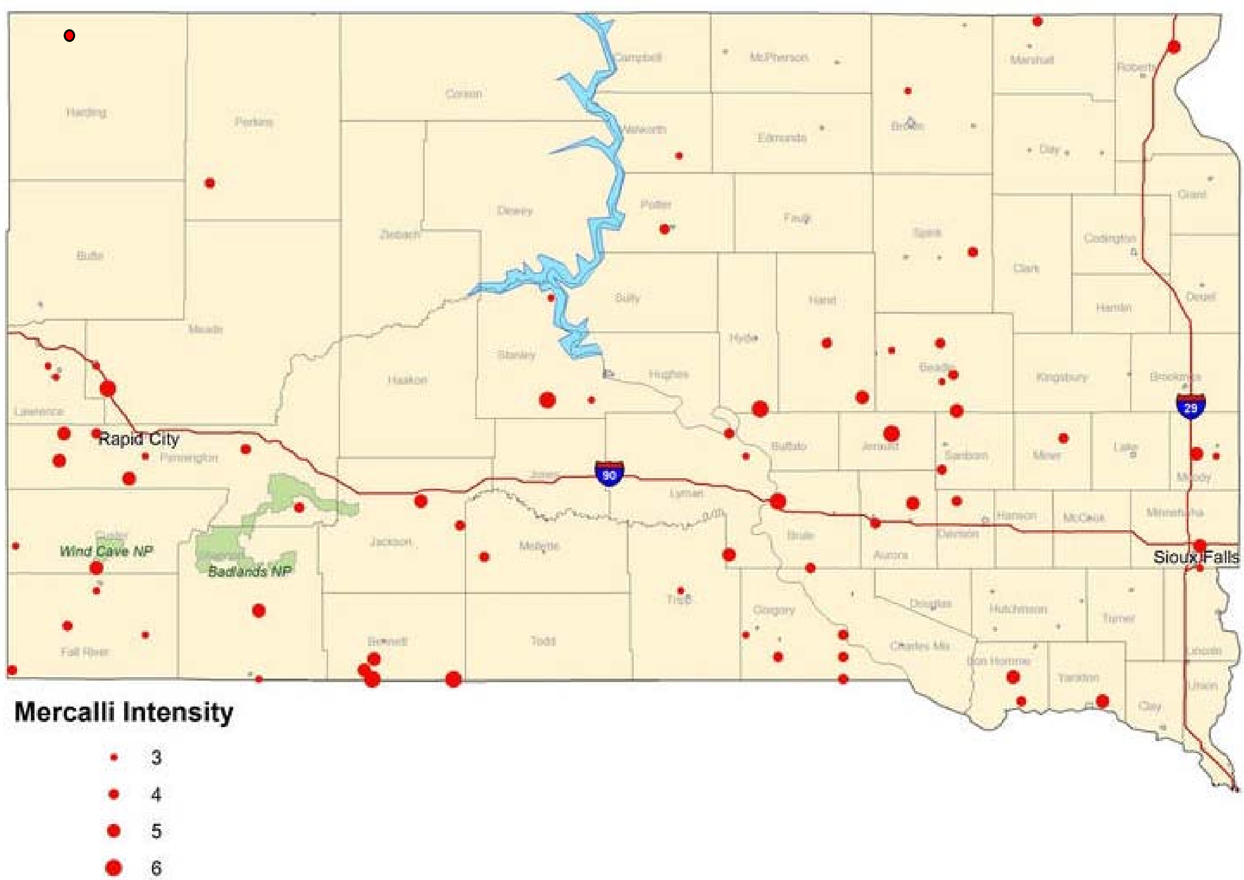


Table 3-26: South Dakota Earthquakes

Date	Comments
September 25, 2009	Magnitude 3.8 at 10:11 am. 30 miles northwest of Belle Fourche
February 7, 2007	Maximum Intensity III—Magnitude 3.1, 4:35 a.m. 7 miles west southwest of Wasta, 17 miles west northwest of Wall.
October 19, 2005	Magnitude 3.1
January 24, 2004	Magnitude 2.5
January 5, 2004	Magnitude 2.8
November 21, 2003	Magnitude 3.5
May 25, 2003	Intensity IV at Kyle and Gordon, III at Pine Ridge and Chadron—Magnitude 4.0, 1:32 a.m. 35 miles east of Pine Ridge, 115 miles southwest of Pierre.
July 26, 2002	Magnitude 3.1
July 12, 1998	Magnitude 3.1
May 3, 1996	Magnitude 3.1
February 6, 1996	Intensity V—9:10 a.m. 24 miles south southwest of Yankton (Magnitude 3.6). Felt by many people. The quake caused Gavins Point Dam personnel to conduct dam safety checks. Intensity V—9:08 a.m. Northwest of Mt. Rushmore (3.7 Richter). Felt by many people who noticed typical earthquake ground movement. Both of these quakes were centered about 5 km below the surface. Neither quake can be definitely associated with any mapped fault, but both are near known or postulated faults.
July 3, 1995	Intensity III—Southwest of Ft. Thompson (2.8 Richter)
March 18, 1994	Intensity III—Hot Springs (2.8 Richter)
September 5, 1993	Intensity III—Deadwood (2.7 Richter)
October 25, 1990	Intensity V—Aurora County north of Plankinton and west southwest of Storla.
March 2, 1990	Intensity IV—Shannon County north of Manderson.
January 28, 1990	Intensity V—Shannon County north of Manderson.
November 26, 1989	Intensity III—Walworth County near Lowery.
October 15, 1987	Intensity III—Beadle County northeast of Wessington.
July 9, 1987	Intensity III—Beadle County near Virgil.
May 25, 1986	Intensity IV—Sanborn County slightly northeast of Storla.
March 4, 1983	Intensity VI—On Hyde–Buffalo County border south of Mac's Corner.
November 15, 1982	Intensity V—Bon Homme County near Avon.
July 11, 1982	Intensity V—Moody County near Egan.
September 13, 1981	Intensity V—Bennett County southeast of Batesland on the Nebraska border.
May 16, 1975	Intensity IV—Fall River County near Edgemont.
October 19, 1971	Intensity IV—3:15 p.m. Jackson County half way between Kadoka and Norris. Glass rattled.
November 23, 1967	Intensity V—Lyman County east of Hamill near Tripp-Lyman County border. Magnitude 4.4, felt in Winner, Rosebud, White River areas. Many residents were frightened in Gregory, where furniture shifted and windows cracked. Livestock stampeded through fences on some farms.

Date	Comments
Jun 26, 1966	Intensity VI—5:59 a.m. Meade County between Bethlehem and Tilford. Magnitude 4.1, slight damage at Rapid City. At Keystone, well water was muddied for several hours. At Rapid City, concrete steps cracked away from a house and a patio cracked. At Deadwood, there was a fallen tree due to the shock. At Keystone, one observer reported he could see the ground moving. Pictures on walls bounced, buildings creaked, and dishes rattled. There was a gradual on-set with a bumping swaying motion. In Rapid City, buildings creaked and loose objects rattled. There was a rapid on-set with a bumping motion, and moderately loud earth sounds were also heard.
August 26, 1964	Intensity IV—Pennington County south of Wall in Badlands National Park.
March 28, 1964	Intensity VII—Epicenter in western Nebraska. Magnitude 5.1. Duration: 10 seconds. Depth: 65.98 miles. (This quake was not actually in South Dakota but caused damage anyway. It is listed here to represent the danger from earthquakes that originate outside the state's borders.)
March 27, 1964	Unknown strength due to proximity of the Great Alaska Quake—9:00 p.m. Near Van Taussell, Wyoming. Felt throughout Black Hills with an apparent intensity of IV. (This quake was not actually in South Dakota but caused damage anyway. It is listed here to represent the danger from earthquakes that originate outside the state's borders.)
March 24, 1964	Intensity V—12:12 a.m. Custer County north northeast of Hot Springs near Fall River-Custer County border. Felt by all at Wind Cave National Park. Small rocks fell in cave, buildings creaked, and loose objects rattled. Moderately loud, rumbling noise heard. Abrupt on-set, trembling motion. Duration: 3–5 seconds.
December 31, 1961	Intensity VI—10:35 a.m. Stanley County near Wendte. Felt by many in Pierre. Slight damage. Plaster cracked, cement floors cracked, refrigerator doors shaken open, clothes dryer moved several inches. Fishermen along the Missouri River reported that the moment the quake struck, hundreds of fish jumped into the air. Buildings shook and loose objects rattled. Intensity V—Murdo—felt by many. Plaster on walls cracked, venetian blinds swayed, dishes rattled, faint earth sounds heard, trembling motion with abrupt onset. Intensity IV—Presho and Winner. Intensity I-III—Draper, Hayes, Huron, Midland, Onida, Philip, and White River.
January 12, 1959	Intensity IV—7:15 a.m. Spink County near Doland. Felt by many; rumbling sound followed by what sounded like a boiler explosion. Dishes and windows rattled.
December 3, 1957	Intensity IV—1:30 a.m. Davison County near Loomis. Awakened several people in Mount Vernon, where buildings creaked and loose objects rattled. At Mitchell, houses shook and windows and doors rattled. Livestock was "alarmed and all bunched up."
December 31, 1953	Intensity IV—Gregory County south of Burke.
December 21, 1953	Intensity IV—Perkins County near Zeona
November 14, 1952	Intensity IV—Pennington County near Silver City
December 14, 1949	Intensity III—Gregory County near Dallas.
Jun 3, 1949	Intensity IV—Potter County near Gettysburg.
March7, 1949	Intensity III—Hand County near Miller.

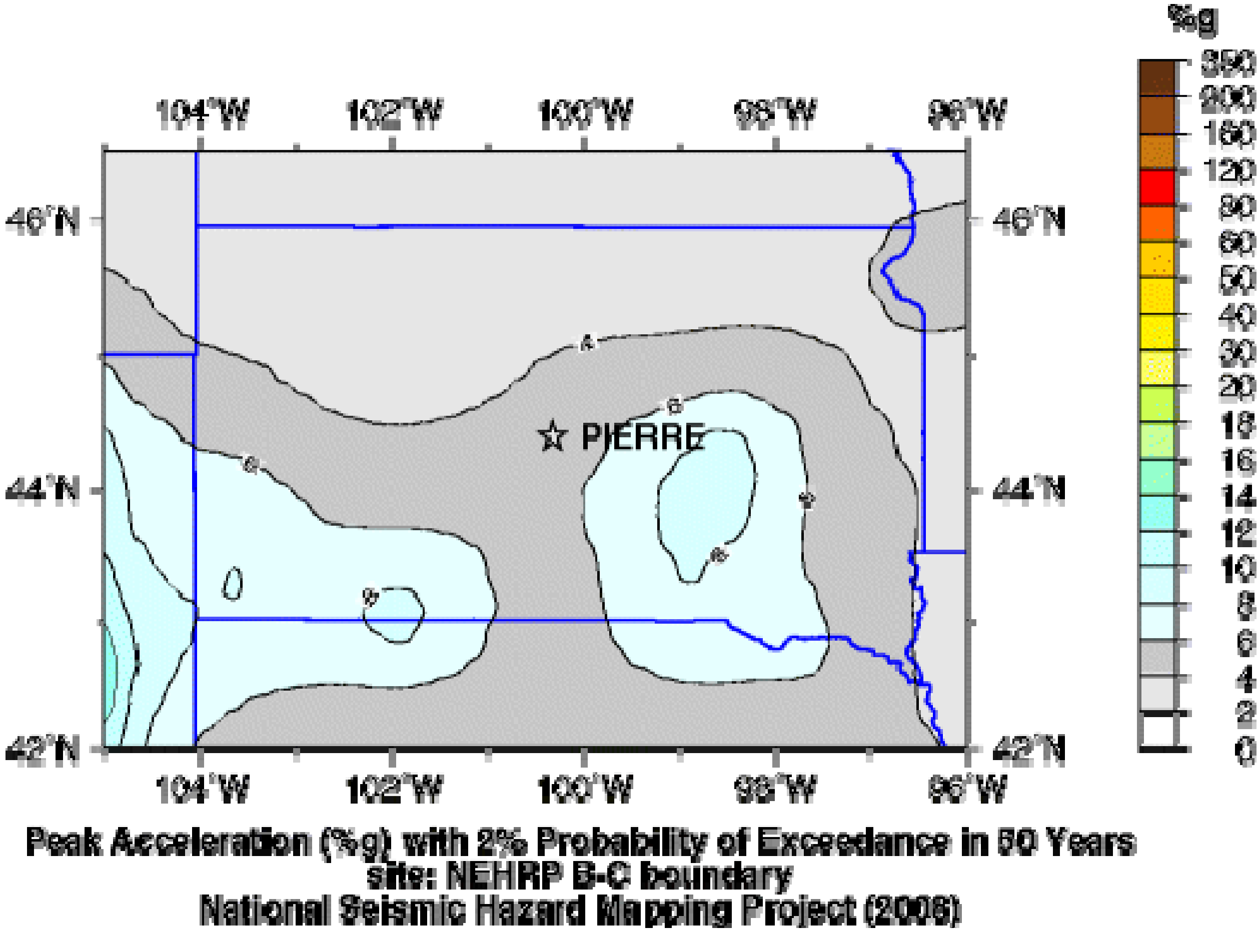
Date	Comments
August 25, 1947	Intensity IV—Gregory County near Bonesteel.
July 23, 1946	Intensity VI—Jerauld County near Wessington Springs. In Wessington water mains cracked at two points.
November 10, 1945	Intensity IV—3:00 a.m. Bon Homme County east of Kingsbury and southeast of Tyndall. Rattled dishes.
May 16, 1943	Intensity IV—12:40 p.m. Custer County north northeast of Hot Springs near Fall River-Custer County border. Felt by many "like heavy trucks rumbling down the street." Dishes rattled.
March 11, 1942	Intensity III—11:55 a.m. Meade County near Sturgis. Light shock felt in Deadwood, Fort Meade, Lead, Piedmont, Sturgis, Terraville, Trojan, Whitewood, and Black Hawk.
May 25, 1941	Intensity V—12:25 a.m. Custer County north northeast of Hot Springs near Fall River-Custer County border. In Hot Springs, one wall reported cracked. Pictures and light fixtures swayed in Hot Springs, Rapid City, and Martin. Not felt in Longvalley, Belvidere, Oelrichs, or Cottonwood.
Jun 10, 1939	Intensity IV—12:30 p.m. Gregory County on Nebraska border south of Fairfax. There was one shock of about 15 seconds duration. It was of a gradual bumping nature, direction northwest to southeast, with a rumbling sound.
November 4, 1938	Intensity IV—10:10 and 10:15 p.m. Gregory County near Whetstone Bay. Felt in Academy, Lake Andes, Burke, Colome, Dallas, Gregory, and Platte.
October 11, 1938	Intensity V—3:37 a.m. Minnehaha County between Renner and Sioux Falls. In Sioux Falls, buildings jarred, beds shook, dishes rattled, and pictures and other loose objects swayed. A rumbling subterranean noise came as a climax of the earthquake. The recording pens on water and electric meters at the municipal water works were jarred. Sioux Falls police received more than 50 calls from citizens. Intensity IV—Humboldt, Madison, Parker, Spencer, and Yankton. Intensity III and under—Canton, Centerville, Egan, Hudson, Lennox, Salem, Sherman, and Vermillion. Not felt in Beresford, Brookings, Howard, Mitchell, or Olivet.
October 1, 1938	Intensity V—4:15 p.m. Brule County near Chamberlain.
January 2, 1938	Intensity IV—11:05 a.m. Beadle County near Broadland.
October 30, 1936	Intensity IV—Custer County north northeast of Hot Springs near Fall River. Not felt elsewhere.
November 1, 1935	Intensity III—Moody County between Egan and the Minnesota border on Highway 34.
August 30, 1934	Intensity IV—On the Brule and Charles Mix County border between Bijou Hills and Academy: Abrupt trembling motion accompanied by a rumbling sound, felt by many, small objects moved. Also felt in Pukwana.
January 29, 1934	Intensity IV—6:30 a.m. Marshall County north northwest of Kidder near Newark. Awakened several, dishes rattled, rumbling sound.
January 17, 1931	Intensity IV—Aurora County east of Platte Lake and south of White Lake. Felt by many. Trembling motion with loud sounds.
October 6, 1929	Strong Shock—6:30 a.m. City of Yankton. Deep rumbling resembling distant thunder set windows rattling. Some dishes thrown from shelves. Felt around Yankton and at Gayville and Volin about 15 miles to the east.

Date	Comments
November 16, 1928	Intensity V—Pennington County near Mystic City. Felt at Custer and Rochford.
December 30, 1924	Intensity IV— 10:10, 10:15, 10:20, and 10:30 p.m.—Custer County north northeast of Hot Springs near Fall River-Custer County border.
January 2, 1922	Intensity VI—Brule County near Chamberlain.
September 24, 1921	Intensity IV—Aurora County east of Platte Lake and south of White Lake.
March 16, 1921	Intensity III—Minnehaha County near Sioux Falls at Lincoln County border.
July 14, 1920	Intensity III—Fall River County near Oelrichs.
June 29, 1916	Intensity III—Tripp County near Winner.
February 24, 1916	Intensity III—Shannon County near Pine Ridge.
October 23, 1915	Intensity V—Jackson County near Kadoka. Loud noises and some cracks in the ground.
Jun 2, 1911	Intensity V—Beadle County near James River crossing into Sanborn County. Felt in the James River Valley.
May 10, 1906	Intensity VI—Bennett County near southeast corner and on the Nebraska border. Felt from Rushville to Valentine, Nebraska.
March 14, 1900	Intensity III—5:00a.m. Brown County near northeast corner of Richmond Lake. Intensity III—3:00a.m. Brown County near northeast corner of Richmond Lake.
December 6, 1899	Intensity IV—Hand County near Miller.
October 12, 1895	Intensity V—Pennington County near Hayward.
October 11, 1895	Intensity IV–V—Pennington County near Hayward. Felt at Rochford, Keystone, and Hill City.
December 29, 1879	Intensity V—Yankton County near Yankton.
August 17, 1876	Intensity IV—Lyman County near Lower Brule.
October 9, 1872	Intensity V—At Sioux City, Iowa. Severe effects at Yankton and White Swan. Felt in all or most of South Dakota.
February 9, 1872	Intensity III—Stanley County near Mission Ridge.

Probability

South Dakota seems to be relatively geologically stable based upon the sparse data available. However, there is potential for larger earthquakes than the magnitude 4.4 earthquake that struck the Black Hills in 1964. The U.S. Geological Survey estimates this risk as only a 10 percent chance of exceeding a 5.1 magnitude in any one 50-year period. The map in Figure 3-29 shows ground motions that have a 2 percent chance of being equaled or exceeded in a 50-year period.

Figure 3-29: Seismic Hazard Map



Source: U.S. Geological Survey, National Earthquake Information Center

3.3 Assessing Vulnerability and Estimating Potential Losses by Jurisdiction

44 CFR Part 201 Requirement:

[The State risk assessment shall include an] overview and analysis of the State's vulnerability to the hazards described in paragraph (c)(2), based on estimates provided in local risk assessments… The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events….

Plan must be reviewed and revised to reflect changes in development….

44 CFR Part 201 Requirement:

[The State risk assessment shall include an] overview and analysis of potential losses to identified vulnerable structures, based on estimates provided in local risk assessments….

The following section assesses the vulnerability of South Dakota by county to the hazards previously identified and profiled. For purposes of this plan, county boundaries are the smallest jurisdictions considered and include information pertinent to all smaller jurisdictions located within the county. Other geographical, political and jurisdictional boundaries such as cities, towns, municipalities, and townships are better evaluated in specific hazard mitigation plans, which allow for the collection and analysis of more detailed information at the specific jurisdictional level.

Vulnerability is defined as the extent to which people and property are exposed to harm or damages created by a hazard. The quantification of vulnerability is based on best available data on the hazard and exposed populations and buildings. The method of determining vulnerability varies by hazard and data availability, and these methods are discussed in detail in each hazard profile. Where the data permits, loss estimations to people and property are provided. It was noted at stakeholder meetings during the 2007 plan update that the state may want to consider impacts to South Dakota's agricultural economy as a vulnerability factor in future plan updates. As such, the hazard profile "Agricultural Diseases and Pestilence" was added during the 2009 update.

The 2007 update to this plan synthesized and analyzed data that was previously included in several attachments and annexes. In 2009, the plan expanded on those data resources and attempted to fill previous data gaps. This new data utilized the methods established in 2007 and allowed for a comparative perspective on vulnerability to the hazards which impact the state. The results of this analysis are presented in this section. In addition, and in response to the FEMA evaluation of 2007, the growth and development trends were developed further in this update. The social vulnerability section, which was added in 2007, was also re-evaluated in the 2009 update but has not changed. Counties and other local jurisdictions can follow this same process to assist in developing or updating their local mitigation plans in a manner that consistently reflects vulnerability evaluations.

New vulnerability assessment methodologies were conducted during the 2007 update to refine vulnerability and loss estimates for flood, tornadoes, severe wind, winter storm, wildfire, and earthquake. These assessments have been updated in 2009-2010. A significant change to the 2009-2010 plan was the incorporation of a statewide flood loss estimation based on HAZUS. Additional information was added in 2009-2010 to improve the drought vulnerability section. A limited vulnerability analysis was added for hazardous materials. Vulnerability and loss assessments were not conducted for geologic hazards due to their ranking as limited for planning significance. With each successive update the vulnerability and loss estimates improve, though some information gaps remain.

The State Hazard Mitigation Team reviewed current and approved local hazard mitigation plans covering 64 counties for vulnerability and loss information. While some plans used a standard format for identifying potential loss, most of the plans contained limited vulnerability information and utilized different methodologies for determining the vulnerability. Therefore, it is currently not possible to consolidate the vulnerability and loss information from the local plans for a complete statewide comparison.

Growth and Development

As part of the plan update process, the state looked at changes in growth and development at the county level and examined these changes in the context of the state's hazard-prone areas and how the changes in growth and development affect loss estimates and vulnerability. Population and development growth increases the vulnerability of a given area and appropriate mitigation measures should be undertaken to minimize this increase.

General Land Use in South Dakota

Land use and development trends exert a significant impact on the vulnerability assessments for South Dakota relative to specific hazards. In some cases, a dominant land use may increase the vulnerability to a specific hazard, such as agricultural diseases or wildfire. Land use trends may also indicate areas where vulnerability and risk may be more sustained than in other areas of the state, and also help identify areas where vulnerability and risk levels vary. This is particularly important to examine in a statewide hazard mitigation plan, to ensure the document reflects accurate variability of these elements.

One characteristic of local land use in South Dakota that must be considered in both state and local hazard mitigation planning is how the land use patterns are changing at the community level. Identifying both the type and rate of change from existing land uses to future land uses, whether they are planned or unplanned, can help to identify the local jurisdictions most subject to development pressures and consequently help to focus the mitigation planning to minimize the vulnerability to future disasters of the newly constructed neighborhoods, facilities, and infrastructure. Data from local plans can be used to identify the jurisdictions where planned land uses are significantly different from existing land uses.

Land cover in South Dakota is predominantly cropland and rangeland. The significant forested areas in the state are concentrated in the Black Hills region, located in the south west corner of the state. Large bands of cultivated cropland and pastureland or haymaking areas run from north to south across eastern South Dakota. Areas in the western half of the state are marked with cropland and pastureland and pockets of barren land, but are primarily characterized by grasslands. Highly concentrated areas of development, including residential and commercial/industrial/transportation classifications of land, are limited geographically and centralized around the major population centers of Rapid City, Pierre, and

Sioux Falls. Other areas of concentrated urbanization include Aberdeen, Watertown, and Huron, which correspond to the population and demographic information outlined in the next section.

County Land Use in South Dakota

Notable and important growth and development trends were identified in the review of county hazard mitigation plans. Considerations of county growth and development trends is important in that increased growth exposes more citizens and building to hazards such as tornadoes, winter storms, and floods. As such, Table 3-27 summarizes the trends identified in the county mitigation plans.

Table 3-27 Growth and Development Trends Extracted from Local Plans

County	**Growth and Development Trend**
Aurora	No development is expected to increase the severity of hazards identified in the plan.
Beadle	The only community in Beadle County that is experiencing any growth and/or development is Huron. The rest of the jurisdictions have experienced declining populations over the past 10 years. Due to the declining population, these jurisdictions do not maintain plans for growth or development.
Bennett	It took into consideration present and projected land use and development trends within the communities and the unincorporated portions of Bennett County. The planning team evaluated county and community demographic data to get a picture of the changes that have taken place during the past 60 years.
Bon Homme	Little development is expected anywhere in the county. The population is expected to continue decreasing. However, one place where growth was identified to likely occur is the southern edge of Tyndall, which is covered in part by a flood prone area identified by HAZUS. The conversion of wetlands and other marginal land in the county to agricultural land due to the ethanol boom is of some concern because it may increase the probability and severity of flooding as the land's natural capacity to absorb excess surface water is decreased. This development could also have a negative impact on rural roads and structures. Conditions for growth were also identified along the Missouri River. Since this area is fairly rugged with a considerable amount of cedar trees and brushy vegetation, new housing constructed in this area would be somewhat vulnerable to wildfire.
Brookings	There was a 12 percent population increase 1990 and 2000. Mitigation activities are needed at the business level to ensure the safety and welfare of workers and limit damage to industrial infrastructure. Transportation systems in Brookings County have expanded and evolved
Brule	No development in this county is expected to increase severity of identified hazards.
Buffalo	No development in this county is expected to increase severity of identified hazards.
Charles Mix	There is no significant development occurring in Charles Mix, nor is any activity foreseen. However, the conversion of wetlands and other marginal

County	Growth and Development Trend
	land in the county could have an adverse impact on flooding. Much of the county's soil is fertile and suitable for growing crops, such as corn and wheat. Cattle production is also important. The economy is dependent upon agriculture. The County experienced a population decline during the last half of the twentieth century, but did register a slight increase from 1990 to 2000. The City of Wagner has decided to participate in NFIP to ensure that future development does not occur in the City's flood zone. Some development has been occurring in the hilly terrain west of Wagner. It is possible that area will experience increased damage from fires because the hilly terrain and thick vegetation makes firefighting difficult.
Codington	Construction of new homes
Custer	Rural areas of Custer County and the communities of Custer and Hermosa will grow over the next 20 years (in-migration of elderly persons looking for retirement and development of urban fringe areas).
Day	Steadily losing population since 1930. No future buildings, infrastructure, or critical facilities proposed that would be located in identified hazard areas. Mitigation options will be considered in future land use decisions.
Douglas	No development in this county is expected to increase severity of identified hazards.
Edmunds	No future development is identified to be within hazard areas.
Gregory	No development in this county is expected to increase severity of identified hazards.
Haakon	Declining number of farms, rural population steadily decreased and now leveling off, and some rural subdivision development. No future development is identified in a hazard area.
Hamlin	Slow and steady growth due to its proximity to larger communities such as Watertown and Codington County. No future buildings, infrastructure, or critical facilities are planned within hazard areas and mitigation options will be considered in future land use decisions. Small businesses and industries that are agricultural related are also increasing employment in the area. Agriculture is the basis of the economy.
Hand	In 2006, the County had a population of 3,323, a decline of 11.2% from the 2000 Census, which translates to around 2.3 persons per square mile, classifying the County as mostly rural. One major city, Miller, has a population of 1,530. The population has been decreasing over the years. The declining population offers limited potential for growth in the county and communities. As a result, there are currently no planned or potential buildings.
Hughes	Population increase, reduction in household size, trend toward rural living without farming, size of farms increasing, no future development was identified in a hazard area.
Hutchinson	No development in this county is expected to increase severity of identified

County	Growth and Development Trend
	hazards.
Hyde	Declining population. Small, rural county. Future development will be within or near the city. No future development is identified within hazard areas.
Jerauld	No development in this county is expected to increase severity of identified hazards.
Jones	Declining number of farms, rural population steadily decreased and now leveling off, and some rural subdivision development. No future development is identified in a hazard area. Future development will focus on the traveling public.
McCook	Since 1930, the population of McCook County has experienced a rise and then a decline of population growth. This trend is expected to continue.
Meade	Growth and development along I-90, Sturgis, and also in the southwest corner of the County near Piedmont and Summerset. The Black Hills Motorcycle Rally increases population and chances for hazards.
Mellette	Residential growth is not expected to be significant but needs to be controlled through planning and development guidelines. No development is expected to increase the severity of identified hazards.
Moody	Steadily losing population since 1930. Agriculture is the basis of the economy. No future buildings, infrastructure or critical facilities are planned to be located in hazard areas. Mitigation options will be considered in future land use decisions.
Pennington	Population growth, most in established towns and communities, mining is focus of industrial land use.
Potter	Steadily losing population since 1930. Agriculture is the basis of the economy. No future buildings, infrastructure, or critical facilities proposed to be located in identified hazard areas. Mitigation options will be considered in future land use decisions.
Roberts	Steadily losing population since 1930. Agriculture is the basis of the economy. No future buildings, infrastructure, or critical facilities proposed to be located in identified hazard areas. Mitigation options will be considered in future land use decisions.
Shannon	Minimal population growth
Spink	Decreasing population and limited potential for growth. There are no planned or potential buildings.
Stanley	Population increase, reduction in household size, trend toward rural living without farming, size of farms increasing, no future development is identified in a hazard area.
Sully	Declining number of farms, rural population steadily decreased and now leveling off, and some rural subdivision development, but the overall population trend is decidedly downward. Development is occurring along the bluffs overlooking the Oahe Reservoir.

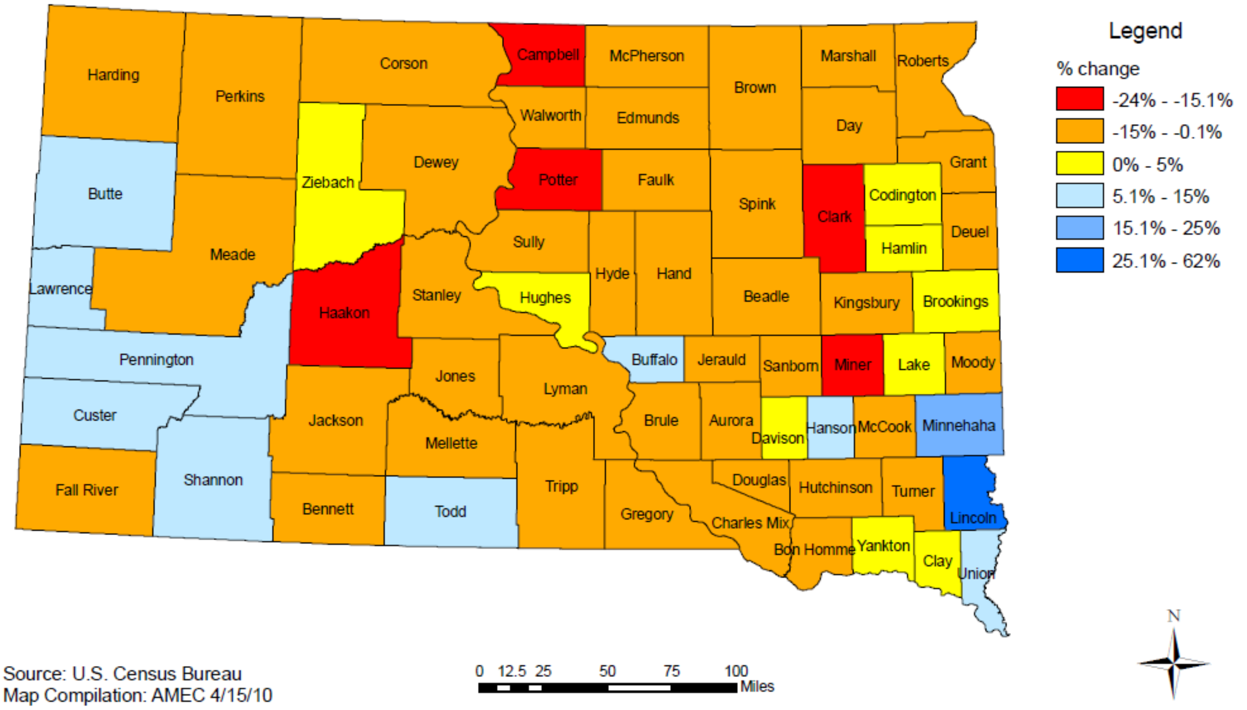
County	Growth and Development Trend
Tripp	No development in this county is expected to increase severity of identified hazards.
Turner	Steady decline in population since 1930, increase shown in 2000 census.
Union	Steady decline in population since 1930, large increase in population since 1990.
Yankton	Intensively farmed. Many of the poorly drained areas have been left as wetlands. There is no significant development in areas that are prone to flooding. In general, increased population in and around the City of Yankton leads to increased risk to the hazards identified in the plan.
Rosebud Sioux Tribe	Rural housing may increase vulnerability to winter storms and tornadoes. Increasing number of methamphetamine labs.

In addition to the trends noted in the hazard mitigation plans, plan reviewers commented on the following: Butte County is developing an ethanol plant and as a result experiencing a population increase. Lawrence County is noticing growth in the Spearfish area. The discussion that follows focuses on population growth and housing unit trends and density by county, based on the most recent U.S. Census Bureau data.

Population

U.S. Census Bureau American Community Survey (ACS) estimates South Dakota's 2008 population at 804,194. This reflects an increase of 6.4% between 2000 and 2008. In 2008, South Dakota ranked 46th among the 50 states in population, 22nd in rate of growth, 16th in land area, and 47th in population density from 2000 to 2008. Figure 3-30 illustrates the estimated population changes (by percent) for the counties in the state.

Figure 3-30 Estimated Percent Change in Population by County, 2000-2008



Decennial Census findings from the last few decades illustrate South Dakota's growth (see Table 3-28). This information appeared in the previous plan update, but cannot be updated or expanded until the publication of the 2010 Census. The information was, however, confirmed during the update process.

Table 3-28 South Dakota Decennial Census 1970-2000

Year	Population	% Change
1970	665,507	-2.2
1980	690,768	+3.8
1990	696,004	+.8
2000	754,844	+8.5

Source: Demographic Trends in the 20th Century, U.S. Census Bureau 2009

Between 2000 and 2008, 20 South Dakota counties gained population. With an estimated population gain of 64.5%, Lincoln County is the 7th[th] fastest growing county in the United States (of counties with 10,000 or more in population). No counties in South Dakota were ranked among the top 100 largest (by population) in the U.S. The three largest counties in the state (Minnehaha, Pennington, and Lincoln) were in the Top 10 Counties that experienced the largest population growth by number and by percent gained. Table 3-29, Table 3-30, and Table 3-31 show the Top 10 South Dakota counties ranked by estimated population and those with the greatest estimated population gains.

Table 3-29 10 Largest Counties Ranked by Population (Estimated), 2008

County	2008 Population
Minnehaha	179,180
Pennington	98,533

County	2008 Population
Lincoln	39,713
Brown	35,154
Brookings	29,668
Codington	26,317
Meade	23,989
Lawrence	23,524
Yankton	21,835
Davison	18,931

Source: U.S. Census Bureau American Community Survey 2008 Estimates

Table 3-30 Top 10 Counties with Greatest Estimated Population Gains (Numerical), 2000-2008

County	Population Gain 2000-2008
Minnehaha	30,101
Lincoln	15,184
Pennington	9,739
Lawrence	1,761
Union	1,541
Brookings	1,379
Todd	1,082
Shannon	1,081
Custer	524
Butte	482

Source: U.S. Census Bureau American Community Survey 2008 Estimates

Table 3-31 Top 10 Counties with Greatest Estimated Population Gains (Percent), 2000-2008

County	Population Gain (%) 2000-2008
Lincoln	64.5%
Minnehaha	20.2%
Hanson	14.4%
Union	12.2%
Todd	11.9%
Pennington	11.0%
Shannon	8.6%
Lawrence	8.1%
Custer	7.2%
Buffalo	6.7%

Source: U.S. Census Bureau American Community Survey 2008 Estimates

Between 2000 and 2008, 46 South Dakota counties lost population (see Table 3-33 and Table 3-34). Of the counties with the most rapid losses, two of them (Campbell and Potter) also rank among South

Dakota's 10 least populous counties (see Table 3-32). This is an improvement from the data in the 2007 plan, where four of the least populous counties experienced rapid population loss.

