STATE OF SOUTH DAKOTA

HAZARD MITIGATION PLAN

BASIC PLAN

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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

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MISSION STATEMENT

*To reduce the impacts to life and property from hazards through a long term sustainable statewide mitigation strategy.**

*Mission Statement prepared by the State Hazard Mitigation Team on August 17th, 2007

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EXECUTIVE SUMMARY

Introduction

This plan is an update of the 2004 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.

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 2007 revised and updated Multi-Hazard Mitigation Plan be adopted by the governor. Governor M. Michael Rounds adopted the revised and updated (in 2007) State plan by letter dated April 22, 2008.

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 series of regional stakeholder meetings, 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 2007 State of South Dakota Multi-Hazard Mitigation Plan for review and edit by the project team, SHMT, and regional stakeholders. Each section of the plan was reviewed, analyzed and thoroughly updated.

Participants

A representative from FEMA Region VIII (Nan Johnson) was actively involved in the SHMT and Stakeholder meetings. 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 Electric Coops to identify relevant hazards and develop emergency restoration plans. 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 Stakeholder Meetings, as described in Section 2.1, and asked to complete a Public and Stakeholder Survey.

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 does not always apply. Table 3-1 indicates the ranking established by the state using the method described above.

Table 0-1: Hazard Ranking and Planning Consideration

Hazard Type and Ranking	Planning Consideration Based on Hazard Level
Flooding	Significant
Winter Storms	Significant
Wildfires	Significant
Drought	Significant
Tornadoes	Significant
Wind	Moderate
Hazardous Materials	Moderate
Landslides and Mudflows	Limited
Earthquakes	Limited

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. Floods result in $17 million per year in average annualized losses to the state. Nearly every county in South Dakota is vulnerable to floods. Potential losses are highest in Minnehaha, Pennington, Codington, and Brown counties. Floods in these four counties have the potential to displace at least a thousand persons.

Winter Storm Hazard Profile Summary

According to the National Climatic Data Center, there were 357 winter storm events in South Dakota between 1993 and 2006 (14 years). 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 $14 million in winter storm losses each year. Every South Dakota county is vulnerable to winter storms. Minnehaha has a very high vulnerability, while Lincoln, Meade, Pennington, Brookings, Butte, and Yankton have high vulnerabilities.

Wildfire Hazard Profile Summary

Wildfires have a 100 percent chance of occurrence from early spring to late fall every year. Based on past fire history, Table 3-49 indicates the counties most vulnerable to wildland and prairie fires (from 2004 plan updated with 2005 HAZUS valuations and 2006 population).

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. 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 1,485 tornadoes in South Dakota between 1950 and 2006 (57 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 $10.7 million. Every South Dakota county is vulnerable to tornadoes. Minnehaha and Lincoln County have very high vulnerabilities. Brown, Pennington, and Turner counties have high vulnerabilities.

Wind Hazard Profile Summary

According to the National Climatic Data Center, there were 4,455 wind events (excluding events from October through March 31 and those associated with snow, see event description above) in South Dakota between 1955 and 2006 (52 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 $8 million. Every South Dakota county is vulnerable to wind. Minnehaha has a very high vulnerability, while Pennington, Brown, and Meade have high vulnerabilities. It is noted that Hughes County includes Pierre, the state capital, and has the highest concentration of state owned buildings, facilities and employees.

Hazardous Materials Hazard Profile Summary

- According to the U.S. Department of Transportation's Hazardous Materials Information System, there were 628 transportation incidents involving hazardous materials in South Dakota between 1971 and 2006 (36 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. 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.
- 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). Based on this information, the probability that at least one pipeline incident will occur in South Dakota in any given year is 100 percent. 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.
- According to the U.S. Environmental Protection Agency's Toxic Resource Inventory, 8 million pounds of hazardous materials were disposed of or released in South Dakota in 2005. 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.

Landslides and Mudflows Hazard Profile Summary

Although historical landslide 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. Limited areas throughout the state are vulnerable to landslides and mudflows.

Earthquake Hazard Profile Summary

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 estimated 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. History has proven that earthquakes have not caused significant damage in the State of South Dakota.

Growth and Development
In general, counties with growing populations and number of housing units will have increased vulnerability to hazard events, particularly those hazards not confined to geographic areas such as 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.

Building Exposure
There are an estimated 240 thousand buildings in South Dakota with a total building replacement value (excluding contents) of $38,357 (millions of dollars). Approximately 98 percent of the buildings (and 80 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 3-30 illustrates critical facilities and their relationship to floodplains. Table 3H-A in Appendix 3H illustrates the numbers and names of facilities in the floodplain, by county.

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 3-32 and descriptions of the facilities are listed in Table 3H-B in Appendix 3H.

Tornadoes, Wind, Winter Storms
Eleven counties were identified to have either 'very high' or 'high' vulnerability to tornadoes, wind, and/or winter storms. The number of facilities in four state facility GIS layers (StateLayer, Power, Natural Gas, and Fuel) was quantified in each of these counties. The results are displayed in Table 3-69. It is noted that Hughes County includes Pierre, the state capital, and has the highest concentration of state owned buildings, facilities and employees. 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 3-32 and descriptions of the facilities are listed in Table 3H-B in Appendix 3H.

Section 4 Mitigation Strategies
Goals:

- Reduce injuries and loss of life from hazards
- Reduce damage to existing and future structures within hazard areas

- Reduce the losses to critical facilities, utilities, and infrastructure from 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 actions are detailed in Section 4.4

Section 5 Local Mitigation Planning Coordination

The State Hazard Mitigation Officer (SHMO) works with every county throughout the state to support their development of a local mitigation plan. Section 3.1.3 discusses the consideration of the hazards identified in the local plans. Section 4.3 discusses the common capabilities identified in the local plans. The goals represented in the local plans were summarized and presented to the State Hazard Mitigation Team at SHMT Meeting #2. They were taken into consideration during the development of the goals identified in Section 4.1. The estimated losses, where provided, were integrated into the Risk Assessment (Chapter 3 of this plan). Table 3-22 in Section 3.3.1 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. A compilation of all the mitigation actions in the local plans is provided as Appendix G. These will be used as references for the State Hazard Mitigation Team during project application reviews as well as future plan updates. The mitigation actions and goals of the local mitigation plans are taken into consideration when determining the priorities for the state mitigation plan.

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.

Section 6 Plan Maintenance Procedures

The State Hazard Mitigation Team will convene following every declared disaster event and at a minimum every three years as proclaimed in the Executive Order signed by the governor. Every three years, as required by DMA 2000, the State will submit an updated Hazard Mitigation Plan to FEMA for review and approval. The progress of mitigation activities will be monitored through ongoing grants application and management processes. The State Hazard Mitigation Officer will review the mitigation activities outlined in this plan every six months to document progress and/or completion of each activity.

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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.

The first State of South Dakota Multi-Hazard Mitigation Plan 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. As required by the three year plan update cycle, the State of South Dakota formed a State Hazard Mitigation Team in April 2007 and prepared this revised State of South Dakota Multi-Hazard Mitigation Plan.

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.

INTRODUCTION

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.

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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. This letter is included on the following page.

On April 11, 2008 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 2007 revised and updated Multi-Hazard Mitigation Plan be adopted by the governor.

Governor M. Michael Rounds adopted the revised and updated (in 2007) State plan by letter dated April 22, 2008.

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

The original 2004 State of South Dakota Multi-Hazard Mitigation Plan (Plan) was developed by an interagency Mitigation Team established in 1993. They participated in discussions to identify, categorize, and prioritize issues pertinent to each disaster event in South Dakota.

FEMA's review of the original 2004 Plan cited several shortcomings of that planning process. This section demonstrates the revised planning process used to develop this 2007 update to the State of South Dakota Multi-Hazard Mitigation Plan. The planning process began in April 2007, 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 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 original Plan. SDOEM staff specifically responsible for coordinating the completion of the Plan update included Kristi Turman, Tina Titze, Jason Bauder, Cynthia Maszk, and Michelle Saxman. SDOEM contracted with a consulting team comprised of Dewberry and AMEC for technical assistance throughout the process.

State Hazard Mitigation Team

The first step in updating the original 2004 Plan was to establish a statewide interagency team to provide input and participate in the revision. 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. A copy of the executive order is included following this page.

INSERT EXECUTIVE ORDER 2007-07

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 names provided in Table 2-1 are the individuals who participated at the State Hazard Mitigation Team meetings and throughout development of this plan. 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

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	Steve Harding Paige Hoskinson
Department of Agriculture	Kevin Fridley
Department of Game, Fish, and Parks	Leslie Petersen Jayme Severyn (Parks and Rec)
Department of Health	Rick LaBrie
Department of Public Safety, Office of Emergency Management	Jason Bauder Cynthia Maszk Michelle Saxman Tina Titze
Department of Transportation	
Bureau of Administration, Risk Management	Ian Paul
As needed: Office of Homeland Security	Daren Ketcham
As needed: Rural Electric Associations	Audry Ricketts
As needed: Department of Environment and Natural Resources	Mark Rath
As needed: State Climatologist	Dennis Todey
As needed:	

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 planning process involved several meetings of the State Hazard Mitigation Team, a series of regional stakeholder meetings, 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.

Table 2-2: Summary of Planning Process

March 28, 2007 – Project Team Kick Off
SDOEM, Dewberry, and AMEC began the planning process with a conference call to establish connections and outline the workflow process among project team members. As a result of this call, Dewberry/AMEC received the information regarding establishment of the State Hazard Mitigation Team. The project team members also discussed the FTP site and Project Team: Share Site made available by Dewberry for digital data sharing. Dewberry provided a list of data (including plans and reports) for SDOEM to begin collecting and posting to the share site. Dewberry agreed to host bi-weekly conference calls for the project team to maintain communication regarding progress and data needs.
May 3, 2007 – SHMT Kick Off
All members of the State Hazard Mitigation Team were requested to attend the first meeting regarding the State of South Dakota Multi-Hazard Mitigation Plan update. Dewberry reviewed (via a Power Point presentation) the plan update process and the role of the State Hazard Mitigation Team (SHMT). Together, the SHMT reviewed the natural hazards identified in the original 2004 State of South Dakota Multi-Hazard Mitigation Plan and discussed additional natural hazards that regularly affect the State. The SHMT also discussed man-made hazards and whether or not to include them in this plan. After identifying and agreeing upon the hazards to be included in the 2007 State of South Dakota Multi-Hazard Mitigation Plan, the SHMT went through a ranking exercise to prioritize the identified hazards by level of importance. Details about the hazard selection and prioritization are included in Section 3 – Risk Assessment. The SHMT discussed potential stakeholders and additional departments/agencies/offices that should be involved in the plan update. This list was used in preparing the invitations for the regional stakeholder meetings. Members of the SHMT were asked to complete an Agency Comment Form and a State Capability Assessment Questionnaire prepared by Dewberry to assist with the documentation of agency specific concerns and capabilities. The results of the Agency Comment Form are summarized in Section 2.2 below and the results of the State Capability Assessment Questionnaire are included in Section 4.2.
July 17, 2007 – SHMT Meeting #2
The SHMT was called together in July to review the preliminary risk assessment based on the identified hazards and updates to the original 2004 risk assessment. Dewberry discussed preliminary findings of their review of the approved local hazard mitigation plans. 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 mission statement and goals during this meeting. 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.
July 17-19, 2007 – Stakeholder Meetings
Regional stakeholder meetings were held in Pierre, Aberdeen, Sioux Falls, and Rapid City to give emergency managers, town representatives, the general public, utility representatives, tribal representatives, and many more the opportunity to learn about the Multi-Hazard Mitigation Plan and provide input into the 2007 Plan update. At these meetings, Dewberry, AMEC and SDOEM discussed the planning process to date, the preliminary risk assessment results, and the mission statement and goals. The stakeholders were encouraged to share their concerns regarding natural hazards and hazardous

materials incidents as they relate to mitigation strategies. Each stakeholder was asked to complete a survey to assist with the documentation of specific concerns and capabilities in each region. Feedback from the stakeholders who attended the meeting was integrated into the final Risk Assessment presented herein as Section 3. A summary of the survey responses is included in Section 2.2 below.
August 27, 2007 – SHMT Review of Goals, Objectives, Actions
SDOEM drafted objectives and actions to define the state's mitigation strategy based on prior experience, discussions and on-going relationships with local representatives, and feedback from the SHMT. These were circulated to the SHMT for review and comment. The SHMT's response and review has been integrated in this updated plan.
October 17, 2007 – SHMT Review of Risk Assessment
The SHMT was asked to review and comment on the draft Risk Assessment as prepared by AMEC and confirmed by SDOEM. Additional data and clarifications from the SHMT were encouraged and incorporated into the Risk Assessment.
November 28, 2007 – FEMA Preliminary Review of Risk Assessment
SDOEM submitted the complete draft of the Risk Assessment to FEMA Region VIII for preliminary review. Ryan Pietramali returned several comments via e-mail in the form of a completed review crosswalk. These comments were reviewed and discussed by SDOEM, Dewberry, and AMEC in order to be addressed in the complete State of South Dakota Multi-Hazard Mitigation Plan submitted to FEMA for approval.
January 22 – 29, 2008 – SHMT Review of Complete Draft
SDOEM made the complete draft plan available for review by the SHMT and relevant stakeholders via FTP. Several SHMT members and stakeholders submitted comments via email. SDOEM visited with each SHMT member to discuss concerns/revisions. All members thought the plan was put together very well and were pleased with it.
February 6, 2008 – FEMA Review of Complete Draft
SDOEM submitted one hardcopy plan accompanied by a CD with a PDF version to FEMA Region VIII for conditional approval.
INSERT DATE – Adoption by the State of South Dakota
INSERT DATE – Final Plan Submittal to FEMA
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 A. A list of participants in the regional stakeholder meetings is included here as Table 2-3.

Table 2-3: Participants in the Regional Stakeholder Meetings

Affiliation	Individual Representative
Campbell County Emergency Management	Lawrence Goehring
Hughes/Stanley County	Rob Fines
Hughes County, County Manager	Kevin Hipple
Brule/Buffalo County Emergency Management, Emergency Manager	Katheryn Benton
Ellsworth AFB, Chief Disaster Preparedness	Margery Orem
Regional Coordinator	Jason Forrest
Groton City, Finance Officer	Anita Lowary
Groton City, Mayor	Roy Olson
Brown County Emergency Management, Director	Scott Meints
Spink County Emergency Management, Director	Randy Maddox
Faulk County Emergency Management, Director	Wayne Vetter
FEM Electric, Manager	Scott Moore
Central Electric, Purchasing/Plant Manager	Bruce Sparks
Sioux Valley Energy & East River Electric, Safety Coordinator	Terry Ebright
Hanson County Emergency Management, Cord. Director	Ray Thomas
Lincoln County Emergency Management, Director	Harold Timmerman
Moody County Emergency Management, Manager	Terry Albers
Southeastern Electric Coop, Operation Manager	Ron Globke
Union County Emergency Management, Public Works Admin/EM	Raymond Roggow
Charles Mix County Emergency Management, Director	R.G. Svatos
Pennington County Emergency Management, Asst. Director	Pam Buck
Meade County Emergency Management, Director	Kathie Grant
City of Wall Public Works Department	Jeff Clark
City of Hill, City Planning Directory	Dick Johnson
Rosebud Sioux Tribe, E.M.C.	Bill Giroux
Rosebud Sioux Tribe, Water and Env. Director	Syed Hug
SDOEM	Brent Kolstad
Fall River / Shannon Emergency Management, Emergency Manager	Frank Maynard

Drafting the Plan

Based on the collaboration among SDOEM, the SHMT, and the contracted consultants, Dewberry was able to draft a complete updated 2007 State of South Dakota Multi-Hazard Mitigation Plan for review and edit by the project team, SHMT, and regional stakeholders. Each section of the plan was reviewed, analyzed and thoroughly updated. Comments and required actions noted in FEMA's previously completed crosswalk (reviewing the original 2004 Hazard Mitigation Plan) were addressed and integrated into this Plan. There were no sections of the original 2004 Plan that did not need updating or revision. Each section of this plan contains a detailed description of the methodologies and data sources used to prepare that section.

2.2 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:

A representative from FEMA Region VIII (Nan Johnson) was actively involved in the SHMT and Stakeholder meetings. FEMA Region VIII provided constant support for mitigation planning through the current disaster declarations during the time of this plan update. FEMA Region VIII (Ryan Pietramali) provided a preliminary review of the Risk Assessment (Section 3) portion of this plan.

Coordination with state agencies:

The formation of the State Hazard Mitigation Team (SHMT) provided a convenient vehicle for coordinating the plan update with relevant state agencies. The State Hazard Mitigation Officer (Cindy Maszk) 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 in the 2007 State of South Dakota Multi-Hazard Mitigation Plan.

Agency Comment Form Survey Results

Each member of the SHMT was asked to complete an Agency Comment Form in addition to their participation in the SHMT meetings. The seven agencies who responded are:

State Historical Society,
SD Game, Fish & Parks,
SD Department of Agriculture,
SD Department of Tourism & State Development – Governor's office of Economic Development
SD Department of Environment and Natural Resources
SD Department of Public Safety, Office of Emergency Management
SD Rural Electric Association

The agencies were asked to identify which hazards in the following list are addressed by their department. The State Historical Society does not address any specific hazards.

Table 2-4 summarizes the number of respondents that identified each hazard as one included in their regular duties.

Table 2-4: Hazards Addressed by State Agencies

Hazard	Number of Agencies
Drought	5
Floods	5
Tornadoes	5
Wildfires	5
Hazardous Materials	4
Wildland Interface Fire	4
Winter Storms	4
Landslide and Mudflow	4
Railway Incident	3
Motor Vehicle Incident	3
Ground Transportation Incident	3
Summer Storms	3
Utility Mishap	3
Wind Storms	3
Epidemic	2
Aviation Incident	2
Hail	2
Thunder Storms	2
Extreme Heat	2
Mass Casualty Incident	1
Expansive Soils	1
Urban Fire	1
Earthquake	1

Statewide Existing and Prior Mitigation Projects

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; power line burial, wind spoilers, twisted lines to shed ice building to prevent winter and wind storm damage, and shelters for use in the event of a tornado.

The Rural Electric Association has worked with the Electric Coops 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 statewide mitigation initiatives include the State Drought Task Force and the development and implementation of this Multi-Hazard Mitigation Plan.

The following were suggested as additional participants in the multi-hazard mitigation planning process:

Tribal governments
SD Wildland Fire Suppression
SD Housing Development Authority
SD Tribal Relations
SD State Climatologist
Rural Waters
Rural Telephones

Many of these were contacted and given an opportunity to review and participate in development of this plan update. Those that were unable to participate remain documented for inclusion in the implementation and future updates of this plan.

The State agencies rated six hazard reduction alternatives on a scale of Very Important, Somewhat Important, or Not Important. Table 2-5 identifies the number of "Very Important" responses for each alternative. Prevention, as a method for reducing risks to hazard, was identified as "Very Important" by all respondents. Natural Resource Protection received the next highest amount of "Very Important" votes by the respondents.