Table 3-32 Ten Smallest Counties Ranked by Population (Estimated), 2008

County	2008 Population
Jones	1,024
Harding	1,145
Campbell	1,352
Sully	1,356
Hyde	1,424
Haakon	1,819
Jerauld	1,982
Mellette	1,982
Potter	2,123
Buffalo	2,142

Source: U.S. Census Bureau American Community Survey 2008 Estimates

Table 3-33 Top 10 Counties with Greatest Estimated Population Losses (Numerical), 2000-2008

County	Population Loss 2000-2008
Beadle	-1,105
Hutchinson	-819
Spink	-756
Grant	-731
Day	-717
Tripp	-705
Walworth	-687
Clark	-685
Gregory	-676
Potter	-550

Source: U.S. Census Bureau American Community Survey 2008 Estimates

Table 3-34 Top 10 Counties with Greatest Estimated Population Losses (Percent), 2000-2008

County	Population Loss (%) 2000-2008
Campbell	-24.0%
Potter	-20.6%
Clark	-16.6%
Haakon	-16.4%
Miner	-15.5%
Harding	-14.6%
Hyde	-14.5%
Douglas	-14.4%

County	Population Loss (%) 2000-2008
Gregory	-14.2%
McPherson	-14.2%

Source: U.S. Census Bureau American Community Survey 2008 Estimates

Interim population projections issued by the U.S. Census Bureau in 2009 suggests that South Dakota's population will continue to grow but percentages will drop through 2020 (see Table 3-35). After 2020, population growth is projected to level off and begin to decline slightly after 2025. Population projections are only available at the state level.

Table 3-35 Interim South Dakota Population Projections, 2010-2030

Year	Projected Population	% Change
2010	786,399	+1.9
2015	796,954	+1.3
2020	801,939	+.6
2025	801,845	0
2030	800,462	-.2

Source: U.S. Census Bureau 2009

Appendix 3A Population and Growth contains population and growth information for all South Dakota counties.

Housing Units

Another indicator of growth is the number of housing units in a county. The Census defines a housing unit as a house, an apartment, a mobile home or trailer, a group of rooms, or a single room that is occupied, or, if vacant, is intended for occupancy as separate living quarters. According to the U.S. Census Bureau, the number of estimated housing units in South Dakota increased 11.8 percent (38,274 units) between 2000 and 2008. With 361,482 units, South Dakota ranked 46th among the 50 states in number of housing units. Table 3-36 lists the ten counties with the most housing units, which corresponds to the ten most populous counties shown in Table 3-29. Minnehaha, Pennington, and Lincoln topped the list for numerical gains (Table 3-37) and, tracking with its rate of population growth, Lincoln topped the list of percent gained (33.4 percent). Table 3-37 and Table 3-38 list the counties that have grown the most in terms of housing units by number and percent respectively.

Table 3-36 Top 10 Counties Ranked by Number of Housing Units (Estimated), 2008

County	2008 Housing Units
Minnehaha	74,865
Pennington	42,970
Brown	16,606
Brookings	13,080
Codington	12,273
Lincoln	12,179
Lawrence	12,083
Meade	11,587

County	2008 Housing Units
Yankton	9,563
Davison	8,718

Source: U.S. Census Bureau American Community Survey 2008 Estimates

Table 3-37 Top 10 Counties with Greatest Estimated Housing Unit Gains (Numerical), 2000 – 2008

County	Housing Unit Gains 2000-2008
Minnehaha	14,628
Pennington	5,721
Lincoln	3,048
Lawrence	1,656
Brookings	1,504
Meade	1,438
Codington	949
Union	841
Custer	749
Brown	745

Source: U.S. Census Bureau American Community Survey 2008 Estimates

Table 3-38 Top 10 Counties with Greatest Estimated Housing Unit Gains (Percent), 2000–2008

County	Housing Unit Gains (%) 2000-2008
Lincoln	33.4%
Minnehaha	24.3%
Custer	20.7%
Lawrence	15.9%
Union	15.7%
Pennington	15.4%
Meade	14.2%
Brookings	13.0%
Stanley	11.3%
Butte	9.5%

Source: U.S. Census Bureau American Community Survey 2008 Estimates

Density

South Dakota has a surface land area of 75,885 square miles (2000 Census) and a population of 804,194 (American Community Survey 2008 Estimate). Based on these estimates, South Dakota ranked 46th in both population and housing density among the 50 states. The same 10 counties ranked at the top in terms of both population density and housing density, as shown in Table 3-39. Eight of these counties (excluding Clay and Union) also ranked among South Dakota's Top 10 Most Populous Counties in Table 3-29.

Table 3-39 Top 10 Counties Ranked by Population Density, 2008

County	2008 Estimated Population Density*	Population Density Change (%) 2000-2008	2008 Estimated Housing Density	Housing Density Change (%) 2000-2008
Minnehaha	221.3	20.2%	92.5	24.3%
Lincoln	68.7	61.9%	21.1	33.4%
Davison	43.5	1.1%	20.0	7.7%
Yankton	41.9	1.1%	18.3	8.2%
Codington	38.3	1.6%	17.8	8.4%
Brookings	37.3	4.9%	16.5	13.0%
Pennington	35.5	11.0%	15.5	15.4%
Clay	33.1	0.8%	14.2	7.6%
Union	30.7	12.2%	13.4	15.7%
Lawrence	29.4	8.1%	15.1	15.9%

Source: U.S. Census Bureau 2000 Census and American Community Survey 2008 Estimate

*Note: Density is reported as people/housing units per square mile and is based on the square mileage of each county's land area.

The percent change in population density tracks with the percent change in population growth. The fastest growing counties are also experiencing a more rapid increase in population density than the other counties. This information is located in Table 3-40. Determining areas of significant population density growth helps establish areas that may be more vulnerable to hazards due to the increased number of people living in a potentially impacted area.

Table 3-40 Counties with Greatest Estimated Population Gains (Percent), 2000 – 2008

County	Population Density* Gains (%) 2000-2008
Lincoln	61.9%
Minnehaha	20.2%
Hanson	14.4%
Union	12.2%
Todd	11.9%
Pennington	11.0%
Shannon	8.6%
Lawrence	8.1%
Custer	7.2%
Buffalo	6.7%

Source: U.S. Census Bureau 2000 Census and American Community Survey 2008 Estimate

Summary of Impact of Growth and Development Trends on Vulnerability and Loss Estimates

In general, counties with growing populations and number of housing units have an increased vulnerability to hazards not defined by specific geographic areas. These hazards may include winter storms, tornadoes, wind, drought and earthquake. With the exception of Shannon and Todd, which do not have flood maps, the counties experiencing the most development pressures all participate in the National

Flood Insurance Program. Rapid City, in Pennington County, is in the Community Rating System. This suggests that flood risk should not be increasing, assuming that county floodplain ordinances are being effectively implemented and wise use of floodplains encouraged. Union County is one of the fastest growing counties and also has potential for high flood losses as described in the flood vulnerability section. Growth and development trends and their impact on vulnerability were noted during stakeholder meetings held in conjunction with the 2007 update to the plan. In Charles Mix County, lodges are being built with potential risk to wildfire. New development amongst trees in Minnehaha County east of Sioux Falls are demanding city services for fire protection. New housing being built near Mitchell Lake and in North Lincoln County could also be at risk to wildfire. Costs of homes in forested areas in southwestern South Dakota are rising, thus the exposure analysis conducted for this plan is likely to underestimate the property values exposed to wildfire risk. New homes being built in Meade and other Counties increase the exposure to damage from tornados.

Social Vulnerability

A Social Vulnerability Index (SVI) compiled by the Hazards and Vulnerability Research Institute in the Department of Geography at the University of South Carolina measures the social vulnerability of U.S. counties to environmental hazards. The comparison of SVI values between counties within the state allows for a more detailed depiction of variances in risk and vulnerability. The Index is based on national data sources, primarily the 2000 census, and synthesizes 42 socioeconomic and built-environment variables that research literature suggests contribute to reduction in a community's ability to prepare for, respond to, and recover from hazards. Eleven composite factors differentiate counties according to their relative level of social vulnerability. These categories are personal wealth, age, density of the built environment, single-sector economic dependence, housing stock and tenancy, race (African American and Asian), ethnicity (Hispanic and Native American), occupation, and infrastructure dependence. The Index has not been updated since the 2007 plan update, but the information was verified in the 2009 update process.

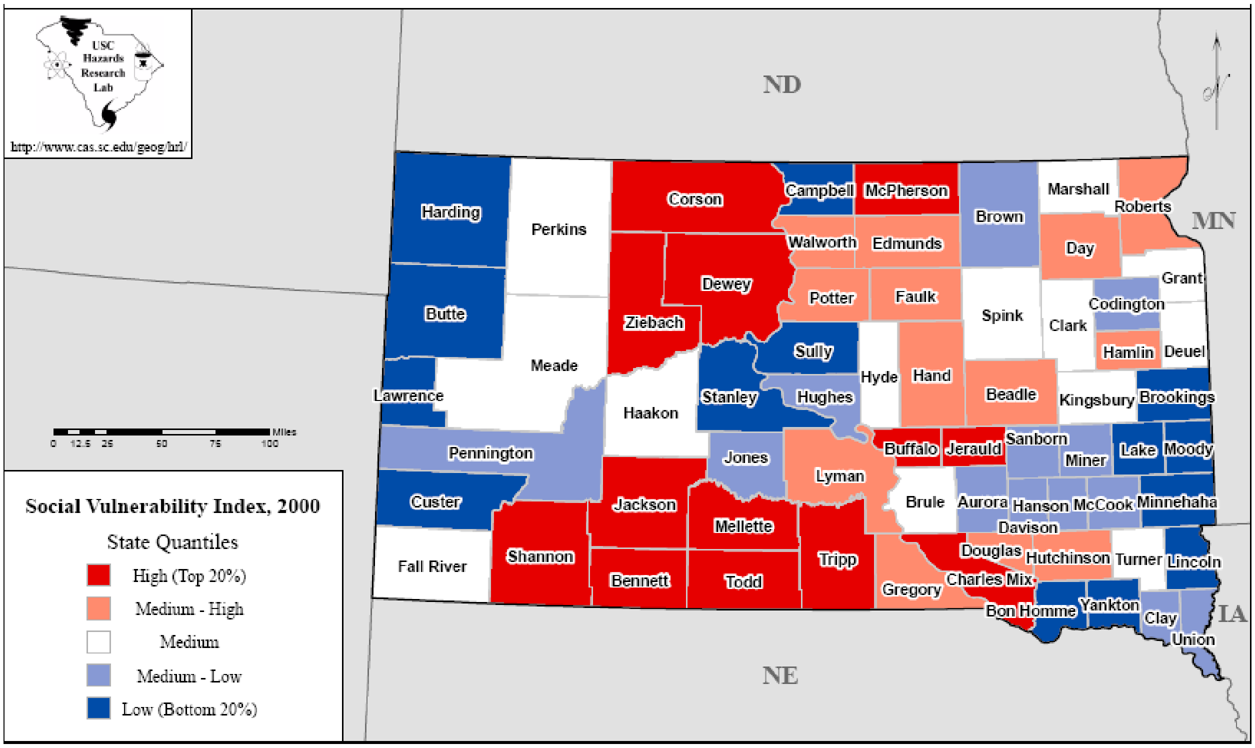
The index can be used by the state to help determine where social vulnerability and exposure to hazards overlaps and how and where mitigation resources might best be used. See Figure 3-31 for a map that illustrates South Dakota's geographic variation in social vulnerability. According to the index, the following, listed in order, are South Dakota's most socially vulnerable counties (i.e., they rank in the top 20 percent in the state):

- Shannon*
- Todd*
- Buffalo
- Ziebach
- Dewey
- Bennett
- Jackson
- Jerauld
- McPherson
- Tripp
- Charles Mix

- Mellette
- Corson

Note: An asterisk (*) denotes counties that are among the 10 fastest growing counties in the state. The counties of Potter, Roberts, Gregory, Hamlin, Edmunds, Walworth, Faulk, Douglas, Day, Hand, and Hutchinson also rank in the top 20 percent in the nation in terms of social vulnerability.

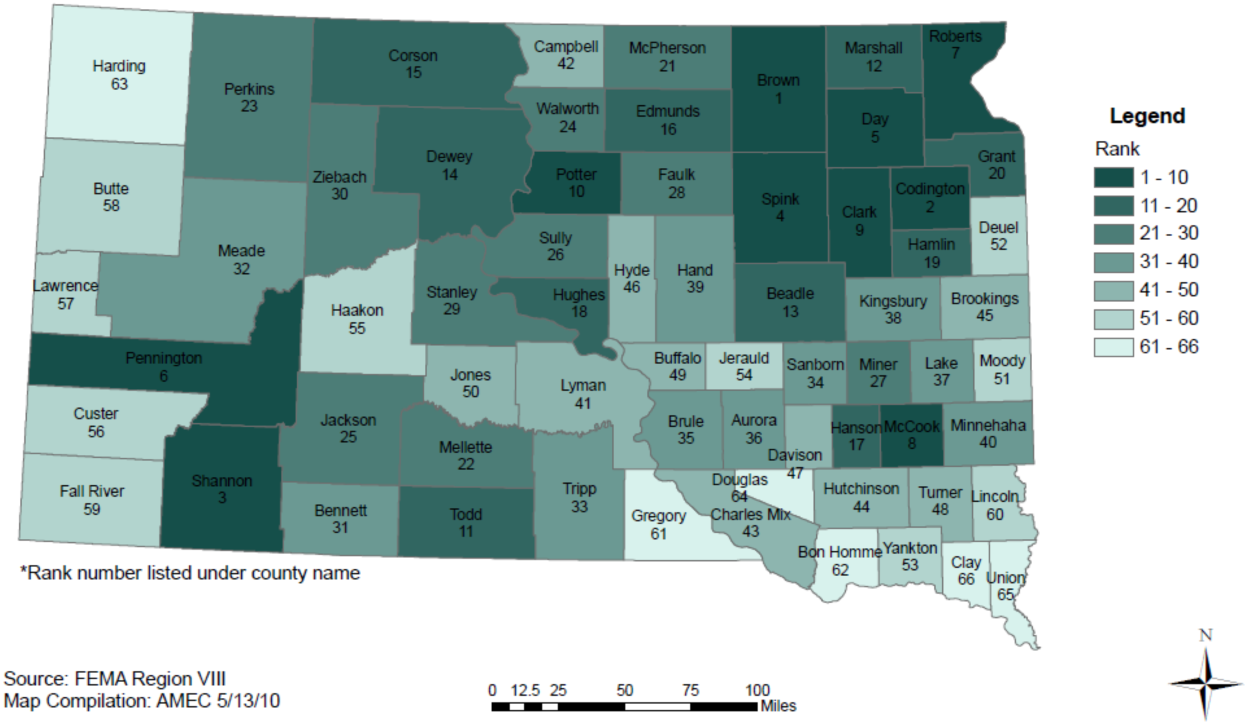
Figure 3-31 Social Vulnerability to Environmental Hazards, County Comparison within the State, 2000



Federal Disaster Declaration History

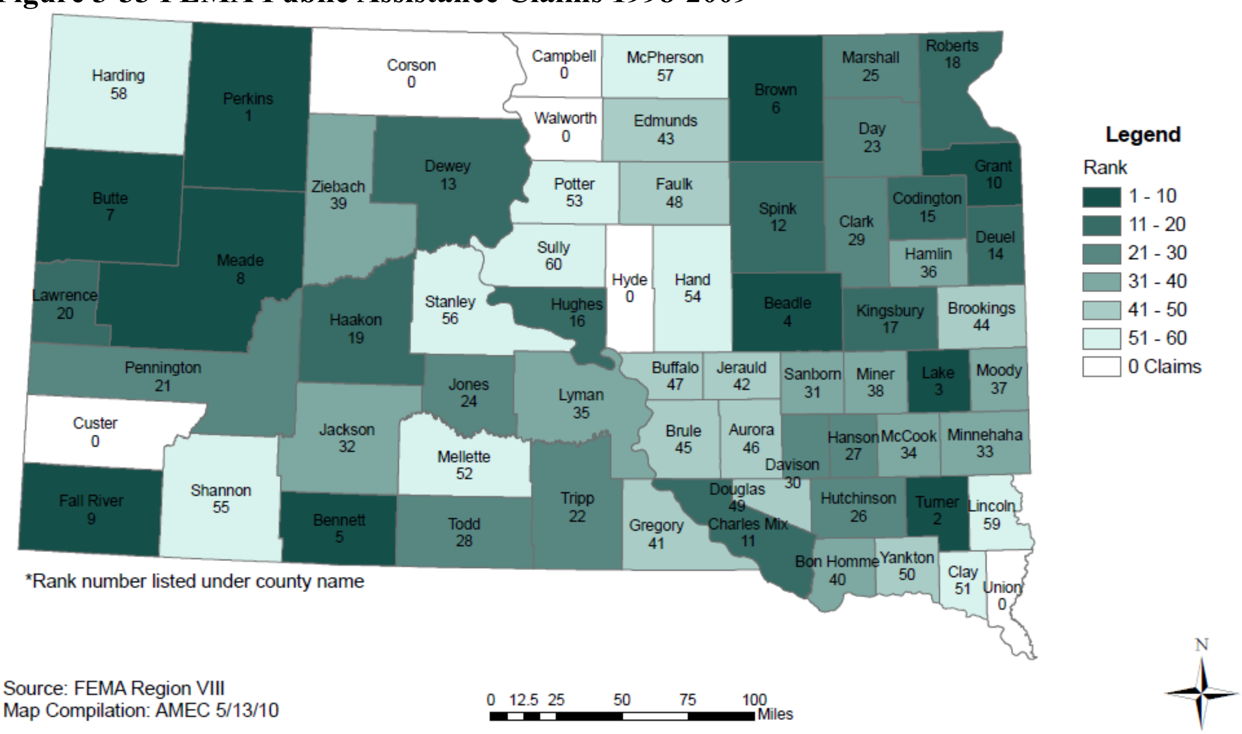
Another indicator of vulnerability by jurisdiction is looking at the pattern of past disaster declarations by county across the State. FEMA Region VIII made available summary counts of the number of Individual Assistance (IA) and Public Assistance (PA) claims. These summaries are presented on the maps in Figure 3-32 and Figure 3-33 for the time period of July 1993 to May 2009 for the IA claims and November 1998 to May of 2009 for the PA claims.

Figure 3-32 FEMA Individual Assistance Claims 1993-2009



Source: FEMA Region VIII

Figure 3-33 FEMA Public Assistance Claims 1998-2009



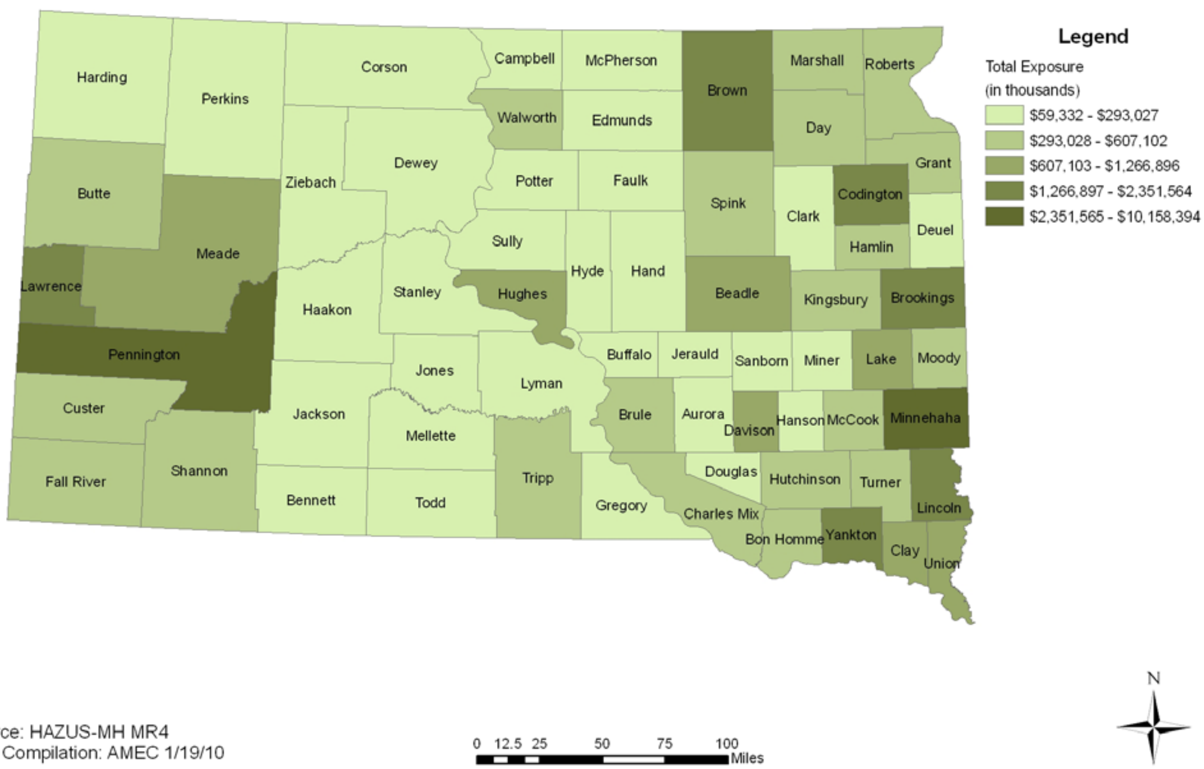
Source FEMA Region VIII

Building Exposure

Exposure is a term borrowed from the insurance industry as a measure of property "exposed" to a particular hazard. HAZUS-MH MR 4 building inventory data provided the basis for measuring the number and value of buildings vulnerable to hazards. There are an estimated 406 thousand buildings in South Dakota with a total building replacement value (excluding contents) of $47,276,961,000. Approximately 92 percent of the buildings (and 70 percent of the building value) are associated with residential housing. Figure 3-34 shows a thematic map at how building exposure varies by county across the state.

In terms of a catastrophic event, the entire building inventory could be at risk to a hazard. An event that would destroy or damage the entire inventory in a given county is unlikely, but it is possible that a tornado impacting the heart of a rural community could result in considerable building losses.

Figure 3-34 Building Exposure



Source: HAZUS-MH MR4
Map Compilation: AMEC 1/19/10

Floods

Nearly every county in South Dakota is vulnerable to floods. South Dakota's January 2004 Map Modernization Plan divides the state into five regions based on population and flooding hazards. The priority regions and the jurisdictions associated with those regions are:

- **Priority 1: Big Sioux Region**—Brookings, Clark, Clay, Codington, Day, Deuel, Grant, Hamlin, Hutchinson, Kingsbury, Lake, Lincoln, Marshall, McCook, Miner, Minnehaha, Moody, Roberts, Turner, Union, and Yankton.
- **Priority 2: James Region**—Aurora, Beadle, Bon Homme, Brown, Brule, Buffalo, Campbell, Charles Mix, Davison, Douglas, Edmunds, Faulk, Hand, Hanson, Hughes, Hyde, Jerauld, McPherson, Potter, Sanborn, Spink, Sully, and Walworth*.
- **Priority 3: Grand/Moreau Region**—Butte, Corson, Dewey, Harding, Meade, Perkins, and Ziebach.
- **Priority 4: Cheyenne Region**—Custer, Fall River, Haakon, Lawrence, Pennington, Shannon, and Stanley.
- **Priority 5: White/Bad Region**—Bennett, Gregory, Jackson, Jones, Lyman, Mellette, Todd, and Tripp.

The following section describes progress the State has made developing vulnerability and loss estimates for the highlighted counties. Future updates to this plan will include additional vulnerability analyses as more DFIRMs become available and as more resources for HAZUS-MH studies are obtained.

Methodology

Planning level flood loss estimates were made available for every county in South Dakota with the 2010 update to the South Dakota Hazard Mitigation Plan. FEMA used HAZUS-MH MR2 to model the 100-year floodplain and perform associated building and population risk assessments. HAZUS-MH is FEMA's GIS-based natural hazard loss estimation software. The HAZUS-MH flood model results included analysis for each of the 66 counties modeling streams draining a 10 square mile minimum drainage area, using 30 meter (1 arc second) Digital Elevation Models (DEM). Hydrology and hydraulic processes utilize the DEMs, along with flows from USGS regressions and gauge data, to determine reach discharges and to model the floodplain. Losses are then calculated using HAZUS-MH national baseline inventories (buildings and population) at the census block level.

HAZUS-MH produces a flood polygon and flood-depth grid that represents the 100-year floodplain. The 100-year floodplain represents a flood that has a 1% chance of being equaled or exceeded in any single year. While not as accurate as official flood maps, these floodplain boundaries are available for use in GIS and could be valuable to communities that have not been mapped by the National Flood Insurance Program. HAZUS-MH generated damage estimates are directly related to depth of flooding and are based on FEMA's depth-damage functions. For example, a two-foot flood generally results in about 20 percent damage to the structure (which translates to 20 percent of the structure's replacement value). The HAZUS-MH flood analysis results provide number of buildings impacted, estimates of the building repair costs, and the associated loss of building contents and business inventory. Building damage can cause additional losses to a community as a whole by restricting the building's ability to function properly. Income loss data accounts for losses such as business interruption and rental income losses as well as the resources associated with damage repair and job and housing losses.

Data Limitations: Potential losses derived from HAZUS-MH used default national databases and may contain inaccuracies; loss estimates should be used for planning level applications only. There could also be errors and inadequacies associated with the hydrologic and hydraulic modeling of the HAZUS-MH model. In rural South Dakota, census blocks are large and often sparsely populated or developed; this may create inaccurate loss estimates. HAZUS-MH assumes population and building inventory to be evenly distributed over a census block; flooding may occur in a small section of the census block where there are not actually any buildings or people, but the model assumes that there is damage to that block. In addition, excessive flood depths may occur due to problems with a DEM or with modeling lake flooding. Errors in the extent and depth of the floodplain may also be present from the use of 30 meter digital elevation models. HAZUS-MH Level II analyses based on local building inventory, higher resolution terrain models, and DFIRMs could be used in the future to refine and improve the accuracy of the results. Another limitation is that HAZUS does not model lake shore flooding and may not represent the closed basin flooding scenarios common in South Dakota, such as in Brown County. HAZUS level 1 modeling does not account for levee protection.

HAZUS-MH building data is based on average housing costs and 2000 census counts. There may be errors within the HAZUS-MH data itself. The size and shape of the census block affects the accuracy of this model. The larger and more irregular the census block, typically found in rural areas, the less accurate this method becomes. There could be spatial inaccuracies with DFIRM data, or the data may not include all the possible flood hazards within a particular county. This model may include structures within the 100-year floodplain (A Zone) that may be elevated above the level of the base flood elevation, according to local floodplain development requirements. This model may not reflect actual real world conditions, but it does serve as a basis to quantify the possible risk from floods, using the best available data.

HAZUS-MH produces a flood polygon and flood-depth grid that represents the base flood. While not as accurate as official flood maps, such as digital flood insurance rate maps, these floodplain boundaries are available for use in GIS and could be valuable to communities that have not been mapped by the National Flood Insurance Program. A statewide digital flood hazard layer was created by appending floodplain boundaries created in each county run and is displayed in Figure 3-36. Figure 3-37 and Figure 3-38 show sample HAZUS-MH flood hazard outputs. Figure 3-35 shows the current extent of effective DFIRMs in the state.

Figure 3-35 South Dakota Digital Flood Insurance Rate Map Coverage 2010

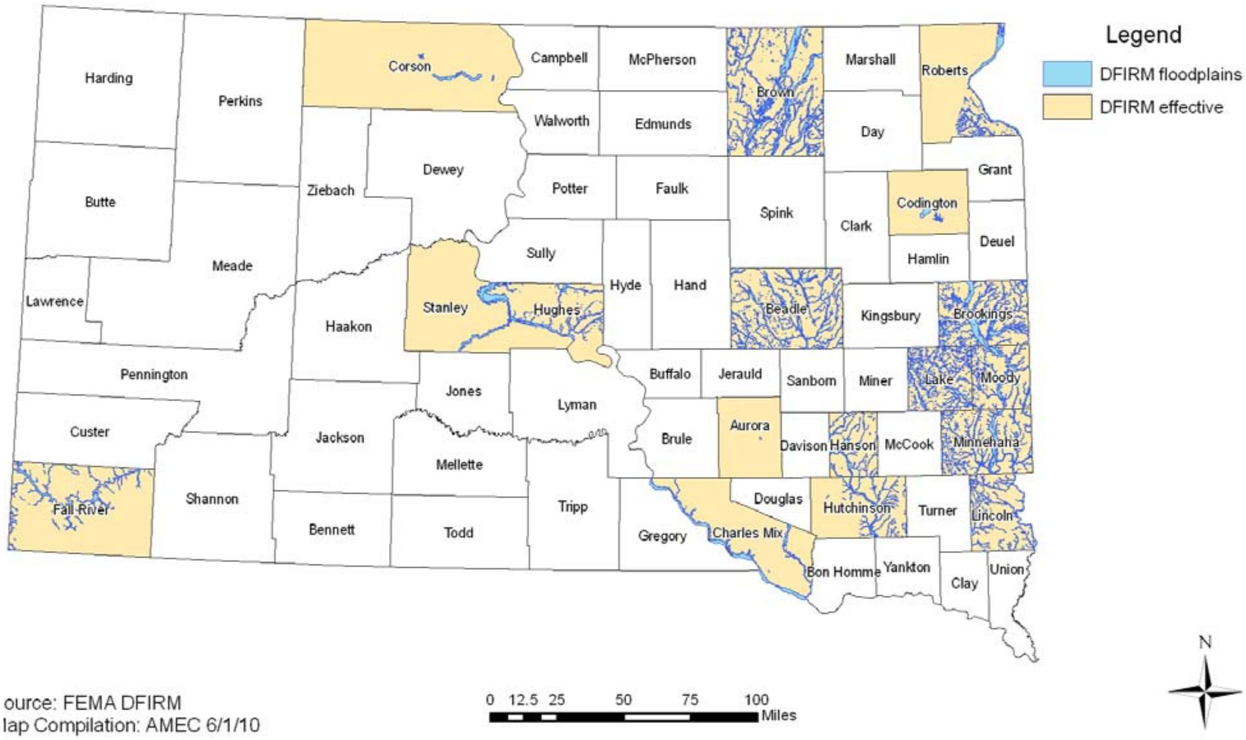


Figure 3-36 South Dakotas 100-year Flood Zones based on HAZUS

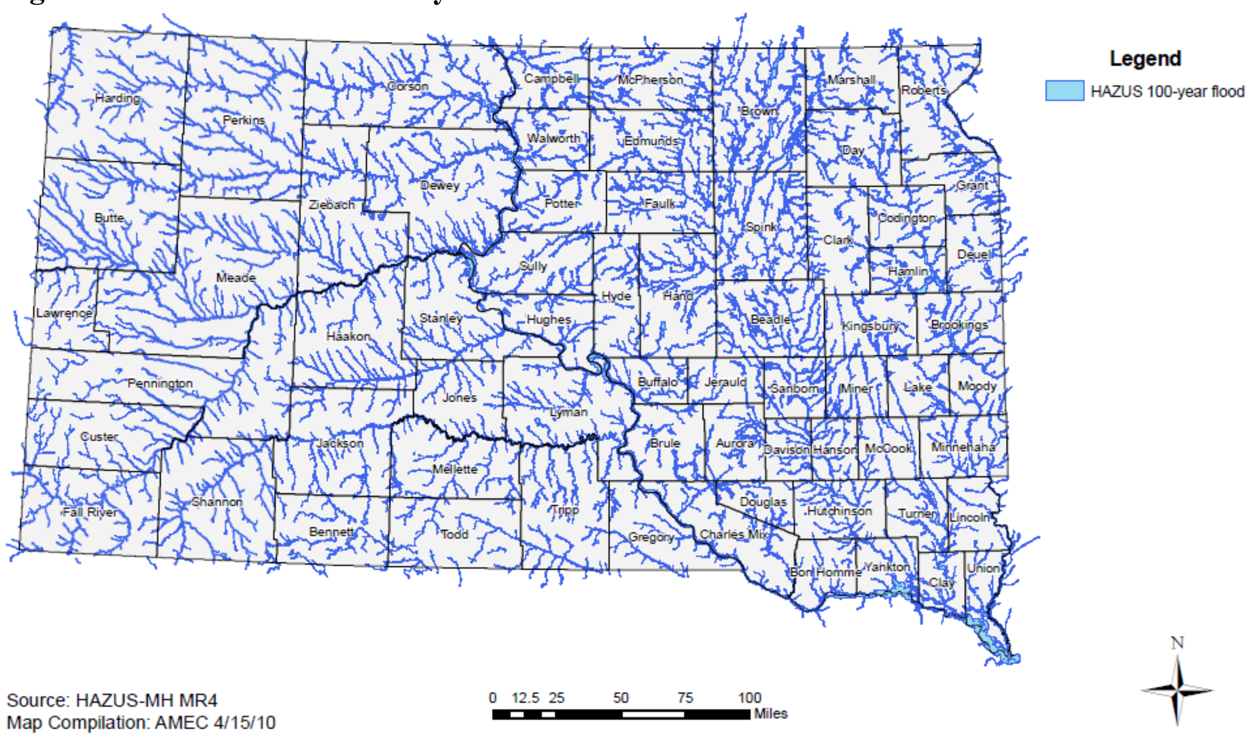


Figure 3-37 Example of a Floodplain Depth Grid Output by HAZUS-MH Minnehaha County

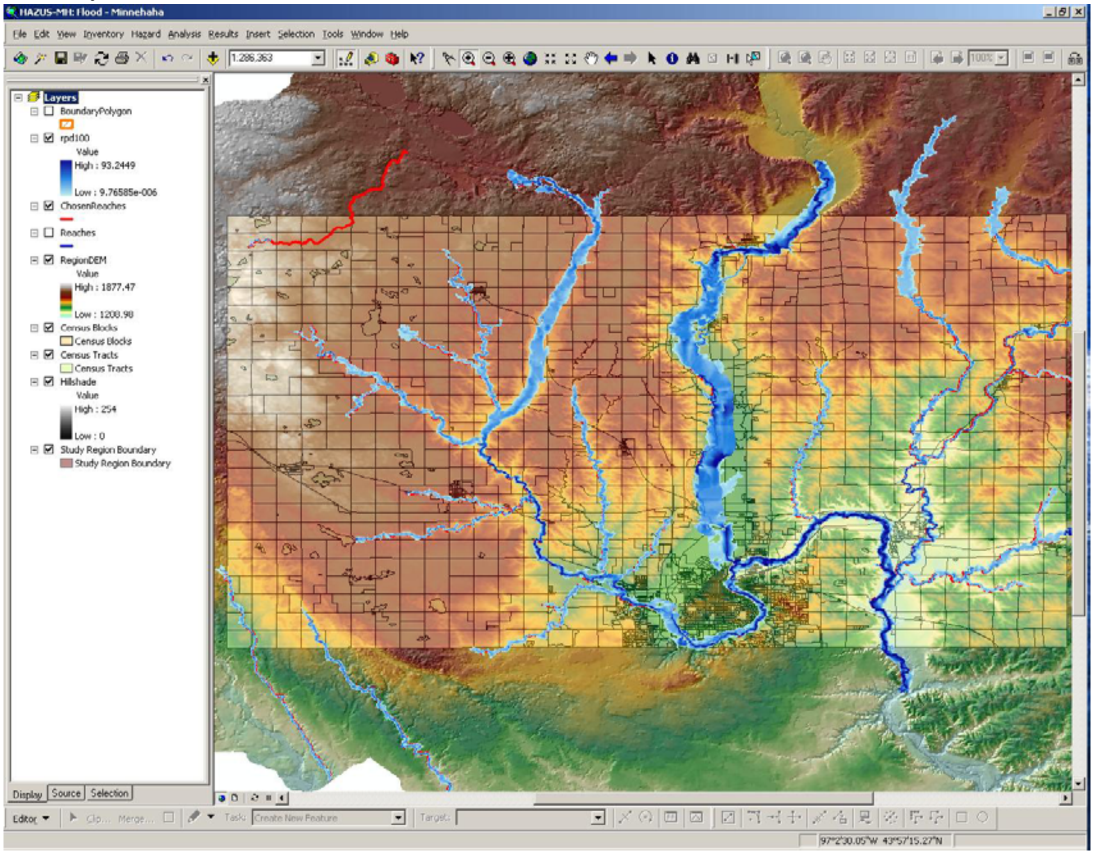
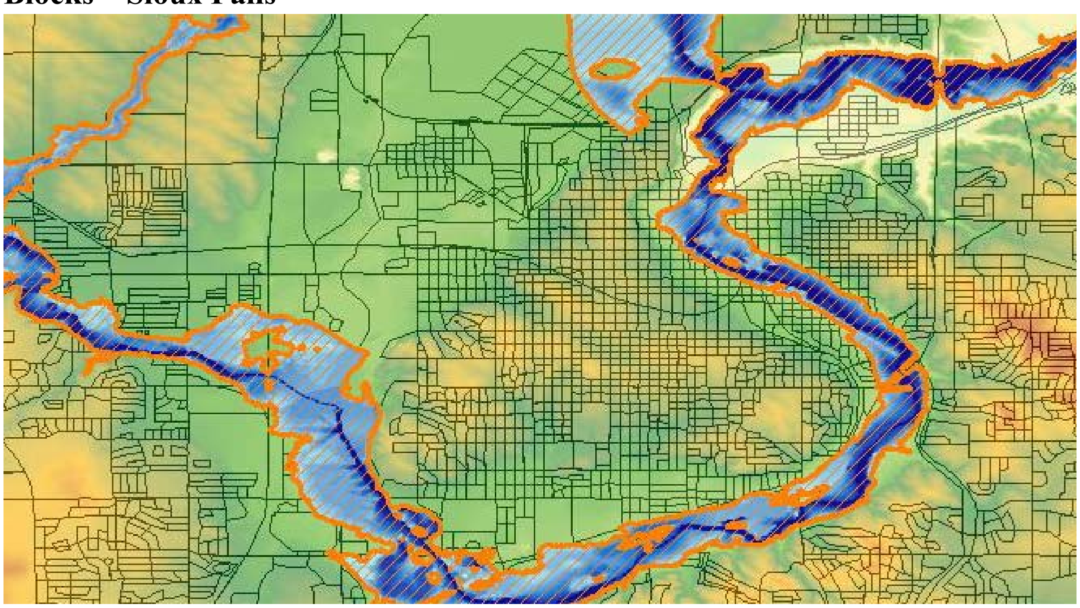


Figure 3-38 Example of HAZUS-MH Floodplain Boundary and Depth Detail and Census Blocks – Sioux Falls



HAZUS-MH can analyze additional impacts, including what type of infrastructure could be affected and how severely. Project files for the studied counties are available for use by local governments and the state if more details on the impacts discussed here, or information about other impacts, such as vehicle losses, agricultural losses, utility system losses, essential facility impacts, and transportation impacts, are desired.

Vulnerable Jurisdictions and Potential Losses

The intent of this analysis was to enable the state to estimate where flood losses could occur and quantify the degree of severity using a consistent methodology. The computer modeling helps quantify risk along known flood hazard corridors such as along the James, Big Sioux, and Vermillion rivers. In addition, flood losses are estimated for certain lesser streams and rivers where the flood hazard may not have been previously studied.

HAZUS-MH impact analyses were run for direct economic losses for buildings and societal impacts (displaced people and shelter needs) to display the relative ranking of counties based on these risk indicators (these losses and impacts are illustrated in the tables that follow). The primary indicators used to assess flood losses were:

- Direct building losses combined with income losses,
- Loss ratio of the direct building losses compared to overall building inventory,
- Loss ratio of building contents compared to overall building inventory, and
- Population displaced by the flood and shelter needs.

The results, shown in Table 3-41, Figure 3-39, Figure 3-40, Figure 3-41, and Figure 3-42, display the potential base flood losses to all counties. More detailed results are in Appendix 3B. The results show potential losses as highest in Minnehaha, Union, Yankton, Pennington, Codington, Lawrence and Brown counties. Floods in these counties have the potential to displace at least a thousand persons in each county. Statewide there is the potential for $1.7 Billion in flood losses from the 1% annual chance flood.

Based on the loss ratio, which is the percent of the total building inventory value that could be damaged from flooding in any given year, Union, Yankton, Fall River and Campbell Counties are most at risk and may have difficulty recovering from a flood event. Note that Union County does contain levees (see the flood hazard profile section), which is likely being ignored by HAZUS. The results presented for Union County may be more representative of a levee failure scenario.

Table 3-41 HAZUS-MH Base Flood (1 Percent Chance) Loss Estimation Results: Impacts by County, Ranked by Highest Building Losses

County Name	Building Damage Count	Building Damage Loss ($K)	Building Damage Loss Ratio*	Contents Damage Loss ($K)	Contents Loss Ratio	Total Direct Econ Bldg Loss **($K)	Short Term Shelter Needs	Displaced Population
Minnehaha	719	162,527	1.6%	252,358	3.6%	432,484	6,159	7,482
Union	867	119,836	11.6%	203,473	25.4%	349,991	3,451	4,428
Yankton	713	81,492	5.6%	105,103	9.7%	193,250	2,614	3,328

County Name	Building Damage Count	Building Damage Loss ($K)	Building Damage Loss Ratio*	Contents Damage Loss ($K)	Contents Loss Ratio	Total Direct Econ Bldg Loss **($K)	Short Term Shelter Needs	Displaced Population
Pennington***	88	15,085	0.32%	33,970	0.4%	113,162	888	1,301
Codington	221	28,917	1.7%	48,403	3.9%	81,843	2,301	3,027
Lawrence	72	20,631	1.5%	28,237	3.0%	50,103	504	979
Brown	71	16,502	0.7%	22,083	1.4%	40,502	854	1,785
Stanley	131	14,974	9.2%	11,356	10.9%	26,644	340	666
Fall River	92	14,007	3.2%	20,735	7.5%	36,379	250	525
Butte	24	9,890	2.3%	10,891	4.0%	21,428	271	892
Lake	72	8,740	1.1%	11,306	2.1%	20,840	664	1,128
Shannon	34	8,180	2.5%	11,173	5.1%	20,430	492	1,214
Lincoln	26	7,275	0.5%	6,826	0.7%	14,514	210	524
Spink	15	6,474	1.3%	7,554	2.4%	14,644	217	572
Davison	24	6,417	0.6%	6,297	0.8%	13,185	216	530
Hutchinson	29	5,799	1.2%	9,436	2.6%	16,001	646	957
Turner	12	5,659	0.9%	7,748	1.9%	14,191	39	391
Hamlin	18	5,398	1.4%	9,963	4.0%	16,441	31	387
Custer	6	5,092	1.1%	10,476	3.7%	16,746	44	257
Meade	8	4,808	0.4%	6,458	0.8%	11,765	106	469
Brookings	7	4,563	0.3%	9,953	0.8%	15,476	383	943
Grant	22	4,422	0.9%	4,652	1.4%	9,592	97	415
Charles Mix	4	4,020	0.7%	5,337	1.4%	9,842	46	232
Aurora	17	3,914	2.0%	5,561	4.5%	10,125	101	481
Haakon	13	3,761	2.6%	5,756	5.3%	10,151	78	303
Beadle	6	3,673	0.3%	6,000	0.8%	10,393	64	387
Tripp	31	3,470	0.9%	3,446	1.3%	7,248	86	265
Campbell	37	3,393	3.2%	5,017	7.1%	8,813	124	383
Lyman	13	3,267	1.5%	3,329	2.3%	6,876	38	145
McCook	18	3,257	0.9%	2,680	1.1%	6,096	65	252
Hughes	7	3,195	0.3%	5,319	0.7%	8,871	297	611
Clay	18	2,952	0.4%	2,268	0.5%	5,327	88	248
Roberts	8	2,903	0.5%	3,991	1.0%	7,273	36	320
Edmunds	30	2,718	1.0%	2,526	1.4%	5,461	156	293
Todd	9	2,227	0.8%	3,458	1.9%	5,723	105	314
Corson	16	2,089	1.5%	1,711	1.9%	3,894	285	446
Hand	9	2,083	0.7%	1,931	1.0%	4,161	39	197
Moody	2	2,072	0.5%	1,949	0.8%	4,220	9	216
Bon Homme	7	1,815	0.4%	1,870	48.9%	3,828	37	117
Day	5	1,649	0.3%	1,386	0.5%	3,187	10	157

County Name	Building Damage Count	Building Damage Loss ($K)	Building Damage Loss Ratio*	Contents Damage Loss ($K)	Contents Loss Ratio	Total Direct Econ Bldg Loss **($K)	Short Term Shelter Needs	Displaced Population
Dewey	3	1,532	0.8%	981	0.9%	2,557	31	166
Miner	9	1,527	0.8%	1,685	1.4%	3,363	66	159
Mellette	14	1,501	1.9%	817	1.6%	2,331	109	223
Brule	1	1,423	0.4%	1,813	0.7%	3,498	19	151
Ziebach	8	1,403	2.1%	749	1.9%	2,158	75	191
Deuel	2	1,386	0.5%	2,256	1.2%	3,922	34	154
Hanson	0	1,368	0.8%	1,029	0.9%	2,473	3	94
Kingsbury	0	1,366	0.3%	2,080	0.8%	3,672	48	281
Perkins	0	1,293	0.6%	982	0.7%	2,339	-	76
Faulk	4	1,275	0.8%	1,592	1.4%	3,056	94	179
Clark	2	1,208	0.5%	1,880	1.1%	3,328	45	159
Bennett	0	1,165	1.0%	1,808	2.3%	3,145	2	71
Sanborn	0	1,121	0.7%	1,121	1.0%	2,400	3	142
Marshall	0	1,062	0.3%	1,052	0.5%	2,223	7	143
Douglas	5	984	0.5%	1,163	0.9%	2,342	14	152
Walworth	0	780	0.2%	786	0.3%	1,632	-	63
Jackson	0	702	0.6%	723	1.0%	1,445	3	69
Buffalo	1	645	1.1%	631	1.5%	1,347	30	79
McPherson	0	628	0.3%	815	0.6%	1,545	4	95
Jerauld	0	591	0.3%	833	0.7%	1,534	8	77
Potter	0	537	0.2%	781	0.4%	1,416	1	44
Harding	0	504	0.6%	516	1.0%	1,045	2	43
Sully	0	502	0.4%	456	0.6%	1,016	1	42
Gregory	0	474	0.2%	254	0.1%	731	-	44
Hyde	0	292	0.3%	370	0.5%	709	-	39
Jones	1	288	0.4%	243	0.5%	551	-	17
	3,571	634,703	1.3%	929,402	3%	1,706,878	22,876	40,598

Source: FEMA Region VIII HAZUS-MH MR2 Notes:
*Loss ratio is the percent of the total building inventory value that could be damaged from flooding in any given year.
**Total Direct Economic loss includes relocation loss, capital-related loss, wages loss, rental income loss and building loss.
***Added from South Dakota Emergency Management HAZUS run to account for problem reach in FEMA analysis

Figure 3-39 HAZUS-MH Base Flood (1 Percent Chance) Building and Income Loss Estimation by County

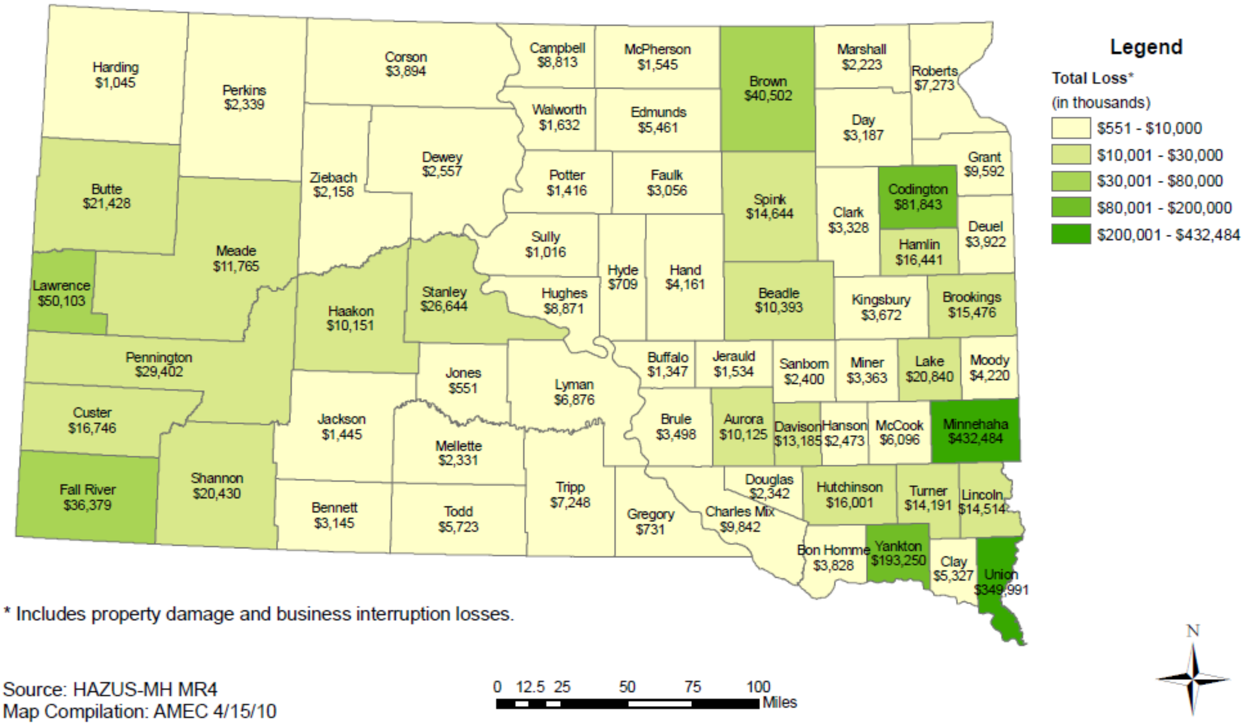


Figure 3-40 HAZUS-MH Base Flood (1 Percent Chance) Building Loss Ratio

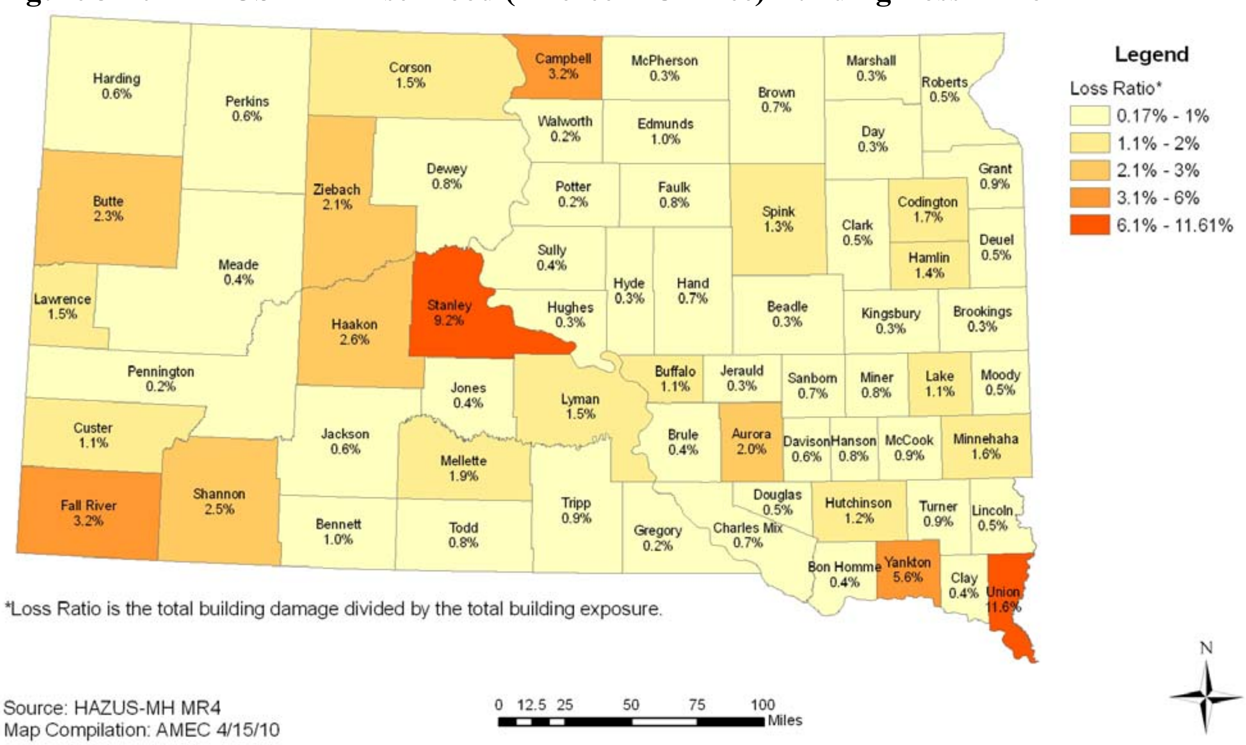


Figure 3-41 HAZUS-MH Base Flood (1 Percent Chance) Content Loss Ratio

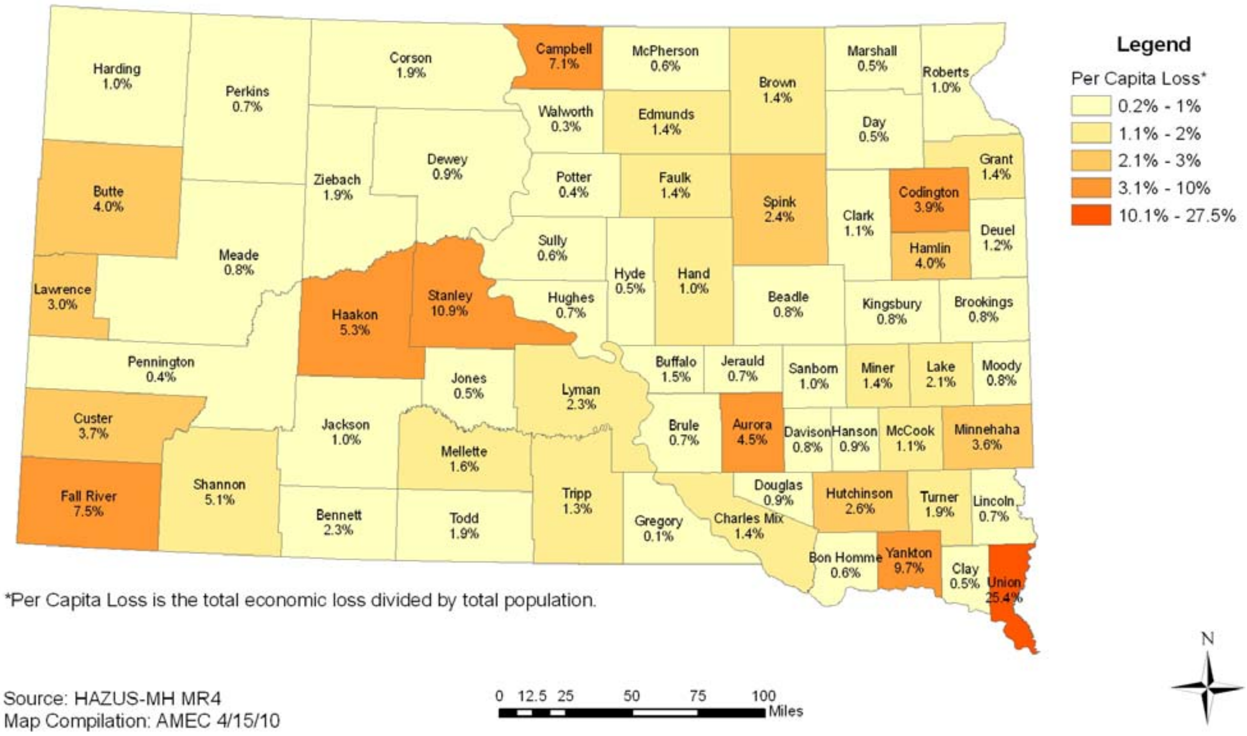
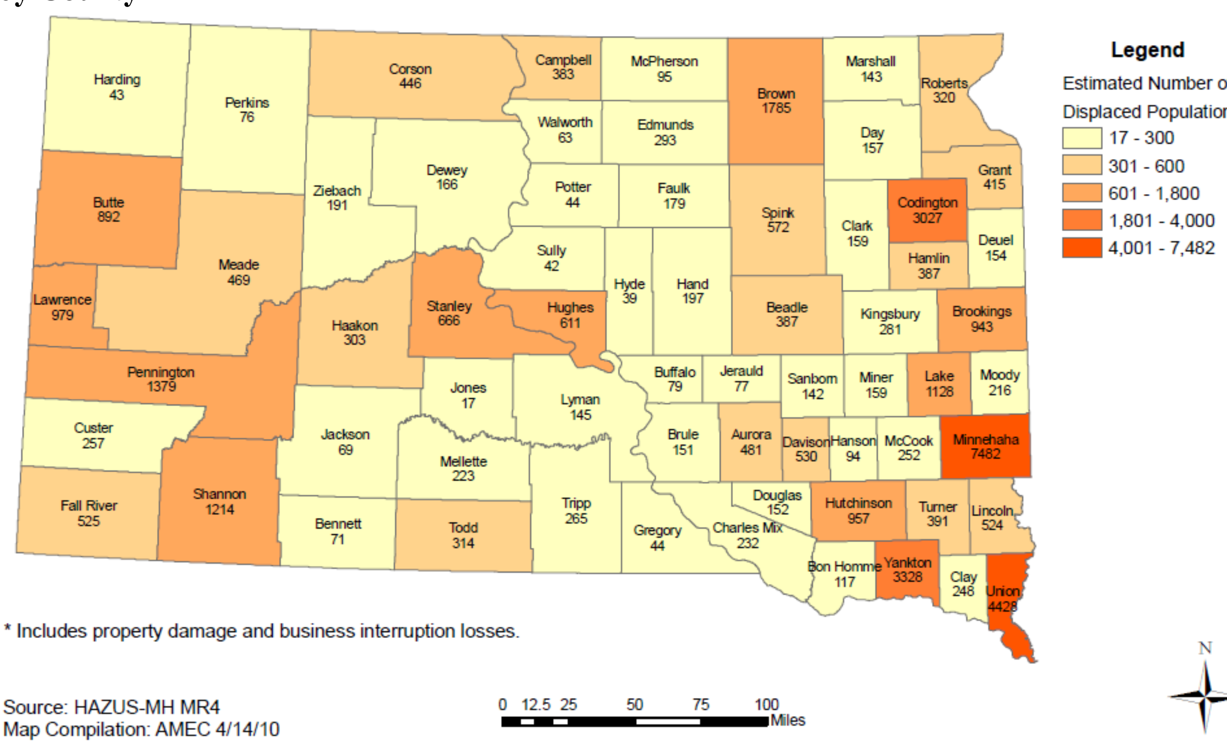


Figure 3-42 HAZUS-MH Base Flood (1 Percent Chance) Displaced Population Estimation by County



A separate methodology was used in 2007 to analyze those counties with existing DFIRMs. Using GIS, the DFIRM special flood hazard area boundaries were overlayed on HAZUS-MH building inventory, which is linked to census block geography. A proportional division was performed to account for blocks that were split by flood boundaries, and to better model values in the floodplain. For example, a census block that was split in two by a floodplain (50 percent in, 50 percent out) had its building count and valuation attributes multiplied by .50. From this method, information on the number of buildings and building replacement value at risk could be estimated by county and by flood zone.

The DFIRM loss estimation results are presented separately in Table 3-42. The DFIRM floodplains should be more accurate, but likely not as extensive, as the HAZUS-MH generated floodplains. Note that Hughes County was also analyzed using the DFIRM method as well. Some DFIRMs are community-based only and do not cover the entire county.

Table 3-42 Digital Flood Insurance Rate Maps Base Flood (1 Percent Chance) Loss Estimations

County	Building Count	Building Value* ($)	Estimated Content Value ($)	Total Value ($)	Estimated Flood Loss ($)
Hughes	237	42,452,000	21,226,000	63,678,000	12,736,000
Stanley	331	37,165,000	18,582,000	55,747,000	11,149,000
Charles Mix	82	12,038,000	6,019,000	18,057,000	3,611,000
Hutchinson	48	7,664,000	3,832,000	11,496,000	2,299,000
Aurora	31	4,959,000	2,479,000	7,438,000	1,488,000
Ziebach	45	3,289,000	1,644,000	4,933,000	987,000
Dewey	35	3,210,000	1,605,000	4,815,000	963,000
Corson	42	3,189,000	1,595,000	4,784,000	957,000
Pennington (Hill City)	24	2,222,000	1,111,000	3,333,000	667,000
Davison	3	345,000	172,000	517,000	103,000

Source: Building value is from HAZUS-MH. Estimated content value is 50 percent of building value. Estimated flood loss is 20 percent of total value.

Note: The Minnehaha DFIRM was not included in this analysis because it was preliminary.

Flood Insurance Claims Analysis

In addition to the HAZUS-MH flood runs and local plans, the state analyzed National Flood Insurance Program (NFIP) flood-loss data to determine areas of South Dakota with the greatest flood risk. South Dakota flood-loss information was culled from FEMA's "Policy and Loss Data by Community with County and State Data," which documents losses from 1978 to the present (this analysis is based on the report dated June 3, 2010).

There are several limitations to this data, including:

- Only losses to participating NFIP communities are represented,
- Communities joined the NFIP at various times since 1978,
- The number of flood insurance policies in effect may not include all structures at risk to flooding, and

- Some of the historical loss areas have been mitigated with property buyouts.

Despite these limitations, the data depict a pattern of historical flood losses in the state. The greatest losses have been in Codington, Brown, and Day counties. Table 3-43 shows the details of the 10 South Dakota counties with the greatest historical dollar losses. Brown County moved up from number 5 to number 2 from 2007 to 2010. The number of policies decreased from 628 to 588 over that time period. Codington’s polices increased from 371 to 835.

Table 3-43 Top 10 Counties for Flood Insurance Dollars Paid (Historical), 1978 - 2010

County	Dollars Paid ($ Historical)	Flood Claims	Current Policies	Coverage ($)
Codington	$5,225,806	359	835	$118,916,700
Brown	$2,826,266	452	588	$108,341,900
Day	$1,883,101	166	71	$8,133,200
Hamlin	$1,050,799	150	159	$28,083,100
Lake	$941,529	105	196	$27,473,200
Minnehaha	$836,205	120	1,352	$332,484,400
Custer	$552,346	40	79	$12,238,700
Lincoln	$413,008	46	1,261	$328,428,500
Spink	$406,329	34	46	$7,419,500
Brookings	$399,320	48	194	$25,030,400

Source: FEMA, “Policy and Loss Data by Community with County and State Data,” June 3, 2010

Information about flood insurance losses and policies for all South Dakota counties is in Appendix 3C.

Repetitive Loss Analysis

A high priority in South Dakota and nationwide is the reduction of losses to repetitive loss structures. These structures strain the National Flood Insurance Fund. They increase the NFIP’s annual losses and the need for borrowing and, more importantly, they drain resources needed to prepare for catastrophic events. The NFIP defines a repetitive loss property as “any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. At least two of the claims must be more than 10-days apart.” Table 3-44 illustrates the number and location (county) of South Dakota’s repetitive loss properties. The table ranks counties by repetitive loss dollars paid. Codington, Day, and Hamlin counties are the top three. The numbers from the 2007 have been preserved to show changes in the past 3 years. Note the increase in repetitive loss claims for Day County, and a few more properties made the list in Brown County.

Table 3-44 NFIP Policies and Repetitive Loss Summary by County (Ranked by Total Repetitive Loss Dollars Paid)

County*	Total Current Policies	Total Flood Claims since 1978	Total Dollars Paid ($ Historical)	2007 # of RL Properties**	2010 # of RL Properties	2007 # of RL Claims	2010 # of RL Claims	Repetitive Loss Dollars Paid ($ Historical)
Codington	835	359	5,225,806	33	33	74	72	1,427,850
Day	71	166	1,883,101	8	9	16	118	359,057
Hamlin	159	150	1,050,799	4	4	9	9	185,508
Brown	588	452	2,826,266	7	10	14	21	162,871
Charles Mix	9	3	239,659	0	1	0	2	156,344
Minnehaha	1,352	120	836,205	10	10	21	21	94,423
Moody	32	41	224,909	3	3	7	8	81,815
Lake	196	105	941,529	3	3	6	6	81,511
Clark	13	8	162,850	1	2	2	4	78,954
Grant	44	22	198,277	2	2	4	5	44,453
Beadle	19	12	281,396	0	1	0	3	43,389
Hughes County	67	39	206,061	2	2	4	4	36,385
Davison	36	8	43,213	1	1	2	2	19,206

Source: x and FEMA, "Policy and Loss Data by Community with County and State Data," June 3, 2010
*County includes policy and loss information for both incorporated and unincorporated areas
**Includes insured and uninsured properties

Severe Repetitive Loss Analysis

The Flood Insurance Reform Act of 2004 identified another category of repetitive loss, severe repetitive loss, and defined it as "a single family property (consisting of one-to-four residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage for which four or more separate claims payments have been paid under flood insurance coverage with the amount of each claim payment exceeding $5,000 and with cumulative amount of such claims payments exceeding $20,000; or for which at least two separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property." Fortunately for South Dakota, there is only one property that meets this definition: a campground in Codington County. Losses to this property, which has multiple structures, between March 1986 and April 2001 equaled $337,374.

Future vulnerability

Pennington and Codington counties identified population growth and construction of new homes in their local plans. Lincoln experienced the greatest population gain from 2000 – 2008 of all the counties in South Dakota. Campbell experienced the greatest population loss from 2000 – 2008. These growth and development trends must be taken into consideration when reviewing the vulnerability results. Minnehaha, Union, and Yankton counties continue to increase their vulnerability as population and development increases.

Winter Storms

Methodology

All counties in South Dakota are vulnerable to winter storms. To assess the relative vulnerability of each of South Dakota's counties to winter storms, the state assigned ratings to three factors that were examined at the county level: prior events, building exposure, and population density. The state then summed the ratings to obtain overall vulnerability scores for each county so that they could be compared and greatest relative vulnerability determined.

This methodology assumes that the more developed areas, represented by greater building values and higher population densities, will generally have greater costs for snow removal and functional downtime as a result of loss of utility services. The more developed areas may have the capacity to absorb those costs more than the rural areas, so in terms of loss ratio (ratio of the losses to the total inventory in the county) the rural areas are potentially more vulnerable. This is difficult to measure without good historical damage data, and is a limitation of this vulnerability assessment. Another factor not considered is the vulnerability of livestock to winter storms. The state may consider livestock in future updates to this plan improving this methodology and better representing the vulnerability of rural areas to winter storms.

Vulnerability Factors

Prior Events—This rating is based on the number of past winter storms experienced by each county between January 1993 and August 2009 according to data from the National Climatic Data Center's Storm Events database (a compilation of storm data from the National Weather Service). The database does not have information for winter storms prior to 1993. Although the University of South Carolina Hazards and Vulnerability Research Institute's Spatial Hazard Events and Losses Database for the United States (SHELDUS) has events from 1963-2005, it only includes those events for which damage was reported, thus it is not as comprehensive as the National Climatic Data Center's. The winter storm profile in Section 3.2.2 describes events that happened before 1993, but that data is not appropriate for this vulnerability assessment. This information was verified during the 2009 update, and the NCDC database remains the most comprehensive dataset for assessing vulnerability.

In the previous plan, no records were identified for Lawrence County. During the update process in 2009, this information was verified: the NCDC database reflects no documented ice and snow events for Lawrence County. However, there are eight recorded events listed as impacting either all of the state, the black hills region, or the western part of the state which, presumably, includes this county. In addition, there are 23 events not counted above that impacted the three counties surrounding Lawrence, so it would be reasonable to assume Lawrence was also impacted. As such, 31 events are recorded for this county.

To develop the prior event rating, the total range of past occurrences (24 to 69) was divided into 10 roughly equal ranges as shown in Table 3-45. The ranges were numbered 1 through 10 in ascending order.

Table 3-45 Winter Storm Prior Event Ratings

# of Past Occurrences	Rating
24-28	1
29-33	2
34-38	3
39-43	4
44-48	5
49-53	6
54-58	7
59-63	8
64-68	9
69-73	10

Building Exposure—To best compare the vulnerability of one county to another, it is necessary to consider assets vulnerable to loss. This rating is based on total building exposure from HAZUS-MH4 (residential, commercial, industrial, agricultural, religion, government, and education). The total range of building exposure ($59,332,000 to $10,158,394,000) was divided into 10 roughly equal ranges as shown in Table 3-46. The ranges were numbered 1 through 10 in ascending order.

Table 3-46 Winter Storm Building Exposure Ratings

Building Exposure ($000)	Rating
59,332 - 1,069,238	1
1,069,239 - 2,079,144	2
2,079,145 - 3,089,051	3
3,089,052 - 4,098,957	4
4,098,958 - 5,108,863	5
5,108,864 - 6,118,769	6
6,118,770 - 7,128,675	7
7,128,676 - 8,138,582	8
8,138,583 - 9,148,488	9
9,148,489 - 10,158,394	10

Population Density—Population density is determined by dividing a county's population by its land area. This section is based on the 2009 U.S. Census Bureau population estimates and the land area reported in the 2000 Census. The range of population densities (.4 to 221.3) was divided into 10 roughly equal ranges as shown in Table 3-47. The ranges were numbered 1 through 10 in ascending order.

Table 3-47 Population Density Ratings

Population Density	Rating
0.4 - 22.4	1
22.5 - 44.5	2
44.6 - 66.6	3
66.7 - 88.7	4
88.8 - 110.8	5
110.9 - 132.9	6
133 - 155	7
155.1 - 177.1	8
177.2 - 199.2	9
199.3 - 221.3	10

A fourth factor, past winter storm damage, may be considered for the next plan update based on the availability of information. Currently, county-level damage information is not available for winter storms. The damage values captured in the National Climatic Data Center's Storm Event database are for an entire event and cannot be approximated for each individual county.

After the rating for each of the factors described above was determined for each county, the three factor ratings were added together to produce a county-level vulnerability rating. The highest possible total vulnerability rating is 30. The range of vulnerability (1 to 30) was divided into three equal ranges as shown in Table 3-48. The ranges were assigned a corresponding level of winter storm vulnerability: moderate, high, and very high.

Table 3-48 Winter Storm Vulnerability

Winter Storm Vulnerability Range	Winter Storm Vulnerability
3-10	Moderate
11-19	High
20-27	Very High

Results

Summary of Prior Event Ratings—The lowest number of recorded winter storms over this 15.6-year period (188 months) was 24 in Custer County; the highest was 69 in Meade County. All counties in South Dakota experienced at least 24 winter storms. Meade was the only county that received a rating of 10 and Custer was the only county that received a rating of 1. 53% of the counties received ratings between 4 and 7. The 25 counties that received a prior event rating greater than 6 are shown in Table 3-49.