Table 2-5: Hazard Reduction Alternatives Ranked by Importance to State Agencies

Hazard Reduction Alternative	Number of "Very Important" Responses
Prevention	7
Natural Resource Protection	5
Property Protection	4
Structural Projects	4
Public Education and Awareness	4
Emergency Service	3

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 (Cindy Maszk) 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.

Public and Stakeholder Survey Results

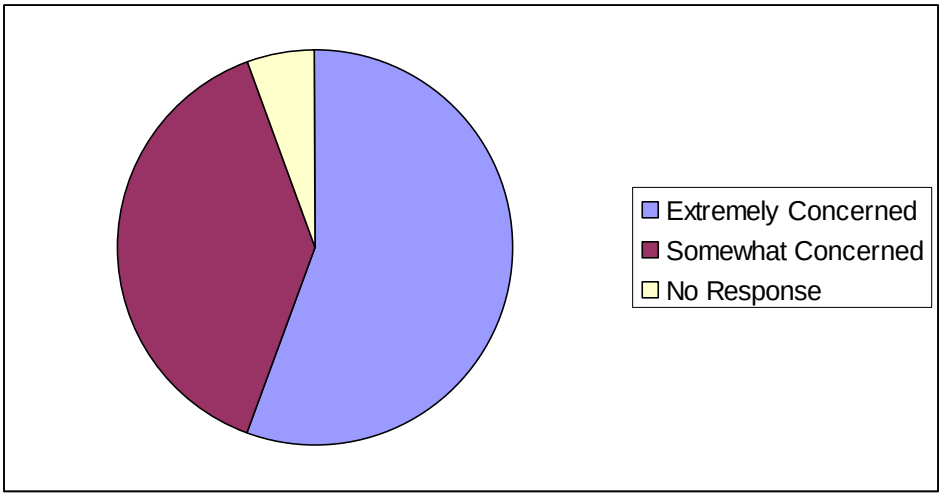
Local representatives were invited to participate in Stakeholder Meetings, as described in Section 2.1, and asked to complete a Public and Stakeholder Survey. This survey provided an opportunity for the local representatives to document their mitigation accomplishments and suggestions as to how the State may continue to assist them in reaching their goals to reduce risk. The format of this survey was very similar to the Agency Comment Form so that the results from the two may be compared for consistency. This section includes a summary of results from the completed Public and Stakeholder Surveys.

Eighteen local agencies responded to the Public and Stakeholder Survey. These respondents were:

Union County Emergency Management
Hughes County
Central Electric Cooperation
Rosebud Sioux Tribe
City of Wall
City of Hill City
Meade County
Pennington County Emergency Management
Charles Mix County Emergency Management
Moody County Emergency Management
Southeastern Electric Coop Inc.
Spink County Emergency Management
Brown County Emergency Management
SDOEM – Regional Coordinator
FEM Electric
Brule/Buffalo Emergency Management District
28CES/CEX Ellsworth Airforce Base
Campbell County Emergency Management

More than half of the respondents indicated they are "Extremely Concerned" about the possibility of being impacted by a natural hazard. Figure 2-1 demonstrates the distribution of the level of concern among the respondents. No respondents marked the "Not Concerned" option on the survey.

Figure 2-1: Local Agency Concern for Future Natural Hazard Impacts



As with the Agency Comment Form, the local agencies were asked to identify hazards addressed by their agencies. Table 2-1 identifies the number of agencies which identified each hazard.

Table 2-6: Hazards Addressed by Local Agencies

Hazard	Number of Agencies
Winter Storms	17
Floods	16
Tornadoes	16
Thunder Storms	14
Wildfires	13
Wind Storms	12
Summer Storms	11
Hazardous Materials	11
Hail	11
Wildland Interface Fire	9
Epidemic	9
Drought	9
Motor Vehicle Incident	8
Utility Mishap	7
Railway Incident	6
Mass Casualty Incident	5
Extreme Heat	5
Ground Transportation Incident	4
Aviation Incident	4
Landslide and Mudflow	4
Urban Fire	3
Nuclear Event	2
Earthquake	2
Dam Break & Drinking Water Contamination	1
Expansive Soils	1

The local agencies were asked 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

	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**
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**

Local Existing and Prior Mitigation Projects

Several existing or prior projects which resulted in or were intended to reduce risk and vulnerability to hazards were identified by the 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.

Several 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 following were suggested as additional participants in the multi-hazard mitigation planning process:

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

Many of these were contacted and given an opportunity to review and participate in development of this plan update. Those that were unable to participate remain documented for inclusion in the implementation and future updates of this plan.

The local agencies rated six hazard reduction alternatives on a scale of Very Important, Somewhat Important, or Not Important. Table 2-8 identifies the number of "Very Important" responses for each alternative. Prevention and Emergency Service received the highest number of "Very Important" responses at 15 each. Natural Resource Protection and Public Education and Awareness each received 13 "Very Important" responses.

Table 2-8: Hazard Reduction Alternatives Ranked by Importance to Local Agencies

Hazard Reduction Alternative	Number of "Very Important" Responses
Prevention	15
Emergency Service	15
Natural Resource Protection	13
Public Education and Awareness	13
Property Protection	9
Structural Projects	9

Suggested Local Projects
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.

Complete responses to the Public and Stakeholder Surveys may be found in Appendix B.

2.3 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 has identified the priority for mitigation strategy implementation to support local mitigation needs. This 2007 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.

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.

Outreach

During the preparation of this 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. It was also distributed at three applicant briefings following the Aberdeen floods disaster declaration (DR-1702-SD). These applicant briefings were held July 24th – 26th 2007 in Rapid City, Pierre, and Huron.

In addition, SDOEM partnered 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).

Between August 3rd and 15th, 2007 the SHMO met with 8 native American tribes and distributed the mitigation brochure, funding information for DR-1702-SD, and the B.ready information.

Outreach materials used in the efforts mentioned above are included as Appendix D.

Completed Mitigation Projects

The State of South Dakota has 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

At the time this plan was written, 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.

Funding sources for all approved mitigation projects since the prior hazard mitigation plan include the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM); and Flood Mitigation Assistance (FMA). Table 2-9 lists the HMGP approved mitigation projects since the completion of the prior hazard mitigation plan. Table 2-10 lists the approved 2005 PDM projects. No projects were submitted in 2006 or 2007. There are 18 PDM projects under review by FEMA for 2008. Future plan updates may include

mention of mitigation actions implemented by other state agencies such as South Dakota Dept. of Agriculture, Resource Conservation and Forestry division.

Table 2-9: Approved HMGP Projects Since Completion of Prior Hazard Mitigation Plan (2005- 2007)

Disaster Declaration	Declaration Date	Project Description	Status
DR-1596-SD	July 22, 2005	Oahe Electric Spoiler	Closed, April 2007
DR-1620-SD	December 20, 2005	State Plan Update	On-going
DR-1620-SD	December 20, 2005	Jackson County Plan	On-going
DR-1620-SD	December 20, 2005	Moody County Plan	On-going
DR-1620-SD	December 20, 2005	Beadle County Powerline Burial	On-going
DR-1620-SD	December 20, 2005	Douglas County Powerline Burial	On-going
DR-1620-SD	December 20, 2005	Hutchinson County Powerline Burial	On-going
DR-1620-SD	December 20, 2005	Davison/Hanson County(s) Powerline Burial	In closeout process
DR-1647-SD	June 5, 2006	Beadle County Powerline Burial	On-going
DR-1647-SD	June 5, 2006	Kingsbury County Powerline Burial	On-going
DR-1702-SD	May 22, 2007	14 Various Projects (in NEMIS)	Pending FEMA Approval
This table is to be monitored and updated by the SHMO on a six month basis and after every declared disaster.			

Table 2-10: PDM Projects for Fiscal Year 2005

Grant Program	Subgrantee	Project Description	Performance Period	Project Due Date	STATUS
PDM-SD-2005-001	MARSHALL COUNTY	PDM CTY PLAN	8/8/2005	10.01/2008	**APPROVED**
PDM-SD-2005-002	HAMLIN COUNTY	PDM CTY PLAN	2/6/2006	10.01/2008	**APPROVED**
PDM-SD-2005-003	KINGSBURY COUNTY	PDM CTY PLAN	8/8/2005	10.01/2008	**APPROVED**
PDM-SD-2005-004	CLARK COUNTY	PDM CTY PLAN	8/8/2005	10.01/2008	**APPROVED**
PDM-SD-2005-005	GRANT COUNTY	PDM CTY PLAN	9/12/2005	10.01/2008	**APPROVED**
PDM-SD-2005-006	MINER COUNTY	PDM CTY PLAN	9/12/2005	10.01/2008	**APPROVED**
PDM-SD-2005-007	POTTER COUNTY	PDM CTY PLAN	2/6/2006	10.01/2008	**APPROVED**
PDM-SD-2005-008	CHARLES MIX CTY	PDM CTY PLAN	9/12/2005	10.01/2008	**being completed**
PDM-SD-2005-009	SPINK COUNTY	PDM CTY PLAN	9/12/2005	10.01/2008	**APPROVED**
PDM-SD-2005-010	FALL RIVER COUNTY	PDM CTY PROJECT	8/8/2005	10.01/2008	**being completed**
PDM-SD-2005-011	MCPHERSON CTY	PDM CTY PLAN	9/12/2005	10.01/2008	**APPROVED**
PDM-SD-2005-012	FAULK COUNTY	PDM CTY PLAN	8/8/2005	10.01/2008	**APPROVED**
PDM-SD-2005-013	DAY COUNTY	PDM CTY PLAN	8/8/2005	10.01/2008	**FEMA review**
PDM-SD-2005-014	ROBERTS COUNTY	PDM CTY PLAN	8/8/2005	10.01/2008	**APPROVED**
PDM-SD-2005-016	PERKINS COUNTY	PDM CTY PLAN	8/8/2005	10.01/2008	**being completed**
PDM-SD-2005-017	STATE PLAN UPDATE	PDM STATE PLAN	8/26/2005	10.01/2008	**being completed**

Additional details on the active PDM projects are included in Appendix C.

The State's implementation of mitigation project funding extends to the local Native American tribes as shown below.

FEMA-1702-DR-SD

TRIBAL RELATIONS PLAN

MILESTONES	TARGET DATE	COMPLETION DATE	REMARKS
PA Activities:			
Pine Ridge Indian Reservation			
PDA		17-May-07	Road damage
RPA		25-May-07	
Initial Disaster Briefing		5-Jun-07	
PA Kickoff	8-Jun-07	8-Jun-07	Tribal Housing damages reported-followup-6/14
PW's Complete			
Crow Creek Indian Reservation			
PDA		17-May-07	Road damage
PRA		29-May-07	
Initial Disaster Briefing		7-Jun-07	
PA Kickoff	7-Jun-07	7-Jun-07	Road damage only
PW's Complete			
Sisseton-Wahpeton Oyate			
PDA		17-Jun-07	No reported damage during PDA
RPA		6-Jun-07	Reported damages from June storms
PA closeout	12-Jun-07		not eligible for PA
IA Activites:			
Aberdeen Indian Health Service	30-May-07	30-May-07	
Aberdeen Bureau of Indian Affairs	1-Jun-07	1-Jun-07	
Sisseton-Wahpeton Oyate	1-Jun-07	4-Jun-07	IA information provided to Tribal EM
HMGP Activities:			
Pine Ridge Indian Reservation			
HMGP Briefing	14-Jun-07		Mitigation Plan meeting
Crow Creek Indian Reservation			
HMGP Briefing	13-Jun-07		Mitigation Plan meeting
Sisseton-Wahpeton Indian Reservation			
HMGP Briefing	12-Jun-07		HMGP Project meeting

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SECTION 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 3-2)
- Risk assessments of the 48 local hazard mitigation plans (covering 60 counties) submitted to the state prior to October 2007
- 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.

3.1.1 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.

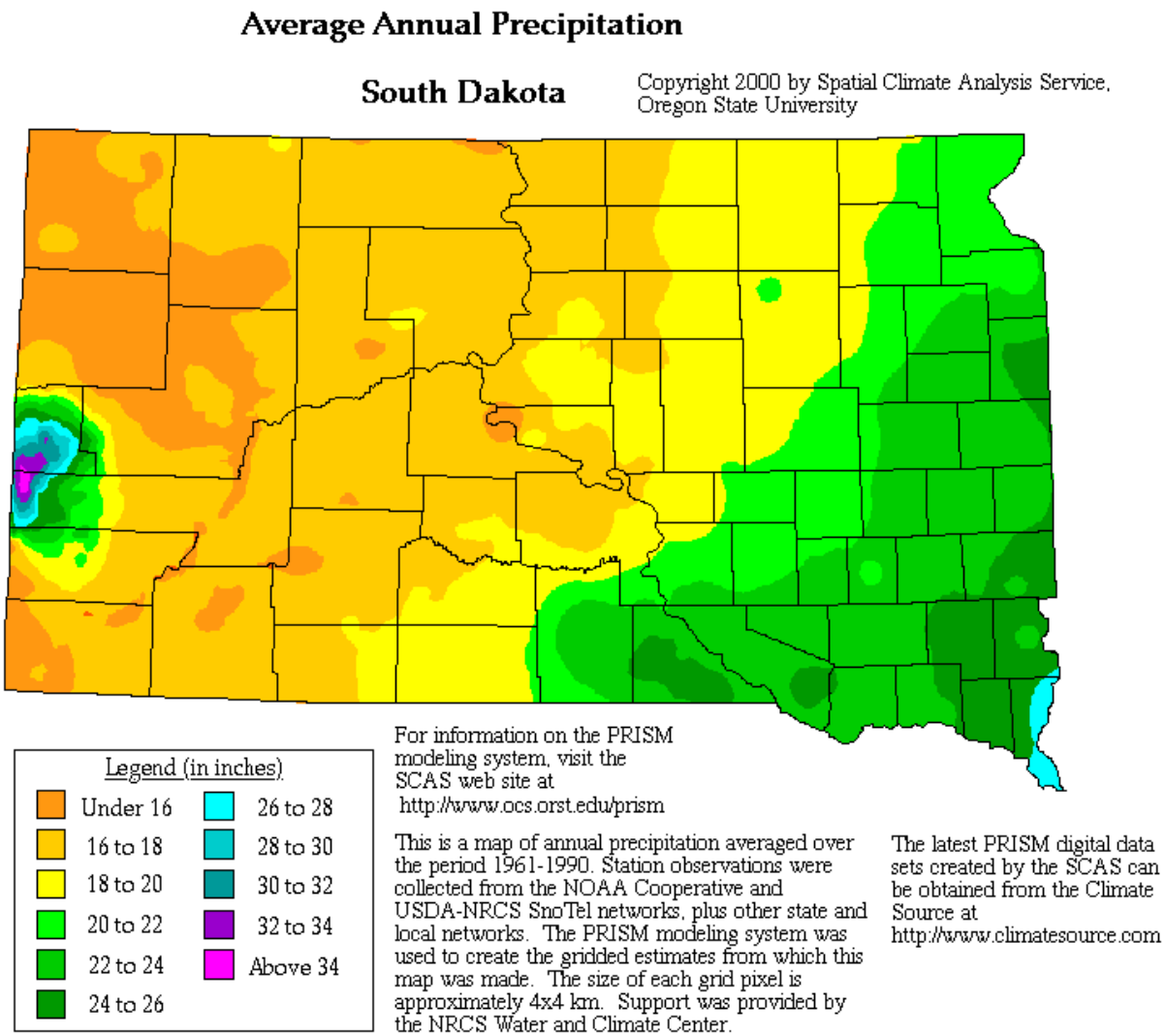
The **Great Plains** cover most of the western two thirds of South Dakota. The Coteau de Missouri hills and valleys lie between the James River Basin of the Drift Prairie and the Missouri River. West of the Missouri River much landscape becomes more rugged and consists of rolling hills, plains, canyons, 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.

3.1.2 Climate

- **Highest Temperature**—The highest temperature recorded in South Dakota is 120°F. This record high was recorded on July 5, 1936 at Gannvalley.
- **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



3.1.3 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:

- Floods (flash, long-rain, snowmelt, and dam failure floods)
- Winter Storms
- Wildfires
- Drought*
- Tornadoes
- Wind*
- Hazardous Materials*
- Landslides and Mudflows
- Earthquakes

*During the 2007 plan update, the State Hazard Mitigation Team reexamined the hazards that threaten South Dakota and added drought, wind, and hazardous materials. Based on a hazard ranking exercise (see below), all three of these hazards were determined to be of greater concern than landslides/mudflows and earthquakes, which had been identified in the previous plan, and drought was found to rank slightly higher in significance than tornadoes.

The following natural hazards are not included in this analysis because they do not threaten South Dakota: avalanches, coastal erosion, coastal storms, hurricanes, land subsidence, tsunamis, and volcanoes. While expansive soils, extreme heat, and hailstorms are recognized as hazards in South Dakota, their impacts tend to be limited and not tax state resources or result in presidential disaster declarations; so they are not addressed further in this document. 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 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 difficult to quantify the impacts. Manmade and biological hazards were also considered, but none (with the exception of hazardous materials) were deemed significant enough to warrant further analysis at this time. Terrorism was considered for inclusion in the plan in 2007, but the State Hazard Mitigation Team felt this hazard is already, and more appropriately, being addressed by other state agencies and in other planning mechanisms.

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 3-1 indicates the ranking established by the state using the method described above.

Table 3-1: Hazard Ranking and Planning Consideration

Hazard Type and Ranking	Planning Consideration Based on Hazard Level
Flooding	Significant
Winter Storms	Significant
Wildfires	Significant
Drought	Significant
Tornadoes	Significant
Wind	Moderate
Hazardous Materials	Moderate
Landslides and Mudflows	Limited
Earthquakes	Limited

A Hazard Identification and Ranking Worksheet is included on the following page and contains the calculations and formulas utilized.

South Dakota Hazard Ranking Worksheet

Hazard Type	Probability	Impact			Total Score	Hazard Planning Consideration
		Affected Area	Primary Impact	Secondary Impacts		
Flooding	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	4	3	2	4	46.40	Significant
Tornadoes	4	1	4	4	44.80	Significant
Wind	4	2	2	2	32.00	Moderate
Hazardous Materials	4	1	1	3	24.00	Moderate
Landslides/Mudflows	2	1	1	2	10.00	Limited
Earthquake	2	1	1	1	8.00	Limited

Probability: Importance 2.0	Score
Unlikely	1
Somewhat Likely	2
Likely	3
Highly Likely	4

Affected Area: Importance 0.8	Score
Isolated	1
Small	2
Medium	3
Large	4

Primary Impact: Importance: 0.7	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	Score
Negligible - no loss of function, downtime, and/or evacuations	1
Limited - minimal loss of function, downtime, and/or evacuations	2
Moderate - some loss of function, downtime, and/or evacuations	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	Hazard Level
0.0 - 20.0	Limited
21.0 - 42.0	Moderate
43.0 - 64.0	Significant

1

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 60 counties with approved local mitigation plans 57 identified flooding, 59 identified winter storms, 54 identified wildfires, 48 identified drought, 42 identified tornadoes, 29 identified wind, 52 identified hazardous materials, 7 identified landslides and mudflows, and 18 identified earthquakes 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:

Thunderstorms (19) *(see flooding, tornadoes, and wind),*
Summer storms (18) *(see flooding, tornadoes, and wind),*
Hail (17),
Lightning strikes (14),
Ice storms (10) *(see winter storms),*
Wildland interface fire (13) *(see wildfires),*
Urban fire (32),
Transportation incidents (33),
Utility mishap (14),
Nuclear incident (11), and
Mass casualty incident (17)

It must be noted that 51 of the 60 counties 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.