Table 3-49 Counties with Winter Storm Prior Event Ratings Greater Than 6

County	# of Prior Events	Prior Event Rating
Perkins	54	7
Gregory	54	7
Yankton	54	7
Marshall	55	7
Roberts	56	7
Jerauld	57	7
Kingsbury	57	7
Davison	57	7
Lincoln	57	7
Miner	58	7
Charles Mix	59	8
Aurora	60	8
Brule	60	8
Harding	61	8
Beadle	61	8
Hanson	62	8
Turner	62	8
McCook	63	8
Bon Homme	63	8
Lake	63	8
Butte	64	9
Brookings	64	9
Hutchinson	65	9
Minnehaha	68	9
Meade	69	10

Table 3-52 in the Total Winter Storm Vulnerability section shows prior event ratings for all South Dakota counties. A spreadsheet that includes the corresponding values can be found in Appendix 3D South Dakota Winter Storm Vulnerability.

Table 3-50 Counties with Winter Storm Building Exposure Ratings Greater Than 1

County	Building Exposure ($000)	Building Exposure Rating
Hughes	893,330	2
Beadle	900,970	2
Davison	922,126	2
Meade	1,081,493	2
Lawrence	1,146,222	2
Yankton	1,215,039	2
Lincoln	1,223,753	2
Codington	1,253,341	2
Brookings	1,366,448	2
Brown	1,890,100	3
Pennington	4,682,628	6
Minnehaha	8,442,273	10

Table 3-52 in the Total Winter Storm Vulnerability section shows building exposure ratings for all South Dakota counties. A spreadsheet that includes the corresponding values can be found in Appendix 3D South Dakota Winter Storm Vulnerability.

Summary of Population Density Ratings—The lowest population density was .5 people per square mile in Harding County; the highest was 201.7 people per square mile in Minnehaha County. Minnehaha, the most populous county in the state, was the only county to receive a 10 rating and the only county to receive a rating greater than 4. With a population density of 61 people per square mile, Lincoln County is the second densest county and received the only 4 rating. More than 83 percent of the counties received a rating of 1. The counties that received a rating greater than 1 are listed in Table 3-51.

Table 3-51 Counties with Population Density Ratings Greater Than 1

County	Population Density	Population Density Rating
Lawrence	29.4	2
Hughes	22.6	2
Clay	33.1	2
Union	30.7	2
Pennington	35.5	2
Codington	38.3	2
Yankton	41.9	2
Davison	43.5	2
Brookings	37.3	2
Lincoln	68.7	4
Minnehaha	221.3	10

Table 3-52 in the Total Winter Storm Vulnerability section shows population density ratings for all South Dakota counties. A spreadsheet that includes the corresponding values can be found in Appendix 3D South Dakota Winter Storm Vulnerability.

Total Winter Storm Vulnerability and Estimate of Potential Loss

According to this methodology, while every county in South Dakota is vulnerable to winter storms, only Minnehaha was rated as having a very high vulnerability. Beadle, Brookings, Brown, Brule, Butte, Davison, Hutchinson, Lincoln, McCook, Meade, Pennington, and Yankton all rated as a high vulnerability. The remaining counties (70 %) have a moderate vulnerability. Since the 2007 plan, Aurora, Bon Homme, Brule, Charles Mix, Hanson, Harding, Lake, and Turner counties have changed from high to moderate vulnerability. Figure 3-43 illustrates the vulnerability of South Dakota counties to winter storms, and Table 3-52 lists all the South Dakota counties ranked by total winter storm vulnerability along with their three vulnerability factor ratings.

To estimate potential losses to winter storms, historic loss data was analyzed. The National Climatic Data Center data did not lend itself to county by county loss summaries, only a statewide summary. According to the National Climatic Data Center Storm Events database, there were 863 winter storms (snow and ice events) in South Dakota between January 1993 and March 2010. Total property damage for these events is estimated at $124.707 million. This suggests that South Dakota experiences 47.9 winter storms and

$6.93 million in winter storm losses each year. There were 16 deaths and 192 injuries in this time period, which averages out to approximately 1 death and 11 injuries each year. Of these storms, 11 resulted in major disaster declarations. Based on the frequency of events, South Dakota averages one major disaster-level winter storm every year and a half.

If areas with the highest number of winter storm events are plotted on a map, it becomes immediately clear that some areas of the state have a higher occurrence rate than others. If counties with at least 50 events are plotted, the concentration of winter storms occurs primarily in the southeast corner of the state and in the Black Hills region, with a smaller occurrence in the far northeast corner. When these counties are narrowed to those with at least 60 events, the groupings of events is even clearer. This distribution corresponds to the areas of highest elevation (the Black Hills region) and the areas with the greatest moisture content (the southeast corner of the state, where terrain is peppered with lakes and streams.

Figure 3-43 Vulnerability of South Dakota Counties to Winter Storms

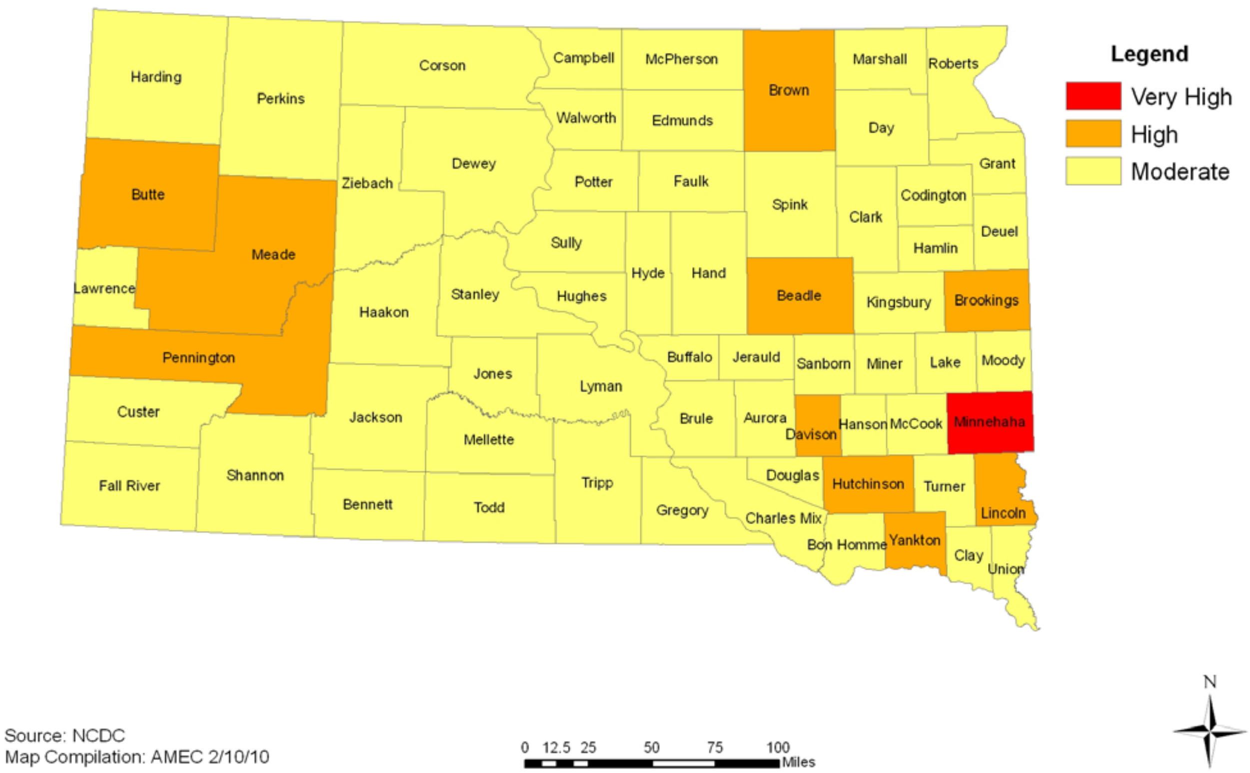


Table 3-52 Vulnerability of South Dakota Counties to Winter Storms (ranked by vulnerability)

County	Prior Event Rating	Building Exposure Valuation Rating	Pop. Density Rating	Total Vuln.	Winter Storm Vulnerability
Minnehaha	9	10	10	29	Very High
Brookings	9	2	2	13	High
Lincoln	7	2	4	13	High

County	Prior Event Rating	Building Exposure Valuation Rating	Pop. Density Rating	Total Vuln.	Winter Storm Vulnerability
Meade	10	2	1	13	High
Beadle	8	2	1	11	High
Brown	6	4	1	11	High
Butte	9	1	1	11	High
Davison	7	2	2	11	High
Hutchinson	9	1	1	11	High
Pennington	3	6	2	11	High
Yankton	7	2	2	11	High
Aurora	8	1	1	10	Moderate
Bon Homme	8	1	1	10	Moderate
Brule	8	1	1	10	Moderate
Charles Mix	8	1	1	10	Moderate
Hanson	8	1	1	10	Moderate
Harding	8	1	1	10	Moderate
Lake	8	1	1	10	Moderate
McCook	8	1	1	10	Moderate
Turner	8	1	1	10	Moderate
Gregory	7	1	1	9	Moderate
Jerauld	7	1	1	9	Moderate
Kingsbury	7	1	1	9	Moderate
Marshall	7	1	1	9	Moderate
Miner	7	1	1	9	Moderate
Perkins	7	1	1	9	Moderate
Roberts	7	1	1	9	Moderate
Clay	5	1	2	8	Moderate
Codington	4	2	2	8	Moderate
Day	6	1	1	8	Moderate
Edmunds	6	1	1	8	Moderate
Faulk	6	1	1	8	Moderate
Hughes	4	2	2	8	Moderate
Moody	6	1	1	8	Moderate
Spink	6	1	1	8	Moderate
Union	5	1	2	8	Moderate
Clark	5	1	1	7	Moderate
Douglas	5	1	1	7	Moderate
Grant	5	1	1	7	Moderate
Hand	5	1	1	7	Moderate
McPherson	5	1	1	7	Moderate

County	Prior Event Rating	Building Exposure Valuation Rating	Pop. Density Rating	Total Vuln.	Winter Storm Vulnerability
Sanborn	5	1	1	7	Moderate
Deul	4	1	1	6	Moderate
Dewey	4	1	1	6	Moderate
Hamlin	4	1	1	6	Moderate
Jackson	4	1	1	6	Moderate
Jones	4	1	1	6	Moderate
Lawrence*	2	2	2	6	Moderate
Lyman	4	1	1	6	Moderate
Potter	4	1	1	6	Moderate
Tripp	4	1	1	6	Moderate
Walworth	4	1	1	6	Moderate
Bennett	3	1	1	5	Moderate
Buffalo	3	1	1	5	Moderate
Campbell	3	1	1	5	Moderate
Corson	3	1	1	5	Moderate
Fall River	3	1	1	5	Moderate
Haakon	3	1	1	5	Moderate
Hyde	3	1	1	5	Moderate
Mellette	3	1	1	5	Moderate
Shannon	3	1	1	5	Moderate
Sully	3	1	1	5	Moderate
Todd	3	1	1	5	Moderate
Ziebach	3	1	1	5	Moderate
Stanley	2	1	1	4	Moderate
Custer	1	1	1	3	Moderate

Future vulnerability

Lincoln County experienced the greatest population gain from 2000 – 2008 of all the counties in South Dakota. Of the other counties with high or very high vulnerability to winter storms, Brookings, Butte, Davison, Hanson, Lake, Minnehaha, Pennington, and Yankton Counties all experienced population growth between 2000 and 2008. As these counties continue to grow, their vulnerability to winter storms will increase as the exposure of population and property continues to grow.

Wildfire

Methodology

During the 2007 update to this plan a more detailed (in comparison to the 2004 plan) exposure analysis was performed on the southwestern counties of Butte, Custer, Fall River, Lawrence, Meade, Pennington and Shannon. These counties are known to contain forested lands, so the vulnerability assessment was focused on these counties.

The vulnerability analysis involved the use of GIS overlay of wildfire risk zones upon Census block -level building inventory from HAZUS-MH. The best available data for wildfire risk was the wildland urban interface/intermix data from the SILVIS Lab at the University of Wisconsin–Madison mentioned previously in the wildfire hazard profile. The SILVIS data is classified into 13 categories, based on 2000 Census housing unit density and percent of vegetation in the area. In both interface and intermix communities, housing must meet or exceed a minimum density of one structure per 40 acres. Intermix communities are areas where housing and vegetation intermingle and vegetation exceeds 50 percent. Interface communities are areas with housing in the vicinity of contiguous vegetation, have less than 50 percent vegetation, and are within 1.5 miles of an area that exceeds 1,325 acres and are more than 75 percent vegetated. These areas were further classified by the State of South Dakota into High, Moderate, and Low risk threat zones based as follows:

High Risk Threat Zone (areas of various housing unit density within areas of high vegetation)

- High Density Intermix
- Medium Density Intermix
- High Density Interface

Moderate Risk Threat Zone (areas of various housing unit density within areas of high vegetation)

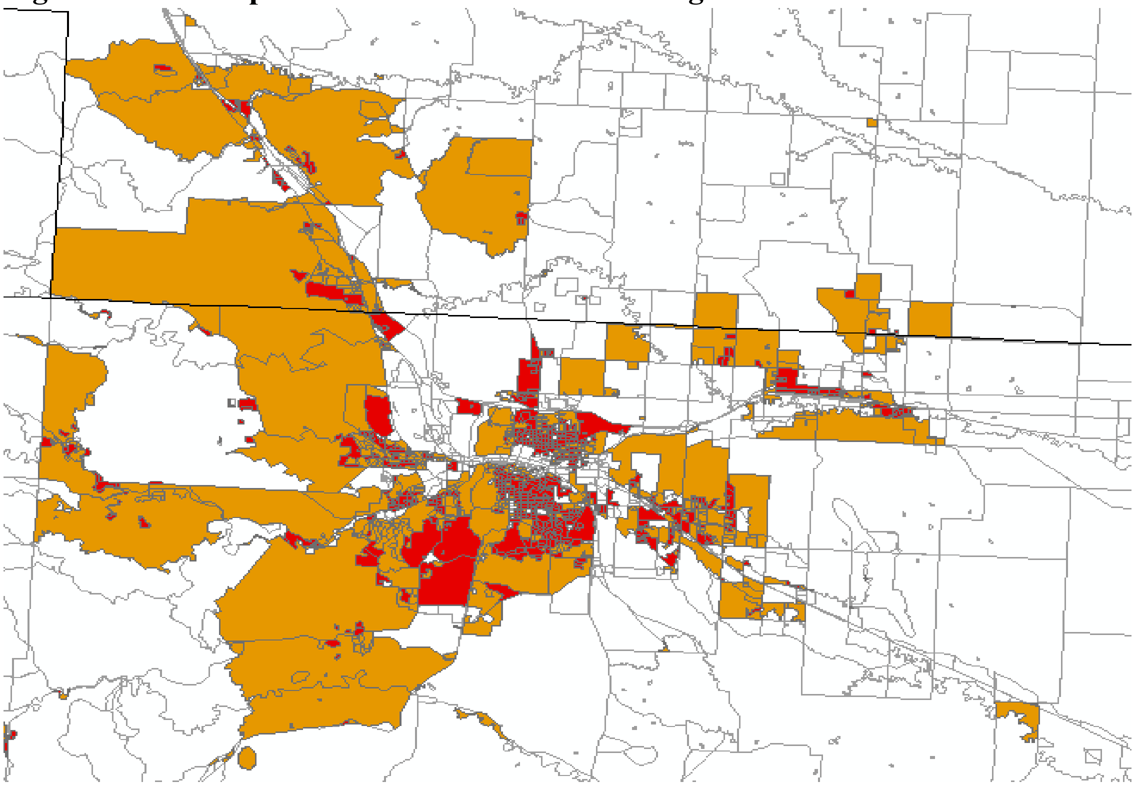
- Medium Density Interface
- Low Density Intermix

Low Risk Threat Zone (either no vegetation, or no housing density)

- Low Density Interface
- High Density No Vegetation
- Medium Density No Vegetation
- Wildland Intermix
- Uninhabited Vegetation
- Uninhabited No Vegetation
- Low Density No Vegetation
- Wildland No Vegetation

Figure 3-44 shows the High and Moderate Risk Zones in parts of two of the seven forested counties in southwestern South Dakota (Pennington and Meade Counties). The red areas are high risk and the orange areas are moderate, with the low risk zones unshaded. The gray lines are Census Block boundaries. The total number of buildings, both residential and non-residential, in each zone for each county was calculated using GIS. The replacement value of these structures was summarized by zone and by county as well. For the purposes of estimating potential loss, the total replacement value is used, as catastrophic fires tend to result in total loss of the structure.

Figure 3-44 Example of Fire Risk Zones in Pennington and Meade Counties



Total Wildfire Vulnerability and Estimate of Potential Loss

The results of the GIS analysis are presented in Table 3-53. Pennington County has the highest building count by far (over 25,000) compared to the other six counties.

Table 3-53 Wildfire Vulnerability and Loss Estimation

County	Total Building Count in High and Moderate Risk Zone	Total Building Value Exposure in High and Moderate Risk Zone ($)
Pennington	25,087	3,702,856,000
Lawrence	5,628	872,710,000
Meade	6,609	825,389,000
Fall River	2,005	250,029,000
Butte	1,833	224,877,000
Custer	1,699	208,101,000
Shannon	1,130	92,465,000

Source: HAZUS-MH

Between 1994 and 2009, South Dakota received 19 fire management assistance declarations from FEMA, which provided financial support for fire suppression. Fire suppression costs for these 15 years totaled $11,647,391 (see the fire management assistance declarations in Table 3-3). This averages out to $776,402 per year and does not include losses to structures, forests, utilities, etc.

Forest fires tend to require more suppression costs, and could do significant property and building damage. Prairie fires tend to stress local response resources and can quickly damage livestock grazing areas. Damage to agricultural resources is very dependent on when the fire occurs, with the early season March and April fires easier to recover from. While historic loss data was limited on agricultural losses from fires this information may be collected in future updates from sources that might include the Farm Services Agency, State Department of Agriculture, or South Dakota State University.

Based on past fire history, Table 3-54 indicates the counties most vulnerable to wildland and prairie fires (from 2004 plan updated with 2010 HAZUS valuations and 2000 US Census population data).

Table 3-54 Wildland and Prairie Fire Exposure

County	Estimated Building Replacement Value (HAZUS-MH) ($)	Population (2000 Census)	Exposure Per Capita ($)
Bennett	119,819,000	3,543	33,819
Butte	422,631,000	9,374	45,085
Corson	134,270,000	4,288	31,312
Custer	460,590,000	7,944	57,980
Dewey	183,377,000	6,112	30,003
Fall River	431,536,000	7,304	59,063
Gregory	272,939,000	4,268	63,950
Haakon	145,945,000	1,864	78,297
Harding	69,761,000	1,205	67,582
Jackson	116,514,000	2,900	40,177
Jones	69,761,000	1,067	65,381
Lawrence	1,418,003,000	22,685	62,508
McPherson	184,182,000	2,565	71,806
Meade	1,266,896,000	24,425	51,869
Mellette	77,393,000	2,099	36,872
Pennington	5,599,723,000	94,338	59,358
Perkins	207,947,000	3,025	68,743
Shannon	319,931,000	13,824	23,143
Todd	275,698,000	1,038	265,605
Ziebach	65,710,000	2,706	24,283

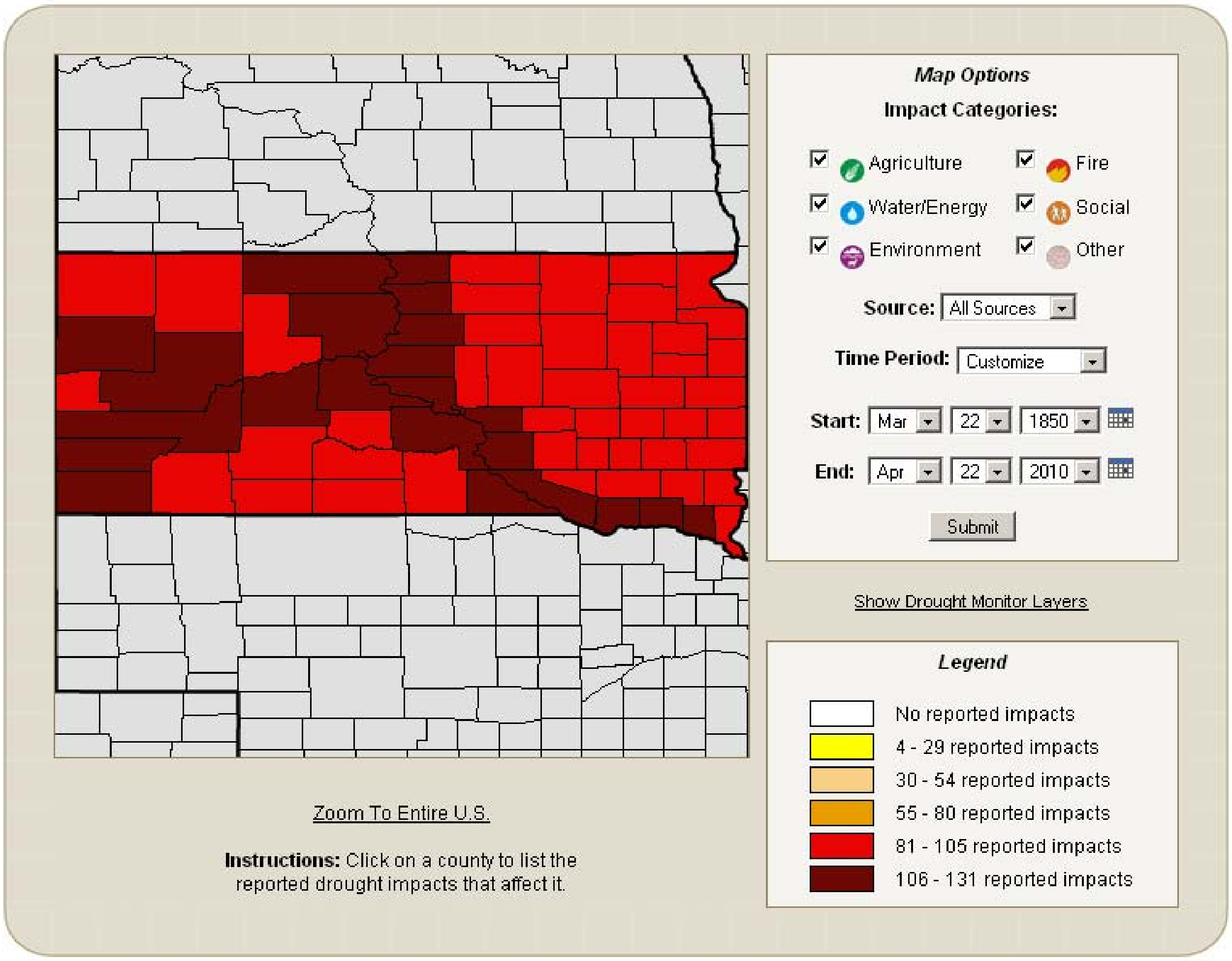
Future vulnerability

Of the counties with high vulnerability to wildland and prairie fire, Custer, Meade, Pennington, Shannon, and Todd identified increased population. These growth and development trends must be taken into consideration when reviewing the vulnerability results below. As population increases in these rural counties they continue to increase their vulnerability to wildland and prairie fires.

Drought

As discussed in the profile, the entire State of South Dakota is vulnerable to drought, but in different ways. A summary of impacts from the Drought Impact Reporter for the period of 1850-2010 indicates that all counties are vulnerable. Those counties shown has having 106 or more reported impacts are also susceptible to social impacts related to recreational areas such as the “Great Lakes” Missouri River corridor and Black Hills Regions. In addition to agriculture impacts these areas could suffer from lowered lakes levels impacting boating and fishing activities and associated revenue.

Figure 3-45 Drought Monitor for South Dakota



Source: National Drought Mitigation Center

Table 3-55 Drought Monitor Reported Impacts by County

County	Agriculture	Fire	Water/Energy	Environment	Social	Other	Total
Aurora	40	4	8	6	5	24	**87**
Beadle	41	4	10	6	5	23	**89**

County	Agriculture	Fire	Water/Energy	Environment	Social	Other	Total
Bennett	39	4	8	6	5	25	**87**
Bon Homme	40	5	23	7	8	24	**107**
Brookings	39	4	8	6	5	23	**85**
Brown	40	4	10	7	5	25	**91**
Brule	40	5	23	7	8	25	**108**
Buffalo	40	4	23	7	8	25	**107**
Butte	47	6	11	7	9	28	**108**
Campbell	53	6	26	7	14	25	**131**
Charles Mix	40	4	23	7	8	26	**108**
Clark	39	4	8	6	5	21	**83**
Clay	40	4	23	7	9	23	**106**
Codington	39	4	8	6	5	21	**83**
Corson	46	8	25	7	12	27	**125**
Custer	45	12	12	10	7	27	**113**
Davison	40	4	9	6	7	24	**90**
Day	39	4	8	6	5	20	**82**
Deuel	40	4	8	6	5	21	**84**
Dewey	45	8	27	7	12	28	**127**
Douglas	40	4	8	6	5	23	**86**
Edmunds	41	4	8	6	5	24	**88**
Fall River	49	13	18	9	9	29	**127**
Faulk	42	5	8	6	5	24	**90**
Grant	39	4	8	6	5	22	**84**
Gregory	40	4	23	7	8	28	**110**
Haakon	43	6	25	7	10	29	**120**
Hamlin	39	4	8	6	5	22	**84**
Hand	41	4	8	6	5	24	**88**
Hanson	39	4	9	6	5	22	**85**
Harding	40	6	8	8	6	27	**95**
Hughes	44	6	25	7	11	28	**121**
Hutchinson	39	4	9	6	5	23	**86**
Hyde	40	4	8	6	5	24	**87**
Jackson	40	7	9	6	5	27	**94**
Jerauld	40	4	8	6	5	24	**87**
Jones	41	4	8	6	5	26	**41**
Kingsbury	39	4	8	6	5	22	**84**
Lake	39	4	9	6	5	20	**83**
Lawrence	41	13	9	7	6	27	**103**
Lincoln	39	4	8	6	5	20	**82**

County	Agriculture	Fire	Water/Energy	Environment	Social	Other	Total
Lyman	43	5	23	7	8	27	**113**
Marshall	39	4	8	6	5	20	**82**
McCook	39	4	8	6	5	22	**84**
McPherson	41	5	8	6	5	23	**88**
Meade	44	10	11	7	6	31	**109**
Mellette	39	4	8	6	5	25	**87**
Miner	39	4	8	6	6	23	**86**
Minnehaha	40	4	8	6	5	22	**85**
Moody	39	4	8	6	5	20	**82**
Pennington	47	15	17	10	9	32	**130**
Perkins	43	7	8	6	6	29	**99**
Potter	44	6	25	7	11	25	**118**
Roberts	39	4	8	6	5	21	**83**
Sanborn	43	4	9	6	5	24	**91**
Shannon	40	5	9	6	5	27	**92**
Spink	39	4	10	6	5	23	**87**
Stanley	44	7	26	7	11	28	**123**
Sully	42	4	25	7	11	25	**114**
Todd	39	4	8	6	5	25	**87**
Tripp	40	4	8	6	5	25	**88**
Turner	39	4	8	6	5	22	**84**
Union	40	4	23	7	8	20	**102**
Walworth	48	7	25	9	13	27	**129**
Yankton	40	4	24	7	8	24	**107**
Ziebach	39	4	8	6	6	19	**82**
Totals	**2716**	**345**	**864**	**433**	**440**	**1609**	**6358**

Source: National Drought Mitigation Center

Drought takes a particularly heavy toll on agriculture due to crop losses from lack of moisture. Farmers often protect themselves from the affects of drought by insuring all or a portion of their crop against drought losses. This is done through multi-peril crop insurance, which is underwritten by The Risk Management Agency. The Risk Management Agency, part of the USDA, maintains a database of crop insurance claims. Table 3-56 shows the crop losses due to drought in one of the most recent and severe periods of statewide drought, which occurred in 2002. Based on this analysis the state could incur losses in the range of $294 million to crops alone should another severe drought impact the state.

Table 3-56 2002 South Dakota Crop Loss Due to Drought

County	Total Loss ($)
Aurora	9,981,468

County	Total Loss ($)
Beadle	16,888,079
Bennett	3,031,438
Bon Homme	6,868,510
Brookings	387,848
Brown	3,492,269
Brule	10,078,871
Buffalo	3,093,701
Butte	570,113
Campbell	3,352,881
Charles Mix	14,953,511
Clark	4,452,317
Clay	1,250,351
Codington	1,394,286
Corson	4,422,324
Custer	309,970
Davison	7,885,578
Day	979,621
Deuel	371,275
Dewey	2,612,684
Douglas	5,463,319
Edmunds	5,121,562
Fall River	319,652
Faulk	3,245,909
Grant	218,744
Gregory	4,700,876
Haakon	4,439,525
Hamlin	347,794
Hand	12,896,771
Hanson	3,298,202
Harding	3,404,637
Hughes	9,941,061
Hutchinson	9,758,512
Hyde	8,411,019
Jackson	2,546,546
Jerauld	5,164,721
Jones	2,182,334
Kingsbury	4,896,508
Lake	1,167,346
Lawrence	19,545
Lincoln	139,801
Lyman	9,304,103
McCook	624,002
McPherson	4,624,314

County	Total Loss ($)
Marshall	476,464
Meade	4,288,087
Mellette	1,187,891
Miner	3,799,930
Minnehaha	576,527
Moody	311,254
Pennington	3,261,621
Perkins	8,077,696
Potter	13,821,625
Roberts	80,479
Sanborn	3,651,509
Shannon	1,188,991
Spink	10,169,572
Stanley	4,749,540
Sully	18,609,676
Todd	978,777
Tripp	7,241,518
Turner	1,379,258
Union	131,241
Walworth	5,895,543
Yankton	3,498,560
Ziebach	2,638,591
Total	**294,628,248**

Source: Risk Management Agency Cause of Loss Historical Data Files

Tornadoes

Methodology

All 66 counties in the state of South Dakota are vulnerable to tornado hazards. To refine and assess the relative vulnerability of each of South Dakota's counties to tornadoes, the state assigned ratings to four factors that were examined at the county level: prior events, building exposure, population density, and past tornado damage. The state then summed the ratings to obtain overall vulnerability scores for each county so that they could be compared and greatest vulnerability determined. The factors are described below.

Vulnerability Factors

Prior Events—This rating is based on the number of past tornadoes experienced by each county between January 1950 and August 2009 according to data from the National Climatic Data Center's Storm Events database (a compilation of storm data from the National Weather Service). Tornadoes reported in the database are in segments. So, the number of past occurrences is really a reflection of the number of past tornado segments. To develop the prior event rating, the total range of past occurrences was divided into

10 roughly equal ranges as shown in Table 3-57. The ranges were numbered 1 through 10 in ascending order.

Table 3-57 Tornadoes Prior Event Ratings

0-7	1
8-15	2
16-23	3
24-31	4
32-39	5
40-47	6
48-55	7
56-63	8
64-71	9
72-79	10

In addition to the total events tabulation, a prior event rating was established for each county based on the number of F1 or greater tornadoes in the county. This was used to help determine if there are areas of particular vulnerability to more severe tornado events. The information was drawn from the NCDC database and may not account for new methodologies in assessing a tornado's rating. This information was also divided into ten roughly equal ranges and is displayed in the table below.

Table 3-58 Tornadoes of at least F1 Rating Prior Event Ratings

# of Past Occurrences	Rating
0-1	1
2-3	2
4-5	3
6-8	4
9-10	5
11-12	6
13-15	7
16-17	8
18-20	9
21-22	10

Building Exposure—To best compare the vulnerability of one county to another, it is necessary to consider assets vulnerable to loss. This rating is based on total building exposure from HAZUS-MH4 (residential, commercial, industrial, agricultural, religion, government, and education). The total range of building exposure ($59,332,000 to $10,158,394,000) was divided into 10 roughly equal ranges as shown in Table 3-59. The ranges were numbered 1 through 10 in ascending order.

Table 3-59 Tornado Building Exposure Ratings

Building Exposure ($000)	Rating
59,332 - 1,069,238	1

Building Exposure ($000)	Rating
1,069,239 - 2,079,144	2
2,079,145 - 3,089,051	3
3,089,052 - 4,098,957	4
4,098,958 - 5,108,863	5
5,108,864 - 6,118,769	6
6,118,770 - 7,128,675	7
7,128,676 - 8,138,582	8
8,138,583 - 9,148,488	9
9,148,489 - 10,158,394	10

Population Density—Population density is determined by dividing a county's population by its land area. This section is based on the 2009 U.S. Census Bureau population estimates and the land area reported in the 2000 Census. The range of population densities (.4 to 221.3) was divided into 10 roughly equal ranges as shown in Table 3-51. The ranges were numbered 1 through 10 in ascending order.

Table 3-60 Population Density Ratings

Population Density	Rating
0.4 - 22.4	1
22.5 - 44.5	2
44.6 - 66.6	3
66.7 - 88.7	4
88.8 - 110.8	5
110.9 - 132.9	6
133 - 155	7
155.1 - 177.1	8
177.2 - 199.2	9
199.3 - 221.3	10

Past Tornado Damage— This rating is based on the property damage for the tornadoes that occurred in South Dakota between 1950 and 2009 as reported in the National Climatic Data Center's Storm Events database. This damage was presented in actual values for the year the events occurred. To more accurately compare the damage values, they were converted to 2009 dollars using Consumer Price Index conversion factors published by Oregon State University (this is similar to the methodology used in FEMA's inflation calculator in its Benefits Cost Analysis Toolkit). The inflated values suggest that the state had $642,948,576 (2009 dollars) in tornado damage between 1950 and 2009, which averages out to approximately $10,715,807 per year. The total range of past tornado damage was divided into 10 roughly equal ranges as shown in Table 3-61. The ranges were numbered 1 through 10 in ascending order.

Table 3-61 Past Tornado Damage Ratings

Damages ($)	Rating
828,039 – 15,748,684	1
15,748,685 – 30,669,330	2
30,669,331 – 45,589,976	3
45,589,977 – 60,510,622	4
60,510,623 – 75,431,268	5
75,431,269 – 90,351,914	6
90,351,915 – 105,272,560	7
105,272,561 – 120,193,206	8
120,193,207 – 135,113,852	9
135,113,853 - 150,034,502	10

After rating each of the counties on the factors described above, the four factor ratings were added together to produce a county-level vulnerability rating. The highest possible total vulnerability rating was 40. The total range of vulnerability (4 to 27) was divided into three equal ranges as shown in Table 3-62. The ranges were assigned a corresponding level of tornado vulnerability: moderate, high, and very high. The vulnerability scale begins at moderate as every county has some degree of vulnerability.

Table 3-62 Tornado Vulnerability

Tornado Vulnerability Range	**Tornado Vulnerability**
1-13	Moderate
14-27	High
28-40	Very High

Results

Summary of Prior Event Ratings—The lowest number of recorded tornadoes over this 61 year period was 6 in Jones County, which is the same as identified in the 2007 plan. The highest number of tornadoes was 76 in Brown County. Brown County experienced nearly twice as many tornadoes as the next highest county (Charles Mix) and was the only county that received a rating of 10. When only F1 or greater tornadoes were considered, Brown County still held the highest number (22), but was joined by McCook and Charles Mix counties at the rating of 10. The difference in the range of F1 or greater tornado events was significantly lower. When evaluating all prior events, only Jones County received a rating of 1, while 40 counties (61%) received ratings of 2 or 3. The counties that received a prior event rating greater than 4 are shown in Table 3-63. When only events of F1 magnitude or greater were evaluated, Hyde and Corson Counties received ratings of 1, while Jones County increased in rating to a rating of 2. McCook, Charles Mix, and Brown counties all received ratings of 10 and Turner and Minnehaha counties received ratings of 9. 32 counties (48%) received a rating between 3 and 5. The list of all counties receiving a rating greater than 6 is listed in Table 3-56.

Table 3-63 Counties with Tornadoes Prior Event Ratings Greater Than 4

County	# of Prior Events	Prior Event Rating
Todd	35	5
Spink	32	5
Perkins	34	5
Lyman	35	5
Beadle	32	5
Meade	38	5
Kingsbury	39	5
McCook	39	5
Pennington	41	6
Hutchinson	41	6
Minnehaha	41	6
Turner	43	6
Charles Mix	42	6
Lincoln	50	7
Brown	76	10

Table 3-64 Counties with at least F1 Tornadoes Prior Event Ratings Greater Than 6

County	# of Prior Events	Prior Event Rating
Lake	13	7
Bon Homme	13	7
Clark	14	7
Davison	13	7
Miner	13	7
Yankton	14	7
Clay	13	7
Tripp	14	7
Beadle	13	7
Meade	14	7
Kingsbury	14	7
Hutchinson	15	7
Lincoln	16	8
Minnehaha	18	9
Turner	20	9
McCook	21	10
Charles Mix	21	10
Brown	22	10

Table 3-66 in the Total Tornado Vulnerability section shows population density ratings for all South Dakota counties. A spreadsheet that includes the corresponding values can be found in Appendix 3E

South Dakota Tornado Vulnerability. Building exposure ratings and population density ratings can be found in Table 3-46 and Table 3-50 respectively.

Summary of Past Tornado Damage Ratings— During the 61-year period, Lincoln County incurred the most tornado damage: $150,034,052. Jones County incurred the least: $828,039. Lincoln County was the only one to receive a rating of 10. Those counties that received a rating higher than 2 are listed in Table 3-65.

Figure 3-46 shows the distribution of tornado damage across the state between 1950 and 2009.

Table 3-65 Counties with Past Tornado Damage Ratings Greater Than 1

County	Damages Amount	Damages Rating
Kingsbury	$ 6,517,000	3
Codington	$ 7,825,000	3
Minnehaha	$ 12,143,000	5
Turner	$ 17,443,000	6
Beadle	$ 18,588,000	7
Buffalo	$ 25,025,000	9
Lincoln	$ 29,221,000	10
McCook	$ 29,383,000	10

Figure 3-46 Tornado Damage 1950-2008

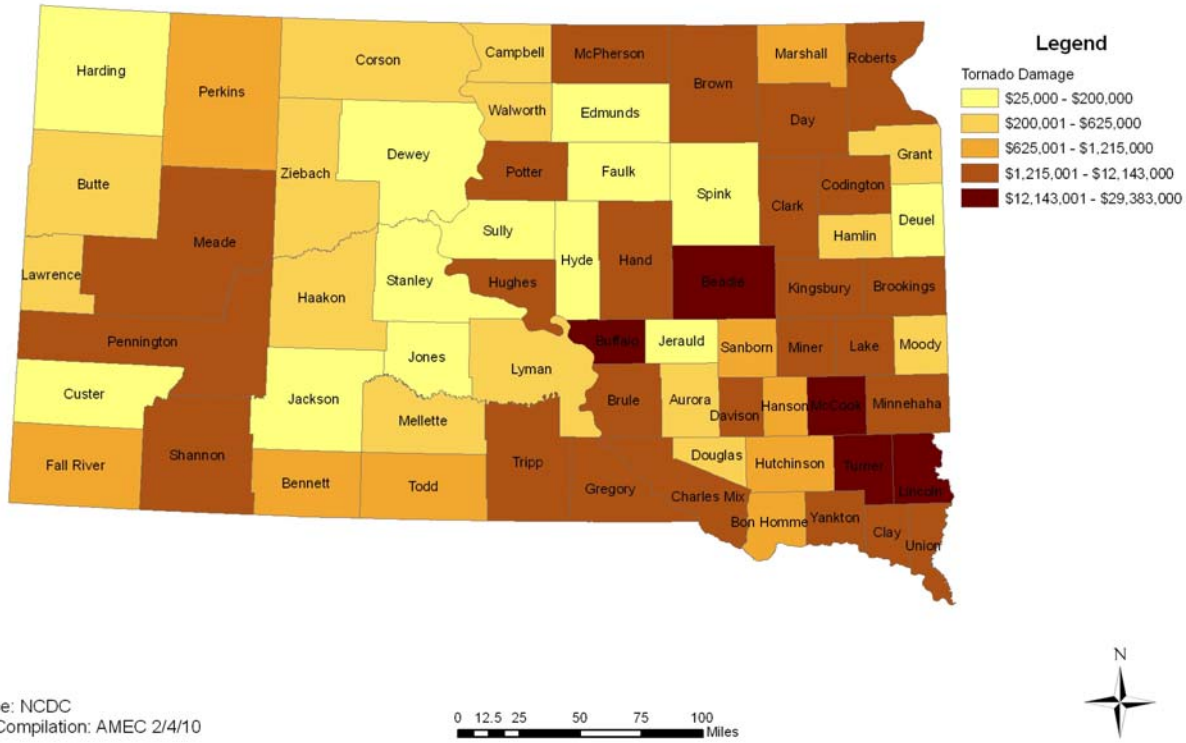


Table 3-66 in the Total Tornado Vulnerability section shows past tornado damage ratings for all South Dakota counties. A spreadsheet that includes the corresponding values can be found in Appendix 3E South Dakota Tornado Vulnerability.

Total Tornado Vulnerability and Estimate of Potential Loss

According to this methodology, while every South Dakota county is vulnerable to tornadoes, only Minnehaha County has a very high vulnerabilities. Beadle, Brown, Lincoln, McCook, Pennington, and Turner counties have high vulnerabilities. The remaining 59 counties (89%) have moderate vulnerabilities. Figure 3-47 illustrates the vulnerability of South Dakota counties to tornadoes, and Table 3-66 shows all the South Dakota counties ranked by total tornado vulnerability along with their four vulnerability factor ratings.

To provide additional insight into potential losses caused by tornadoes, historic loss data were also analyzed on a statewide scale. According to the National Climatic Data Center Storm Events database, there were 1,592 tornadoes in South Dakota between January 1950 and April 2010. Of those, 61 were rated as an F3 event, 6 as an F4, and 1 as an F5. Total property damage for these events is estimated at $643 million. This suggests that South Dakota experiences 10 tornadoes and $10.5 million in losses each year. There were 17 deaths and 441 injuries in this time period, which averages out to approximately 8 injuries each year. Of these storms, 5 resulted in major disaster declarations, with a total relief cost estimated at $148,686,613 in 2008 dollars. This averages out to $29.737 million (also in 2008 dollars) per major disaster. Based on the frequency of events, South Dakota averages one major disaster-level tornado every 318 events or approximately every 12 years.

The total historic losses and annualized losses by county are presented in Table 3-67. A loss ratio is calculated, which is the average annual loss divided by the total building exposure, as an indication of the significance of past tornado impacts to the overall building inventory in the county.

If areas with an overall vulnerability rating of high or very high are plotted on a map of the state, it becomes immediately clear that the concentration of highest vulnerability is in the southeast corner of the state. In addition, if the counties with at least 15 F1 or greater events are plotted on the map, the concentration remains in the southeast corner. The only outlier is Pennington County. As such, it is expected that the counties of McCook, Minnehaha, Hutchinson, Turner, Lincoln, Charles Mix, and Yankton have higher vulnerabilities to tornados and associated losses than the other counties in the state, although Pennington, Beadle, and Brown Counties should all also be considered at high risk.

Future vulnerability

Lincoln County experienced the greatest population gain from 2000 – 2008 of all the counties in South Dakota. Of the other counties with high or very high vulnerability to tornadoes, only Minnehaha and Pennington County experienced population growth between 2000 and 2008. As these counties continue to grow, their vulnerability to winter storms will increase as the exposure of population and property continues to grow. However, future growth in any county may alter the increased future vulnerability to tornado events, as density increases (which increases the potential for catastrophic damages) or as more population becomes exposed. This should be carefully monitored in the southeast corner of the state.

Figure 3-47 Tornado Vulnerability

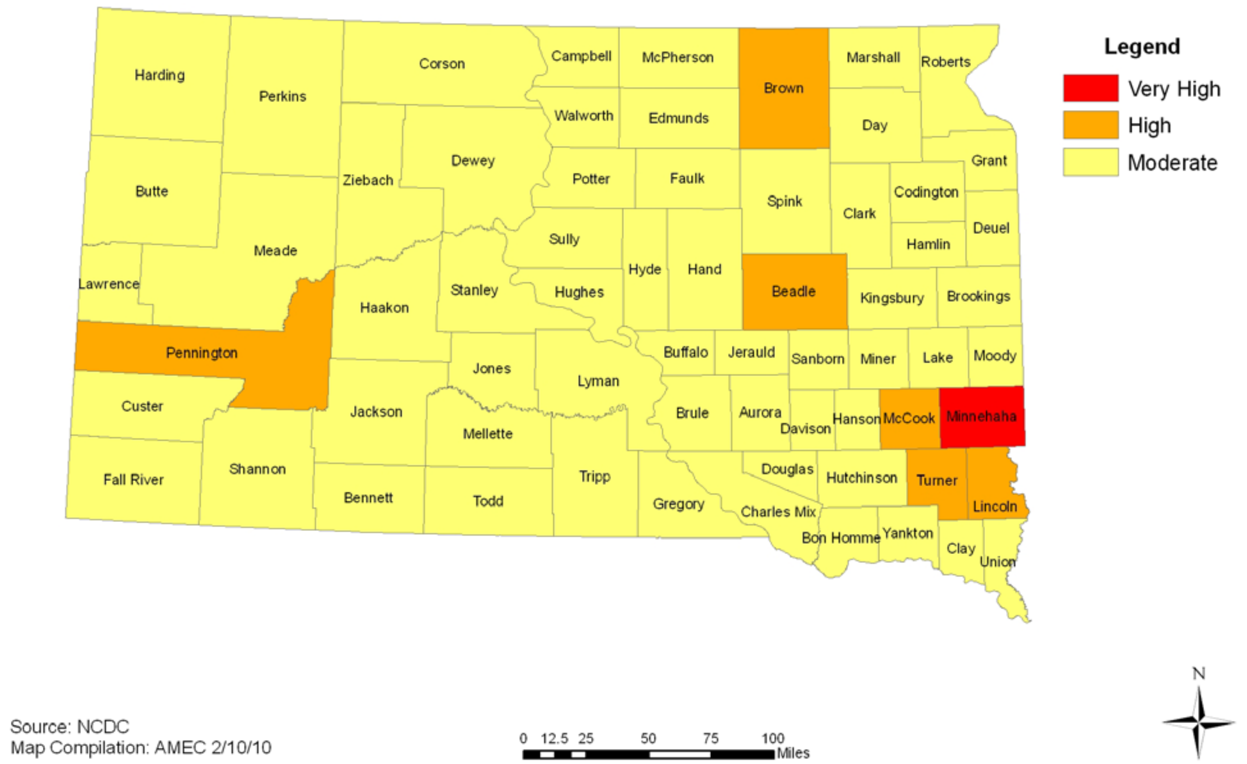


Table 3-66 Vulnerability of South Dakota Counties to Tornadoes

County	2009 Prior Event Rating	2009 Prior Event Rating ≥F1	Building Exposure Valuation Rating	Pop. Density Rating	Tornado Vulnerability
Minnehaha	6	9	10	10	Very High
Beadle	5	7	2	1	High
Brown	10	10	3	1	High
Lincoln	7	8	2	4	High
McCook	5	10	1	1	High
Pennington	6	6	6	2	High
Turner	6	9	1	1	High
Aurora	2	3	1	1	Moderate
Bennett	3	4	1	1	Moderate
Bon Homme	3	7	1	1	Moderate
Brookings	4	5	2	2	Moderate
Brule	3	5	1	1	Moderate
Buffalo	2	2	1	1	Moderate
Butte	2	3	1	1	Moderate
Campbell	2	4	1	1	Moderate
Charles Mix	6	10	1	1	Moderate
Clark	3	7	1	1	Moderate
Clay	4	7	1	2	Moderate

Codington	4	5	2	2	Moderate
Corson	3	1	1	1	Moderate
Custer	2	3	1	1	Moderate
Davison	4	7	2	2	Moderate
Day	3	4	1	1	Moderate
Deuel	3	4	1	1	Moderate
Dewey	4	3	1	1	Moderate
Douglas	3	4	1	1	Moderate
Edmunds	3	4	1	1	Moderate
Fall River	4	5	1	1	Moderate
Faulk	2	4	1	1	Moderate
Grant	3	4	1	1	Moderate
Gregory	3	5	1	1	Moderate
Haakon	3	6	1	1	Moderate
Hamlin	3	4	1	1	Moderate
Hand	4	6	1	1	Moderate
Hanson	3	6	1	1	Moderate
Harding	2	3	1	1	Moderate
Hughes	2	3	2	2	Moderate
Hutchinson	6	7	1	1	Moderate
Hyde	2	1	1	1	Moderate
Jackson	3	2	1	1	Moderate
Jerauld	2	2	1	1	Moderate
Jones	1	2	1	1	Moderate
Kingsbury	5	7	1	1	Moderate
Lake	3	7	1	1	Moderate
Lawrence	3	5	2	2	Moderate
Lyman	5	6	1	1	Moderate
Marshall	2	4	1	1	Moderate
McPherson	3	5	1	1	Moderate
Meade	5	7	2	1	Moderate
Mellette	2	2	1	1	Moderate
Miner	4	7	1	1	Moderate
Moody	2	2	1	1	Moderate
Perkins	5	6	1	1	Moderate
Potter	3	6	1	1	Moderate
Roberts	3	5	1	1	Moderate
Sanborn	3	4	1	1	Moderate
Shannon	3	4	1	1	Moderate
Spink	5	5	1	1	Moderate
Stanley	3	4	1	1	Moderate
Sully	3	3	1	1	Moderate
Todd	5	4	1	1	Moderate
Tripp	4	7	1	1	Moderate
Union	3	4	1	2	Moderate
Walworth	3	5	1	1	Moderate
Yankton	4	7	2	2	Moderate
Ziebach	2	2	1	1	Moderate

Table 3-67 Annualized Losses from Tornadoes

County	Total Events	Total Property Damage (inflated to 2009 $)	Annualized Losses ($)	Total Building Exposure	Loss Ratio
Buffalo	13	39,006,728	650,112	59,332,000	0.01096
McCook	39	41,608,934	693,482	371,482,000	0.00187
Lincoln	50	150,034,502	2,500,575	1,521,847,000	0.00164
Turner	43	48,977,097	816,285	601,439,000	0.00136
Gregory	20	21,145,104	352,418	272,939,000	0.00129
McPherson	21	12,463,755	207,729	184,182,000	0.00113
Hand	27	18,952,849	315,881	293,027,000	0.00108
Tripp	30	17,903,484	298,391	387,383,000	0.00077
Clark	23	10,846,441	180,774	250,785,000	0.00072
Brule	24	11,472,139	191,202	355,797,000	0.00054
Potter	19	8,068,975	134,483	253,216,000	0.00053
Kingsbury	39	11,461,952	191,033	393,331,000	0.00049
Campbell	12	2,983,882	49,731	104,897,000	0.00047
Miner	27	4,772,396	79,540	179,219,000	0.00044
Bennett	23	3,069,045	51,151	119,819,000	0.00043
Yankton	27	27,523,323	458,722	1,460,696,000	0.00031
Beadle	32	20,792,530	346,542	1,134,964,000	0.00031
Mellette	12	1,276,996	21,283	77,393,000	0.00028
Day	22	7,832,830	130,547	481,258,000	0.00027
Corson	20	2,074,032	34,567	134,270,000	0.00026
Charles Mix	42	8,081,569	134,693	537,232,000	0.00025
Roberts	21	9,045,221	150,754	607,102,000	0.00025
Shannon	20	4,492,969	74,883	319,931,000	0.00023
Marshall	14	4,310,601	71,843	341,521,000	0.00021
Ziebach	15	828,039	13,801	65,710,000	0.00021
Codington	29	20,494,124	341,569	1,678,645,000	0.00020
Perkins	34	2,412,149	40,202	207,947,000	0.00019
Hughes	12	12,477,511	207,959	1,122,519,000	0.00019
Bon Homme	22	4,674,062	77,901	434,736,000	0.00018
Hanson	17	1,758,400	29,307	173,253,000	0.00017
Douglas	22	1,737,183	28,953	189,496,000	0.00015
Walworth	22	3,186,284	53,105	388,990,000	0.00014
Todd	35	2,143,299	35,722	275,698,000	0.00013
Sanborn	21	1,178,080	19,635	163,444,000	0.00012
Lake	20	5,627,940	93,799	799,974,000	0.00012
Clay	30	4,791,466	79,858	784,888,000	0.00010

County	Total Events	Total Property Damage (inflated to 2009 $)	Annualized Losses ($)	Total Building Exposure	Loss Ratio
Haakon	21	887,594	14,793	145,945,000	0.00010
Brown	76	13,644,920	227,415	2,351,564,000	0.00010
Jackson	19	647,729	10,795	116,514,000	0.00009
Meade	38	6,439,416	107,324	1,266,896,000	0.00008
Butte	13	1,989,975	33,166	422,631,000	0.00008
Union	21	4,346,377	72,440	1,028,705,000	0.00007
Fall River	28	1,793,564	29,893	431,536,000	0.00007
Hutchinson	41	1,901,285	31,688	499,887,000	0.00006
Lyman	35	698,217	11,637	208,870,000	0.00006
Pennington	41	17,222,362	287,039	5,599,723,000	0.00005
Dewey	25	539,193	8,987	183,377,000	0.00005
Davison	24	3,288,806	54,813	1,154,737,000	0.00005
Faulk	16	442,170	7,369	160,231,000	0.00005
Brookings	24	4,704,888	78,415	1,755,705,000	0.00004
Sully	20	301,513	5,025	113,389,000	0.00004
Minnehaha	41	26,914,174	448,570	10,158,394,000	0.00004
Aurora	13	472,710	7,879	189,613,000	0.00004
Hyde	10	257,717	4,295	103,528,000	0.00004
Spink	32	1,189,757	19,829	479,333,000	0.00004
Harding	15	191,663	3,194	81,436,000	0.00004
Stanley	21	365,587	6,093	162,436,000	0.00004
Moody	10	788,721	13,145	388,500,000	0.00003
Jones	6	134,602	2,243	69,761,000	0.00003
Hamlin	17	738,730	12,312	385,529,000	0.00003
Grant	17	828,854	13,814	483,455,000	0.00003
Lawrence	16	1,914,662	31,911	1,418,003,000	0.00002
Custer	9	366,866	6,114	460,590,000	0.00001
Jerauld	8	113,183	1,886	171,669,000	0.00001
Deul	18	182,960	3,049	284,516,000	0.00001
Edmunds	18	134,490	2,242	272,126,000	0.00001
Total	**1592**	**642,948,576**	**10,715,807**	**47,276,961,000**	**n/a**

Windstorms

Methodology

To assess the vulnerability of each of South Dakota's counties to windstorm events, the state assigned ratings to three factors that were examined at the county level: prior events, building exposure, and population density. The state then summed the ratings to obtain overall vulnerability scores for each county so that they could be compared and greatest vulnerability determined. This methodology is similar to that used in assessing vulnerability for winter storms. The factors are described below.

Vulnerability Factors

Prior Events—This rating is based on the number of past windstorm events experienced by each county between January 1955 and August 2009 according to data from the National Climatic Data Center's Storm Events database (a compilation of storm data from the National Weather Service). For the purposes of this plan, a windstorm event is considered thunderstorm winds or high winds as identified in the National Climatic Data Center's database. In addition, particularly severe events (those with a speed of 70 knots or higher) were also assessed. (see the description of the windstorm events that affect South Dakota in the Windstorm Hazard Profile).

To develop the prior event rating, the total range of past occurrences was divided into 10 roughly equal ranges as shown in Table 3-68 and Table 3-69. The ranges were numbered 1 through 10 in ascending order.

Table 3-68 Windstorm Prior Event Ratings

# of Past Occurrences	Rating
33-63	1
64-94	2
95-125	3
126-156	4
157-187	5
188-218	6
219-249	7
250-280	8
281-311	9
312-342	10

Table 3-69 Windstorm Prior Event Ratings (Wind speed ≥70 kts)

# of Past Occurrences	Rating
0-2	1
3-6	2
7-9	3
10-13	4
14-16	5
17-20	6

# of Past Occurrences	Rating
21-23	7
24-27	8
28-30	9
31-35	10

Building exposure ratings and population density ratings can be found in Table 3-46 and Table 3-50 respectively.

A fourth factor, past windstorm damage, may be considered for the next plan update based on the availability of information. Currently, county-level damage information is not available for wind. While many of the events in the National Climatic Data Center's Storm Event database are at the county level, there are some events that are regional and for which damage values are for an entire storm and cannot be approximated for each individual affected county.

After rating each of the counties on the factors described above, the three factor ratings were added together to produce a county-level vulnerability rating. The highest possible total vulnerability rating was 30. The total range of vulnerability was divided into three equal ranges as shown in Table 3-64. The ranges were assigned a corresponding level of windstorm vulnerability: moderate, high, and very high.

Table 3-70 Windstorm Vulnerability

Windstorm Vulnerability Range	Windstorm Vulnerability
0-9	Moderate
10-19	High
20-30	Very High

This vulnerability was assigned to each county considering both all windstorm events and just those events above 70 knots.

Results

Summary of Prior Event Ratings—The lowest number of recorded windstorm events over this 54-year period was 33 in Lawrence County; the highest was 196 in Pennington County. For events of at least 70 knots, the least reported was 0 (Kingsbury, Miner, and Union counties) and the most was 35, also in Meade County. For both ratings, only Meade County received a score of 10. In terms of all events, Lawrence, Douglas, Buffalo, Aurora, Jerauld, Moody and Mellette received ratings of 1. This category expanded when events were limited to at least 70 knots, and included Gregory, Hanson, Sanborn, Miner, McPherson, Clay, Union and Kingsbury. In addition, the counties of Douglas, Buffalo, Moody, and Mellette increased their ratings. In both cases, ratings of 2 and 3 were most prevalent, accounting for about 50% of counties respectively. The counties that received a prior event rating greater than 4 are shown in Table 3-71 and counties that received a prior event rating greater than 4 for events of at least 70 knots are shown in Table 3-72.

Table 3-71 Counties with Windstorm Prior Event Ratings Greater Than 4

County	# of Prior Events	Prior Event Rating
Perkins	158	5
Butte	160	5
Haakon	162	5
Hughes	178	5
Beadle	193	6
Harding	194	6
Minnehaha	229	7
Brown	230	7
Pennington	310	9
Meade	340	10

Table 3-72 Counties with Windstorm Prior Event Ratings of ≥70 kts Greater Than 4

County	# of Prior Events	Prior Event Rating
Faulk	15	5
Spink	14	5
Tripp	14	5
Beadle	14	5
Perkins	19	6
Butte	20	6
Haakon	19	6
Harding	18	6
Pennington	21	7
Day	24	8
Hughes	24	8
Brown	24	8
Meade	35	10

Table 3-73 in the Total Windstorm Vulnerability section shows prior event ratings for all South Dakota counties. A spreadsheet that includes the corresponding values can be found in Appendix 3F South Dakota Windstorm Vulnerability.

Total Windstorm Vulnerability and Estimate of Potential Loss

According to this methodology, every South Dakota county is vulnerable to windstorm but some counties have a higher risk than others. In addition, the severity of the windstorm event varies the vulnerability slightly. In both scenarios, only Minnehaha County has a very high vulnerability. In the total windstorm events vulnerability, Pennington, Brown, Meade and Lincoln have high vulnerabilities. When windstorm events of at least 70 knots are considered, Lincoln is rated as a moderate risk while Day and Hughes are added to this list of high vulnerabilities. The remaining counties have moderate vulnerabilities. Figure 3-48 illustrates the vulnerability of South Dakota counties to windstorm, and Table 3-73 shows all the

South Dakota counties ranked by total windstorm vulnerability along with their three vulnerability factor ratings. In general, the counties with the greatest vulnerability to windstorm events are those in the Black Hills region and those with major cities. This assessment is very similar to the 2007 plan.

It is difficult to pick an area of higher vulnerability to windstorms in the state if all windstorm events are examined. Counties where at least 100 events have been recorded are fairly evenly distributed across the state. Counties with at least 150 reported events are centralized in the Black Hills region, and then include the counties of Hughes, Brown, Beadle and Minnehaha. When counties receiving a past events rating higher than 5 for events of at least 70 knots are plotted, they mirror the distribution of 150+ total event counties. The counties of Hughes, Brown, Day and Minnehaha are home to the cities of Pierre, Aberdeen, Webster, and Sioux Falls (respectively), which (with the exception of Day) also have higher population densities, which may account for the outliers.

Future vulnerability

Lincoln County experienced the greatest population gain from 2000 – 2008 of all the counties in South Dakota, followed by Minnehaha. Of the other counties with high vulnerability to windstorms, Pennington identified increased population while Meade and Brown identified population losses. Population increases, and the associated growth of development, increases a county's risk to damages and losses from windstorms. In general, livestock are not severely impacted by windstorms although particularly severe events or events that cause a drastic change in the environment (such as wind chill) may incur disproportionate losses in livestock relative to the rest of the hazard events, therefore agricultural counties may also increase periodic increases of vulnerability to events.

Figure 3-48: Windstorm Vulnerability

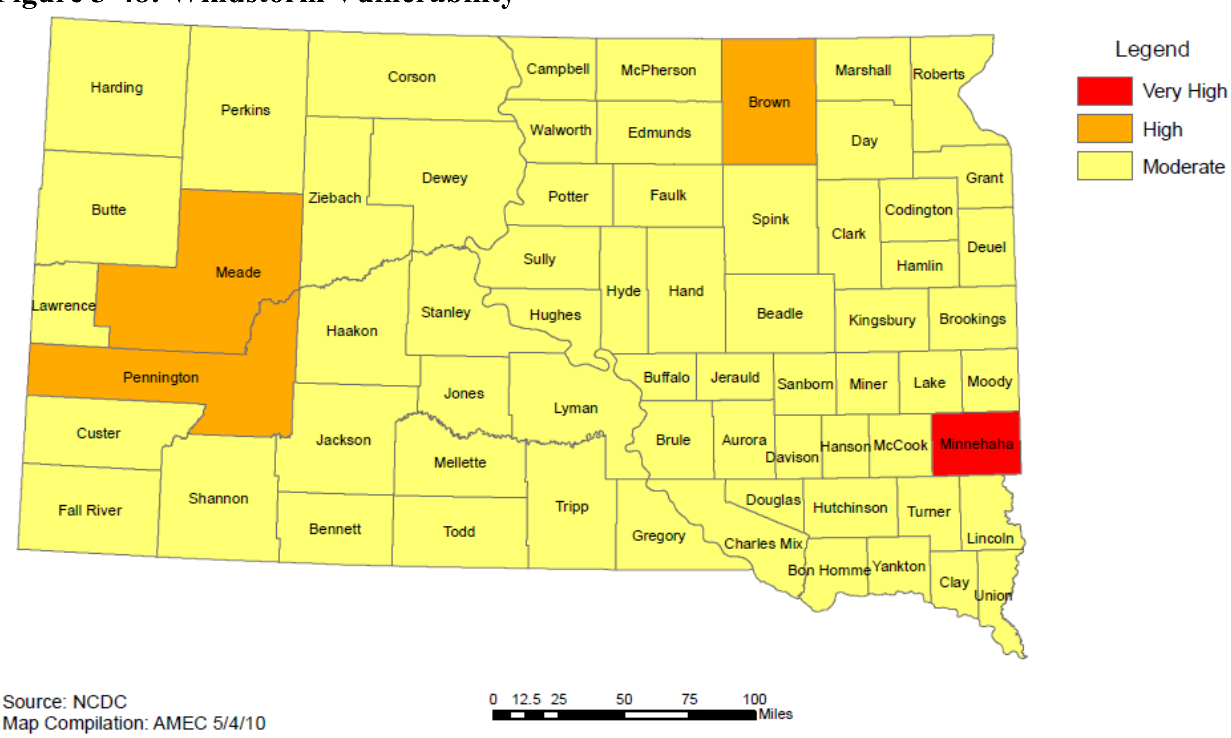


Table 3-73 Vulnerability of South Dakota Counties to Windstorm

County	Prior Event Rating	Building Exposure Valuation Rating	Pop. Density Rating	Windstorm Vulnerability
Minnehaha	7	10	10	Very High
Brown	7	3	1	High
Lincoln	4	2	4	High
Meade	10	2	1	High
Pennington	9	6	2	High
Aurora	1	1	1	Moderate
Beadle	6	2	1	Moderate
Bennett	2	1	1	Moderate
Bon Homme	2	1	1	Moderate
Brookings	3	2	2	Moderate
Brule	3	1	1	Moderate
Buffalo	1	1	1	Moderate
Butte	5	1	1	Moderate
Campbell	2	1	1	Moderate
Charles Mix	3	1	1	Moderate
Clark	2	1	1	Moderate
Clay	2	1	2	Moderate
Codington	3	2	2	Moderate
Corson	3	1	1	Moderate
Custer	3	1	1	Moderate
Davison	4	2	2	Moderate
Day	3	1	1	Moderate
Deuel	2	1	1	Moderate
Dewey	3	1	1	Moderate
Douglas	1	1	1	Moderate
Edmunds	4	1	1	Moderate
Fall River	2	1	1	Moderate
Faulk	3	1	1	Moderate
Grant	2	1	1	Moderate
Gregory	2	1	1	Moderate
Haakon	5	1	1	Moderate
Hamlin	2	1	1	Moderate
Hand	3	1	1	Moderate
Hanson	2	1	1	Moderate
Harding	6	1	1	Moderate
Hughes	5	2	2	Moderate
Hutchinson	2	1	1	Moderate
Hyde	2	1	1	Moderate
Jackson	3	1	1	Moderate
Jerauld	1	1	1	Moderate
Jones	2	1	1	Moderate
Kingsbury	3	1	1	Moderate
Lake	2	1	1	Moderate
Lawrence	1	2	2	Moderate
Lyman	3	1	1	Moderate

County	Prior Event Rating	Building Exposure Valuation Rating	Pop. Density Rating	Windstorm Vulnerability
Marshall	2	1	1	Moderate
McCook	2	1	1	Moderate
McPherson	2	1	1	Moderate
Mellette	1	1	1	Moderate
Miner	2	1	1	Moderate
Moody	1	1	1	Moderate
Perkins	5	1	1	Moderate
Potter	2	1	1	Moderate
Roberts	2	1	1	Moderate
Sanborn	2	1	1	Moderate
Shannon	3	1	1	Moderate
Spink	3	1	1	Moderate
Stanley	3	1	1	Moderate
Sully	3	1	1	Moderate
Todd	3	1	1	Moderate
Tripp	3	1	1	Moderate
Turner	2	1	1	Moderate
Union	3	1	2	Moderate
Walworth	3	1	1	Moderate
Yankton	3	2	2	Moderate
Ziebach	3	1	1	Moderate

To estimate potential losses to wind, historic loss data was analyzed. The National Climatic Data Center data did not lend itself to county by county loss summaries, only a statewide summary. Based on historic loss information presented in the wind hazard profile, South Dakota averages 105.7 windstorm. $1.962 million in wind losses, and nearly three injuries each year. The average cost of a windstorm in South Dakota is $18,564. The state has also experienced 490 events since 1955 with a windspeed of at least 70 knots, which accounted for three deaths and 66 injuries. This averages out to 9 particularly severe storms per year with an average yearly cost of $1.028 million. In addition, South Dakota has experienced three windstorms that resulted in a disaster declaration. Of these three events, the event on July 22, 2005 was credited entirely to wind, while the other two events also included damages from flooding and/or tornadoes. The total FEMA disaster relief costs for these three events is estimated at over $114 million in 2008 dollars, with an average cost of $38 million (also in 2008 dollars.) Based on past events, South Dakota can expect a disaster declaration-level windstorm event every 1,891 events or once approximately every 18 years.

Hazardous Materials

It is difficult to quantify trends in hazardous materials transportation incidents due to their somewhat random nature, but based on historic incidents more than half of the transportation incidents between 1971 and 2010 occurred in Minnehaha and Pennington counties, where the state's largest cities, Sioux Falls and Rapid City, are located. These counties are trailed by Lincoln, Brown, and Codington in terms of numbers of incidents. Based on the information in the hazard profile section, South Dakota experienced 709 transportation incidents involving hazardous materials between 1971 and 2010. The total cost of damage associated with these incidents was approximately $6,415,374. This suggests that South Dakota experiences 23.6 transportation incidents involving hazardous materials and $159,000 in related damage each year. 14 of the incidents were rail related, 19 were air, and the remaining 709 were highway. Other concerns noted in the planning process are the transport of nuclear materials, which often occurs without the knowledge of local governments or tribal organizations.

Vulnerability to pipeline incidents was determined solely on the total number of miles of gas or hazardous liquid transmission lines, as detailed in the hazard profile section. Based on this table the top ten counties with the most transmission lines are Lincoln, Minnehaha, Brown, Spink, Butte, Union, Clark, Harding, Duel, and Hutchinson, most of which are located in southeastern South Dakota. According to the U.S. Department of Transportation's Office of Pipeline Safety, there were 35 pipeline incidents in South Dakota between 1983 and 2006 (24 years), totaling $10,354,962, which equates to $431,457 in average annual loss. Pennington and Minnehaha each had 8 incidents in this time period, with Beadle, Brown, Clark, Custer, Decatur, Kingsbury, Lawrence, Lincoln, McCook, Sanborn, Union, Walworth, Waterton, and Yankton 2 or less.

Future vulnerability

Minnehaha, Lincoln, and Pennington experienced the greatest population gains from 2000 – 2006 of all the counties in South Dakota. These counties may continue to see the most hazardous materials incidents throughout the state due to the higher populations. Codington County identified construction of new homes indicating an increase in population and development. These growth and development trends must be taken into consideration when assessing vulnerability of jurisdictions to hazardous materials incidents. Although a high vulnerability for Brookings County did not arise in this plan, they may become more vulnerable to hazardous materials as the population increases and the transportation systems expand throughout the county.

Southeastern counties are more vulnerable to fixed facility incidents in general due to the number of facilities there. The counties with these facilities are listed in the hazard profile section. Available data does not support further refinement of vulnerability to fixed facility incidents based on historic losses.

Geologic Hazards

Information regarding previous landslides, mudflows, and subsidence throughout the State of South Dakota was too limited, at the time of this plan update, to assess the vulnerability and potential losses by jurisdiction. Limited areas throughout the state are vulnerable to landslides and mudflows as depicted in the hazard profile. Available data does not support further refinement of vulnerability to landslides and mudflows based on historic losses.

A HAZUS-MH annualized earthquake loss scenario was run for the entire state in the 2007 update to this plan. This enabled a consistent comparison of earthquake risk across the state. The annualized expected loss (AEL) addresses key components of risk: the probability of hazard occurring in the study area, the consequences of the hazard (largely a function of building construction type and quality), and the intensity of the hazard event. By annualizing estimated losses, the AEL factors in historical patterns of frequent small events with infrequent larger events to provide a balanced presentation of the risk. In

HAZUS-MH, losses are annualized over eight earthquake return periods (100, 200, 500, 750, 1,000, 1,500, 2,000, and 2,500 years).