3.1.4 Presidential Declarations

Table 3-2 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 1990s the state has had a presidential declaration on nearly an annual basis.

Table 3-2: 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-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
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

Declaration Number	Declaration Date	Incident Period Start	Incident Period End	Cost Share % (Federal/State)	Counties (#)	Disaster Type	FEMA Disaster Relief Costs[1]
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
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

Declaration Number	Declaration Date	Incident Period Start	Incident Period End	Cost Share % (Federal/State)	Counties (#)	Disaster Type	FEMA Disaster Relief Costs[1]
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
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 of FEMA-1702-DR, which is a 2007 event). 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).

3.1.5 Probability of Future Events

Predicting probability of future events is estimated by looking at the number of past damaging events, where possible, 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 of these are more likely to occur and cause more damage than others, which is discussed in more detail in the 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

3.2.1 Flood Hazard Profile

3.2.1.1 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. 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.

South Dakota has approximately 2,500 dams in the National Inventory of Dams (see Figure 3-3 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 82 are high hazard dams. Sixty one of these high hazard dams, of which 31 are state regulated, have emergency action plans. 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 21 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. While not required, 13 significant hazard dams, 6 of which are state regulated, have emergency action plans. 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.

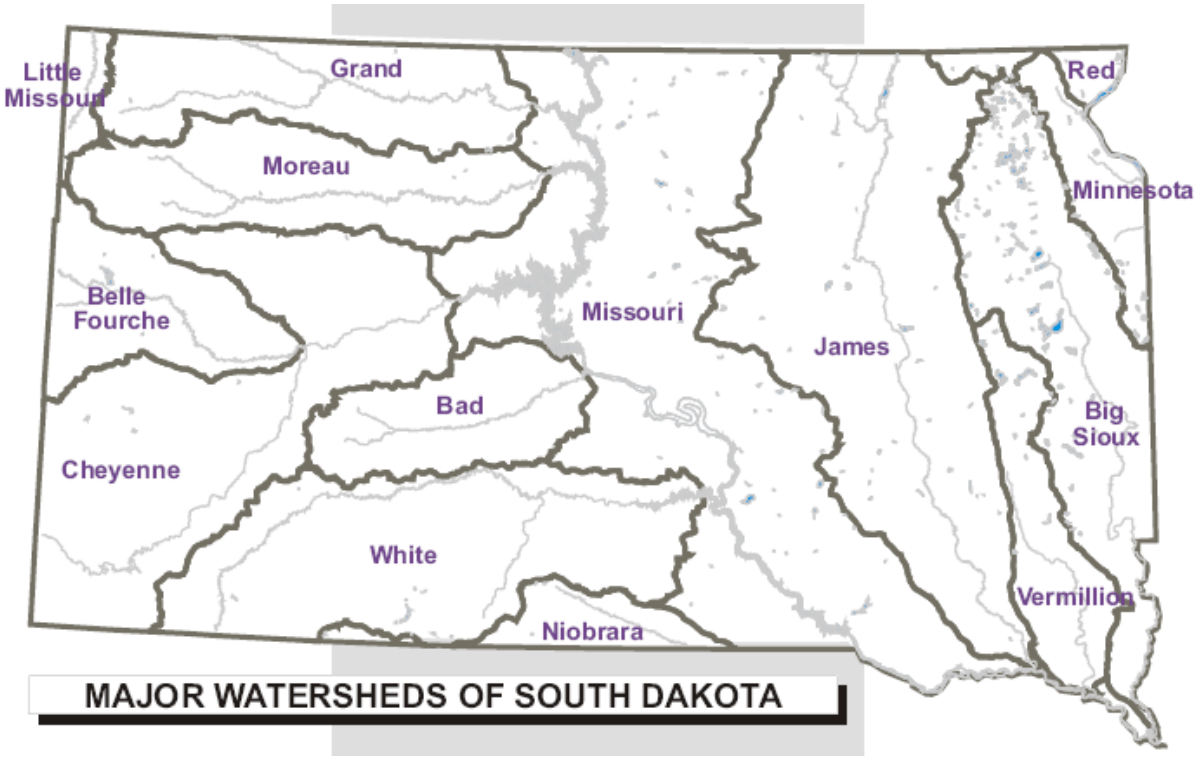
3.2.1.2 Location

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 3-2). 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 3-2: Drainage Basins of South Dakota



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

3.2.1.2.1 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.

3.2.1.2.2 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.

3.2.1.2.3 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.

3.2.1.2.4 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.

3.2.1.2.5 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.

3.2.1.2.6 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

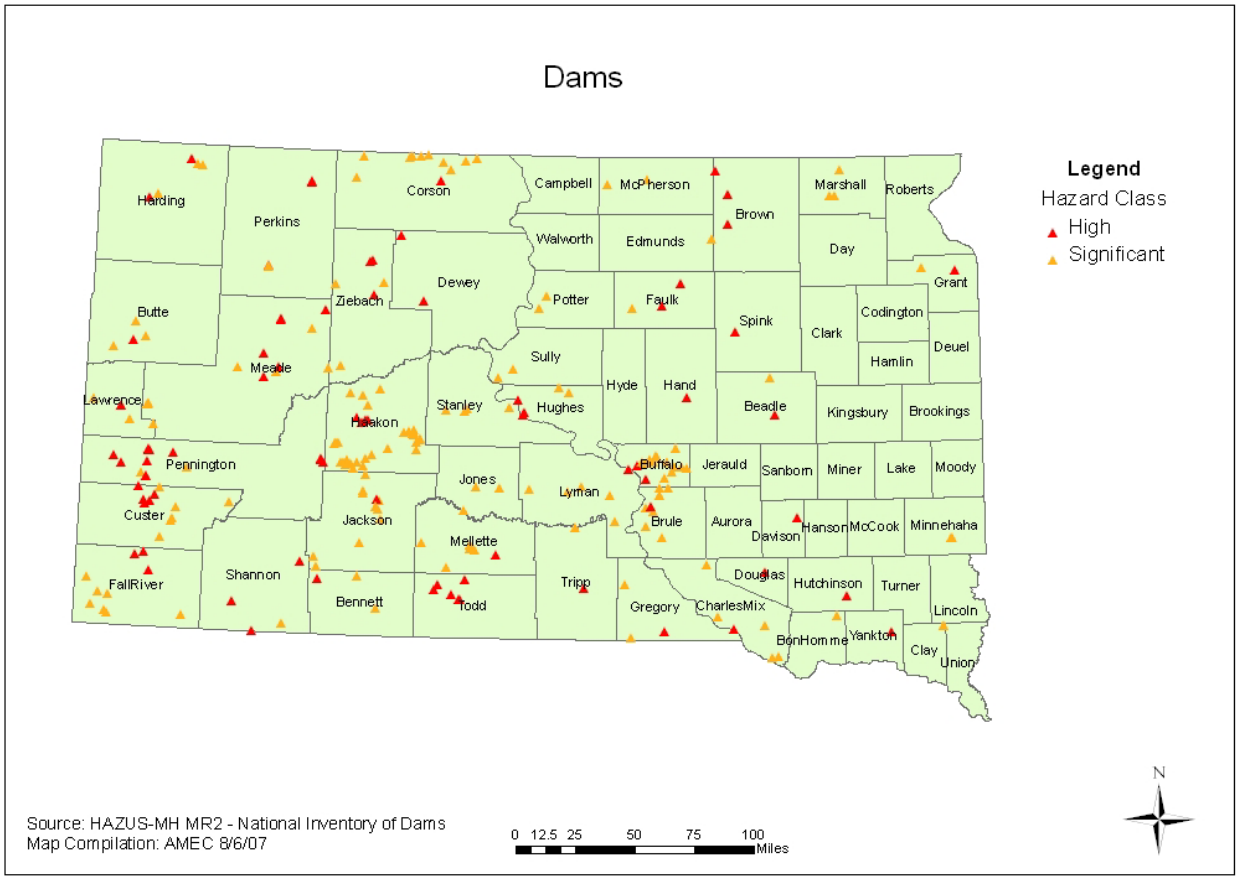
Dog, Enemy Swim, and Pickerel lakes have concrete weir outlet structures and experienced lake level increases of 2.7, 1.8, and 0.1 feet respectively between fall 1991 and fall 1998. Minnewasta and Rush lakes experienced lake level increases of 9.2 feet and 3.9 feet respectively.

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.

3.2.1.2.7 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 3-3 shows the locations of the high and significant hazard dams in South Dakota.

Figure 3-3: South Dakota Dams



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

3.2.1.3 Past Events

According to the National Climatic Data Center Storm Events database, there were 329 floods in South Dakota between 1993 and 2006. Total property and crop damage for these events is estimated at $244 million in 2006 dollars. This suggests that South Dakota experiences 23.5 floods and $17 million in flood losses (property and crop) each year. There were two deaths and three injuries in this time period. Table 3C 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 3-3: South Dakota Flood Events

Date	Comments
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 2007	**Severe Storms, Tornadoes, and Flooding (FEMA-1702-DR)** 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

Date	Comments
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 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.

Date	Comments
	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 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

Date	Comments
	form 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 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–	**Flooding, Severe Storms, Tornadoes (FEMA-999-DR)** Early and rapid snowmelt resulted in localized flooding along portions of the three

Date	Comments
September 1993	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. 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

Date	Comments
	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 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

Date	Comments
	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 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.

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	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)** 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

Date	Comments
	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 evacuated.
June 17, 1957	General Comments: Rated as a 10 to greater than a 100-year event. Five deaths. Attributed solely to rain.

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	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 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

Date	Comments
	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.

3.2.1.4 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 $17 million per year in average annualized losses to the state.

3.2.2 Winter Storm Hazard Profile

3.2.2.1 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.

3.2.2.2 Location

The topography of South Dakota is such that no one area is immune from effects of winter storms. 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.

3.2.2.3 Past Events

According to the National Climatic Data Center Storm Events database, there were 357 winter storms (snow and ice events) in South Dakota between 1993 and 2006. Total property damage for these events is estimated at $195 million in 2006 dollars. This suggests that South Dakota experiences 25.5 winter storms and $14 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 14 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.

Table 3-4: South Dakota Winter Storm Events

Date	Comments
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 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.

Date	Comments
	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.
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 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.

Date	Comments
	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 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.

Date	Comments
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, over-turned 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 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.

Date	Comments
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.

3.2.2.4 Probability

According to the National Climatic Data Center, there were 357 winter storm events in South Dakota between 1993 and 2006 (14 years). 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 $14 million in winter storm losses each year.

3.2.3 Wildfire Hazard Profile

3.2.3.1 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 and widespread infestations by tree-killing beetles has created the potential for catastrophic wildfires in South Dakota. 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 presettlement 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.

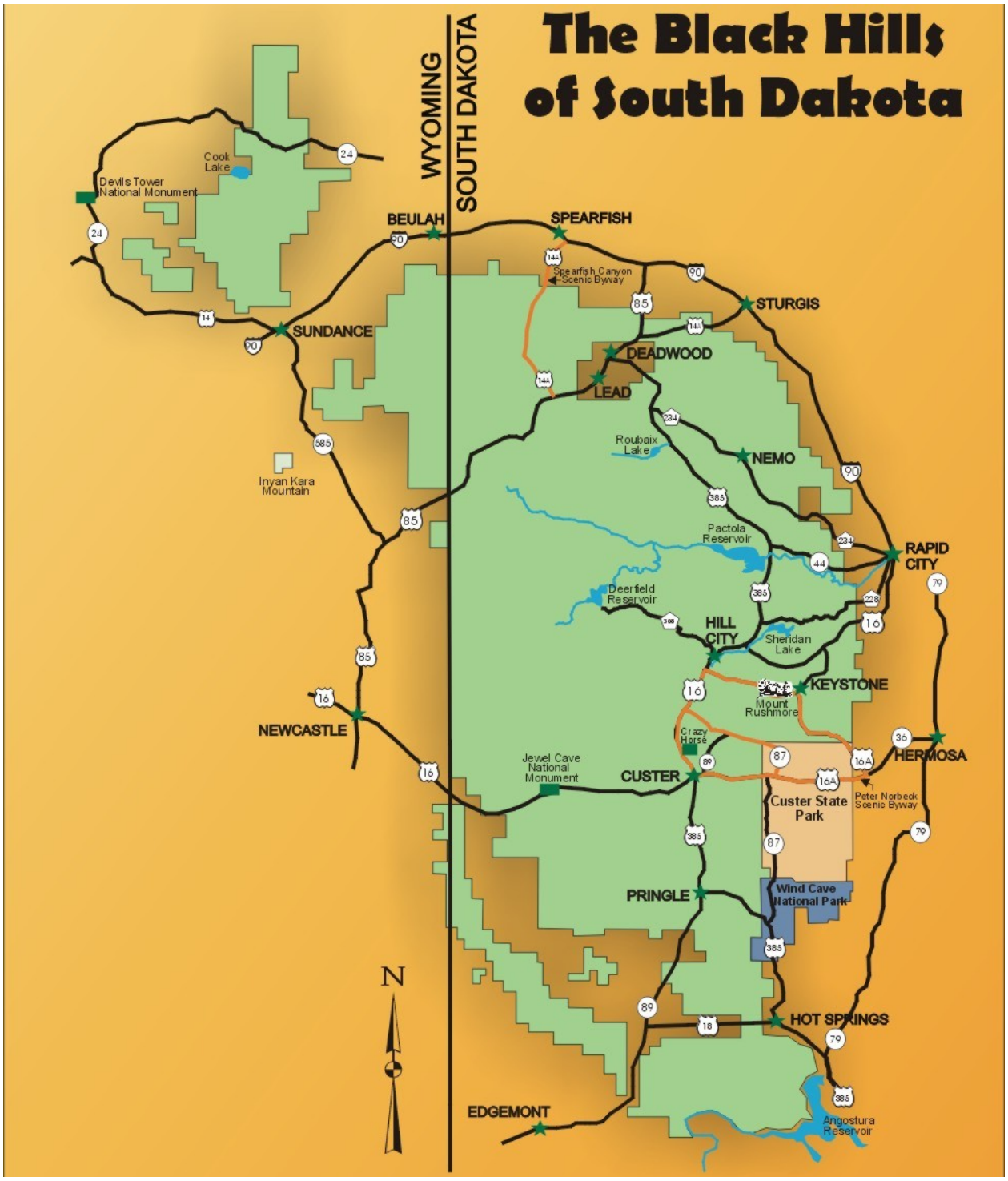
3.2.3.2 Location

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 3-4). 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 3-4: 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.

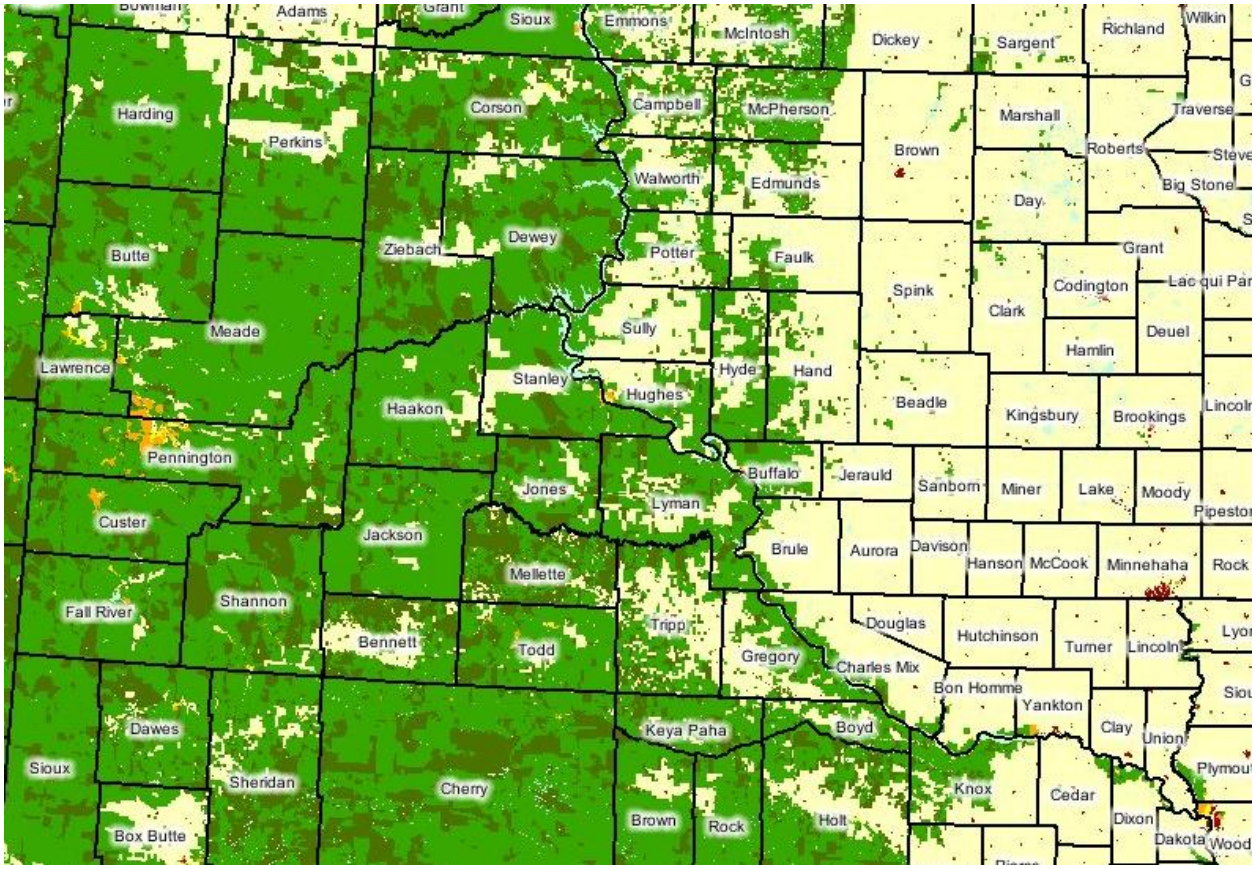
The greatest concentration of structures is located in and around the towns and cities in the Black Hills, including subdivisions within a few miles of the town and city limits. Rapid City and bedroom communities within a five-mile radius of the city represent the greatest concentration of structures 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.

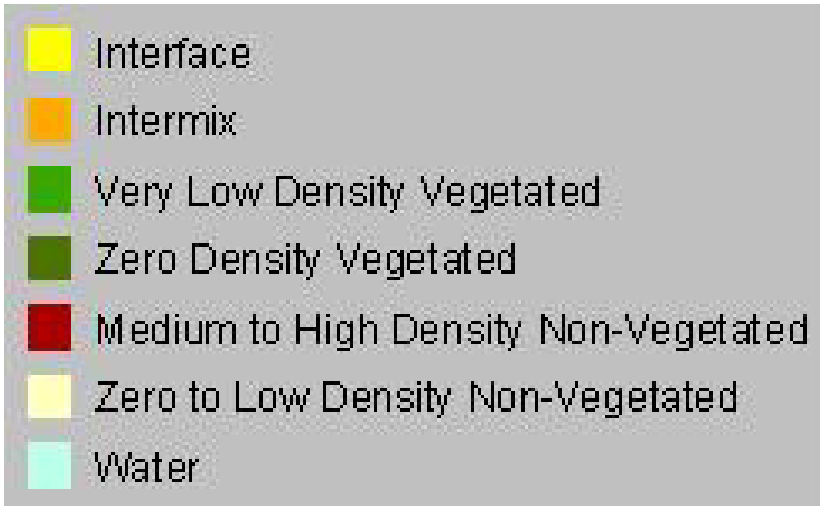
Many new residents are unfamiliar with the realities and responsibilities of living in a fire dependent ecosystem such as the Black Hills, are unaware of the natural role of fire, the concept of defensible space, and the capabilities of local government services. Many homeowners seem to value aesthetics 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 3-5 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 3-5: South Dakota's Wildland-Urban Interface





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

3.2.3.3 Past Events

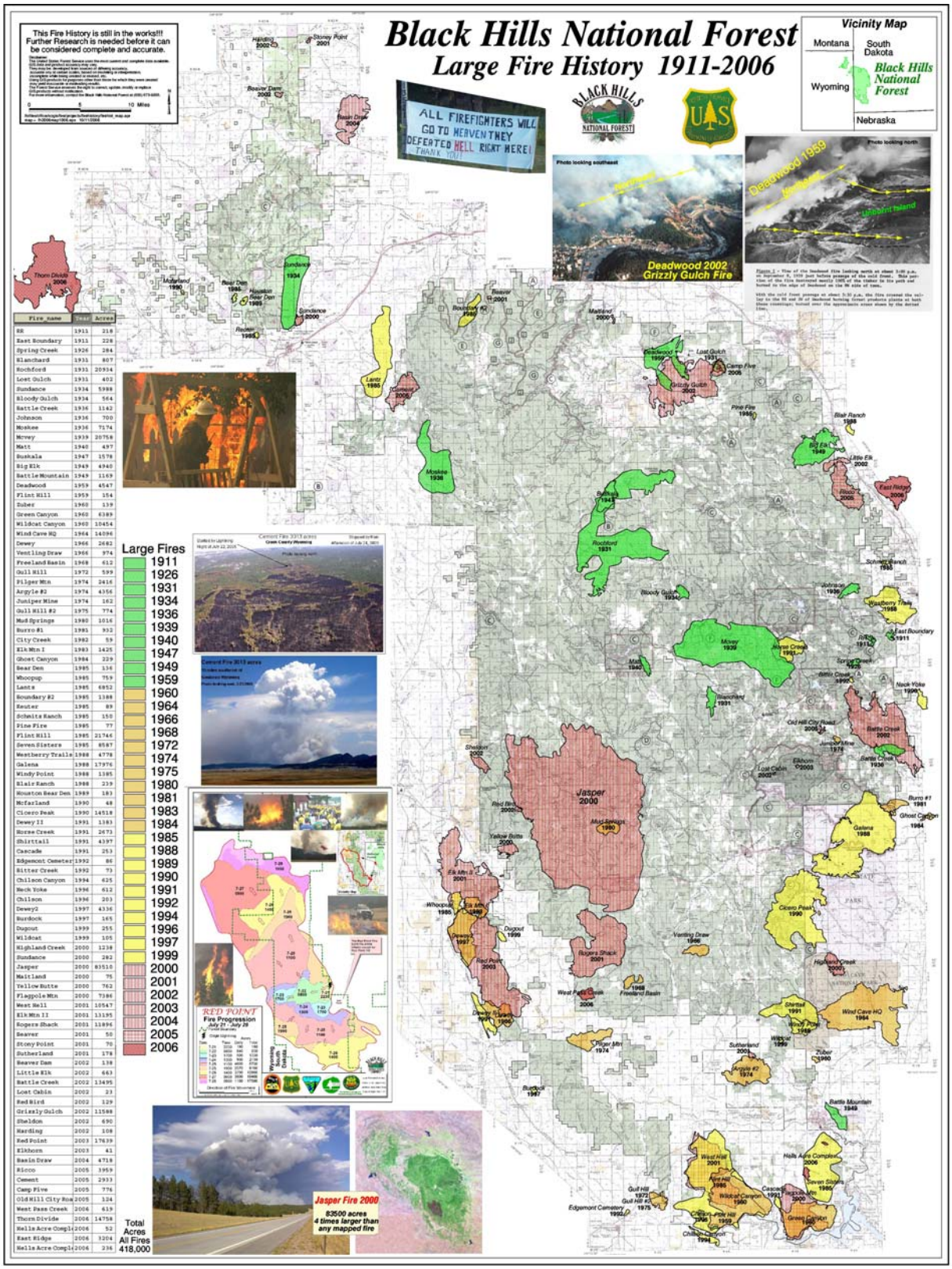
The South Dakota Department of Agriculture's Division of Resource Conservation and Forestry database indicates that lightning represents the single largest ignition source in its jurisdiction, causing 35 percent of fires and burning 41 percent of the acreage lost between 1996 and 2000. While debris burning caused slightly more fires, these fires burned only about one third of the acreage lost to lightning-caused fires. Table 3E contains information about wildfires in the Black Hills between 1977 and 2000. Figure 3-6 shows the large fire history for the Black Hills National Forest between 1911 and 2006 from South Dakota Wildland Fire Suppression.

Table 3-5: 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

Figure 3-6: Black Hills National Forest Large Fire History, 1911 – 2006



Fire_name	Year	Acres
RS	1911	218
East Boundary	1911	228
Spring Creek	1926	284
Blanchard	1931	807
Rochford	1931	20934
Lost Gulch	1931	402
Sundance	1934	5988
Bloody Gulch	1934	564
Battle Creek	1936	1142
Johnson	1936	700
Moskee	1936	7174
Mcvey	1939	20758
Matt	1940	497
Buskala	1947	1578
Big Elk	1949	4940
Battle Mountain	1949	1169
Deadwood	1959	4547
Flint Hill	1959	154
Suber	1960	139
Green Canyon	1960	6389
Wildcat Canyon	1960	10454
Wind Cave HQ	1964	14096
Dewey	1966	2682
Ventling Draw	1966	974
Freeland Basin	1969	612
Gull Hill	1972	599
Pilger Mtn	1974	2416
Argyle #2	1974	4356
Juniper Mine	1974	162
Gull Hill #2	1975	774
Mud Springs	1980	1016
Burro #1	1981	932
City Creek	1982	39
Elk Mtn I	1983	1425
Ghost Canyon	1984	229
Bear Den	1985	136
Whoopup	1985	759
Lants	1985	6852
Boundary #2	1985	1188
Reuter	1985	89
Schmitz Ranch	1985	150
Pine Fire	1985	77
Flint Hill	1985	21746
Seven Sisters	1985	8587
Westberry Trails	1988	4778
Galena	1988	17976
Windy Point	1988	1185
Blair Ranch	1988	239
Houston Bear Den	1989	183
Mcfarland	1990	48
Cicero Peak	1990	14518
Dewey II	1991	1383
Horse Creek	1991	2673
Shirttail	1991	4397
Cascade	1991	253
Edgemont Cemeter	1992	86
Ritter Creek	1992	73
Chilson Canyon	1994	625
Nock Yoke	1996	612
Chilson	1996	203
Dewey2	1997	4336
Burdock	1997	165
Dugout	1999	255
Wildcat	1999	105
Highland Creek	2000	1238
Sundance	2000	282
Jasper	2000	83510
Maitland	2000	75
Yellow Butte	2000	762
Flagpole Mtn	2000	7386
West Hell	2001	10547
Elk Mtn II	2001	13195
Rogers Shack	2001	11896
Beaver	2001	50
Stony Point	2001	75
Sutherland	2001	178
Beaver Dam	2002	138
Little Elk	2002	663
Battle Creek	2002	13495
Lost Cabin	2002	23
Red Bird	2002	129
Grizzly Gulch	2002	11588
Sheldon	2002	690
Harding	2002	108
Red Point	2003	17639
Elkhorn	2003	41
Basin Draw	2004	4718
Ricco	2005	3959
Cement	2005	2933
Camp Five	2005	776
Old Hill City Roa	2005	124
West Pass Creek	2006	619
Thorn Divide	2006	14758
Hells Acre Compl	2006	52
East Ridge	2006	3204
Hells Acre Compl	2006	236

Table 3-6: 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 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"

Date	Comments
	(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. 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

Date	Comments
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.
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.

Date	Comments
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.

3.2.3.4 Probability

Wildfires have a 100 percent chance of occurrence from early spring to late fall every year.

3.2.4 Drought

3.2.4.1 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.

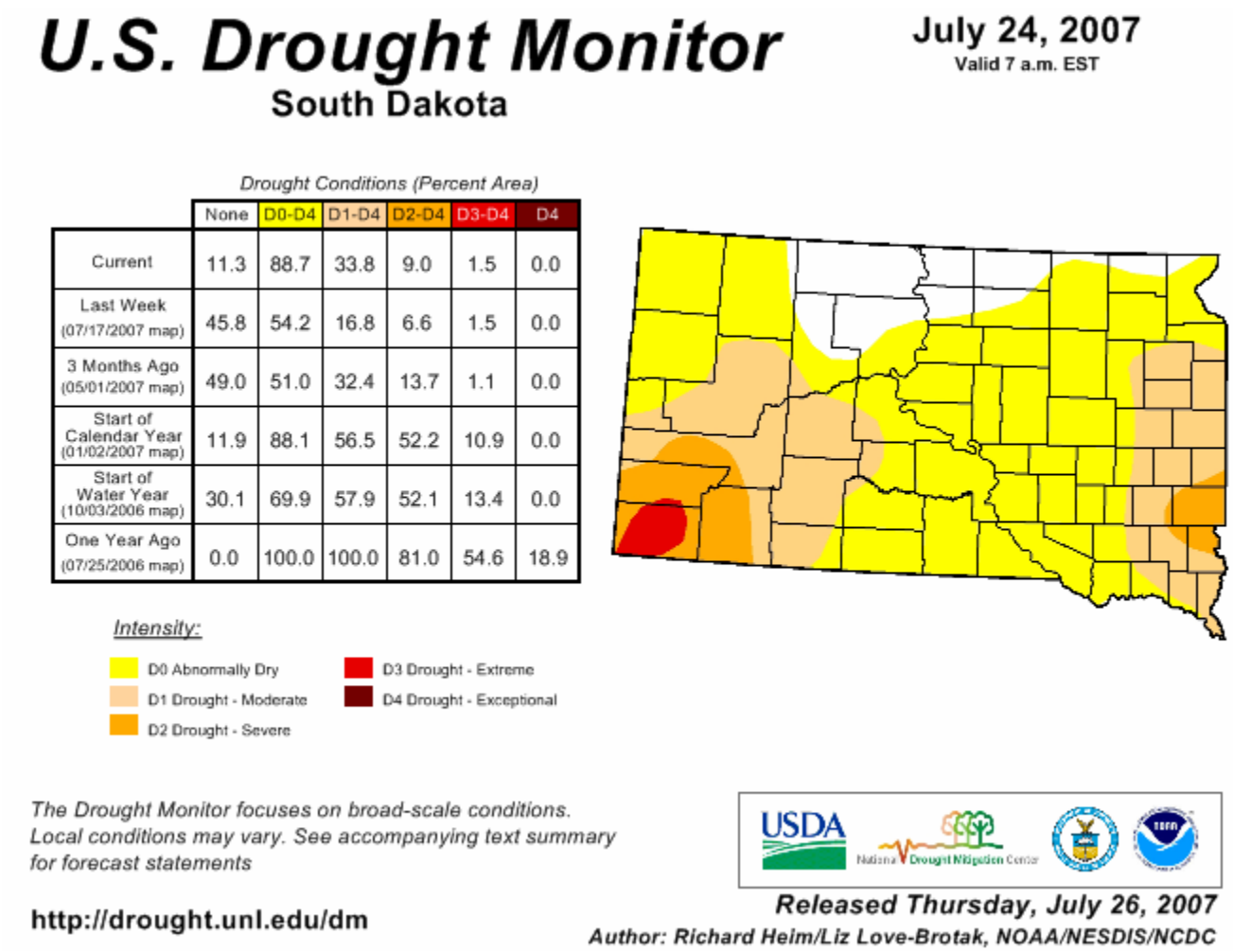
South Dakota is vulnerable to the social, economic, and environmental impacts of drought. Specifically, drought in South Dakota means limited water availability for people, agriculture, and recreation. The demand for water for multiple uses also impacts water availability. Rural water systems designed 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.

South Dakota has been experiencing some level of drought since 2002. Some years have been worse than others, and some areas have been harder hit than others, but there has not been any real wet period in recent years. The U.S. Drought Monitor summarizes current 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 3-7.

Figure 3-7: 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

3.2.4.2 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. The Drought Monitor graphic above illustrates South Dakota's drought status as of July 24, 2007.

Figure 3-8 shows the state's drought status a little more than a month prior. Together the two graphics show how intensity and coverage varies over time.

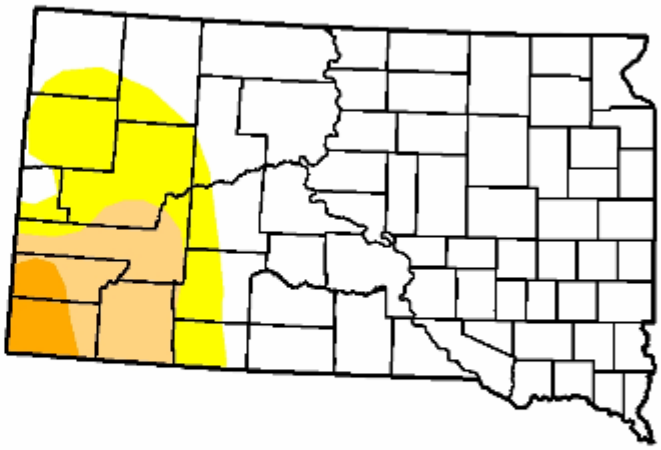
Figure 3-8: South Dakota's Drought Status, June 12, 2007

U.S. Drought Monitor
South Dakota

June 12, 2007
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	76.4	23.6	10.6	2.5	0.0	0.0
Last Week (06/05/2007 map)	64.2	35.8	10.6	2.5	0.0	0.0
3 Months Ago (03/20/2007 map)	30.1	69.9	55.9	43.1	3.6	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 (06/13/2006 map)	9.7	90.3	54.2	27.2	5.1	0.0



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements

http://drought.unl.edu/dm

USDA National Drought Mitigation Center

Released Thursday, June 14, 2007
Author: Rich Tinker, CPC/NCEP/NWS/NOAA

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

3.2.4.3 Past Events

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 3-7.

Table 3-7: 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
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 225 drought impacts from droughts that affected South Dakota between January 1, 1980 and July 2007. Most of the impacts, 86, were classified as "agriculture." Other impacts include "water/energy" (43), "social" (28), "fire" (20), "environment" (18), and "other" (43). 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.

The July 24, 2007, Drought Monitor for South Dakota (

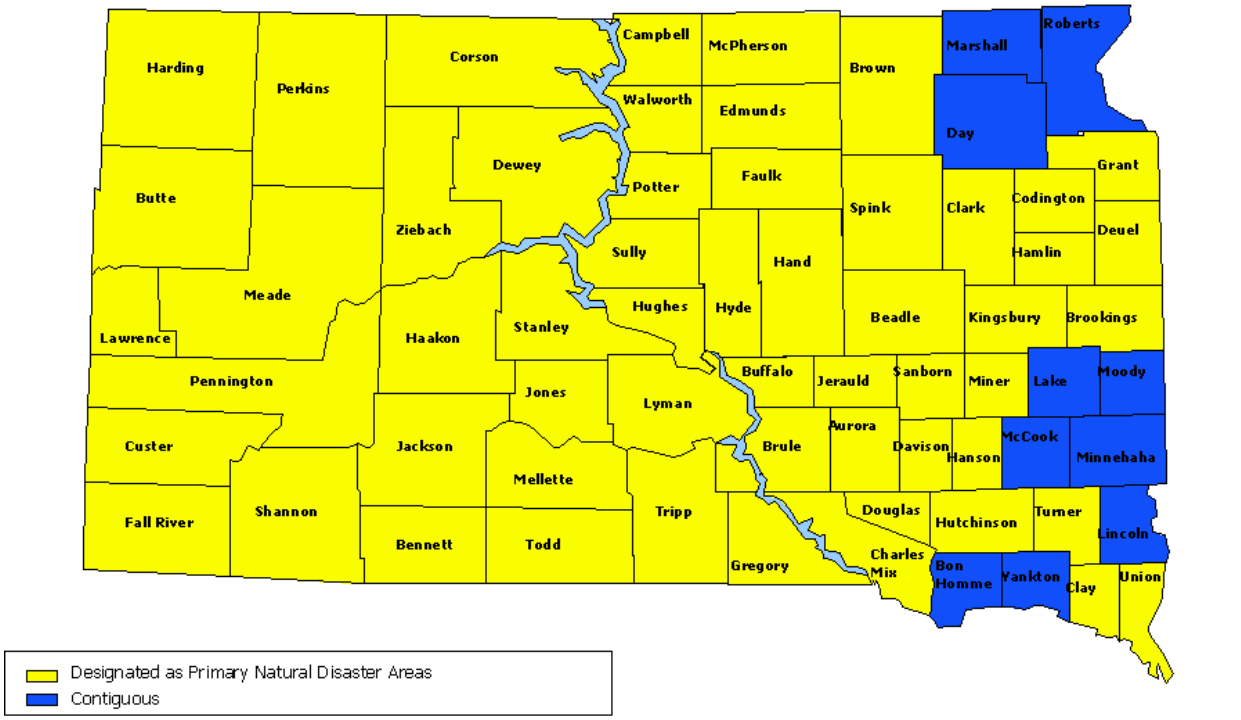
Figure 3-7) showed that drought encompassed most of the state. Most of Fall River County was experiencing severe drought conditions that also reached north into southern Custer County.