The results of this scenario indicate annualized building losses (includes building structure, content and income losses) totaling $440,000. 7,693 buildings would be at least moderately damaged, with 55% of the losses sustained by residential buildings. The counties with the highest building losses are Pennington ($110,000), Minnehaha ($59,000), and Lawrence ($26,000), with the remaining counties having $18,000 or less in annualized loss. 420 households could be displaced by earthquakes according to this scenario. No casualties were generated by the scenario.

Future vulnerability

Minnehaha, Lincoln, and Pennington experienced the greatest population gains from 2000 – 2008 of all the counties in South Dakota. Areas with high development will continue to be the areas most vulnerable to structural damage from earthquakes.

Agricultural Pest and Diseases

This hazard was added to the plan in 2010 and includes a number of different pests and diseases that could affect the agricultural industry. The types of impacts will vary from year to year and county to county, but it is anticipated that the agricultural industry will continue to suffer losses from the various pests and diseases. Economically, these impacts can total up to a billion dollars in the State. Outside of the economic impacts, some of these have the potential to affect human health as well, as noted in Table 3-4 in the Agricultural Pest and Diseases hazard profile. Additional analysis of the risk and potential loss from these hazards should be considered in future updates to this plan.

Rural Electric Cooperative Considerations

During the 2009-2010 update the Rural Electric Cooperatives (REC) were engaged as participants in the state planning effort. This discussion focuses on the potential hazard risks to REC's. Of the hazards identified in this plan winter storms, wind and tornadoes pose the greatest risk to power lines and facilities operated by the RECs. These hazards can knock down power lines, which tend to be the most vulnerable elements of the electrical grid. To determine how this risk may vary across the various REC's an overlay analysis of REC was done to determine their intersection with high and very high vulnerable counties for Winter Storms, Wind, and Tornadoes identified through the previous methods described. The boundaries of the RECs are displayed in Figure 3-49. The results of the analysis are summarized in Table 3-74.

Figure 3-49 South Dakota Rural Electric Cooperative Boundaries

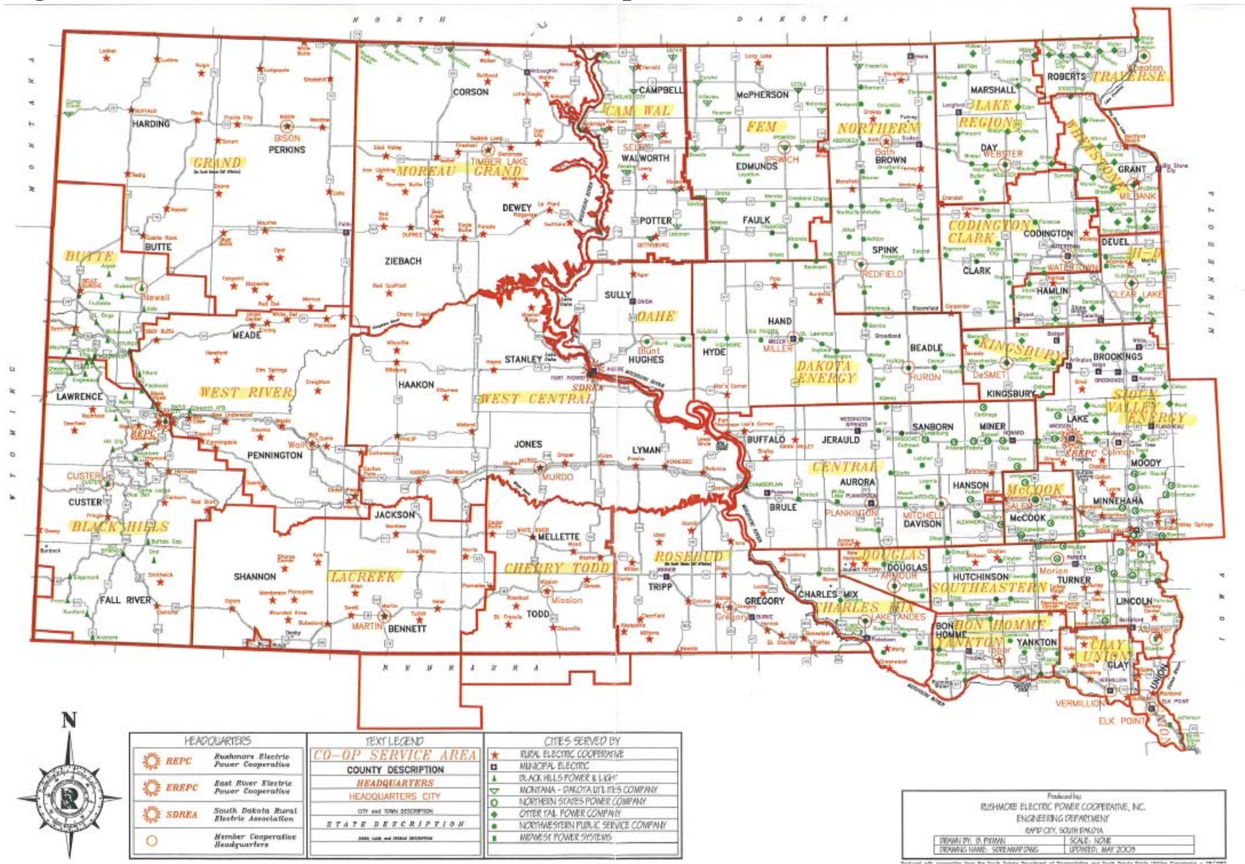


Table 3-74 Rural Electric Cooperative Hazard Vulnerabilities

Rural Electric Cooperative	County	Winter Storm Vulnerability	Wind Storm Vulnerability	Tornado Vulnerability
Black Hills Electric Cooperative, Inc	Pennington	High	High	High
Black Hills Power & Light Co	Butte	High	-	-
Black Hills Power & Light Co	Meade	High	High	-
Black Hills Power & Light Co	Pennington	High	High	High
Bon Homme-Yankton Electric Association, Inc	Yankton	High	-	-
Butte Electric Cooperative, Inc.	Butte	High	-	-
Butte Electric Cooperative, Inc.	Meade	High	High	-
Central Electric Cooperative Inc.	Davison	High	-	-
Clay-Union Electric Corporation	Lincoln	High	-	High
Clay-Union Electric Corporation	Yankton	High	-	-

Rural Electric Cooperative	County	Winter Storm Vulnerability	Wind Storm Vulnerability	Tornado Vulnerability
Clay-Union Electric Corporation	Turner	-	-	High
Dakota Energy Cooperative Inc.	Beadle	High	-	High
Grand Electric Cooperative, Inc.	Butte	High	-	-
Grand Electric Cooperative, Inc.	Meade	High	High	-
H-D Electric Cooperative, Inc	Brookings	High	-	-
Kingsbury Electric Cooperative, Inc	Brookings	High	-	-
Lake Region Electric Association, Inc.	Brown	High	High	High
MidAmerican Energy	Lincoln	High	-	High
Montana-Dakota Utilities Co	Brown	High	High	High
Northern Electric Cooperative Inc.	Brown	High	High	High
Northwestern Energy	Beadle	High	-	High
Northwestern Energy	Brown	High	High	High
Northwestern Energy	Davison	High	-	-
Northwestern Energy	Hutchinson	High	-	-
Northwestern Energy	Yankton	High	-	-
Otter Tail Power Co	Brookings	High	-	-
Sioux Falls Municipal Electric and Xcel Energy	Minnehaha	Very High	Very High	Very High
Sioux Valley Energy	Brookings	High	-	-
Sioux Valley Energy	Minnehaha	Very High	Very High	Very High
Southeastern Electric Cooperative, Inc	Hutchinson	High	-	-
Southeastern Electric Cooperative, Inc	Lincoln	High	-	High
Southeastern Electric Cooperative, Inc	Minnehaha	Very High	Very High	Very High
Southeastern Electric Cooperative, Inc	Yankton	High	-	-
Southeastern Electric Cooperative, Inc	McCook	-	-	High
Southeastern Electric Cooperative, Inc	Turner	-	-	High
West River Electric Association , Inc.	Meade	High	High	-
West River Electric Association , Inc.	Pennington	High	High	High
XCEL Energy	Hutchinson	High	-	-
XCEL Energy	Lincoln	High	-	High
XCEL Energy	Minnehaha	Very High	Very High	Very High
XCEL Energy	McCook	-	-	High

Rural Electric Cooperative	County	Winter Storm Vulnerability	Wind Storm Vulnerability	Tornado Vulnerability
XCEL Energy	Turner	-	-	High

Based on this analysis notable REC's subject to multi-hazard risk include:

- Southeastern Electric Coop
- Black Hills Electric Coop
- Black Hills Power & Light Co.
- Lake Region Electric Assoc.
- Montana-Dakota Utilities Co.
- West River Electric Assoc.

In addition wildfire can impact power lines in the Black Hills. The Black Hills, Butte, and West River REC's are more vulnerable to wildfires.

An overlay of power facilities on flood and wildfire hazard areas to identify specific facilities potentially at risk is discussed in the next section and captured in the tables in Appendix 3H.

Additional data collection and analysis will be needed to estimate potential dollar losses to the REC's. South Dakota has funded several power line burial projects with HMGP funds. The analysis presented previously does not account for how the vulnerability may be reduced from these efforts. Future updates to this plan would benefit from the addition of this information.

3.4 Assessing Vulnerability and Estimating Potential Losses of State Facilities

44 CFR Part 201 Requirement:
[The State risk assessment shall include an overview and analysis of the State's vulnerability to the hazards described in paragraph (c)(2), based on estimates provided in] the State risk assessment. …State owned critical or operated facilities located in the identified hazard areas shall also be addressed…. *The State shall update the overview and analysis of vulnerable State owned or operated buildings, critical facilities, and infrastructure, based on available data. The update should reflect acquisition or development of new properties and infrastructure.*

44 CFR Part 201 Requirement:
[The State risk assessment shall include an overview and analysis of potential losses to identified vulnerable structures, based on estimates provided in] the State risk assessment. The State shall estimate the potential dollar losses to State-owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

South Dakota uses the following definitions from the National Infrastructure Protection Plan to define its infrastructure, critical infrastructure, and key resources:

Infrastructure: The framework of interdependent networks and systems comprising identifiable industries, institutions (including people and procedures), and distribution capabilities that provide a reliable flow of products and services essential to the defense and economic security of the United States, the smooth functioning of government at all levels, and society as a whole. Consistent with the definition in the Homeland Security Act, infrastructure includes physical, cyber, and/or human elements.

Critical Infrastructure: Assets, systems, and networks, whether physical or virtual, so vital to the United States that the incapacity or destruction of such assets, systems, or networks would have a debilitating impact on security, national economic security, public health or safety, or any combination.

Key Resources: As defined in the Homeland Security Act, key resources are publicly or privately controlled resources essential to the minimum operations of the economy and the government.

The State Office of Emergency Management has developed a database of Key Resources and Critical Infrastructure that combines state and local facility information. This database addresses a data limitation noted in the 2004 plan. State owned or operated facilities are included in this database, based on input from state agencies. Utilizing a geocoded database of government office buildings in the State from FEMA, OEM staff worked through a Technical Advisory Group (TAG), whose membership represents: Department of Tourism and State Development; Game, Fish and Parks; Bureau of Information and Telecommunication; Department of Public Safety; Department of Revenue and Regulation; Department of Environmental and National Resources; and Department of Transportation, to obtain available information regarding state owned or operated facilities.

Some local facilities are included in this database as well. The county emergency managers have contributed information on the facilities they feel align with the National Infrastructure Protection Plan definitions. Some of this information is sensitive and has restricted public access. A non-restricted version of the GIS database was made available for analysis during this plan's update in 2007 and 2010. Improvements to the database could include the addition of a building valuation field and a standardized classification of facility type. These improvements are still recommended in 2010. The database included the following types of facilities:

- Educational/School
- Electric power
- Emergency services
- Energy
- Hydro Electric
- Hospitals
- Law Enforcement
- Natural Gas
- Communication
- Airports
- Water Facilities
- Waste Water Facilities
- Processing
- Storage stockpiles
- local health department offices
- State penitentiary
- State office buildings\facilities

Five other GIS layers available from the South Dakota Department of Transportation contain additional information on utility-specific facilities, including:

- Water
- Communication
- Power
- Natural Gas
- Fuel

As of 2010, the state did not have a complete utility/infrastructure layer, but several GIS layers were available from the South Dakota Department of Transportation. These layers included fuel, power, and natural gas utilities (point locations), and road and railroad networks. Utility networks included fiber optic, electric, natural gas, liquid petroleum, telecommunications, television and other networks. These layers were supplemented with national infrastructure data such as the National Inventory of Bridges and National Inventory of Dams for the infrastructure vulnerability analysis.

Maps showing the general locations of the critical facilities and utility infrastructure are included in Figure 3-50 and Figure 3-51. The scale of these maps is limited by the size constraints of this document can be images can be made available for large scale printing if desired or re-created from GIS.

Figure 3-50 South Dakota State Facilities

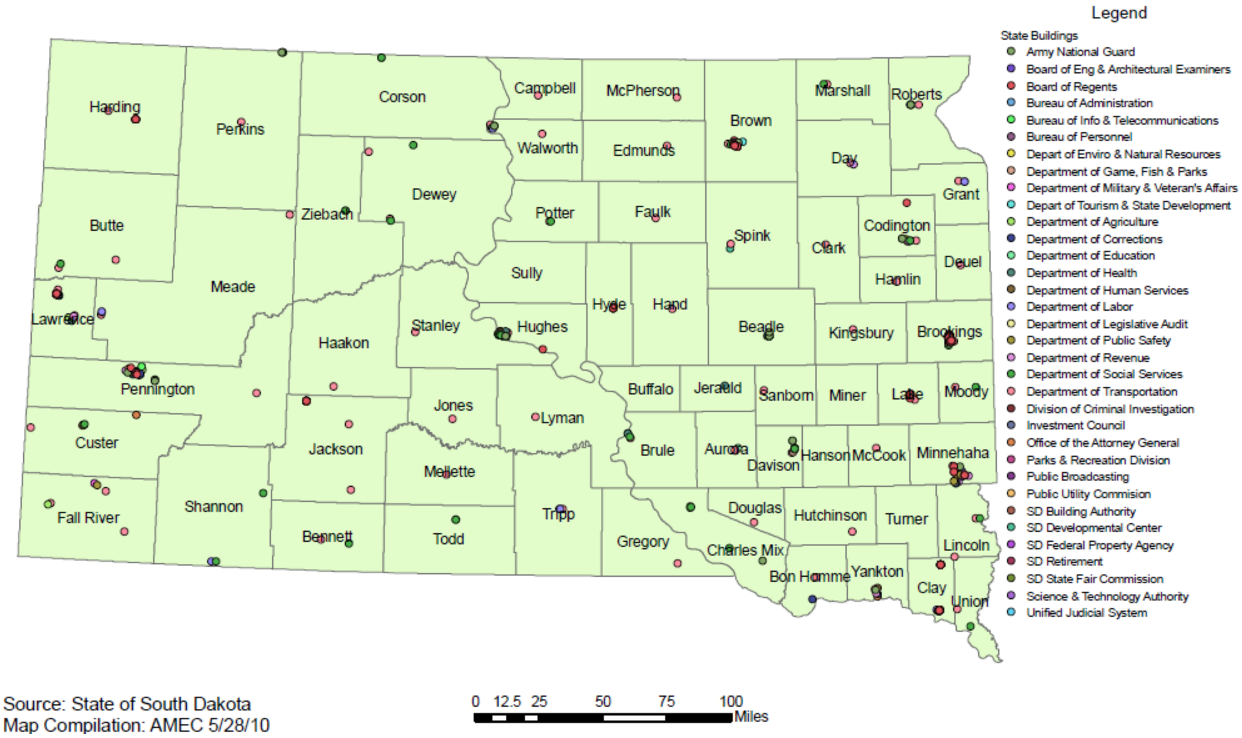


Figure 3-51 South Dakota Utilities

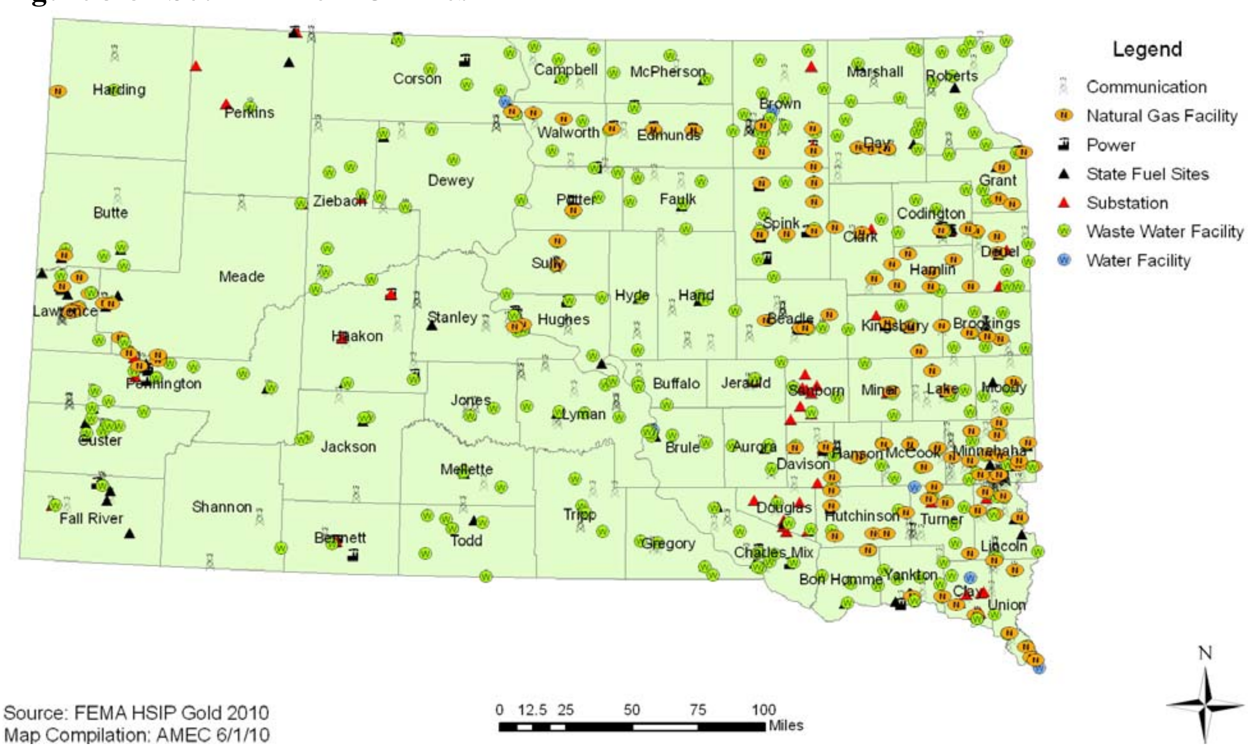


Figure 3-52 South Dakota Utility Infrastructure

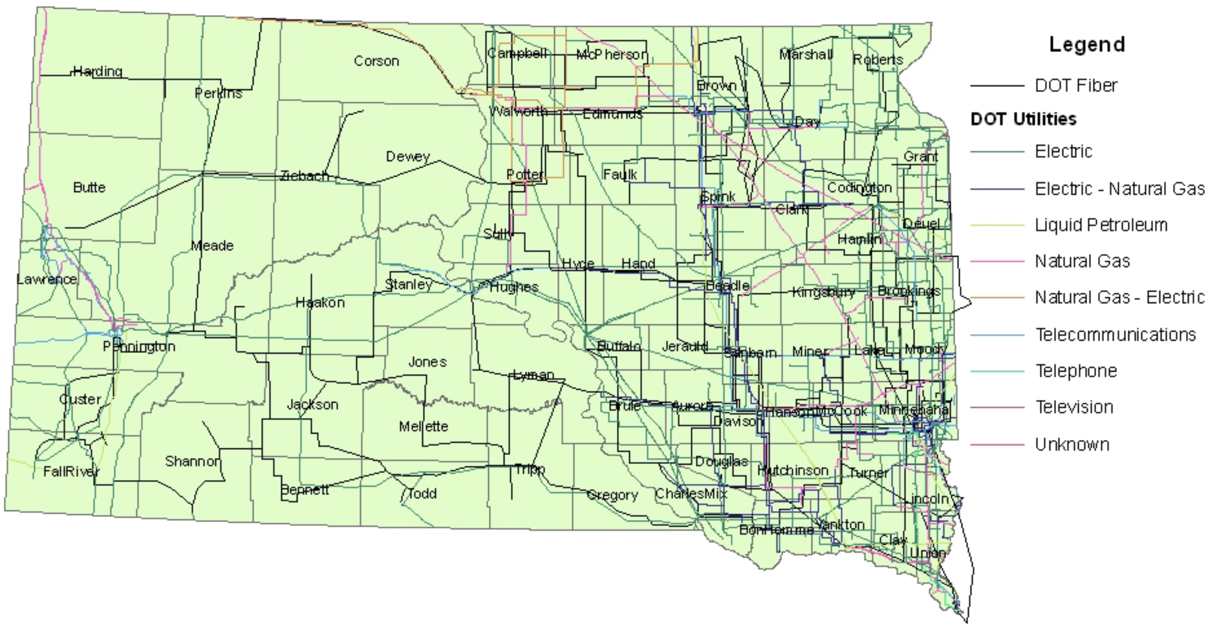
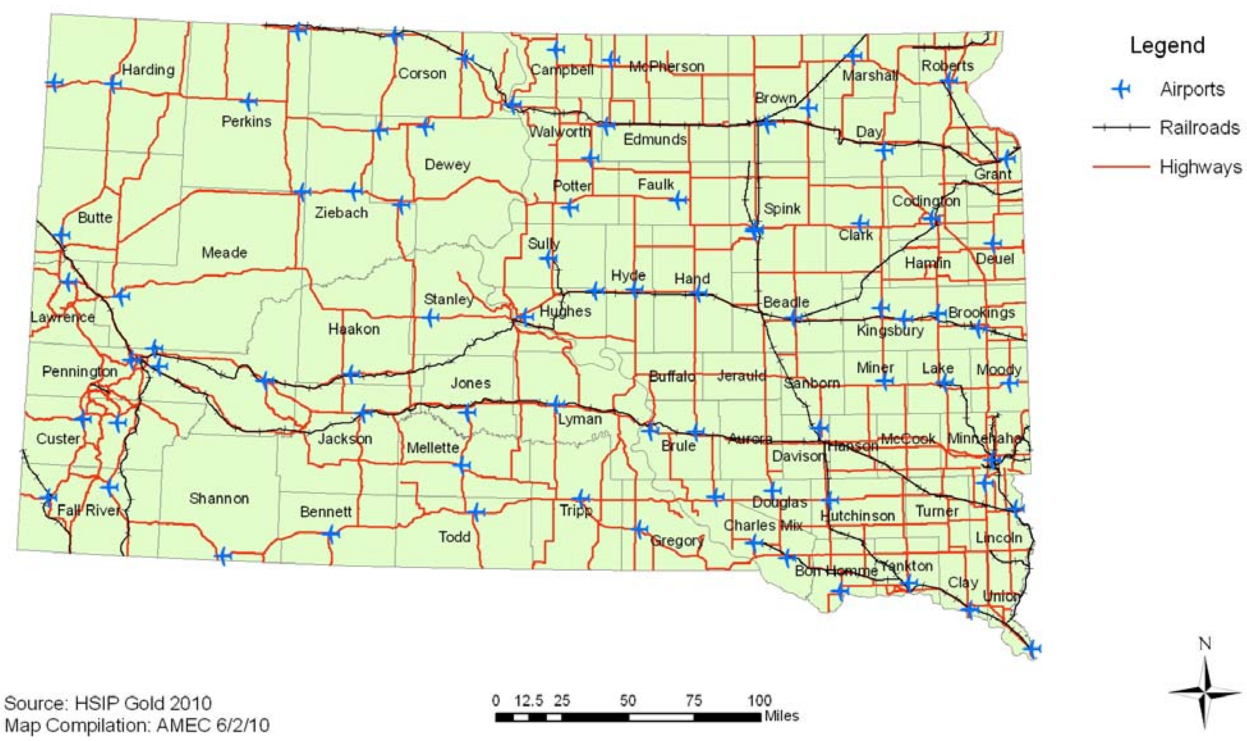


Figure 3-53 South Dakota Transportation Infrastructure



Methodology

The method used to determine vulnerability to state facilities was to overlay facilities data on digital hazard maps, where available, and identify those facilities potentially at risk. This method was used to determine vulnerability to floods and wildfire. For severe weather hazards including winter weather, tornadoes, wind, and drought it is generally accepted that these hazards could strike anywhere in the state at various levels of severity. An exposure analysis was used for these hazards. Exposure analyses are different from loss estimates in that they present facilities that may be exposed to these hazards, but do not attempt to estimate the amount of damages to be incurred during an event. Using the previous county by county risk assessments the numbers of facilities exposed to the high and very high vulnerability counties are quantified, with vulnerabilities discussed in general terms. Available data does not support a detailed vulnerability and loss estimation for impacts on critical facilities from the following identified hazards: hazardous materials, landslides and mudflows, and earthquakes.

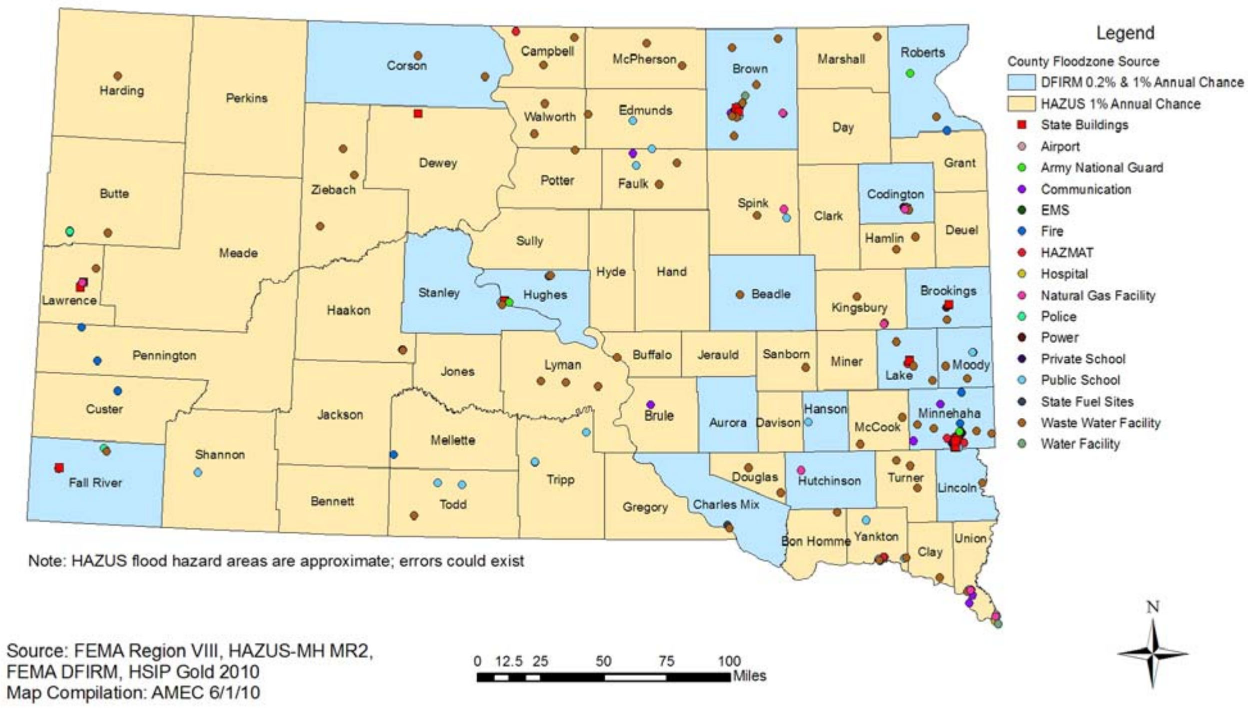
As noted previously, building valuations are not included in the state's facility data, thus an estimate of potential losses to state facilities is difficult to quantify. The state's facility data was used for location information to overlay the facilities with the hazard maps. In order to quantify the value of state facilities, the best available data remains data extracted from HAZUS-MH data sets. HAZUS-MH breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

HAZUS-MH data includes all state owned and operated facilities as part of the total numbers of buildings, square feet, dollars and other pertinent information for each county. This data includes local and private assets such as electrical utility infrastructure maintained by the Rural Electric Cooperatives. The Government category in the building stock inventory includes all facilities owned and operated by the State of South Dakota as well as Schools, Police Departments, Fire Departments and Emergency Operations Centers. Using the exposure analysis approach, the total value of buildings included in these categories total approximately $837 million. Other essential facilities in HAZUS include 841 schools representing $374 million in potential losses, 54 hospitals with 4,538 beds representing $290 million in potential losses, 157 police departments, 122 fire departments and 23 emergency operations centers representing $196 million, $65 million and $20 million in potential losses respectively. These numbers represent collectively state property at risk statewide from any disaster event. In HAZUS-MH there are utility and infrastructure data sets that are considered 'lifeline' inventory. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The total value of the lifeline inventory is over $71,721 (millions of dollars). This inventory includes over 11,896 kilometers of highways, 5,122 bridges, and 338,056 kilometers of pipes.

Floods

A GIS overlay analysis was performed to determine vulnerability of critical facilities to flooding. Both the DFIRM (100 and 500 year) and HAZUS-MH modeled base flood extents were used. Figure 3-54 illustrates critical facilities and their relationship to floodplains. Table 3H-D in Appendix 3H illustrates the numbers of facilities in the floodplain. The results of the 2010 analysis found 258 critical facilities potentially at risk to flooding, based on both HAZUS and DFIRM mapping. Notable critical facilities at risk include 20 Board of Regents facilities and 4 Army National Guard. All Board of Regents buildings are insured, and where applicable, have flood insurance. Limitations to this analysis include the number of counties with digital floodplains available, and the accuracy of the digital floodplains themselves, with the HAZUS-MH derived floodplains considered the less accurate of the two sources. This analysis does not consider if the building is elevated on fill or by other means, or flood proofed, since this detailed information is not available.

Figure 3-54 South Dakota Critical Facilities Flood Analysis



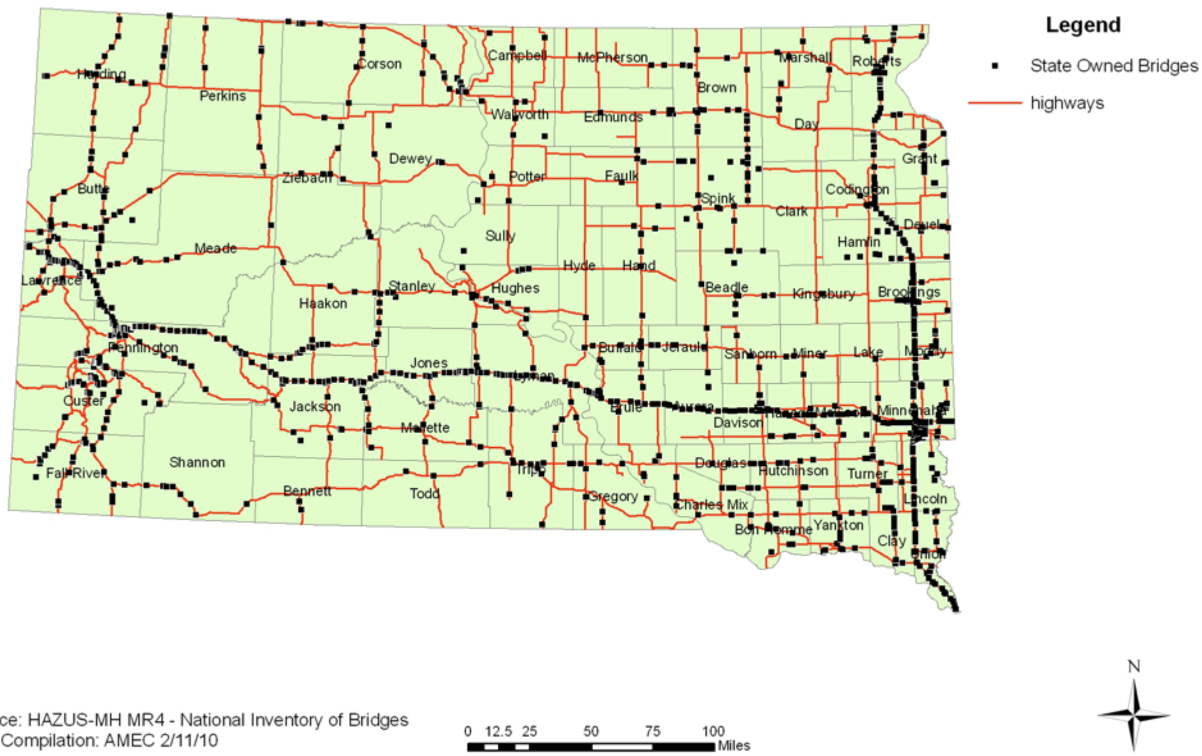
Analysis of Dams

According to information from the South Dakota Department of Natural Resources and the National Inventory of Dams, there are approximately 15 high hazard dams in South Dakota that do not have emergency action plans, only one of which is state owned: Brunning No. 1 in Mellette County. The State DNR has made a concerted effort to improve the number of dams with emergency action plans. For example Kroetch dam in Haakon County is a state-owned dam that did not have an EAP in 2007 but now does. The majority of the 15 high hazard dams that do not have plans are federally owned. The largest (based on normal storage volume) of the high hazard dams without emergency action plans are the Sheridan Lake in Pennington County owned by USDA Forest Service and the Oglala and White Clay Dams, both in Shannon County and owned by Oglala Sioux Tribe. Figure 3-6 illustrates the high and significant hazard dams in South Dakota. The State of South Dakota owns 190 of the 2,545 dams in the state. The majority of these dams are low hazard dams, 2,275.

Analysis of Scour Critical Bridges

Included with HAZUS-MH is a database of bridges called the National Bridge Inventory (NBI), which was developed by the Federal Highway Administration. One of the database items includes a "scour index" that is used to quantify the vulnerability of bridges to scour during a flood. Bridges with a scour index between 1 and 3 are considered "scour critical," or a bridge with a foundation element determined to be unstable for the observed or evaluated scour condition. A query of the database was performed that identified the scour critical bridges. None of the state-owned bridges in South Dakota met these criteria. Another query of county or municipal owned bridges returned no scour critical issues.