Table 3-8: South Dakota Droughts

2007	Drought continues in some areas of South Dakota.
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 (see Figure 3-9).
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.
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. Source: National Climatic Data Center
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.
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.

Figure 3-9: South Dakota Counties Declared in 2006 by U.S. Department of Agriculture for Drought Assistance



South Dakota Office of Emergency Management
December 6, 2006

3.2.4.4 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. Inadequate data on past impacts exists to calculate average annual losses, but it is assumed to be in the millions of dollars.

3.2.5 Tornado Hazard Profile

3.2.5.1 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 3-9 shows the wind speeds associated with the original Fujita scale ratings and the damage that could result at different levels of intensity. Table 3J 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 3-9: 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 3-10: 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	

3.2.5.2 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 3-10 illustrates the number of F3, F4, and F5 tornadoes recorded in the United States per 3,700 square miles between 1950 and 1998. Figure 3-11 illustrates the wind zones in the United States. By noting the South Dakota data from these two maps and matching them up in Table 3-11, 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 3-10: Tornado Activity in the United States

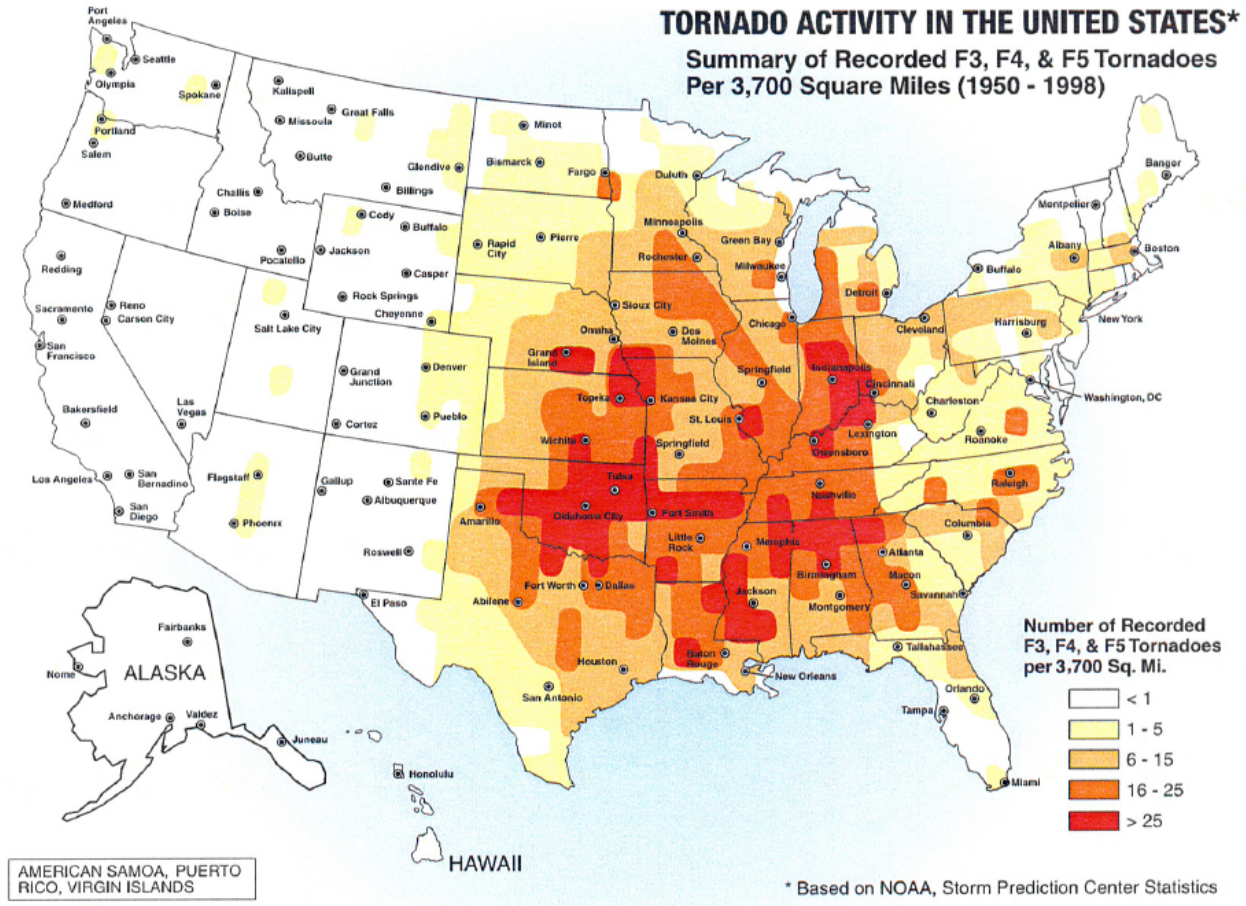
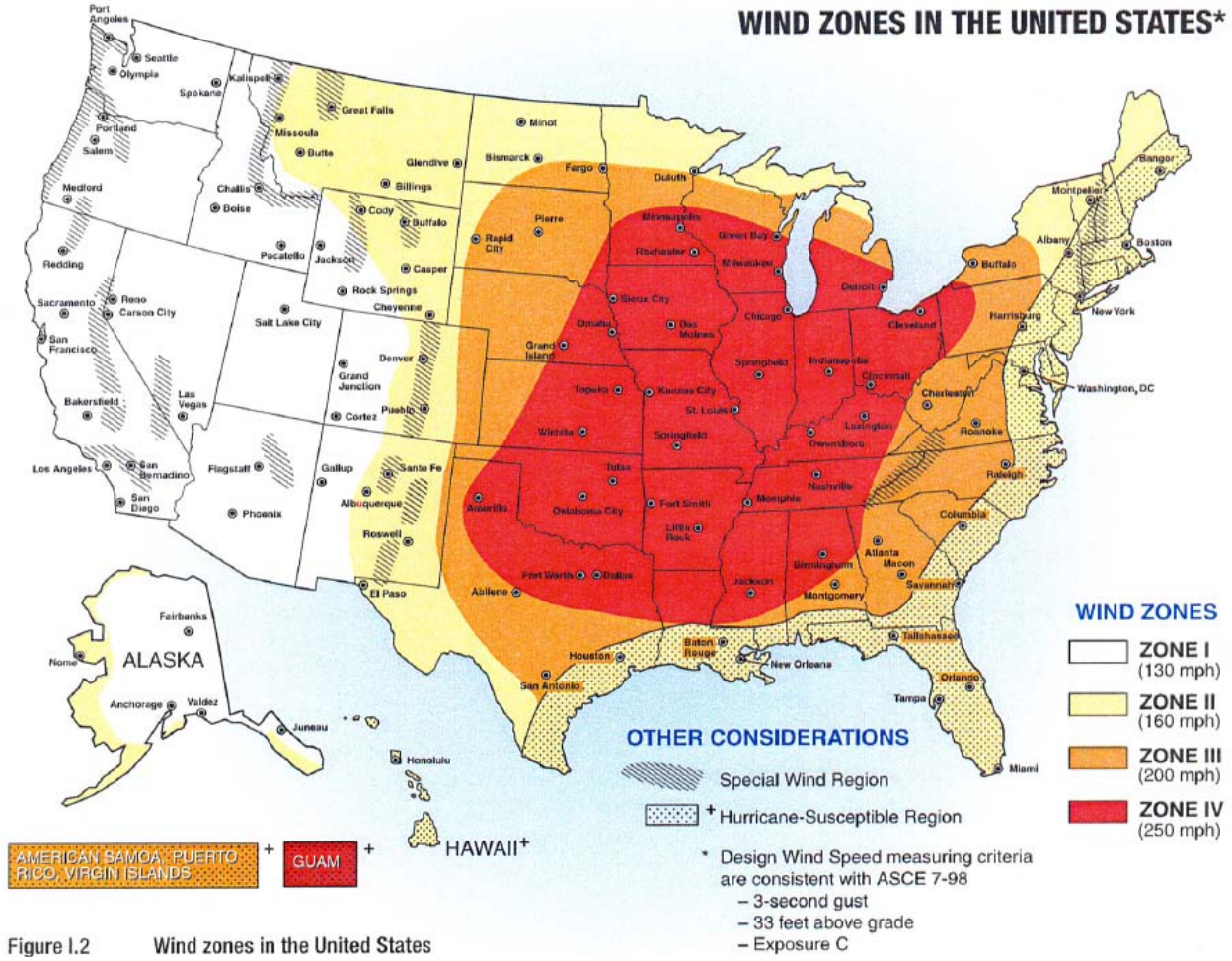


Figure I.1 The number of tornadoes recorded per 3,700 square miles

Source: *Taking Shelter from the Storm* (FEMA 2004)

Figure 3-11: Wind Zones in the United States



Source: *Taking Shelter from the Storm* (FEMA 2004)

Table 3-11: Wind Zones

Number of Tornadoes Per 3,700 square miles (See Figure 3-10)	Wind Zone (See Figure 3-11)			
	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)

3.2.5.3 Past Events

According to the National Climatic Data Center (NCDC) Storm Events database, there were 1,485 tornadoes in South Dakota between 1950 and 2006. 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 $608 million in 2006 dollars. There were 18 deaths and 449 injuries in this time period. This suggests that South Dakota experiences 26 tornadoes, $10.7 million 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 3-12 shows the number of tornadoes by county between 1950 and 2006.

Figure 3-12: South Dakota Tornadoes by County, 1950-2006

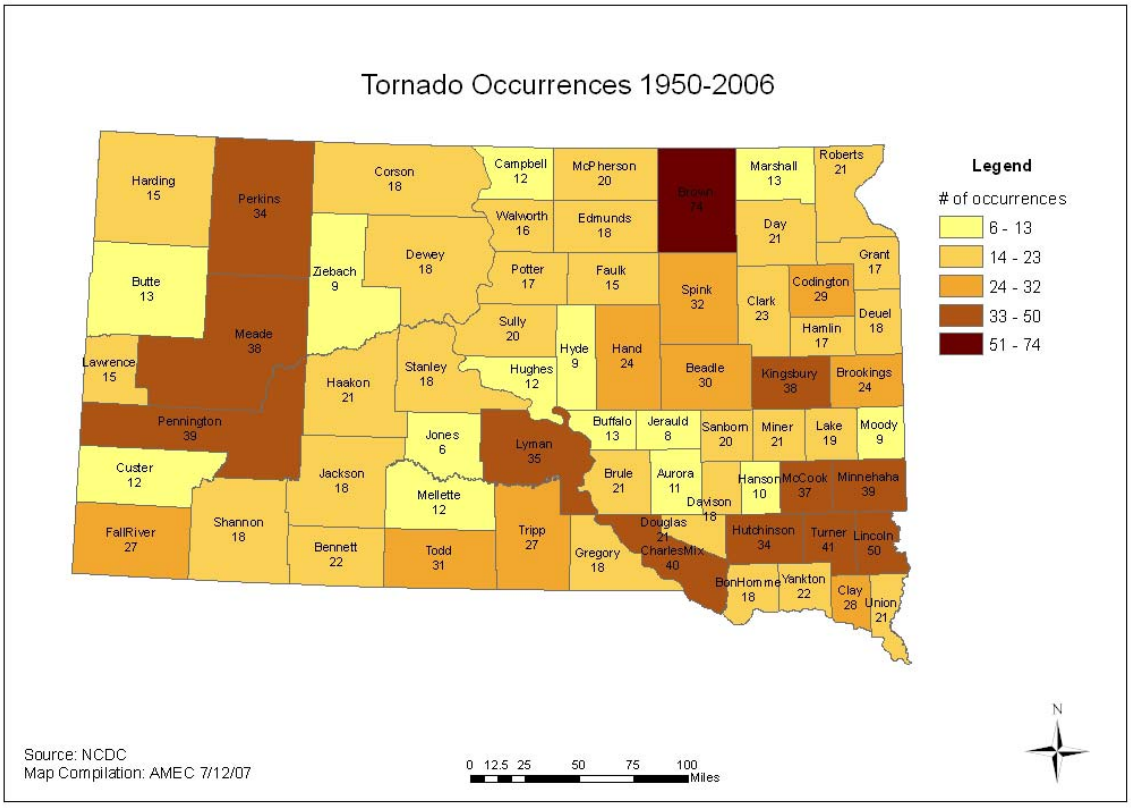


Table 3-12: South Dakota Tornadoes

Date	Comments
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

Date	Comments
	occurred in a period of less than eight hours. The strongest of the 67 tornadoes was an F4, 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

Date	Comments
	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. 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,

Date	Comments
	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. Only 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.

3.2.5.4 Probability

According to the National Climatic Data Center, there were 1,485 tornadoes in South Dakota between 1950 and 2006 (57 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 $10.7 million.

3.2.6 Wind Hazard Profile

3.2.6.1 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.

3.2.6.2 Location

All of South Dakota is susceptible to high wind events. Figure 3-11 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.

3.2.6.3 Past Events

According to the National Climatic Data Center Storm Events database, there were 4,455 wind events in South Dakota between 1955 and 2006 (non-winter storm related events that occurred between April and the end of September). There were 6 deaths and 98 injuries in this time period. Total property and crop damage for events between 1993 and 2006 is estimated at $112.5 million in 2006 dollars. This suggests that South Dakota could experience 85.7 wind events, $8 million in wind losses, and approximately two 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 3-13 shows the number of wind events by county between 1955 and 2006.

Figure 3-13: South Dakota Wind Events by County, 1955 - 2006

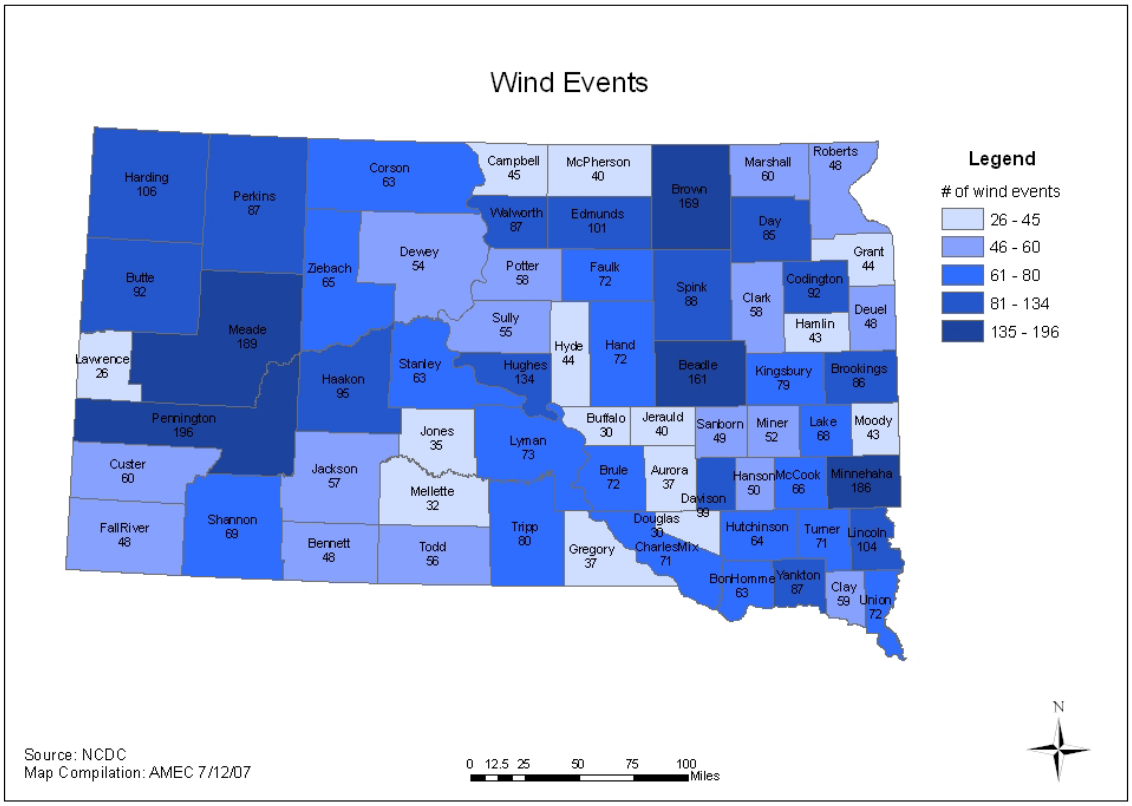


Table 3-13: South Dakota Wind Events

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
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

3.2.6.4 Probability

According to the National Climatic Data Center, there were 4,455 wind events (excluding events from October through March 31 and those associated with snow, see event description above) in South Dakota between 1955 and 2006 (52 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 $8 million.

3.2.7 Hazardous Materials

3.2.7.1 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.

3.2.7.2 Location

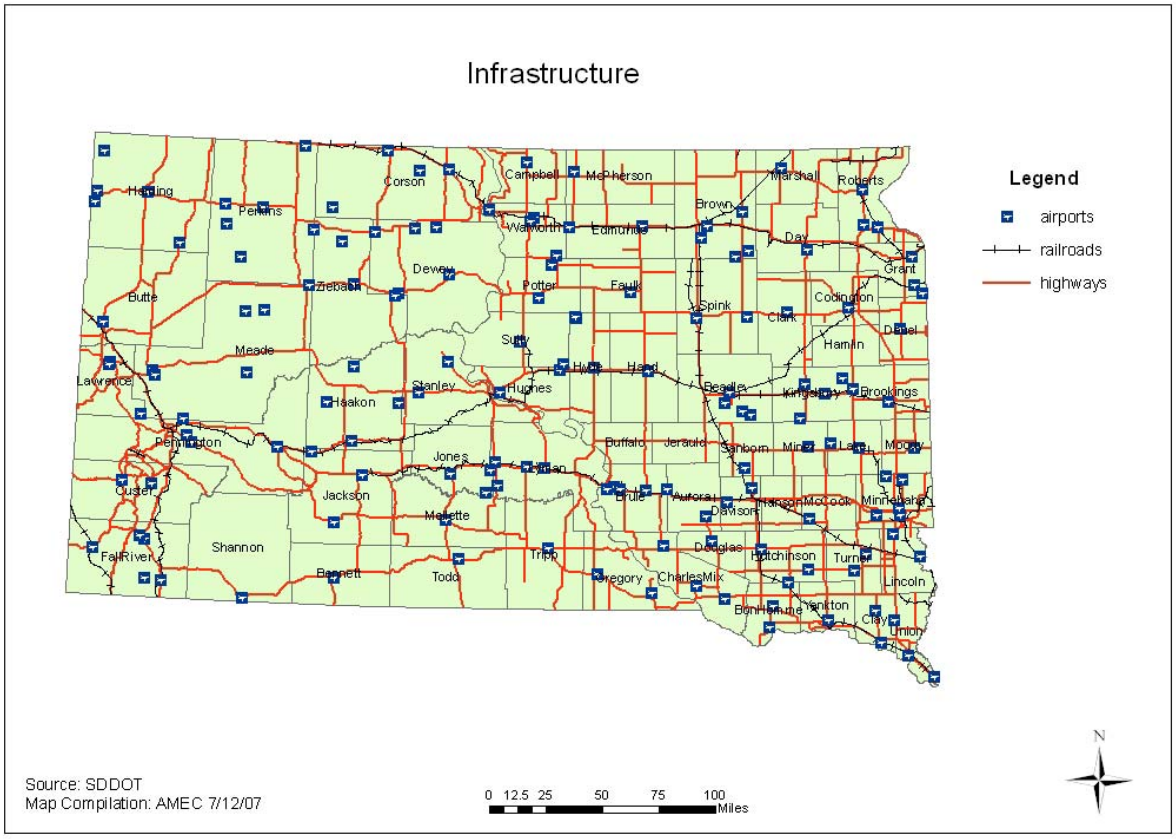
Hazardous materials incidents can happen throughout the state. Localities where hazardous materials are fabricated, processed, and stored as well as those where hazardous waste is treated, stored, and disposed of are most at risk for hazardous materials incidents. Additionally, localities along transportation 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).

3.2.7.2.1 Transportation

Figure 3-14 illustrates South Dakota's transportation infrastructure.

Figure 3-14: South Dakota Transportation Infrastructure.



3.2.7.2.2 Pipelines

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 3-14 shows the breakdown of gas transmission line and hazardous liquid line mileage by county.

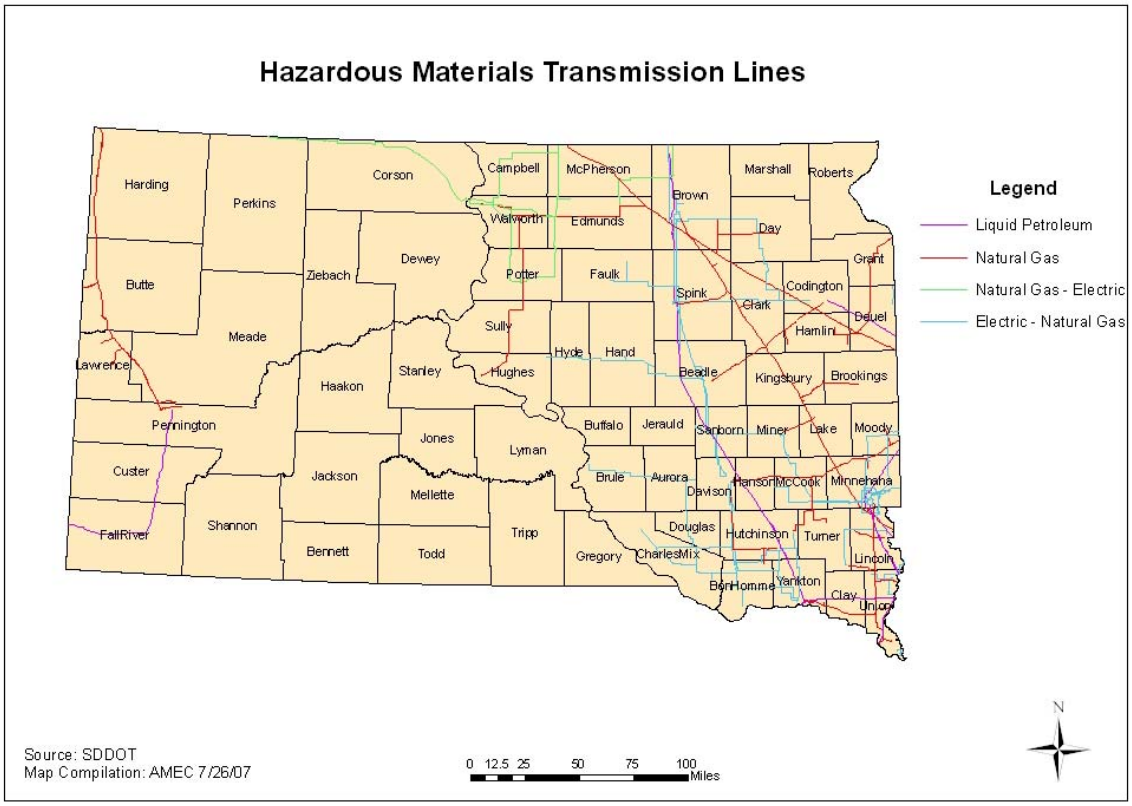
Table 3-14: Gas Transmission Line and Hazardous Liquid Line Mileage by County (ranked by percent of total)

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
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

County	Gas Miles	Liquid Miles	Percent of Total
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 3-15: South Dakota Hazardous Materials Transmission Lines



3.2.7.2.3 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 3-16.

Figure 3-16: South Dakota Hazardous Material Site Locations

3.2.7.3 Past Events

3.2.7.3.1 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 628 transportation incidents involving hazardous materials between 1971 and 2006 (see Table 3O). The total cost of damage associated with these incidents was approximately $5,729,979. This suggests that South Dakota experiences 17.5 transportation incidents

involving hazardous materials and $159,000 in related damage each year. Among these incidents there were 3 deaths and 15 injuries. In total, 282 people were evacuated. Twelve of the incidents were rail related, 13 were air, and the remaining 603 were highway.

Table 3-15: Transportation Hazardous Materials Incidents, 1971-2006

County	# of Events	Fatalities	Total Injuries	Damages ($)	Evacuations
Minnehaha	241	0	3	328,510	213
Pennington	96	1	1	76,822	0
Lincoln	48	0	1	68,004	21
Brown	31	0	2	88,170	0
Codington	26	0	0	7,402	0
Brookings	14	0	0	207,419	1
Davison	14	0	0	51,448	5
Lawrence	14	0	0	216	0
Hughes	13	0	0	1,150	0
Beadle	11	0	3	9,090	40
Meade	11	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	6	0	0	3,706	0
Haakon	6	0	0	0	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	3	0	0	121,500	0
Hutchinson	3	0	0	0	0
Lake	3	0	0	1,000	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	2	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

County	# of Events	Fatalities	Total Injuries	Damages ($)	Evacuations
Buffalo	1	0	0	100	0
Clark	1	0	0	0	0
Corson	1	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

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

3.2.7.3.2 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 2006. Table 3P 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 3-16: Details of South Dakota Pipeline Incidents, 1983 – 2006

County	Date	Fatalities	Injuries	Damage ($)	Gross Barrels Lost	Barrels Recovered	Type of Incident
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 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

County	Date	Fatalities	Injuries	Damage ($)	Gross Barrels Lost	Barrels Recovered	Type of Incident
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 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 shown are in 2006 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, adjusted to 2006 dollars. 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, adjusted to 2006 dollars.

3.2.7.3.3 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 2005, 8 million pounds of hazardous materials were disposed of or released in South Dakota. Table 3-17 ranks chemical releases by county for 2005. Table 3-18 and Table 3-19 show the top 10 releasing facilities and the top 10 chemicals released in 2005.

Table 3-17: Chemical Releases* by County, 2005 (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	3,480,697	24,667	3,505,364
Grant	1,722,663	29,459	1,752,122
Lawrence	1,214,523	498	1,215,021
Brookings	536,394	546	536,940
Pennington	125,511	47,045	172,555
Turner	156,783	0	156,783
Yankton	123,266	2,352	125,618
Brown	122,858	51	122,909
Lincoln	104,398	12	104,410
Codington	55,330	18,144	73,474
Davison	32,482	17,636	50,118
Lake	41,684	561	42,245
Mc Cook	22,392	0	22,392
Bon Homme	20,185	0	20,185
Union	12,750	0	12,750
Day	12,137	0	12,137
Beadle	500	5	505
Roberts	450	0	450
Potter	250	0	250
Hamlin	194	0	194
Deuel	0	60	60
Perkins	4	2	6

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

Table 3-18: Top 10 South Dakota Facilities with Greatest Total Releases,* 2005 (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	3,291,798	24,656	3,316,453
Otter Tail Corp (DBA Otter Tail Power Co)	Grant	1,630,521	29,459	1,659,979
Wharf Resources	Lawrence	1,214,523	5	1,214,528
South Dakota Soybean Processors LLC	Brookings	393,746	0	393,746
Great Plains Ethanol LLC	Turner	156,783	0	156,783
Starmark Cabinetry	Minnehaha	119,696	8	119,704
James Valley Ethanol LLC	Brown	114,828	0	114,828
Alcoa Extrusions Inc	Yankton	94,915	2,350	97,265
Black Hills Corp Ben French Power Plant	Pennington	44,010	47,027	91,037
Northern Lights Ethanol LLC	Grant	87,477	0	87,477

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

Table 3-19: Top 10 Chemicals Reported Released* in South Dakota, 2005 (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	3,380,566	94	3,380,660
Lead Compounds	1,042,123	1,837	1,043,959
Zinc Compounds	911,265	18,275	929,540
Barium Compounds	543,205	69,011	612,215
Ammonia	456,420	24,047	480,467
N-Hexane	413,633	0	413,633
Xylene (Mixed Isomers)	317,486	0	317,486
Styrene	78,181	0	78,181
Toluene	65,660	0	65,660
Acetaldehyde	63,869	0	63,869

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

3.2.7.4 Probability

3.2.7.4.1 Transportation

According to the U.S. Department of Transportation's Hazardous Materials Information System, there were 628 transportation incidents involving hazardous materials in South Dakota between 1971 and 2006 (36 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.

3.2.7.4.2 Pipeline

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). Based on this information, the probability that at least one pipeline incident will occur in South Dakota in any given year is 100 percent.

3.2.7.4.3 Fixed Facility

According to the U.S. Environmental Protection Agency's Toxic Resource Inventory, 8 million pounds of hazardous materials were disposed of or released in South Dakota in 2005. 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.

3.2.8 Landslides and Mudflows Profile

3.2.8.1 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.

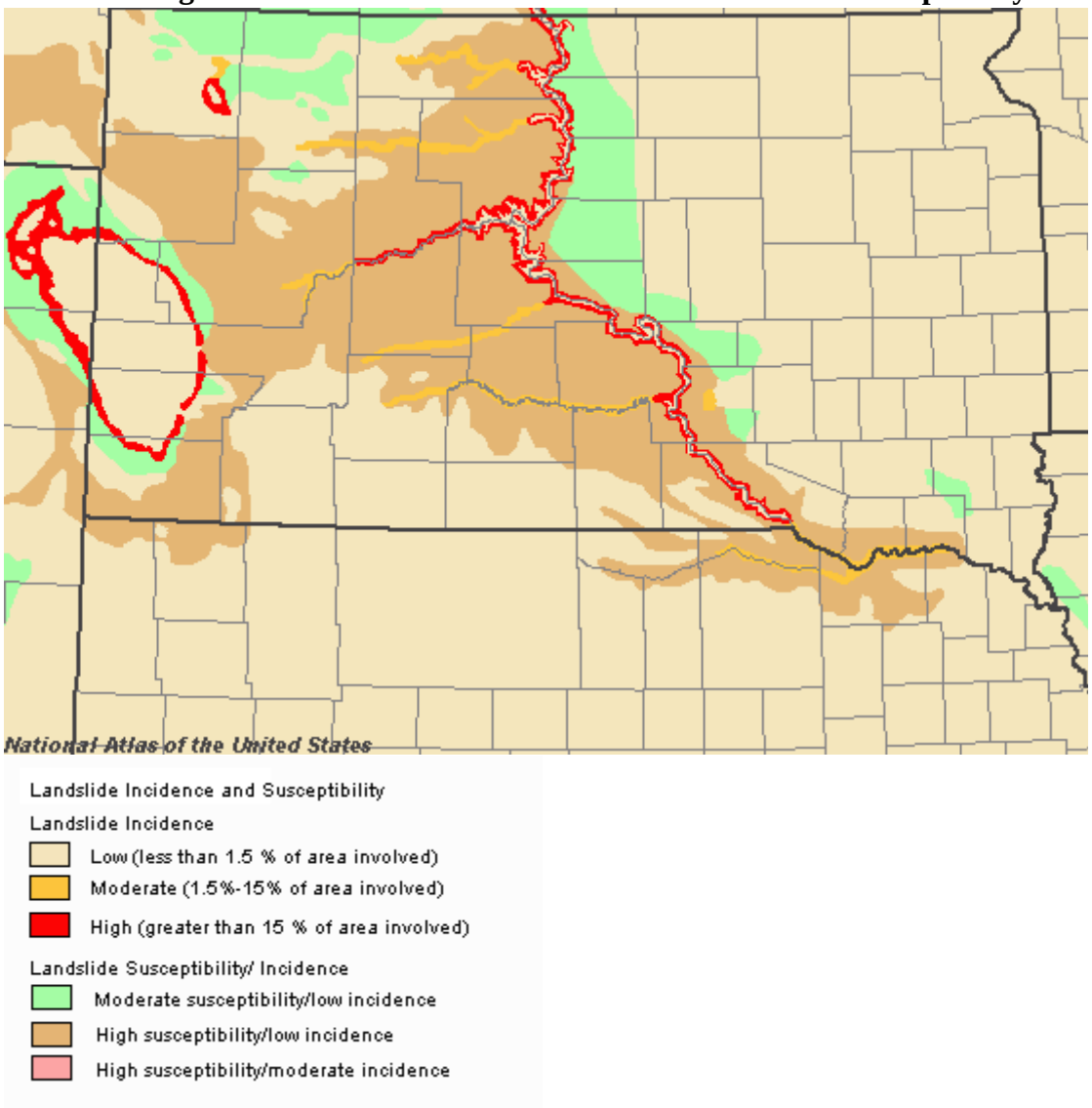
3.2.8.2 Location

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.

Due to the terrain in 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.

Figure 3-17: South Dakota Landslide Incidence and Susceptibility



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

3.2.8.3 Past Events

Table 3-20: 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.

3.2.8.4 Probability

Although historical landslide 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.

3.2.9 Earthquake Profile

3.2.9.1 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.

3.2.9.2 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.

3.2.9.3 Past Events

Historically, earthquakes cause 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.

Table 3-21: South Dakota Earthquakes

Date	Comments
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.

Date	Comments
	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.
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

Date	Comments
	"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.
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.

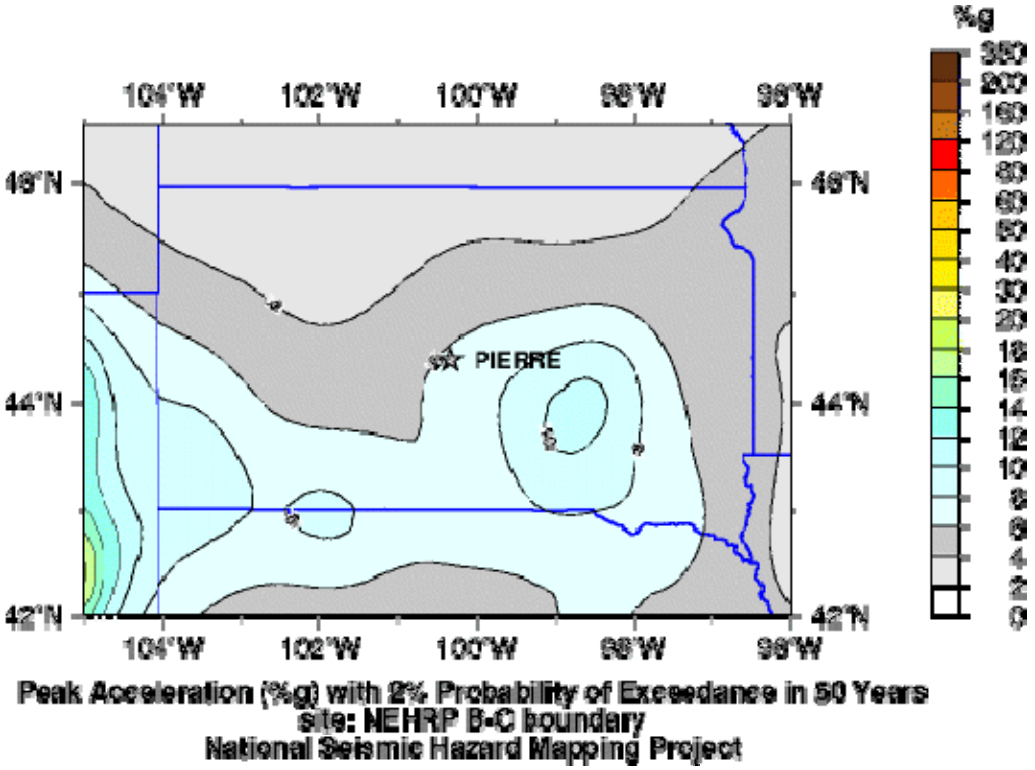
Date	Comments
August 30, 1934	Intensity IV—On the Brule and Charles Mix County border between Bijou Hills and Academy: Abrupt trembling motion accompanied by a rumbling sound, felt by many, small objects moved. Also felt in Pukwana.
January 29, 1934	Intensity IV—6:30 a.m. Marshall County north northwest 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.
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.

3.2.9.4 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 3-18 shows ground motions that have a 2 percent chance of being equaled or exceeded in a 50-year period.

Figure 3-18: 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 attempts to determine the vulnerability of South Dakota, by jurisdiction, to the hazards that have been identified and profiled previously. For purposes of this plan, it is noted here that county boundaries are the smallest jurisdiction considered and in total include information pertinent to all jurisdictions located within the county. Within each county, other geographical, political and jurisdictional boundary plans such as cities, towns, and townships are much better suited for presenting detailed information for their respective jurisdictions.

For the purposes of this plan vulnerability is defined as the extent to which people and property are exposed to harm 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 more detail, hazard by hazard. Where the data permits, loss estimations to people and property are estimated. 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.

The 2007 update to this plan synthesized and analyzed data that was previously included in several attachments and annexes. New data and updated methods allowed for a new perspective on vulnerability to the hazards which impact the state, with the results presented in the following section. More information on growth and development trends and a section on social vulnerability were added in 2007. By following the same process, counties and other local jurisdictions can use this information to assist in developing or updating their local mitigation plans.

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. A limited vulnerability analysis was added for hazardous materials. Vulnerability and loss assessments were not conducted for landslides due to their ranking as limited for planning significance.

The State Hazard Mitigation Team reviewed the 48 approved local hazard mitigation plans 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 impossible to consolidate the vulnerability and loss information from the local plans for a complete statewide comparison.

3.3.1 Growth and Development

As part of the plan update process, the state looked at changes in growth and development 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. When the population in a hazardous area increases, so does the vulnerability of people and property associated with the hazards unless mitigation measures are taken.

Also reviewed were notable and important trends identified in the review of the local hazard mitigation plans. Several of the local mitigation plans identified growth and development trends. It is helpful for the State Hazard Mitigation Team to review these trends in consideration of where to prioritize mitigation projects. Table 3-22 summarizes the trends as identified in the local mitigation plans.

Table 3-22: 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	In addition to Huron's expanding development, the rest of Beadle County is also developing. Most structures are not located within floodplains.
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	Main land use is agriculture. Many of the poorly drained areas have been left as wetlands. There is no significant development in areas that are prone to flooding.
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.
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).