Figure 3-55 South Dakota State-Owned Bridges



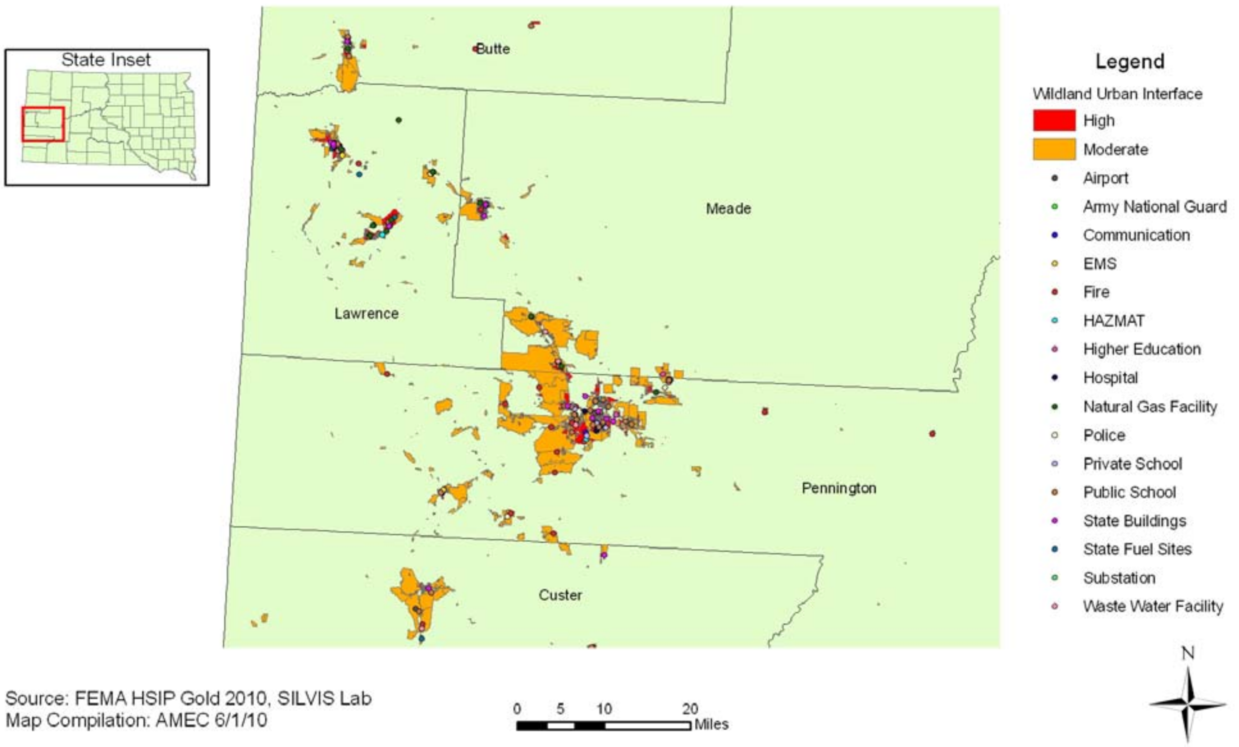
During the 2007 update stakeholder meetings it was noted that railroads are vital to the rural farming economy in South Dakota, and that floods have impacted railroad bridges, delaying rail shipments of agricultural supplies for days or weeks. The NBI bridge database does not contain railroad bridges so further analysis of vulnerability could not be determined. Also noted during the planning process were the number of repeated culvert washouts and replacements on gravel roads from multiple flood disasters. Location and loss information from the FEMA Public Assistance program should be incorporated in future updates to this plan.

According to the 2003 NBI report for South Dakota, the state has 1,048 (about 25% of highway bridges) structurally deficient bridges (56 are state-owned) and 486 functionally obsolete bridges (15 are state-owned). The NBI includes an estimate of $244M needed for bridge improvement costs in South Dakota.

Wildfire

Analysis of wildfire impacts to critical facilities was limited to the six forested counties previously discussed in the analysis of vulnerability by jurisdiction, using the wildfire risk layer. GIS was used to identify the critical facilities that lie within a high or moderate wildfire risk zone. The locations of these facilities are shown in Figure 3-56 and descriptions of the facilities are listed in Table 3H-E in Appendix 3H.

Figure 3-56 South Dakota Critical Facilities Wildfire Analysis



Tornadoes, Wind, and Winter Storms

An exposure analysis was used to identify the number of critical facilities in the counties most susceptible to tornadoes, wind, and winter storm hazards, based on the assessment of vulnerability by jurisdiction section. Eleven counties were identified to have either 'very high' or 'high' vulnerability to one or more of these hazards. The number of facilities in four state facility GIS layers (State Layer, Power, Natural Gas, and Fuel) was quantified in each of these counties. The results are displayed in Table 3-75. Due to the general nature of this exposure analysis individual facilities are not identified, but more detail can be reference in the state's GIS layers. The table also displays overlap in vulnerability to the three hazards, particularly in Minnehaha and Pennington counties. The mitigation strategies for these hazards often overlap as well, and this table indicates where multi-hazard critical facility protection opportunities may lie.

Table 3-75 State Facilities in Counties Vulnerable to Winter Storm, Wind, and Tornado Hazards

COUNTY	Winter Storm Vulnerability	Wind Vulnerability	Tornado Vulnerability	State Layer Facility Count	Power Facility Count	Natural Gas Facility Count	Fuel Facility Count
Brookings	High	Moderate	Moderate	16	1	3	2
Brown	Moderate	High	High	16	9	5	2
Butte	High	Moderate	Moderate	6	0	1	2
Lawrence	High	Moderate	Moderate	13	2	8	5
Lincoln	High	Moderate	Very High	6	2	5	3
Meade	High	High	Moderate	9	3	5	3
Minnehaha	Very High	Very High	Very High	39	6	14	2
Pennington	High	High	High	36	10	2	3
Turner	Moderate	Moderate	High	9	2	4	0
Yankton	High	Moderate	Moderate	16	2	2	3

While these counties are considered more vulnerable, tornadoes, wind and winter storms can happen anywhere in the state with considerable impacts. It is noted that Hughes County includes Pierre, the state capital, and has the highest concentration of state owned buildings, facilities and employees. While rated 'moderate' in terms of vulnerability to the three hazards it does lie within Wind Zone III (200 mph design wind speed).

Drought

Available data does not support a detailed vulnerability and loss estimation for drought impacts on critical facilities. Power plants that generate hydroelectric power from dams on the Missouri River can be impacted by drought-reduced reservoir levels. In terms of assets, state parks in South Dakota are likely to suffer the greatest impacts from drought, particularly those that provide water-based recreational activities. Direct losses to the state can include lost revenue from park access fees.

Hazardous Materials

Resources and data did not support a detailed vulnerability and loss estimation for hazardous material impacts on state facilities during the 2007 and 2010 updates to this plan.

Geologic Hazards

Resources and data did not support a detailed vulnerability and loss estimation for landslides, mudflow, expansive soil, and subsidence impacts on state facilities during the 2007 and 2010 updates to this plan. History has proven that earthquakes have not caused significant damage in the State of South Dakota. A 2,500 year probabilistic earthquake scenario was run in HAZUS-MH. The results showed no damage to critical facilities. The detailed results of this scenario are included as Appendix 3G. This data is not conclusive to develop a detailed vulnerability and loss estimation for earthquake impacts on state facilities.

Future Vulnerability of State Facilities

At the time this plan was prepared limited information regarding development of new state facilities was available. Significant population increases and decreases are outlined per county in Section 3.3.1 Growth and Development. These trends should be considered as existing facilities are maintained, improved, and or enhanced. The hazard areas identified in this plan are being considered when new state facilities are constructed. For example, a new prison in Rapid City was originally planned to be built within a floodplain. SDOEM has coordinated a new site for the prison outside of the floodplain.

The South Dakota Department of Transportation (DOT) is in the process of building a new bridge in Yankton which has been experiencing an increase in population. Yankton County has a high vulnerability to winter storms, a moderate vulnerability to tornados, and a moderate vulnerability to wind.

An oil refinery is planned for development in Union County between state highways 48 and 50. This refinery may increase economic development in the county leading to an increase in population and therefore an overall increase in vulnerability to natural hazards. The oil refinery may also cause vulnerability to man-made hazards generated by mishaps at the refinery. Operation of this facility is not projected to begin until 2014.

The former Homestake gold mine in Lead has been chosen by the National Science Foundation as a site for a multipurpose deep underground science and engineering laboratory. The underground laboratory and proposed Sanford Science Education Center will provide education and outreach opportunities.

3.5 Risk Assessment Summary and Conclusions

Although the majority of the state is vulnerable to all the hazards identified and discussed in this section, concerns vary widely between areas of the state and times of the year events might occur. The hazards as identified in Table 3-2 have impacted or have the potential to impact the citizens and governments of the state to one degree or another at any given time. However, based upon the research and analyses conducted for writing this plan, it is evident that floods, winter storms, wildfires, and tornadoes continue to require the most effort and expense in terms of response and recovery activities and their associated costs. During the 2007 update, drought and severe wind were added as significant hazards that affect the state, though losses from drought are difficult to quantify due to data limitations. During the 2010 update a more comprehensive picture of flood vulnerability resulted from the inclusion of statewide HAZUS flood analyses. Additionally the risk to agricultural pests and diseases is considered as an additional hazard. As this plan matures, the risk assessment will continue to improve and drive the state's mitigation planning measures, projects, and strategies for future loss reduction.

SECTION 4 MITIGATION STRATEGIES

The goals and objectives from the 2007 Plan were reviewed and updated at the June 3, 2010 SHMT meeting. The mitigation actions that were developed during the 2007 plan were also reviewed and the progress for each of the actions was updated. The goals are intended to remain applicable to all identified hazards. The objectives and actions are specific to the identified hazards and may change as they are completed over the future years. This section includes an assessment of the State's capabilities to staff programs or projects and fund actions to achieve the goals of the plan. Potential funding sources are identified where it was possible to do so. The State's priority is to support local mitigation efforts. In order to prioritize these needs, an assessment of local capabilities is included in this section.

4.1 HAZARD MITIGATION GOALS AND OBJECTIVES

44 CFR Part 201 Requirement:

[The State mitigation strategy shall include a] description of State goals to guide the selection of activities to mitigate and reduce potential losses.

[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts and changes in priorities…

During the second milestone meeting of the State Hazard Mitigation Team in June 2010, the group reviewed the preliminary results of the local and state vulnerability assessments and validated the following five goals. These remain relevant and have been modified slightly to emphasize their regard to natural hazards as opposed to man-caused hazards. These are purposefully applicable to all of the identified hazards and intended to encompass all mitigation needs identified by the local communities.

The State Hazard Mitigation Team recognizes that the natural hazards of floods, winter storms, wildfires, and tornados have produced the most documented damages in the history of South Dakota. However, they felt the goals should equally address all of the identified hazards regardless of available data for projecting loss estimations.

These goals were developed to assist the State in maintaining its priority to support local mitigation efforts.

Goals:

- Reduce injuries and loss of life from natural hazards
- Reduce damage to existing and future structures within hazard areas
- Reduce the losses to critical facilities, utilities, and infrastructure from natural hazards
- Reduce impacts to the economy, the environment, and cultural resources from hazards
- Support and assist local / tribal mitigation capabilities and efforts

The SHMT (on June 3, 2010) reviewed and revised the corresponding objectives as shown below in Table 4-1.

Table 4-1: Goals and Objectives

Goal 1	**Reduce injuries and loss of life from hazards**
Objective 1.1	***Reduce the number of injuries/fatalities by severe weather related hazards ~~high winds/tornados~~***

Goal 2	**Reduce damage to existing and future structures within hazard areas**
Objective 2.1	***Reduce the number of repetitive and non-repetitive loss structures***
Objective 2.2	***Reduce the number of structures lost by wildfires***
Objective 2.3	***Reduce the number of structures within the Special Flood Hazard Area ~~floodway~~***
Objective 2.4	***Reduce the number of structures/infrastructure at risk to geologic hazards*** ***~~Reduce the number of structures within the floodplain at risk of flooding~~***

Goal 3	**Reduce the losses to critical facilities, utilities, and infrastructure from hazards**
Objective 3.1	***~~Reduce losses that will cause facility damage/loss~~*** ***Reduce the number of power outages***
Objective 3.2	***Reduce negative impacts to water supply and sewage treatment systems*** ***~~Reduce the number of power outages due to winter/ice storms~~***
Objective 3.3	***Improve reliability of communications during/following hazard events***

Goal 4	**Reduce impacts to the economy, the environment, and cultural resources from hazards**
Objective 4.1	***Reduce loss to environment and cultural resources***
Objective 4.2	***Reduce agricultural losses***

Goal 5	**Support and assist local / tribal mitigation capabilities and efforts**
Objective 5.1	***Encourage locals to participate in reducing impacts of incidents***

4.2 STATE CAPABILITY ASSESSMENT

44 CFR Part 201 Requirement:
[The State mitigation strategy shall include a] discussion of the State's pre- and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area, including: • *An evaluation of State laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas [and]* • *A discussion of State funding capabilities for hazard mitigation projects…*

The State of South Dakota is successful in administering federal mitigation programs. The Hazard Mitigation Grant Program and Pre-Disaster Mitigation grant program administered in collaboration with FEMA currently serve the needs of the State for implementing hazard mitigation projects. The State of South Dakota recognizes there is limited funding available for hazard mitigation projects. SDOEM and the State Hazard Mitigation Team administer funds for local projects requiring the local communities to provide the 25% match required for receipt of federal funds. The Hazard Mitigation Grant Program Administrative Plan last updated November 16, 2010 documents the process for the State's administration of hazard mitigation funding. There have been no significant changes to the State's capabilities for implementing mitigation since the 2007 plan. The following descriptions of programmatic capabilities have been updated as appropriate in 2010.

Hazard Mitigation Grant Program

The State Hazard Mitigation Officer (SHMO) holds applicant briefings throughout the state following each declared disaster. The meetings are an opportunity for subapplicants to discuss potential projects and applications with the State for consideration under the Hazard Mitigation Grant Program. Projects funded through this program are monitored by the SHMO. Each subapplicant is required to submit quarterly reports to the SHMO detailing the progress of the project and the total amount of funds extended to date.

Pre-Disaster Mitigation grant program

As a requirement of the Pre-Disaster Mitigation (PDM) grant program local emergency managers throughout the State have agreed to review the local hazard mitigation plans annually and submit applications for funding as applicable. Similar to the Hazard Mitigation Grant Program, projects funded through PDM are monitored quarterly through an online FEMA-sponsored database and SMARTLINK application.

State Flood Map Modernization / National Flood Insurance Program

The State regulates floodplains through the National Flood Insurance Program. South Dakota Office of Emergency Management is a cooperating technical partner. The State National Flood Insurance Program Coordinator administers, promotes, and provides training for the National Flood Insurance Program, Community Assistance Program, Community Rating System, Map Modernization Program, and the Cooperating Technical Partnership Program. The State meets with county and city commissioners to maintain awareness create a desire to learn more about the programs, and to assist in resolving issues relating to program compliance and management. Pamphlets and/or manuals are distributed outlining the NFIP. A Floodplain Administrators Directory and information bulletin are prepared and distributed biannually to local floodplain administrators and FEMA. The NFIP Coordinator conducts approximately 20 Community Assistance Visits each year. The State, along with FEMA, hosts an annual workshop on floodplain management issues.

SDOEM and FEMA currently have 4 Digital Flood Insurance Rate Map (DFIRM) projects in development (Lawrence, Mead, Cook, and Union Counties). Figure 3-35 (created in June of 2010) in Section 3 portrays South Dakota Digital Flood Insurance Rate Map coverage. Roberts, Brown, Codington, Brookings, Moody, Lake, Minnehaha, Lincoln, Charles Mix, Hutchinson, Hanson, Aurora, Beadle, Hughes, Stanley, Corson, and Fall River Counties all have effective DFIRMs.

According to The National Flood Insurance Program Community Status Book at www.fema.gov/fema/csb.shtm, there were a total of 214 communities throughout the State of South Dakota participating in the National Flood Program as of November, 2010. This is 9 more communities than were participating at the time of the last plan update (2007). The list of participating communities is included as Appendix 4A.

The State NFIP Coordinator provides information at commission meetings to communities that currently do not participate in the NFIP Program.

The state has a recommended flood ordinance but it is not official. The process for the state to adopt floodplain legislation is extensive and may not happen for several years.

Flood Mitigation Assistance (FMA)
Eligible communities are contacted and informed of the availability of FMA funding, and related technical assistance. The State NFIP Coordinator assists these communities with development of individualized mitigation plans and ensures that communities submit viable, complete FMA applications. These applications are forwarded to FEMA for review. FEMA approved projects are monitored to ensure completion in accordance with project scope and grant agreements. Award letters and funds are distributed by the State to approved communities on a reimbursement basis.

FMA Success Story: FEMA approved the Augustana College diversion channel project in 2005. After the project completion in August 2007 a rain event occurred and the buildings were not flooded.

Severe Repetitive Loss Properties
Fortunately for South Dakota, there is only one property that meets the definition of a "severe repetitive loss" property: a campground in Codington County. Losses to this property, which has multiple structures, between March 1986 and April 2001 equaled $337,374. The property contains several structures. These structures are cabins, a store, and a storage building. The owner has stated that they are not interested in mitigation. They will continue to purchase flood insurance.

SDOEM sends out notifications about flood mitigation funding to the all participating NFIP communities and all the County Emergency Managers.

South Dakota Dam Safety Program
The South Dakota Dam Safety program is implemented through the South Dakota Department of Environmental and Natural Resources (SDDENR), Water Rights Program. Details on the status of the dams in South Dakota (high hazard, significant hazard, low hazard) are included in Section 3.

Community Wildfire Protection Plans

The enactment of the Healthy Forests Restoration Act (HFRA) in 2003 provided incentive to communities to develop Community Wildfire Protection Plans. These plans are used by the US Forest Service (USFS) and the Bureau of Land Management (BLM) to give consideration and priorities to local communities with regard to their forest management and hazardous fuel reduction projects. Community Wildfire Protection Plans (CWPP) typically address issues such as wildfire response, hazard mitigation, community preparedness, and/or structure protection. Currently Pennington, Custer, Meade, Lawrence, Butte, Perkins, Fall River, and Stanley Counties have effective CWPPs. (Source: http://sdda.sd.gov/Forestry/Educational-Information/PDF/Draft-SD-Statewide-Assessment-of-Forest-Resources.pdf.)

Building Codes and Regulations

The State does not regulate local building. This is regulated by the local jurisdictions through building permits. The State of South Dakota has approved the International Building Code and the International Fire Code for local adoption. Several jurisdictions have adopted International Codes since the year 2000. The International Code Council tracks code adoption for the State, as well as jurisdictions in South Dakota: http://www.iccsafe.org/gr/Pages/adoptions.aspx. As of November 2010, the following jurisdictions have adopted the International Building Code and the International Residential Code among other International Codes: Aberdeen, Belle Fourche, For Pierre, Hot Springs, Hughes County, Huron, Lead, Meade County, Mitchell, Pierre, Rapid City, Sioux, Sioux Falls, Spearfish, Whitewood, and Winner.

County Planning and Zoning

Within South Dakota's Codified Laws, Statute Title 11 Chapter 2 allows counties to develop comprehensive plans and adopt zoning ordinances. The purpose of a comprehensive plan is for "protecting and guiding the physical, social, economic, and environmental development of the county". Similarly, the purpose of a zoning ordinance is "promoting health, safety, or the general welfare of the county". While these are not required, through this statute the State has empowered local governments to implement regulations consistent with hazard mitigation priorities. The statute may be viewed in detail at http://legis.state.sd.us/statutes/DisplayStatute.aspx?Type=Statute&Statute=11-2.

Additional State Programs

In addition to HMGP, PDM, and NFIP, there are no additional state programs, policies, legislation/laws that directly support mitigation. There is currently no legislation regulating development practices in hazard prone areas. SDOEM continues to improve the integration of mitigation practices throughout the state by working with the Rural Electric Cooperatives, other utilities, and additional state agencies on how their goals coincide with the goals of this plan. Examples for consideration include development of a Statewide Floodplain Management Plan, development of transportation policies in hazard prone areas, and other related policy development. In the meantime, the funding mechanisms and project tracking procedures documented in the HMGP Administrative Plan will be followed for all mitigation related projects overseen by SDOEM. Contact information for relevant federal programs has been carried from the prior hazard mitigation plan into this update as Appendix 4B.

State Agency Capabilities

No changes to state policies were made since the previous plan was developed (in 2007). The additional members on the SHMT (added by executive order in 2007) have been beneficial to the development of this plan.

In 2007, the member agencies of the State Hazard Mitigation Team were asked to complete a State Capability Assessment Questionnaire. Most of the questions were directly applicable to the Office of Emergency Management. The Department of Agriculture and Department of Environment and Natural Resources completed the Staff/Personnel Resources section of the survey. This section summarizes the responses to the questionnaire and statewide capabilities identified through additional resources. Complete responses to the State Capability Assessment Questionnaire may be found in Appendix E.

Table 4-2 summarizes the capabilities identified by the Office of Emergency Management.

Table 4-2: Summary of Capabilities Identified by SDOEM

SHMT meets to decide on projects to fund after each disaster.
The Governor's Executive Order defines the roles of the participants on the State Hazard Mitigation Team.
The SHMT is involved in project prioritization for locally submitted projects.
As of this plan update, the SHMT actively participates in the implementation of the State Mitigation Plan.
The State Historic Preservation Office is on the SHMT and conducts the NEPA reviews for mitigation projects.
The State Historic Preservation Officer reviews state and local project submittals for FEMA grant funding.
Members of SDOEM are capable of performing FEMA Benefit Cost Analyses. Trainings are offered periodically for locals.
The state has been able to effectively utilize all past federal mitigation funding.
The past disasters have been closed in a timely manner and the State continues to improve its timeliness.
The State does NOT have provisions in place for matching federal funds or assisting locals with matching funds for mitigation grants.
There is a state level disaster contingency fund.
The State is fully versed in E-Grant procedures and manages grants electronically.
The biggest obstacle to effectively managing a comprehensive state mitigation program is that funding for projects is granted to the State a year after the disaster has occurred. This makes it difficult to keep applicants enthused about applying for the funds when they find out about the length of time of the process.

Staff / Personnel Resources (2007)
The Department of Agriculture benefits from approximately 5 staff members with GIS skills and 1 grant manager/writer.

The Department of Environment and Natural Resources benefits from approximately:

- 15 planners or engineers with knowledge of land management practices,
- 15 engineers or professionals trained in construction practices related to buildings and/or infrastructure,
- 25 planners or engineers with an understanding of natural and/or manmade hazards,
- 10 floodplain managers,
- 50 personnel skilled in GIS,
- 2 emergency managers, and
- 5 grant managers/writers

4.3 LOCAL CAPABILITY ASSESSMENT

44 CFR Part 201 Requirement:
[The State mitigation strategy shall include] a general description and analysis of the effectiveness of local mitigation policies, programs, and capabilities.

The State reviewed all of the FEMA – approved local mitigation plans at the time of this plan update (2010). The FEMA – approved local mitigation plans at that time covered 64 counties throughout the state, including the Rosebud Sioux Tribe in Todd County. Table 4-3 presents a summary of the common policies and programs identified in the local mitigation plans.

Table 4-3: Summary of Local Capabilities

Policy/Program	# of counties
Regular training for Emergency Responders	43
Fire bans and public water restrictions during dry periods	38
Outdoor / Indoor Warning System / Proactive Weather Program	37
NFIP / Strict development regulation in flood hazard zones	36
Regular dam and culvert inspections and maintenance	27
Local Emergency Operations Plans	25
Public Awareness Campaigns / CERT / Citizen Corp	25
Building Code	24
Increased security, communication, and educational outreach to prevent terrorism	23
Catalogue and track Hazardous Materials	23

A complete inventory of the capabilities identified in the local plans is included in Appendix 4C. SDOEM recognizes that many of the listed capabilities are more effective for disaster response than hazard mitigation. The State Hazard Mitigation Officer will continue to educate the local communities on the difference between hazard mitigation and disaster response as the local mitigation plans are updated. In 2007, SDOEM reviewed the listed local capabilities and assessed how effective each community is at implementing the programs. A general effectiveness rating between 1 and 3 for each county was determined as described below. These are included in Appendix 4C.

1. Low Effectiveness: The county demonstrates limited participation or progress and no mitigation projects.

2. Moderate Effectiveness: The county demonstrates moderate participation and progress and has mitigation project applications pending approval.

3. Highly Effective: The county is currently conducting on-going mitigation projects and looking for further ways to improve communities.

The following counties were considered Highly Effective in implementing hazard mitigation programs: Beadle, Yankton, Brookings, Brown, Butte, Codington, Davison, Douglas, Fall River, Hanson, Hutchinson, Kingsbury, Shannon, Spink, and Sully.

For the 2010 plan update, the SHMT rated the effectiveness of the local mitigation capabilities. The results of this survey can be found in Table 2-8 in Section 2.

The State Hazard Mitigation Officer is working with every county to ensure development of a FEMA approved mitigation plan for each county in the state. SDOEM also coordinates funding for eligible projects and has overseen several power line burial and detention pond projects as listed in Section 2.3. SDOEM intends to build stronger relationships with the South Dakota Department of Agriculture and especially the Resource Conservation and Forestry division. Coordination between the departments will enhance the effectiveness of mitigation practices currently being implemented (i.e. CWPPs). Monitoring the existence and maintenance of CWPPs will make this State Hazard Mitigation Plan more complete.

4.4 MITIGATION ACTIONS

44 CFR Part 201 Requirement:
[The State plan shall include an] identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering and an explanation of how each activity contributes to the overall mitigation strategy. This section should be linked to local plans, where specific local actions and projects are identified. *[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts and changes in priorities….*

The SHMT has confirmed that the actions identified in 2007 are still valid for the 2010 update. All of these mitigation actions are ongoing. Therefore, none of the mitigation actions from the 2007 plan have been deleted. The mitigation actions that were formed for the 2007 plan have been updated to include a 2010 Status Report, which indicates the progress of each mitigation action, and to address the hazards identified in this plan that have changed since the 2007 plan. The newly identified hazards include geologic hazards (instead of earthquakes, landslides and mudflows) and agricultural pests and diseases.

Each action is organized into 8 components:

1. The problem statement,
2. A description of the proposed action including an action number comprised of the main plan objective the action addresses,
3. A level of priority compared to other actions listed here, (see discussion below)
4. The hazards the action will address,
5. The goals the action will address,
6. Potential funding sources,
7. The department responsible for implementing the action, and
8. A target completion date.

The State Hazard Mitigation Team has identified these actions with the understanding that approval of this plan does not obligate the State to complete each project before the required update in 2014. The State Hazard Mitigation Team understands that the 2014 plan update must demonstrate progress in statewide mitigation efforts. This progress may be in the form of the actions listed below or additional actions that assist in reaching the goals and objectives outlined in this plan.

The mitigation actions are listed below in the order of the goals and objectives they respond to. The Action # in the mitigation action description is directly correlated to the objectives (repeated here for convenience). Appendix 4D contains a summary Mitigation Action Matrix, a tool which will allow the SHMT and SHMO to refer to the mitigation action priorities identified in this plan when reviewing project applications. The SHMO currently maintains a spreadsheet of project applications per declared disaster. As projects are funded, the SHMO will incorporate the Mitigation Action # in the disaster spreadsheet. This will allow the SHMO and SHMT to evaluate progress by tallying the number of funded projects associated with each Mitigation Action #.

Mitigation Action Prioritization

During the 2010 update, the SHMT elected to maintain the same priority levels identified in 2007. The overall priority of the SHMT for the 2010 – 2013 period is to increase the diversity of funded mitigation projects. The SHMT prioritizes projects that mitigate risk to flood and winter storm events as those are the most common occurrences in South Dakota and the causes for most declared disasters within the state. Historically, power line burials were the most funded type of mitigation project. Through ongoing outreach by the SHMO, the SHMT intends to fund projects such as drainage improvement, detention ponds, shelters, buyouts, relocations, elevations, and fire mitigation in addition to power line burials. During the next update (2013), the SHMT will review how many different types of projects were funded and evaluate the success of those projects. Based on that evaluation, the mitigation actions will be re-prioritized as necessary to serve as future guidance for determining project funding.

Based on the STAPLE E criteria (included in Section 5.1- Local Funding and Technical Assistance), the State Hazard Mitigation Team rated each action with a level of priority (High, Medium, Low) as described below. These ratings have not changed since the 2007 plan.

- Δ **High** priority actions strongly support reduction of high risk hazards, achieve hazard mitigation goals as outlined in this plan, and eliminate or greatly lessen the impact of future incidents.
- Δ **Medium** priority actions are educational, outreach, maintenance actions. They are small mitigation projects that would minimize severity but not mitigation hazards completely.
- Δ **Low** priority actions are generally the responsibility of the local community. The State supports these projects, but is often unable to provide financial assistance.

South Dakota State Hazard Mitigation Plan 2010 Goals/Objectives	
Goal 1	**Reduce injuries and loss of life from hazards**
Objective 1.1	Reduce the number of injuries/fatalities by severe weather related hazards
Goal 2	**Reduce damage to existing and future structures within hazard areas**
Objective 2.1	Reduce the number of repetitive and non-repetitive loss structures
Objective 2.2	Reduce the number of structures lost by wildfires
Objective 2.3	Reduce the number of structures within the Special Flood Hazard Area
Objective 2.4	Reduce the number of structures/infrastructure at risk to geologic hazards
Goal 3	**Reduce the losses to critical facilities, utilities, and infrastructure from hazards**
Objective 3.1	Reduce the number of power outages
Objective 3.2	Reduce negative impacts to water supply and sewage treatment systems
Objective 3.3	Improve reliability of communications during/following hazard events
Goal 4	**Reduce impacts to the economy, the environment, and cultural resources from hazards**
Objective 4.1	Reduce loss to environment and cultural resources
Objective 4.2	Reduce agricultural losses
Goal 5	**Support and assist local/tribal mitigation capabilities and efforts**
Objective 5.1	Encourage locals to participate in reducing impacts of incidents

Mitigation Action 1.1A	
Problem Statement	There are an insufficient number of existing shelters in hazardous areas.
Description	**Hardened Shelters** – Support the construction of additional hardened shelters throughout the State through local project applications.
Priority	☐ High ☐ Medium ☒ Low
Hazard	☐ Flood ☐ Winter Storm ☐ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☐ Hazardous Materials ☐ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP, CDBG, and local funding, private funding
Responsible Department	DPS, GF&P, local gov't., and private citizens
Target Completion Date	Next Plan Update – 2011 and ongoing
2010- Status Report	Submitted one project for funding under FFY PDM 2010. Awaiting the status of funding.

Mitigation Action 1.1B	
Problem Statement	Many communities throughout the state have inadequate existing warning systems.
Description	**Warning Sirens** – Support the installation of warning sirens through local project applications.
Priority	☐ High ☒ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP; CDBG, EMPG, local funding, and SHSGP
Responsible Department	DPS, OEM, local gov't., and private businesses
Target Completion Date	Next Plan Update – 2011 and ongoing
2010- Status Report	Completed numerous outdoor warning projects through EMPG and SHSGP funds.

Mitigation Action 1.1C	
Problem Statement	Many communities throughout the state have inadequate existing warning systems.
Description	**Weather Radios** – Support the installation of weather radios through local project applications.
Priority	☐ High ☐ Medium ☒ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☐ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP, EMPG, local funding and private funding
Responsible Department	DPS, local gov't., and private citizens
Target Completion Date	Next Plan Update – 2011 and ongoing
2010- Status Report	No Update. Weather Service and TV Stations promote purchase of weather radios.

Mitigation Action 1.1D	
Problem Statement	Many communities do not mandate or enforce zoning requirements. As a result, tie downs for mobile homes are commonly installed improperly.
Description	**Install tie downs on mobile homes** – Support the proper installation of tie downs on mobile homes through local project applications.
Priority	☐ High ☐ Medium ☒ Low
Hazard	☒ Flood ☐ Winter Storm ☐ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☐ Hazardous Materials ☐ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	CDBG, HMGP, FMA, FHA, private citizens
Responsible Department	HUD, DPS, GOED, and private citizens
Target Completion Date	Next Plan Update – 2011 and ongoing
2010-Status Report	No update. South Dakota Housing Authority requires all mobile homes to be inspected for tie-downs. Implemented in 2009. (Insurance companies offer discounts for tied-down homes, but it is not a requirement.) Tie-downs discussed in NFIP outreach material.

Mitigation Action 1.1E	
Problem Statement	No requirements or zoning exists for safe rooms.
Description	**Private safe room installations** – Support and encourage installation of safe rooms in private homes through public outreach efforts.
Priority	☐ High ☐ Medium ☒ Low
Hazard	☒ Flood ☐ Winter Storm ☐ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☐ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	CDBG, HMGP, PDM, FMA, private citizens and local gov't. funding
Responsible Department	DPS, HUD, local gov't. and private citizens
Target Completion Date	Next Plan Update – 2011 and ongoing
2010-Status Report	Outreach at State Fair regarding preparedness. B Ready Campaign by SDOEM, Department of Health, Cooperative Extension

Mitigation Action 1.1F	
Problem Statement	The public may not understand where their community storm shelters are located. They may not understand what the warning systems siren sounds indicate and where to go for shelters. Many communities are tourist areas. The tourists/visitors need to be aware of what the different sirens mean and where to go for shelter, etc.
Description	**Public education on shelters and warning systems** – Coordinate public outreach/education regarding shelter locations and warning systems. Develop brochures, websites, news briefs, and other media to notify the public of shelter locations and what sounds to expect from the warning systems.
Priority	☐ High ☒ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	EMPG, PDM, HMGP, local gov't., and private businesses
Responsible Department	DPS
Target Completion Date	ongoing
2010-Status Report	Severe weather preparedness week funded through EMPG. This is a package of information that goes to schools, EM's, daycare, assisted living centers and nursing homes. Also, State Fair outreach at SDOEM booth. Safe room information also disseminated from hazard mitigation office to EM's and FPA's.

Mitigation Action 1.1G	
Problem Statement	A statewide floodplain regulation does not exist.
Description	Coordinate with South Dakota Building Code Association to integrate floodplain management ordinances into local building codes.
Priority	☐ High ☐ Medium ☒ Low
Hazard	☒ Flood ☐ Winter Storm ☐ Wildfire ☐ Drought ☐ Tornadoes ☐ Wind ☐ Hazardous Materials ☐ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	No funding needed.
Responsible Department	DPS, DENR
Target Completion Date	2011 and ongoing
2010-Status Update	This action has been revised to emphasize coordination with the Building Code Association in lieu of developing a statewide floodplain ordinance, which is politically infeasible at this time. Considered to be a local responsibility for zoning in communities.

Mitigation Action 1.1H	
Problem Statement	Electrical safety is a concern after many disasters due to fallen power lines.
Description	**Electrical safety outreach program**– Support and encourage public education/outreach efforts on electric safety.
Priority	☐ High ☒ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	State Electric Commission, Rural Electric Ass'n., Rural Electric Cooperatives, Private electric companies, local funding
Responsible Department	PUC along with electric companies, and local communities
Target Completion Date	ongoing
2010-Status Report	Work with One Call, PUC. Individual COOPs have literature and outreach materials. Participate in State Fair. Conduct school safety sessions. Safety classes through Extension.

Mitigation Action 2.1A	
Problem Statement	Built structures exist in hazard prone areas.
Description	**Acquisition projects** – Support the purchase and relocation of structures within floodplains and other hazard prone areas through local project applications.
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☐ Winter Storm ☐ Wildfire ☐ Drought ☐ Tornadoes ☐ Wind ☐ Hazardous Materials ☐ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP, PDM, FMA, local funding, USCOE funding
Responsible Department	DPS and local communities, USCOE, DOT
Target Completion Date	ongoing
2010-Status Report	Visited with communities in flood prone areas on submitting an FMA application for buyouts. Currently preparing FMA applications.

Mitigation Action 2.1B	
Problem Statement	Built structures exist in flood prone areas.
Description	**Flood control projects** – Support and encourage flood control projects through local project applications.
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☐ Winter Storm ☐ Wildfire ☐ Drought ☐ Tornadoes ☐ Wind ☐ Hazardous Materials ☐ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP, PDM, FMA, DENR funding, and local funding, USCOE funding
Responsible Department	***DENR, DPS, and local communities, USCOE***
Target Completion Date	ongoing
2010-Status Report	HMGP funded a channel restoration project in Fall River County. As that project was completed, the county has chosen to use local funds to restore the channel farther than the HMGP funds paid for. This greatly reduced the chances of flooding within the City of Hot Springs now that the water will flow properly in the channel. Also funded was a project to remove an existing flood prone building on the campus of Augustana College in Minnehaha County, City of Sioux Falls. This building is not gone and the area has been turned in to parking area. FMA funds were used for this project. City of Sioux Falls, flood control project extension (bridge & dike raise).