County	Growth and Development Trend
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 agricultural related businesses. No future development planned within hazard areas.
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 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	Increasing population in Sturgis (Black Hills Motorcycle Rally). Growth and development along I-90.
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.
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.
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.

County	Growth and Development Trend
Shannon	Minimal population growth
Spink	Decreasing population
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.
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 increases in housing units and density by county, based on the most recent U.S. Census Bureau data.

3.3.1.1 Population

U.S. Census Bureau estimates place South Dakota's 2006 population at 781,919. This reflects an increase of 3.6 percent between 2000 and 2006. In 2006, South Dakota ranked 46th among the 50 states in population, 33rd in rate of growth, 16th in land area, and 46th in population density (assuming land area in 2006 was the same as it was in 2000, which was 75,885 square miles). Decennial census findings from the last few decades illustrate South Dakota's growth (see Table 3-23).

Table 3-23: 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 2002

Between 2000 and 2006, 27 South Dakota counties gained population. The growth was concentrated in the neighboring counties of Minnehaha (home to Sioux Falls) and Lincoln. With an estimated population gain of 45 percent, Lincoln County is the 12th fastest growing county in the United States (of counties with 10,000 or more in population). The three largest counties, Minnehaha, Pennington, and Lincoln gained the most number of people and also ranked in the top 10 by percent gained. Table 3-24 through Table 3-26 show the top 10 South Dakota counties ranked by estimated population and those with the greatest estimated population gains.

Table 3-24: Top 10 Counties Ranked by Population (Estimated), 2006

County	2006 Population
Minnehaha	163,281
Pennington	94,338
Lincoln	35,239
Brown	34,645
Brookings	28,195
Codington	26,347
Meade	24,425
Lawrence	22,685
Yankton	21,779
Davison	19,035

Source: U.S. Census Bureau 2007

Table 3-25: Counties with Greatest Estimated Population Gains (Numerical), 2000-2006

County	Population Gain 2000-2006
Minnehaha	15,016
Lincoln	11,092
Pennington	5,765
Shannon	1,358
Union	1,161
Todd	1,038
Lawrence	883
Custer	669
Hanson	551
Hughes	465

Source: U.S. Census Bureau 2007

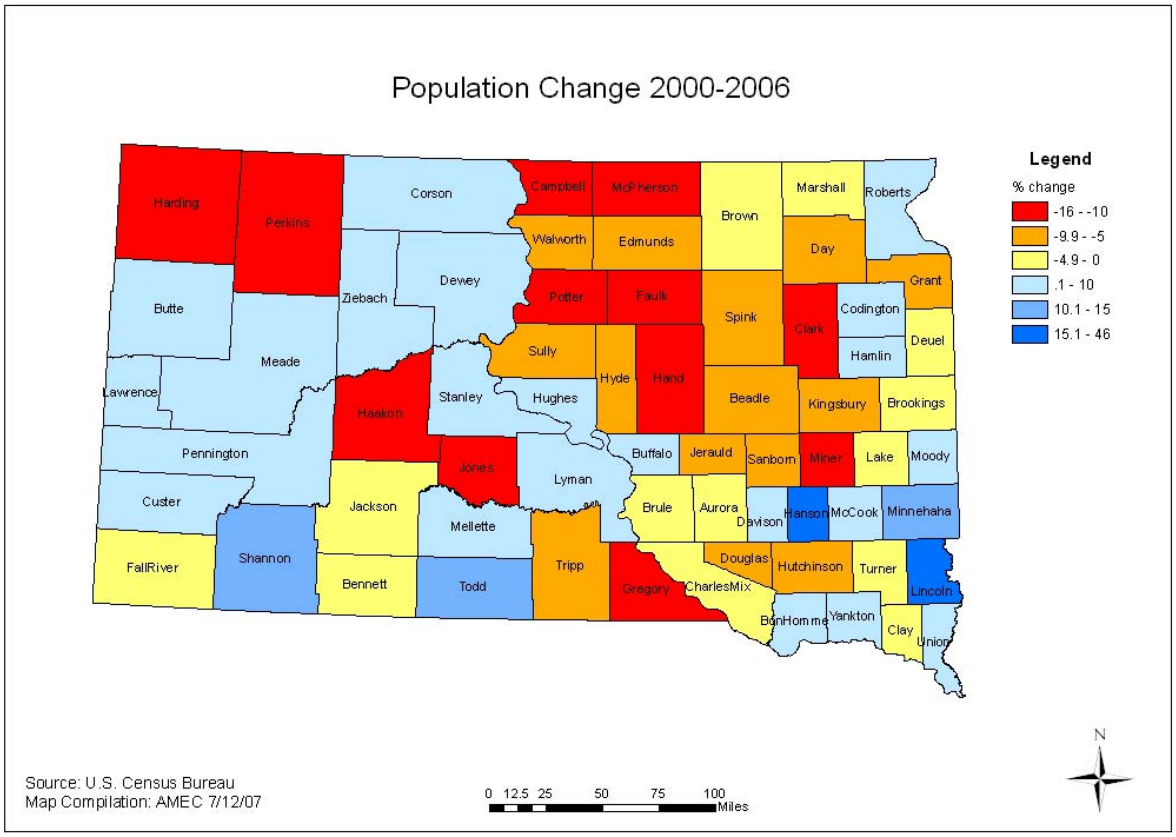
Table 3-26: Counties with Greatest Estimated Population Gains (Percent), 2000-2006

County	Population Gain (%) 2000-2006
Lincoln	45.9
Hanson	17.6
Todd	11.5

County	Population Gain (%) 2000-2006
Shannon	10.9
Minnehaha	10.1
Union	9.2
Custer	9.2
Ziebach	7.4
Pennington	6.5
Lawrence	4.1

Source: U.S. Census Bureau 2007

Figure 3-19: Estimated Percent Change in Population by County, 2000-2006



Between 2000 and 2006, 39 South Dakota counties lost population (see Table 3-27 and Table 3-28). Of the counties with the most rapid losses, four of them (Campbell, Haakon, Potter, and Harding) also rank among South Dakota's 10 least populous counties (see Table 3-29).

Table 3-27: Counties with Greatest Estimated Population Losses (Numerical), 2000-2006

County	Population Loss 2000-2006
Beadle	-1,380
Brown	-815
Clay	-670
Hutchinson	-649
Grant	-574
Walworth	-549
Spink	-531
Gregory	-524
Day	-489
Clark	-460

Source: U.S. Census Bureau 2007

Table 3-28: Counties with Greatest Estimated Population Losses (Percent), 2000-2006

County	Population Loss (%) 2000-2006
Campbell	-16.2
Haakon	-15.1
Potter	-13.8
McPherson	-11.7
Miner	-11.5
Faulk	-11.4
Hand	-11.2
Clark	-11.1
Harding	-10.9
Gregory	-10.9

Source: U.S. Census Bureau 2007

Table 3-29: Ten Smallest Counties Ranked by Population (Estimated), 2006

County	2006 Population
Jones	1,067
Harding	1,205
Sully	1,435
Campbell	1,494
Hyde	1,551
Haakon	1,864
Jerauld	2,071
Mellette	2,099
Buffalo	2,109
Potter	2,321

Source: U.S. Census Bureau 2007

Interim population projections issued by the U.S. Census Bureau in 2005 suggest that South Dakota's population will continue to grow, but percentages will drop, through 2020 (see Table 3-30). 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 3-30: Interim South Dakota Population Projections, 2005-2030

Year	Projected Population	% Change
2005*	771,803	
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 2005

Note: *Estimate issued in 2005 (projections have not been updated)

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

3.3.1.2 Housing Units

Another indicator of growth is number of housing units. 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 7.6 percent (24,724 units) between 2000 and 2005. With 347,931 units, South Dakota ranked 46th among the 50 states in number of housing units. Minnehaha, Lincoln, and Pennington again topped the list for numerical gains and, tracking with its rate of population growth, Lincoln topped the list of percent gained (41.5 percent).

Table 3-31 and Table 3-32 list the counties that have grown the most in terms of housing units by number and percent respectively.

Table 3-31: Counties with Greatest Estimated Housing Unit Gains (Numerical), 2000 – 2005

County	Housing Unit Gains 2000-2005
Minnehaha	7,616
Lincoln	3,786
Pennington	3,421
Lawrence	1,019
Meade	980
Brookings	864
Codington	623
Union	570

County	Housing Unit Gains 2000-2005
Custer	496
Brown	456

Source: U.S. Census Bureau 2006

Table 3-32: Counties with Greatest Estimated Housing Unit Gains (Percent), 2000 – 2005

County	Housing Unit Gains (%) 2000-2005
Lincoln	41.5
Custer	13.7
Minnehaha	12.6
Union	10.7
Lawrence	9.8
Meade	9.7
Pennington	9.2
Stanley	7.8
Brookings	7.5
McCook	5.9

Source: U.S. Census Bureau 2006

As illustrated in Table 3-33, the 10 most populous counties (Table 3-24) also have the most housing units.

Table 3-33: Top 10 Counties Ranked by Number of Housing Units (Estimated), 2005

County	2005 Housing Units
Minnehaha	67,853
Pennington	40,673
Brown	16,317
Lincoln	12,917
Brookings	12,440
Codington	11,947
Lawrence	11,446
Meade	11,126
Yankton	9,233
Davison	8,529

Source: U.S. Census Bureau 2006

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

3.3.1.3 Density

South Dakota has a surface land area of 75,885 square miles (2000 census) and a population of 781,919 (2006 census estimate). Based on the 2006 census 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 (see Table 3-34). Eight of these counties (excluding Clay and Union) also ranked among South Dakota's top 10 most populous counties.

Table 3-34: Top 10 Counties Ranked by Population Density, 2006

County	2006 Estimated Population Density	Population Density Change (%) 2000-2006	2005 Estimated Housing Density	Housing Density Change (%) 2000-2005
Minnehaha	201.7	10.1	83.8	12.6
Lincoln	61.0	46.0	22.3	41.5
Davison	43.7	1.6	19.6	5.4
Yankton	41.8	0.6	17.7	4.4
Codington	38.3	1.7	17.4	5.5
Brookings	35.5	-0.1	15.7	7.5
Pennington	34.0	6.5	14.7	9.2
Clay	31.3	-4.9	13.8	4.6
Union	29.9	9.2	12.8	10.7
Lawrence	28.4	4.1	14.3	9.8

Source: U.S. Census Bureau 2001, 2006, 2007
Notes:
-Density is reported as people/housing units per square mile and is based on the square mileage of the counties
-Housing unit estimates were not available for 2006

As should be expected, the percent change in population density tracks with the percent change in population growth. The fastest growing counties are also seeing their population density increase more rapidly than the other counties (see Table 3-35).

Table 3-35: Counties with Greatest Estimated Population Density Gains (Percent), 2000 – 2006

County	Population Density* Gains (%) 2000-2006
Lincoln	46.0
Hanson	17.6
Todd	11.5
Shannon	10.9
Minnehaha	10.1
Union	9.2
Custer	9.2
Ziebach	7.4

County	Population Density* Gains (%) 2000-2006
Pennington	6.5
Lawrence	4.1

Source: U.S. Census Bureau 2001, 2007

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

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

In general, counties with growing populations and number of housing units will have increased vulnerability to hazard events, particularly those hazards not confined to geographic areas such as 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.

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 developments 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 County increase the risk to damage from tornados.

3.3.2 Social Vulnerability

A Social Vulnerability Index 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 for the purpose of examining the differences in social vulnerability among counties. Based on national data sources, primarily the 2000 census, it 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 (i.e., social vulnerability). Eleven composite factors were identified that differentiate counties according to their relative level of social vulnerability: 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.

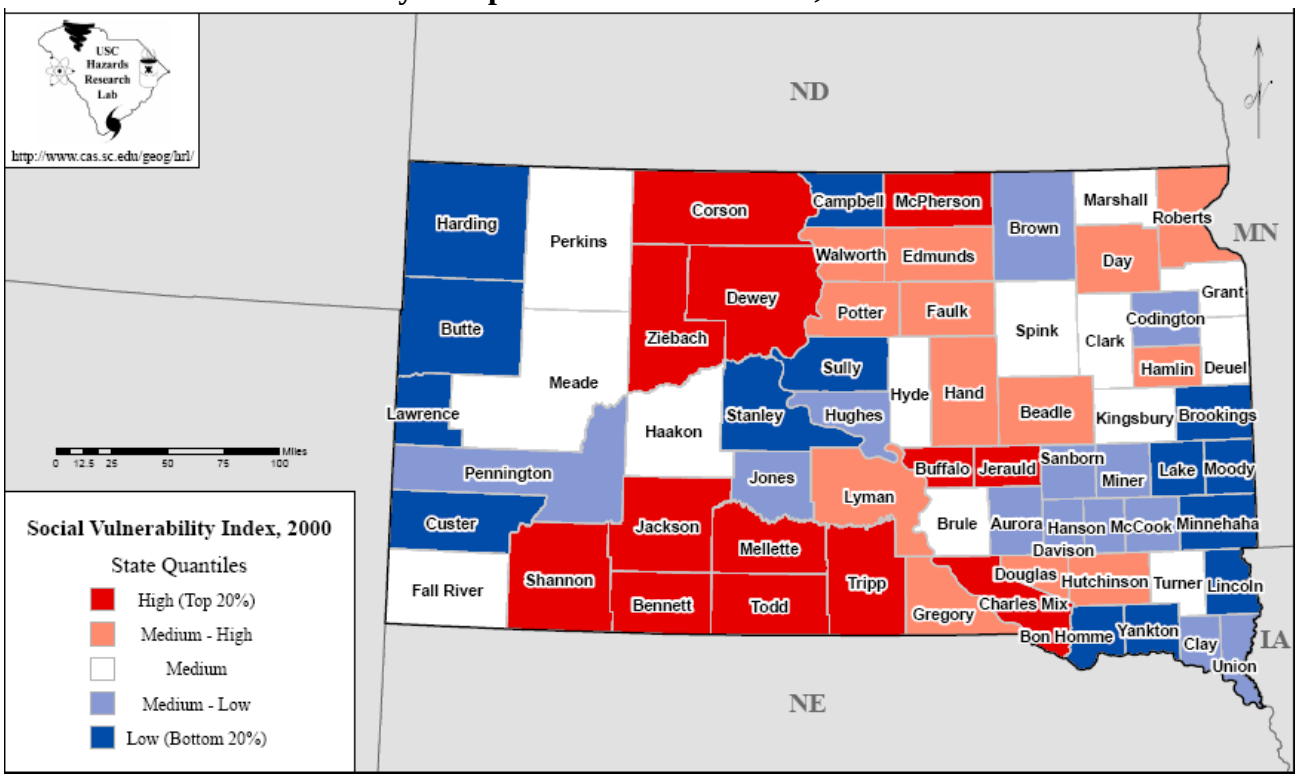
The index can be used by the state to help determine where social vulnerability and exposure to hazards overlaps and how and where mitigation resources might best be used. See Figure 3-20 for a map that illustrates South Dakota's geographic variation in social vulnerability. According to the

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—and the nation):

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.

Figure 3-20: Social Vulnerability to Environmental Hazards, County Comparison within the State, 2000

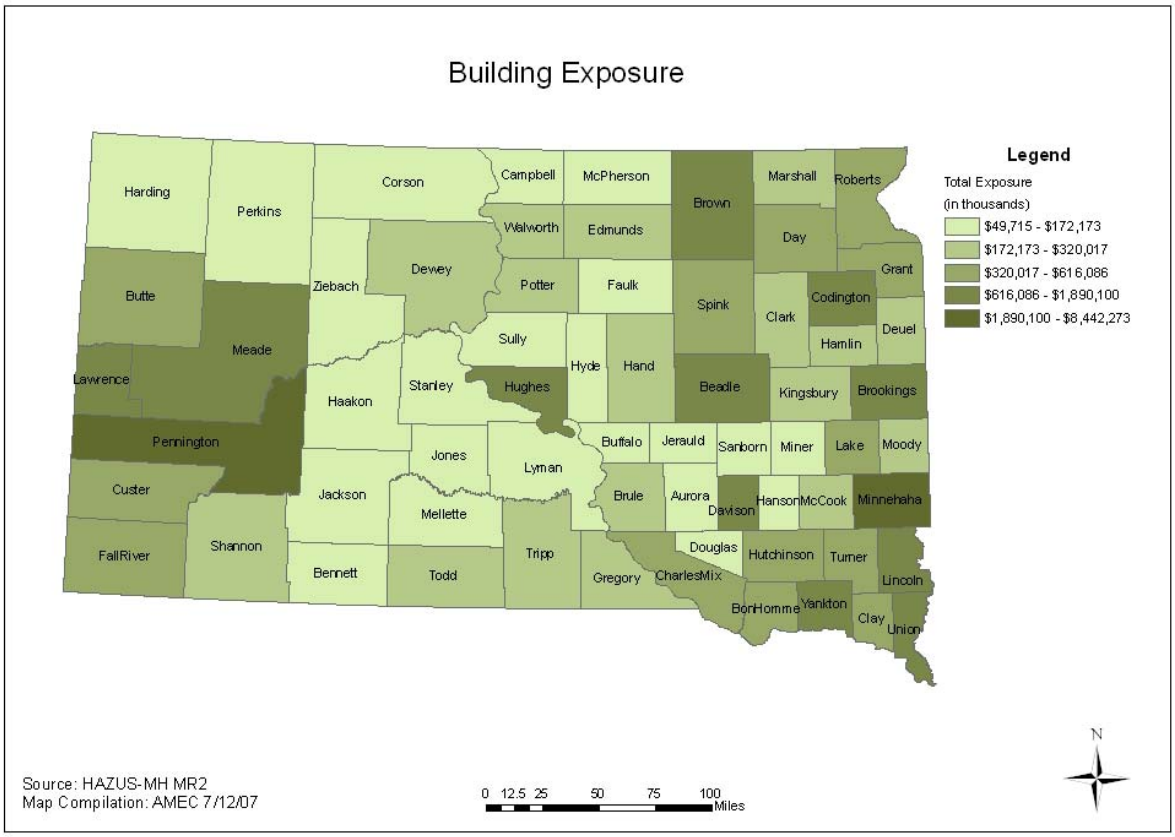


3.3.3 Building Exposure

Exposure is a term borrowed from the insurance industry as a measure of property "exposed" to a particular hazard. HAZUS-MH building inventory data provided the basis for measuring the number and value of buildings vulnerable to hazards. There are an estimated 240 thousand buildings in South Dakota with a total building replacement value (excluding contents) of $38,357 (millions of dollars). Approximately 98 percent of the buildings (and 80 percent of the building value) are associated with residential housing. Figure 3-21 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 3-21: Building Exposure



3.3.4 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 (* indicates HAZUS-MH loss estimation completed, ** indicates DFIRM map and loss estimation completed as of June 2007):

- **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.