Mitigation Action 2.1B	
	Since 1980 DENR has had 37 applications for flood control permits, issued 32 permits, denied 1 permit application and deferred 2 permit applications pending additional information (which has never been submitted). Of the 32 permits issued, 2 have since been cancelled due to non-construction of the projects. Drainage improvement projects: City Mobridge, Summerset, south of Mitchell, Aberdeen Rapid City funded a study of paleo flood events.

Mitigation Action 2.1C	
Problem Statement	Built structures exist in flood prone areas.
Description	**Elevation projects** – Support and encourage elevation of structures in flood prone areas through local project applications.
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☐ Winter Storm ☐ Wildfire ☐ Drought ☐ Tornadoes ☐ Wind ☐ Hazardous Materials ☐ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP, PDM, FMA, DENR funding, local funding, USCOE funding, CDBG
Responsible Department	DENR, DPS, local communities, USCOE
Target Completion Date	ongoing
2010-Status Report	Home elevations are occurring at the local level. Some funded by the local jurisdiction. State released $5 million to do roadwork. Road elevation was completed in City of Waubay by USACE. CDBG funding may be used as 25% match if City decides to do city-wide scale elevation projects.

Mitigation Action 2.1D	
Problem Statement	Not all structures susceptible to high risk hazards throughout the state are identified.
Description	**Identify structures that are susceptible to different hazards (i.e. flooding, tornadoes)** – Coordinate with all state departments and agencies through surveys and other mechanisms to identify structures in hazard areas and their replacement values.
Priority	☐ High ☐ Medium ☒ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	Map Modernization funds
Responsible Department	SHMT members along with their agencies and local communities, FEMA
Target Completion Date	ongoing
2010-Status Report	Have run HAZUS on all counties within the state and have identified State buildings with in flood areas. Working with the Bureau of Administration to obtain $$ amount of building replacement. All agencies through TAG gathered data in preparation for flooding to update critical facilities information.

Mitigation Action 2.2A	
Problem Statement	Wildfires cause losses to communities, private citizens, and the forest.
Description	**Fire breaks** – Support and encourage the installation of fire breaks through local project applications.
Priority	☒ High ☐ Medium ☐ Low
Hazard	☐ Flood ☐ Winter Storm ☒ Wildfire ☒ Drought ☐ Tornadoes ☐ Wind ☐ Hazardous Materials ☐ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	DOA funding, HMGP, PDM, USFS funds, GF&P funds
Responsible Department	***DPS, DOA, USFS, GF&P***
Target Completion Date	ongoing
2010-Status Report	No local projects submitted; however, the SD DOA works with local landowners to make a safe zone around their property. Also, they clean up wooded areas to act as fire breaks.

Mitigation Action 2.2B	
Problem Statement	Communities are at risk of being threatened by wildfire outbreaks.
Description	**Fire resistant communities** – Support and encourage communities to participate in Firewise and other programs to minimize risk to wildfire.
Priority	☐ High ☒ Medium ☐ Low
Hazard	☐ Flood ☐ Winter Storm ☒ Wildfire ☒ Drought ☐ Tornadoes ☐ Wind ☐ Hazardous Materials ☐ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	DOA funding, USFS funding
Responsible Department	DOA, USFS
Target Completion Date	ongoing
2010-Status Report	This activity is ongoing with local residents by the SD DOA.

Mitigation Action 2.2C	
Problem Statement	Structures are threatened by wildfires because the forest is next to the structures at risk.
Description	**Create a defensible space between structures** – Support and encourage local policies to require a defensible space between structures and surrounding structures adjacent to forested areas.
Priority	☐ High ☒ Medium ☐ Low
Hazard	☐ Flood ☐ Winter Storm ☒ Wildfire ☒ Drought ☐ Tornadoes ☐ Wind ☐ Hazardous Materials ☐ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	DOA funding, private citizens
Responsible Department	DOA, USFS, GF&P, private citizens
Target Completion Date	ongoing
2010-Status Report	Activity is ongoing by the SD DOA.

Mitigation Action 2.3A	
Problem Statement	Local planning and zoning are not strict enough or are non-existent in communities.
Description	**Encourage stricter zoning requirements** – Support and encourage development of zoning ordinances in local communities.
Priority	☐ High ☒ Medium ☐ Low
Hazard	☒ Flood ☐ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	No funding needed.
Responsible Department	SHMT members along with their agencies and local communities
Target Completion Date	ongoing
2010-Status Report	The NFIP coordinator has worked with numerous counties/cities to ensure they are doing proper zoning for new construction.

Mitigation Action 2.4A	
Problem Statement	Many communities have adopted the International Building Codes (IBC) but have existing structures built prior to the enforcement of these standards.
Description	**Retrofit existing facilities to comply with IBC for all hazards** – Support retrofitting of existing facilities to comply with IBC through local project applications.
Priority	☐ High ☒ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☒ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP, CDGB, local funding, PDM, FMA
Responsible Department	DPS, local communities, GOED
Target Completion Date	ongoing
2010-Status Report	No update. A few communities have retrofitted buildings using funding outside of HMA. VFWs are exploring opportunities to retrofit facilities.

Mitigation Action 3.0	
Problem Statement	The State BOA does not have a database of all State owned and leased facilities. However, OEM created a database but it does not contain classifications or valuations. OEM can not determine value of damage to the buildings. This information will enhance the risk assessment portion of this plan in future updates.
Description	**Improve the state facilities database by capturing classification and valuation information** –
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	EMGP, State funding
Responsible Department	BOA, Risk Management, DPS
Target Completion Date	2011- next plan update
2010-Status Report	Improvements to database have been made to the critical facilities and state-owned property database. Replacement costs are available for university buildings. OEM is continuing to work with the BOA on obtaining the replacement costs for some of the buildings.

Mitigation Action 3.1A and 3.3A	
Problem Statement	The state experiences a lot of power outage due to storms. Burying power lines eliminates the risk of those power lines falling in a storm. Power outages result in loss of communication during a hazard event. Cordless telephones, cell phone towers, and land line phone systems rely on power. The state radio communication towers also have to run on back up power during a power outage. It is costly to use generators to operate cell phone towers, the land line phone system substations, and state radio communication towers in the event of a power outage. In some scenarios the generators fail and locating back up generator in widespread power outages is not easy due to the numerous communications systems relying on back up power.
Description	**Power line burial** – Continue support of power line burial through local project applications. Increases reliability of buried power lines mitigates loss of communication during hazard event.
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☐ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP, PDM, local utilities budgets, REC funds
Responsible Department	PUC, DPS, REC, local gov't.
Target Completion Date	ongoing
2010-Status Report	Many miles of power lines have been buried through HMGP and 404 mitigation with the FEMA public assistance program

Mitigation Action 3.1A and 3.3A	
	following Presidential disaster declarations. Rural Electric Cooperatives also bury lines with their own funding. 404 mitigation (approximately 200 miles buried) 406 mitigation (874 miles buried funded by Disaster 1887)

Mitigation Action 3.1B	
Problem Statement	The state experiences a lot of power outage due to storms.
Description	**Spoilers** – Support the installation of spoilers through local project applications.
Priority	☐ High ☒ Medium ☐ Low
Hazard	☐ Flood ☒ Winter Storm ☐ Wildfire ☐ Drought ☐ Tornadoes ☐ Wind ☐ Hazardous Materials ☐ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP, PDM, local utilities budgets, REC funding
Responsible Department	PUC, REC, DPS, local gov't.
Target Completion Date	ongoing
2010-Status Report	HMGP funds have been used for spoilers to protect powerline infrastructure.

Mitigation Action 3.1C	
Problem Statement	The state experiences a lot of power outage due to storms.
Description	**Upgrade power lines** – Support the improvement to existing power lines through local project applications.
Priority	☐ High ☒ Medium ☐ Low
Hazard	☐ Flood ☒ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP, PDM, local utilities budget, REC fundings
Responsible Department	PUC, REC, DPS, local gov't.
Target Completion Date	ongoing
2010-Status Report	PDM and HMGP projects have supported such projects. Also Public Assistance funds have also upgraded many miles of lines through heavier conductors and burying lines. REC's have also used their funds for such mentioned projects. Through recent disaster declaration, reconductoring of lines with heavier wire. Putting in additional poles.

Mitigation Action 3.1D	
Problem Statement	The state experiences a lot of power outage due to storms.
Description	**Encourage the purchase of generators for backup power and regular testing for preparedness** –
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP, PDM, local utilities budgets, EMPG, SHSGP
Responsible Department	PUC, REC's, DPS, local gov't.
Target Completion Date	ongoing
2010-Status Report	EMPG and SHSGP funds have purchased numerous generators within counties to enhance local capabilities when there are power outages. Telephone cooperatives and rural water systems have also used their own funds to purchase generators.

Mitigation Action 3.2A	
Problem Statement	Some of the damage that occurs from natural hazards to utilities and infrastructure is from older lines that were not designed for long term use.
Description	**Routine infrastructure inspections –** Support and encourage routine inspections of existing utilities and infrastructure for damage and weaknesses.
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☐ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	Local utilities budgets, REC funding, local funding
Responsible Department	PUC, REC's, and local gov't.
Target Completion Date	ongoing
2010-Status Report	Local utilities as ongoing maintenance do yearly inspections and replace problem areas with their existing budget. REA: completed on a regular bases. COOPs work with lineman and tree trimming contractors to ensure trees are at safe distance. RUS requires inspection of all electrical lines once per year. DOT bridge inspections every two years. DENR's Safety Dam Inspection Program inspects all High Hazard and all state owned Significant Hazard dams every three years.

Mitigation Action 4.1A	
Problem Statement	Many agencies forget to contact other agencies before beginning a project to ensure it will comply with their regulations.
Description	**Encourage communities to comply with existing Federal, State, and Local regulations regarding development** – Develop outreach material for communities highlighting federal, state, and local regulations regarding development.
Priority	☐ High ☒ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☒ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	No funding needed
Responsible Department	All state agencies and local gov't.
Target Completion Date	ongoing
2010-Status Report	The NFIP program reaches out to counties and communities to ensure local enforcement of floodplains is occurring.

Mitigation Action 4.1B	
Problem Statement	Local agencies need to be encouraged to monitor the bridges and culverts on a regular basis to stay abreast of any blockages.
Description	**Encourage removal of debris near bridges and culverts** –
Priority	☐ High ☒ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☐ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☐ Hazardous Materials ☐ Geological Hazards ☒ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	Local gov't. funding
Responsible Department	Local gov't.
Target Completion Date	ongoing
2010-Status Report	Ongoing efforts to remind counties to take such actions to ensure flooding does not occur. DOT does debris removal on state highways.

Mitigation Action 4.2A	
Problem Statement	The State has been in a drought for many years so soil nutrients are limited.
Description	**Encourage crop rotation and drought resistant crops** – Work with extension and SDSU researchers on developing decision-making tools for producers to use
Priority	☐ High ☒ Medium ☐ Low
Hazard	☐ Flood ☐ Winter Storm ☐ Wildfire ☒ Drought ☐ Tornadoes ☐ Wind ☐ Hazardous Materials ☐ Geological Hazards ☒ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	Private citizens, DOA
Responsible Department	DOA and private citizens
Target Completion Date	ongoing
2010-Status Report	This is an ongoing effort through the local FSA extension offices. There is a center funded at SDSU for seed technology.

Mitigation Action 4.2B *(Also applies to objective 4.1)*	
Problem Statement	Many communities and property owners do not have insurance on their property.
Description	**Promote insurance** – Many different forms of insurance are available to cover damages incurred by the various natural hazards. The State will encourage residents, farmers, and business owners to purchase insurance appropriate for their risk.
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☒ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☒ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☐ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	No funding needed
Responsible Department	DORR, DPS
Target Completion Date	ongoing
2010-Status Report	The NFIP program campaigns to promote people to purchase flood insurance. Numerous meetings are held throughout the year to promote this. Ad campaigns are also ongoing throughout the year, especially when we near spring when flooding in prominent. South Dakota has the highest adoption of crop insurance in the country.

Mitigation Action 5.0	
Problem Statement	The public always need to be reminded of the hazards in their communities in order to be self-prepared.
Description	**Educate public on reducing losses due to hazards** – Support and continue public outreach efforts regarding methods to reduce losses due to natural hazards.
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☒ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☒ 1. Reduce injuries and loss of life from hazards ☒ 2. Reduce damage to existing and future structures within hazard areas ☒ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☒ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	EMPG, bioterrorism funding
Responsible Department	DPS, DOH
Target Completion Date	ongoing
2010-Status Report	Outreach through the State Fair and working with county emergency managers and local floodplain coordinators. B Ready Campaign. Extension service.

Mitigation Action 5.1A	
Problem Statement	Local/tribal governments have been discouraged with regard to hazard mitigation projects due to participation requirements and changing rules/regulations.
Description	**Promote state and local/tribal relationships for projects that will reduce losses within their communities** – Continue working with local/tribal governments to develop eligible mitigation project grant applications.
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☒ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	PDM, HMGP
Responsible Department	DPS, SDOEM
Target Completion Date	On-going
2010-Status Report	Ongoing efforts through phone calls with tribal representatives to encourage them to develop a PDM plan. One tribe has submitted a PDM application for a plan. Did not receive the funding. Hosted North and South Dakota tribal mitigation planning workshop. One tribe is currently working on a PDM plan.

Mitigation Action 5.1B	
Problem Statement	Local/Tribal governments lack the personnel and experience to meet hazard mitigation plan requirements.
Description	**Continue working with and supporting local and tribal mitigation plan development** –
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☒ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Geological Hazards ☐ Agricultural Pests and Diseases
Goal(s)	☐ 1. Reduce injuries and loss of life from hazards ☐ 2. Reduce damage to existing and future structures within hazard areas ☐ 3. Reduce the losses to critical facilities, utilities, and infrastructure from hazards ☐ 4. Reduce impacts to the economy, the environment, and cultural resources from hazards ☒ 5. Support and assist local/tribal mitigation capabilities and efforts
Potential Funding Sources	HMGP, PDM
Responsible Department	DPS, SDOEM
Target Completion Date	On-going
2010-Status Report	Ongoing efforts through phone calls with tribal representatives to encourage them to develop a PDM plan. One tribe has submitted a PDM application for a plan. Did not receive the funding. Hosted North and South Dakota tribal mitigation planning workshop. One tribe is currently working on a PDM plan.

4.5 FUNDING SOURCES

44 CFR Part 201 Requirement:
[The State mitigation strategy shall include an] identification of current and potential sources of Federal, State, local, or private funding to implement mitigation activities.

As outlined in the mitigation actions in Section 4.4 the following sources of funding were identified by the State Hazard Mitigation Team to implement mitigation projects.

- **Hazard Mitigation Grant Program (HMGP)**
- **Pre-Disaster Mitigation Grant Program (PDM)**
- **Local Government Funding**
- **Community Development Block Grants (CDBG)**
- **Private Funding (from citizens and/or businesses)**
- **Emergency Management Performance Grants (EMPG)**
- **State Homeland Security Grant Program (SHSGP)**
- **Flood Mitigation Assistance Program (FMA)**
- **Federal Housing Administration (FHA)**
- **State Electric Commission**
- **Rural Electric Association (REA)**
- **Rural Electric Cooperatives (RECs)**
- **Private Electric Companies**
- **United States Corps of Engineers (USCOE)**
- **Department of Environment and Natural Resources (DENR)**
- **Flood Map Modernization Program**
- **South Dakota Department of Agriculture (DOA)**
- **United States Forest Service (USFS)**
- **South Dakota Game, Fish and Parks (GF&P)**
- **Bioterrorism Funding**
- **Local Utilities**
- **State Funding**
- **Emergency Management Performance Grant Funds**
- **Coast Guard**
- **Dingell Johnson**
- **Title VI**
- **Transportation Enhancement funds for living snow fence projects**
- **Rural Utility Service (RUS) loans**
- **Cooperative Finance Corporation (CFC)**
- **CoBank**

Several mitigation actions listed in Section 4.4 will not require specific funding, and can be achieved through greater collaboration and coordination among state and local agencies. In addition to the funding sources identified by the State Hazard Mitigation Team, the local hazard mitigation plans identified the following funding sources. Many of the funding sources identified in the 2007 Plan are similar to those that are identified in this Plan Update. Additional funding sources listed in this update that were not listed in the 2007 plan include Small Business Disaster Assistance Program (SBA), the Bureau of Indian Affairs (BIA), the Economic Development Administration, and Local Emergency Planning Committees (LEPC).

The following funding sources were identified in the local hazard mitigation plans that were reviewed for this plan update:

- **Community Development Block Grant Program (CDBG)**
- **State Department of Environment and Natural Resources (DENR)**
- **State Department of Transportation Funding Programs (DOT)**
- **FEMA Assistance to Firefighters Grant Program**
- **Office of Domestic Preparedness (ODP)**
- **Resource Conservation and Development District Funding (RCD)**
- **Rural Development Grant and Loan Program (RD)**
- **Local funding**
- **State funding**
- **South Dakota Office of Emergency Management (SDOEM)**
- **County funding**
- **Individual Agencies**
- **Federal/Federal Match/FEMA**
- **School District**
- **Rural Water Systems (RWS)**
- **SDDED**
- **SDEMD**
- **Siouxland Interstate Metropolitan Planning Council (SIMPCO)**
- **Red Cross**
- **Salvation Army**
- **USDA**
- **USGS**
- **National Weather Service**
- **Rural Electric Associations (REA)**
- **Small Business Administration Disaster Assistance Program (SBA)- new for 2010 Plan update**
- **Bureau of Indian Affairs (BIA)- new for 2010 Plan update**
- **Economic Development Administration- new for 2010 Plan update**
- **Local Emergency Planning Committees (LEPC)- new for 2010 Plan update**

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SECTION 5 LOCAL MITIGATION PLANNING COORDINATION

5.1 LOCAL FUNDING AND TECHNICAL ASSISTANCE

44 CFR Part 201 Requirement:
[The section on the Coordination of Local Mitigation Planning must include a] description of the State process to support, through funding and technical assistance, the development of local mitigation plans. *The updated plan must describe:* ▪ *The funding and technical assistance the State has provided since approval of the previous plan to assist local jurisdictions in completing approvable mitigation plans; and* ▪ *How the State will continue to provide this funding and technical assistance for new plans as well as local plan updates.*

Funding and technical assistance provided by SDOEM includes provision of funds, plan development assistance, technical assistance for developing risk assessments, G318 trainings for hazard mitigation planning, benefit/cost analysis training, and tribal planning assistance.

The State Hazard Mitigation Officer (SHMO) works with every county throughout the state to support their development of a local mitigation plan. The SHMO performs a preliminary review of each plan prior to submitting it to FEMA. At the time this update was prepared 64 counties had FEMA approved hazard mitigation plans or plans in the process of being updated. It is the SHMO's goal to support every county in the state with developing a mitigation plan, ensuring it meets FEMA's requirements, and supporting the maintenance and updates of these plans. The SHMO will continue regular meetings with each county in order to ensure maintenance and required updates for all local plans are performed.

As documented in the Hazard Mitigation Grant Program Administrative Plan dated November 16, 2010, the SHMO coordinates review of each project application for funding eligibility in FEMA's Hazard Mitigation Assistance programs. The State Hazard Mitigation Team (SHMT) serves as a review panel for the Hazard Mitigation Grant Program (HMGP) when the applications exceed the amount of funding provided to the state or technical advice is required to determine eligibility.

A Project Evaluation Sheet (included on the following pages) is used by the SHMT as guidance for reviewing project applications and determining the priorities for allocating funding. This sheet enables the SHMT to objectively review a project application in terms of federal criteria and the pre-determined state goals (such as the mitigation actions prioritized in Section 4). They look at the priority level of the project type, based on the priorities in Section 4, review the benefit cost analysis, and determine whether the project will help achieve the State's identified goals. Currently, the SHMT is encouraging a more diverse range of project applications than solely power line burials.

As noted in Section 4, the SHMT used the STAPLE/E Selection Criteria to prioritize the mitigation actions. These criteria are also referred to during review of project applications. They are included following the Project Evaluation Sheet.

Further details regarding the State of South Dakota's policies on providing funding are explained in the Hazard Mitigation Grant Program Administrative Plan.

ATTACHMENT 8

Instructions
for
Project Evaluation Sheet

Introduction

Once projects meet the minimum state and federal requirements for the Hazard Mitigation Grant Program, it is necessary for the state to prioritize the projects. Prioritization of projects is only necessary when there are numerous projects seeking funds in excess of the amount available from FEMA.

Instructions

Each member of the SDHMT will individually evaluate each project using the criterion on the Sheet. Each project shall be evaluated on how well it meets or exceeds each listed objective indicating "Yes" or "No" (YES = Does meet the objective/goal; NO = Does not meet the objective/goal).

Once each member of the SDHMT rates each project, the recommendations will be sent to the administration for review.

PROJECT EVALUATION SHEET

APPLICANT:

PROJECT TITLE:

Answer each question below with a "Yes" or "No" or "N/A".
["Yes" = Does Meet Objective/Goal – "No" = Does Not Meet Objective/Goal – "N/A"= Not Applicable]

I. MINIMUM FEDERAL CRITERIA

Please indicate if the proposed project meets or exceeds each of the objectives below.

Does the project:

1. Have significant beneficial impact(s) on the declared disaster area (project may be located outside the disaster area)? YES___ NO___ N/A___
2. Independently solve the problem are a functional part of a larger project where there is assurance that, as a whole, the larger project will be completed? YES___ NO___ N/A___
3. Substantially reduce the risk of damage, hardship, loss, suffering, or death which would result from a future disaster? YES___ NO___ N/A___
4. Apply to a repetitive problem, or one that poses a significant risk if left unresolved? YES___ NO___ N/A___
5. Contribute to the long-term solution of the problem? YES___ NO___ N/A___
6. Show affordable operation and maintenance costs which the local jurisdiction is committed to support? YES___ NO___ N/A___

II. SOUTH DAKOTA GOALS AND OBJECTIVES

Please rate how the proposed project meets or exceeds each objective below.

Does the project:

1. Fall within the goals and objectives of South Dakota's Hazard Mitigation Plan? YES___ NO___ N/A___
2. Protect lives and reduce public risk? YES___ NO___ N/A___
3. Reduce the level of damage vulnerability in existing structures and developed property? YES___ NO___ N/A___
4. Avoid inappropriate future development in areas that are vulnerable to the hazard(s)? YES___ NO___ N/A___

5. Show development and implementation of state or local comprehensive programs, standards, and regulations that reduce future damage?

YES___ NO___ N/A___

6. Provide a long-term mitigation solution in locations which experience repetitive damage?

YES___ NO___ N/A___

7. Reduce the number of vulnerable structures through acquisition, relocation, or retrofitting?

YES___ NO___ N/A___

8. Address secondary damage issues (such as landslides resulting from floods or wild fire)?

YES___ NO___ N/A___

9. Protect or restore wetlands and floodplains?

YES___ NO___ N/A___

10. Restore or protect natural resources, recreational areas, open space, or other environmental values?

YES___ NO___ N/A___

11. Improve the capability or effectiveness to: report time-sensitive information, relay information, or warn the public?

YES___ NO___ N/A___

12. Improve the capability of state agencies and county or local governments to exchange time-sensitive information during the disaster?

YES___ NO___ N/A___

13. Increase public awareness of the hazard(s), preventive measure(s), and emergency response(s) to the hazard(s)?

YES___ NO___ N/A___

Reviewer: ___________________________

Reviewer's Agency: ____________________

STAPLE/E Review and Selection Criteria
Social
• Is the proposed action socially acceptable to the university and surrounding community? • Are there equity issues involved that would mean that one segment of the university and/or community is treated unfairly? • Will the action cause social disruption?
Technical
• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of other university goals?
Administrative
• Can the university implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
Political
• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?
Legal
• Is the university authorized to implement the proposed action? • Are there legal side effects? Could the activity be construed as a taking? • Will the university be liable for action or lack of action? • Will the activity be challenged?
Economic
• What are the costs and benefits of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account? • Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the university? • What burden will this action place on the tax base or local economy? • What are the budget and revenue effects of this activity? • Does the action contribute to other university goals? • What benefits will the action provide?
Environmental
• How will the action affect the environment? • Will the action need environmental regulatory approvals? • Will it meet local and state regulatory requirements? • Are endangered or threatened species likely to be affected?

5.1.1 Recent Technical Assistance and Funding (SHMO activities since the 2007 update)

Section 2.3 details the projects that have been approved through the mitigation funding mechanisms. In addition to these, the State Hazard Mitigation Officer has coordinated several technical assistance activities. These include trainings for flood planning assistance and awareness, Benefit Cost Analysis, and Tribal planning assistance.

June 14th and 15th 2009 in Aberdeen and June 16th and 17th 2009 in Sioux Falls : Benefits Cost Analysis Training Course with the following participants: City of Madison, Planning District III, Arens Engineering, City of Fort Pierre, Black Hills Council of Local Government, Kadmas Lee and Jackson Consulting, Brown County Highway, FEMA Region VIII, Hughes County Planning, Lincoln County, State SHMO, SDOEM

October 7th-8th 2009: Benefits Cost Analysis Classroom Training Course in Pierre. Included the following modules: Damage Frequency Assessment, Flood, Tornado, and Wildfire.

November 3rd and 9th 2009: Planning workshop and applicant briefing for Disaster 1844 in Brookings and Rapid City.

December 2nd 2009: Northeast Flooding Pre-Planning for Brown, Day, Edmunds, Marshall, Roberts, and Spink Counties.

December 21st 2009: Northeast Flooding Pre-Planning for Brown, Codington, Day, Edmunds, Grant, Hamlin, Marshall, Roberts, and Spink Counties.

February 22nd-26th 2010: Flood Awareness Outlook Spring Outreach in North Sioux City, Pierre, Vermillion, Sisseton, Watertown, Aberdeen, Sioux Falls, and Brookings.

March 2nd-5th 2010: Governor town hall meetings to inform the public and local officials of the potential of major spring flooding in Waubay, Britton, Sisseton, Huron, and Mitchell.

April 21 and 22, 2010- Multi-State Tribal Mitigation Training in the Sisseton-Wahpeton Sioux Reservation

September 2010: South Dakota Emergency Managers Conference. Included breakout training sessions on mitigation

November 30 – December 2nd: L242 Unified Hazard Mitigation Grant Assistance Application Development Course held in Souix Falls. 32 people attended.

December 2010: SDOEM to contract with a Council of Governments for technical assistance on project applications.

December 2010: Attend Northeast Regional meeting and make presentation on disasters and available money.

Ongoing: Various trips to local governments to inform them of mitigation programs. (These are resulting in more interest across the state for mitigation grants.)

5.2 LOCAL PLAN INTEGRATION

44 CFR Part 201 Requirement:
[The section on the Coordination of Local Mitigation Planning must include a] description of the State process and timeframe by which the local plans will be reviewed, coordinated, and linked to the State Mitigation Plan. *[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities….*

Local hazard mitigation plans covering 64 of the State's 66 counties were reviewed and integrated into this plan. Each local plan was reviewed for the following components:

- Hazards
- Local Capabilities
- Goals
- Estimated Losses
- Growth and Development Trends
- Funding Sources

Section 3.1discusses the consideration of the hazards identified in the local plans. Section 4.3 discusses the common capabilities identified in the local plans. The estimated losses, where provided, were integrated into the Risk Assessment (Chapter 3 of this plan). Table 3-27 in Section 3.3 summarizes the growth and development trends identified in the local plans. The funding sources identified in the local plans are presented in Section 4.5.

5.3 PRIORITIZING LOCAL ASSISTANCE

44 CFR Part 201 Requirement:
[The section on the Coordination of Local Mitigation Planning must include] criteria for prioritizing communities and local jurisdictions that would receive planning and project grants under available funding programs which should include: ▪ *Consideration for communities with the highest risks,* ▪ *Repetitive loss properties, and* ▪ *Most intense development pressures.* *Further that for non-planning grants, a principal criterion for prioritizing grants shall be the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.* *[The] plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities….*

The State Hazard Mitigation Team recognizes, based on the risk assessment in this plan, that some counties are more vulnerable to certain hazards than others. Table 5-1summarizes the most vulnerable counties and RECs for each of the identified hazards in the 2010 Plan update. In addition to the criteria discussed in Section 5.1 the State will consider the results of the vulnerability assessment as shown.

Table 5-1 Summary of Vulnerability (2010)

Natural Hazard (in order of priority)	**Most Vulnerable Counties**	**Most Vulnerable RECs**
Flood	Potential Losses: Minnehaha, Union, Yankton, Pennington, Codington, Lawrence, Brown Loss Ratio: Union, Yankton, Fall River, Campbell NFIP Greatest Losses: Codington, Brown, Day Repetitive Loss Dollars: Codington, Day, Hamlin Future Growth: Minnehaha, Union, Yankton	
Winter Storm	Prior Events, Building Exposure, and population density: Minnehaha, Brookings, Lincoln, Meade, Beadle, Brown, Butte, Davison, Hutchinson, Pennington, Yankton	Sioux Falls Municipal Electric and Xcel Energy, Sioux Valley Energy, Southeastern Electric Cooperative, XCEL Energy (Minnehaha)
Wildfire	Contain Forested Land: Butte, Custer, Fall River, Lawrence,	All REC's located in Black Hills, Butte, and West River

	Meade, Pennington, Shannon	
Drought	All Counties	
Tornado	Prior Events, Building Exposure, Population Density, and Past Tornado Damage: Minnehaha , Beadle, Brown, Lincoln, McCook, Pennington, and Turner	Sioux Falls Municipal Electric and Xcel Energy, Sioux Valley Energy, Southeastern Electric Cooperative, XCEL Energy (Minnehaha)
Windstorm	Prior Events, Building Exposure, and Population Density: Minnehaha, Pennington, Brown, Meade, Lincoln	Sioux Falls Municipal Electric and Xcel Energy, Sioux Valley Energy, Southeastern Electric Cooperative, XCEL Energy (Minnehaha)
Hazardous Materials	Number of Transportation Incidents: Minnehaha, Pennington, Lincoln, Brown, Codington Counties with the most gas or hazardous liquid transmission lines: Lincoln, Minnehaha, Brown, Spink, Butte, Union, Clark, Harding, Duel, Hutchinson	
Geologic Hazards	Highest Building Losses: Pennington, Minnehaha, Lawrence	
Agricultural Pests and Diseases	Infectious Diseases (from Local Risk Rollup): Hughes, Hyde, Perkins, Stanley all ranked Medium Agriculture Contamination/Illness in Livestock (from Local Risk Rollup): Butte and Meade identified this as a hazard	

The State will continue to prioritize assisting communities in developing and maintaining FEMA approved local mitigation plans. The information gathered in this plan is available to the local communities for use and consideration. The State Hazard Mitigation Officer reviews local plans within 30 days of receiving them.

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SECTION 6 PLAN MAINTENANCE PROCEDURES

6.1 MONITORING, EVALUATING, AND UPDATING THE PLAN

44 CFR Part 201 Requirement:
[The Standard State Plan Maintenance Process must include an] established method and schedule for monitoring, evaluating and updating the plan. *The updated plan must include:* • *an analysis of whether the previously approved plan's method and schedule for monitoring, evaluating, and updating the plan worked, and what elements or processes, if any, were changed; and* • *the method and schedule to be used over the next three years to monitor, evaluate, and update the plan.*

The State Hazard Mitigation Team has a successful process for meeting and implementing mitigation actions after every declared disaster. Due to the disasters declared in 2009 and 2010, the SHMT has been very collaborative in determining priorities for allocating project funding. The 2007 plan update listed an intent for the SHMT to meet every six months to review the progress of the identified mitigation actions and note any relevant updates to the plan. This has not been necessary due to the frequency of collaboration based on the recent disasters. During the second milestone meeting of the SHMT in preparing this plan update, each of the SHMT agencies reviewed and reported on progress for the mitigation actions. This proved to be a very successful process and resulted in quality reports of mitigation progress across the state agencies.

The SHMT will continue to annually review applications for submittal for PDM grants. In addition the SHMT will continue to convene following every declared disaster event. Every three years, as required by DMA 2000, the State will submit an updated Hazard Mitigation Plan to FEMA for review and approval.

The 2007 plan contained a Mitigation Action Tracking Matrix which was not utilized. The revised intended process for tracking mitigation progress is based on the current system the SHMO uses to track project applications.

The SHMO maintains a list of submitted project applications for each declared disaster. The summary Mitigation Action Matrix will be used to correlate the SHMT's prioritized project types with the submitted applications. At every meeting of the SHMT, the team will review the identified priorities in comparison to the already funded projects and discuss overall mitigation progress. This will inform ongoing prioritization decisions for funding additional projects. The summary Mitigation Action Matrix is included as Appendix 4D.

The State Hazard Mitigation Officer is responsible for organizing the State Hazard Mitigation Team meetings, documenting the discussed revisions, and reporting to FEMA on a regular basis the intended updates to the Hazard Mitigation Plan. The SHMO will be responsible for coordinating the development of the required plan update.

6.2 MONITORING PROGRESS OF MITIGATION ACTIVITIES

44 CFR Part 201 Requirement:
[The Standard State Plan Maintenance Process must include a] • *System for monitoring implementation of mitigation measures and project closeouts* • *System for reviewing progress on achieving goals as well as activities and projects in the Mitigation Strategy* *The update must:* • *Describe any modifications to the State's system used to track the initiation, status, and completion of mitigation activities;* • *Discuss if mitigation actions were implemented as planned; and* • *Indicate who will be responsible for continued management and maintenance of the monitoring system, including the timeframe for carrying out future reviews.*

The State Hazard Mitigation Team will review local mitigation project applications using the following three tools to prioritize approval and implementation: 1) HMGP Project Evaluation Sheet, 2) STAPLE/E Criteria, and 3) summary Mitigation Action Matrix (Appendix 4D). The first two tools will help the SHMT identify effective, cost-beneficial projects. The third tool allows the SHMT to monitor progress towards achieving the goals identified in this plan while deciding on projects to implement. As necessary, the SHMT will coordinate with additional relevant and interested state agencies.

The progress of mitigation activities will be monitored through ongoing grants application and management processes. As noted in Section 4.2 the progress of funded projects are tracked via a quarterly reporting system. In addition they are physically inspected every two years while under construction. The State follows project closeout procedures as outlined in the HMGP Administrative Plan. These procedures require the sub-grantee to request closeout of the project by letter addressed to the SHMO. The SHMO coordinates via letters to and from FEMA preparation of final notice that the project was completed in accordance with FEMA approvals. Details of the project closeout procedures may be found in Appendix 6A. The State of South Dakota intends to follow these project closeout procedures for all State supported mitigation projects relevant to this plan. In addition a monthly report is generated for the governor's office noting the progress of all mitigation projects.

The 2007 plan stated that the SHMO will review the completed mitigation projects every six months and cross check them with the Mitigation Actions Tracking Matrix to note progress. Given the amount of current workload, this intent has been revised as noted above. The SHMO will, on an ongoing basis, correlate the prioritized mitigation project types with the submitted project applications. For the next plan update, the SHMO will be able to tally the number of applications and funded projects for each prioritized project type. This will allow for a meaningful evaluation of mitigation progress based on the SHMT's goals.

Prior to the three-year required plan update, in addition to the regular SHMT meetings, the prominent members of SDOEM will perform a thorough review of this plan and note at a minimum the following:

- out-dated information,
- completed mitigation projects,

- significant hazard events from 2011 – 2014,
- newly desired mitigation actions,
- revisions to the State Hazard Mitigation Team,
- status of communities with FEMA approved local mitigation plans,
- etc.

The notes and observations compiled during the SHMT meetings and the thorough review by SDOEM will be used to facilitate a complete update of this plan for submission to FEMA in 2014.

In addition to updating this hazard mitigation plan, the State's HMGP Administrative plan is updated as necessary following every declared disaster. This activity is coordinated by the SHMO.