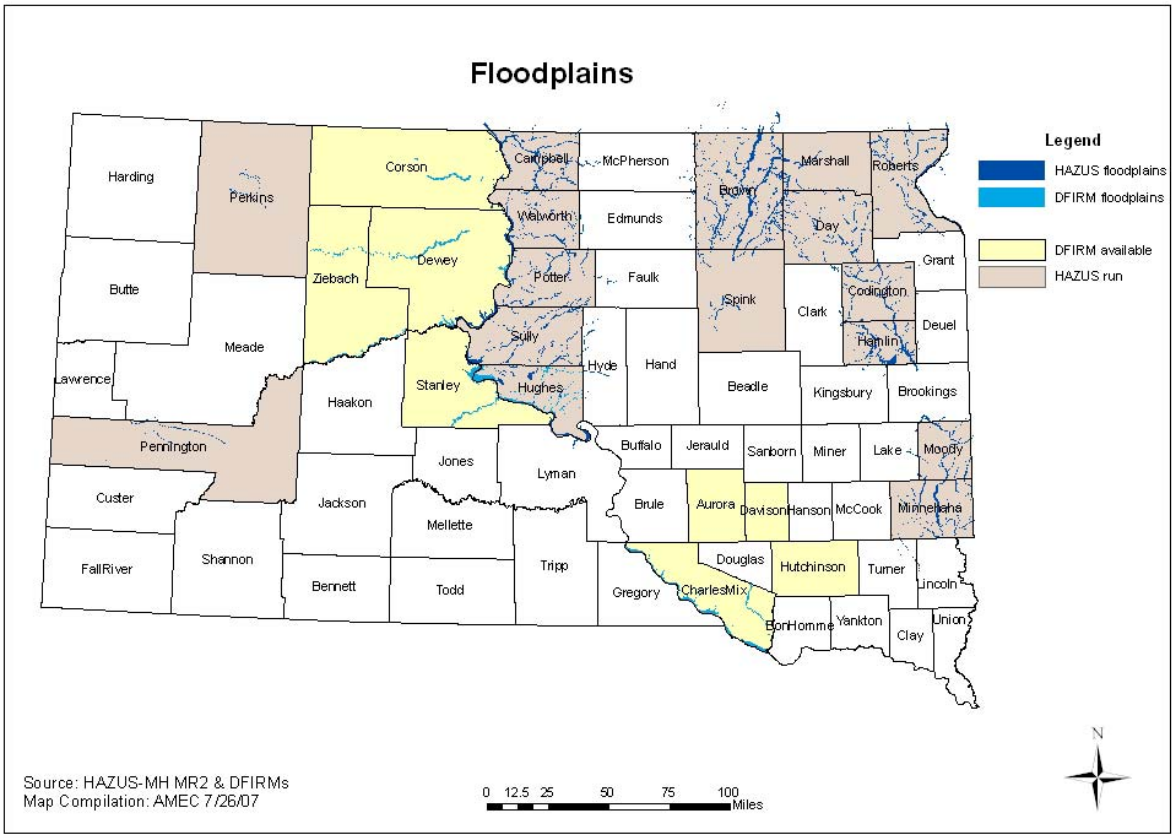
The following section describes progress the State has made developing vulnerability and loss estimates for the highlighted counties. Future updates to this plan will include additional vulnerability analyses as more DFIRMs become available and as more resources for HAZUS-MH studies are obtained.

3.3.4.1 Methodology

During the 2007 plan update, the state used the most recent release of FEMA's loss estimation software, HAZUS-MH MR2 (May 2006), to model flood loss for 16 counties: Brown, Campbell, Codington, Day, Hamlin, Hughes, Marshall, Minnehaha, Moody, Pennington (Rapid City), Perkins, Potter, Roberts, Spink, Sully, and Walworth. These counties were chosen based on past history of flood problems or were counties that requested HAZUS-MH analyses to support local mitigation planning. Five high priority counties (Brown, Codington, Hughes, Minnehaha, and Pennington) were analyzed with a beta version of HAZUS-MH in 2004, and were re-analyzed in 2007. HAZUS-MH can assess flood loss for an entire county if digital terrain data exists. Since digital elevation models (DEMs) were available for these 16 counties, the state was able to use HAZUS-MH to develop computer-generated floodplain boundaries for the flood elevation that has a 1-percent chance of being equaled or exceeded each year (hereafter referred to as the "base flood," also known as the 100-year flood) on major streams in each county (see Figure 3-22). HAZUS-MH computes the potential flood impact on a building inventory database based on the extent and depth of the modeled floodwaters, enabling a consistent methodology for a county by county assessment of potential flood losses.

A second analysis looked at counties with digital flood insurance rate maps (DFIRMs). The 2004 plan indicated that DFIRM data would be used for loss estimations, as it becomes available. In 2007 there were 10 counties with DFIRM data available. A GIS overlay analysis was used to model vulnerability and loss in these counties. Figure 3-22 shows the HAZUS-MH floodplains and the DFIRM floodplains: Aurora, Charles Mix, Corson, Davison, Dewey, Hughes, Hutchinson, Pennington (Hill City), Stanley, and Ziebach. (Note: The Minnehaha DFIRM was not included in this analysis because it was preliminary.)

Figure 3-22: South Dakota Digital Floodplains



The HAZUS-MH flood analysis was a significant undertaking for the state. Producing a HAZUS-MH flood run is very computer resource intensive. Processing a single county takes an average of 12 hours from start to finish, depending on the size of the county, density of the stream network, and density of census blocks.

To develop countywide probabilistic analyses for the 16 counties, the following parameters were used:

- Thirty-meter resolution DEMs as the terrain base to develop hydrologic and hydraulic models
- Streams and rivers with a minimum drainage basin area of 10 square miles all experiencing a base flood at the same time
- U.S. Geological Survey hydrologic regional regression equations and stream gage data included in HAZUS-MH
- HAZUS-MH building inventory defaults summarized to the census-block level with 2005 building valuations

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. Figure 3-23 and Figure 3-24 show sample HAZUS-MH flood hazard outputs.

Figure 3-23: Example of a Floodplain Depth Grid Output by HAZUS-MH Minnehaha County

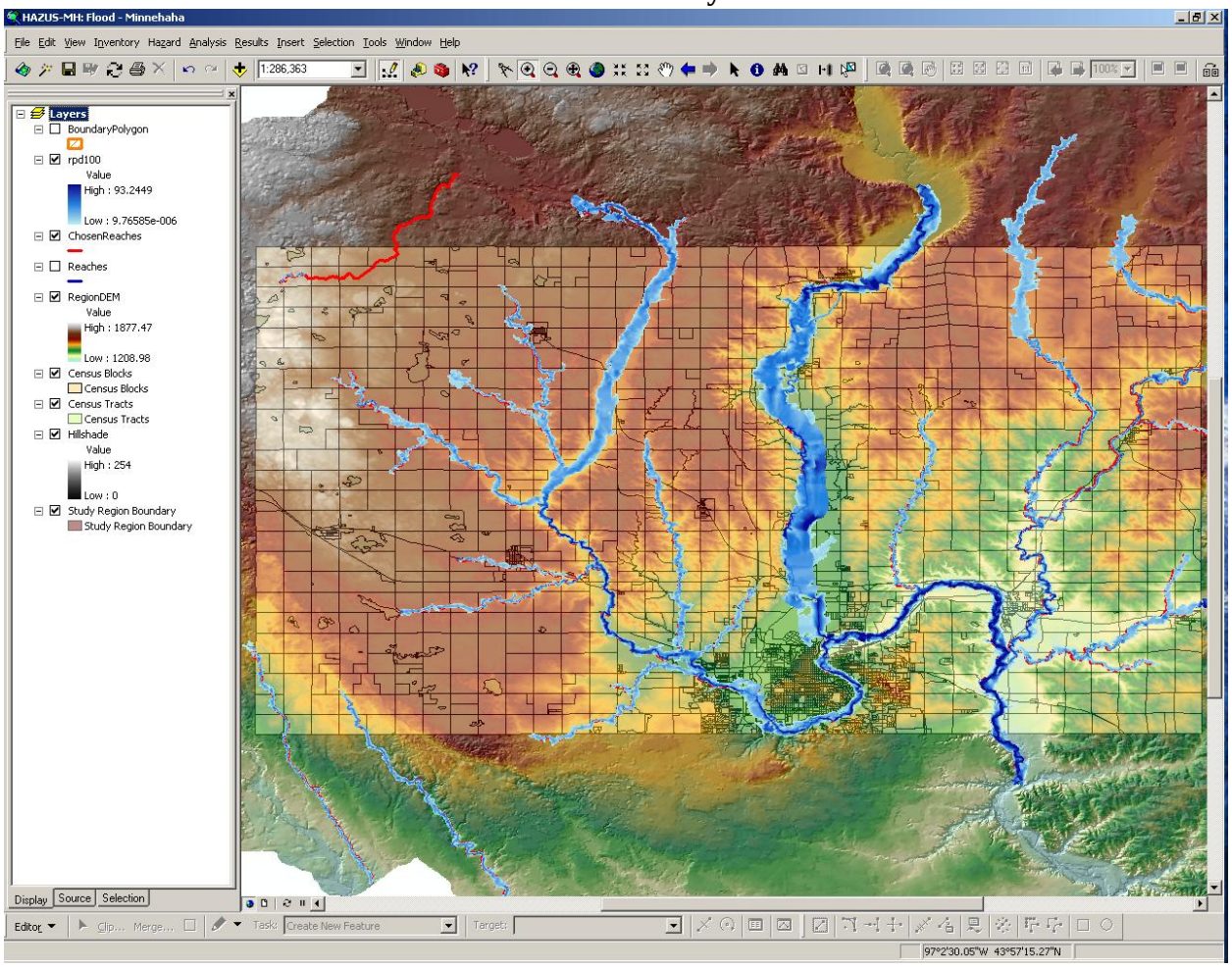
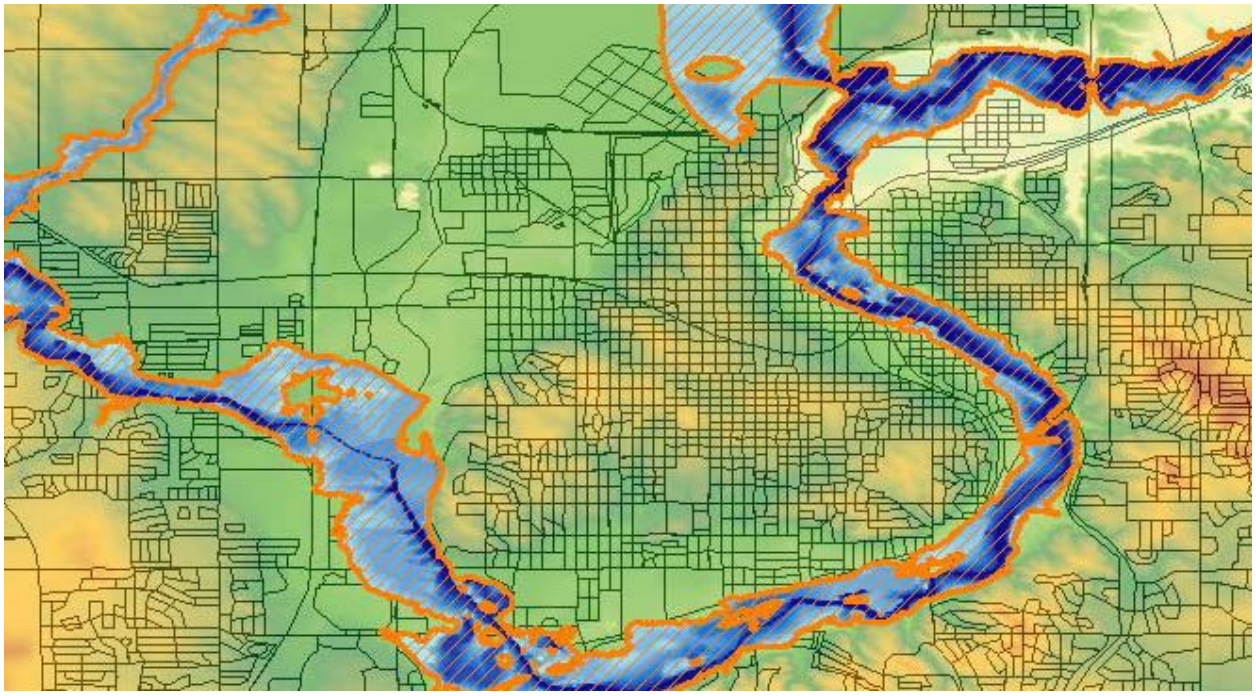


Figure 3-24: Example of HAZUS-MH Floodplain Boundary and Depth Detail and Census Blocks – Sioux Falls



The HAZUS-MH methodology provides the number of buildings impacted, estimates of the building repair costs, and the associated loss of building contents and business inventory. Building damage can also 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. These losses are calculated by HAZUS-MH using a methodology based on the building damage estimates.

Flood damage is directly related to the depth of flooding. 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). HAZUS-MH takes into account flood depth when modeling damage (based on FEMA's depth-damage functions). The HAZUS-MH reports capture damage by occupancy class (in terms of square footage impacted) by damage percent classes. Occupancy classes in HAZUS-MH include agriculture, commercial, education, government, industrial, religion, and residential. Damage percent classes are grouped by 10 percent increments: 1-10 percent, 11-20 percent, etc., up to 50 percent. Buildings that sustain more than 50 percent damage are considered to be "substantially" damaged.

Data Limitations: Default HAZUS-MH data was used to develop the loss estimates. Thus, the potential losses derived from HAZUS-MH, the best available data, may contain some inaccuracies. One obvious limitation is that the building inventory with HAZUS-MH MR2 is based on 2002 counts with valuations adjusted to 2005 dollars. There could be errors and inadequacies associated with the hydrologic and hydraulic modeling of the HAZUS-MH model. HAZUS-MH does not model flood hazards associated with lakes, which is a serious problem in South Dakota.

The damaged building counts generated by HAZUS-MH are susceptible to rounding errors and are likely the weakest output of the model due to the use of census blocks for analysis. The HAZUS-MH "Building Damage Count by General Building Type" report includes this disclaimer: "Unlike the earthquake and hurricane models, the flood model performs its analysis at the census block level. This means that the analysis starts with a small number of buildings within each census block and applies a series of distributions necessary for analyzing the potential damage. The application of these distributions and the small number of buildings make the flood model more sensitive to rounding errors that introduces uncertainty into the building count results. Please use these results with suitable caution."

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.

A separate methodology was used 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 result of the exposure analysis summarizes the values at risk in the floodplain. When a flood occurs, seldom does the event cause total destruction of an area. Potential losses from flooding are related to a variety of factors including flood depth, flood velocity, building type, and construction. Based on FEMA flood depth-damage curves the percent of damage is directly related to the flood depth. FEMA's flood benefit-cost module uses this simplified approach to model flood damage based on building type and flood depth. A damage estimation of 20 percent of the total value and 20 percent of the contents value of a one-story structure with no basement was used. While there are several limitations to this model, it does present a methodology to estimate potential damages.

Data Limitations: 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.

3.3.4.2 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, and
- Population displaced by the flood and shelter needs.

The results, shown in Table 3-36, display the potential base flood losses to the 16 analyzed counties. More detailed results are in Appendix 3B. The results show potential losses as highest in Minnehaha, Pennington, Codington, and Brown counties. Floods in these four counties have the potential to displace at least a thousand persons.

Future vulnerability
Pennington and Codington counties identified population growth and construction of new homes in their local plans. Minnehaha experienced the greatest population gain from 2000 – 2006 of all the counties in South Dakota. Brown experienced the second most population loss from 2000 – 2006. These growth and development trends must be taken into consideration when reviewing the vulnerability results below. Minnehaha, Pennington, and Codington counties continue to increase their vulnerability as population and development increases.

Table 3-36: HAZUS-MH Base Flood (1 Percent Chance) Loss Estimation Results: Impacts by County, Ranked by Highest Building Losses

County	Building Damage ($)	Loss Ratio*	Contents Damage and Inventory Loss ($)	Income Loss ($)**	Total Building Loss ($)	# Displaced People	People Needing Shelter
Minnehaha	94,408,000	1.12%	145,005,000	204,474,000	443,887,000	6,679	5,384
Pennington (Rapid City)	15,085,000	0.32%	33,970,000	64,107,000	113,162,000	1,301	888
Codington	13,795,000	1.10%	27,680,000	51,565,000	93,040,000	2,807	2,196
Brown	7,649,000	0.40%	9,974,000	35,023,000	52,646,000	1,547	802
Hamlin	2,293,000	0.72%	4,100,000	11,577,000	17,970,000	314	31
Hughes	1,273,000	0.14%	2,298,000	5,115,000	8,686,000	601	302
Campbell	1,300,000	1.59%	1,854,000	3,829,000	6,983,000	339	114
Spink	2,194,000	0.58%	2,658,000	841,000	5,693,000	227	142
Day	914,000	0.22%	772,000	3,839,000	5,525,000	51	12
Roberts	682,000	0.14%	482,000	4,149,000	5,313,000	180	7
Sully	360,000	0.39%	1,054,000	3,379,000	4,793,000	33	1
Perkins	158,000	0.10%	695,000	3,291,000	4,144,000		
Moody	1,985,000	0.62%	1,223,000	735,000	3,943,000	195	15

Walworth	539,000	0.17%	1,308,000	1,483,000	3,330,000	81	3
Potter	92,000	0.05%	95,000	192,000	379,000	29	0
Marshall	26,000	0.01%	39,000	102,000	167,000	17	0

Source: 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 income loss includes relocation loss, capital-related loss, wages loss, and rental income loss.

The DFIRM loss estimation results are presented separately in Table 3-37. 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 3-37: 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.

3.3.4.3 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 March 31, 2007).

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, Day, and Hamlin counties. Table 3-38 shows the details of the 10 South Dakota counties with the greatest historical dollar losses.

Table 3-38: Top 10 Counties for Flood Insurance Dollars Paid (Historical), 1978 - 2007

County	Dollars Paid ($ Historical)	Flood Claims	Current Policies	Coverage ($)
Codington	5,154,664	338	371	48,341,000
Day	1,883,101	165	37	4,777,000
Hamlin	1,048,054	147	34	4,018,000
Lake	941,529	104	128	15,182,000
Brown	776,720	269	628	76,375,000
Minnehaha	428,416	77	112	18,683,000
Lincoln	413,008	45	169	50,698,000
Brookings	398,293	47	118	10,084,000
Spink	383,705	26	11	1,149,000
Roberts	261,065	30	28	3,675,000

Source: FEMA, "Policy and Loss Data by Community with County and State Data," March 31, 2007

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

3.3.4.4 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 3-39 illustrates the number and location (county) of South Dakota's repetitive loss properties. The table ranks counties by repetitive loss dollars paid. Once again, Codington, Day, and Hamlin counties are the top three.

Table 3-39: NFIP Policies and Repetitive Loss Summary by County (Ranked by Total Repetitive Loss Dollars Paid)

County	Total Current Policies	Total Flood Claims	Total Dollars Paid ($ Historical)	# of Repetitive Loss Properties*	# of Repetitive Loss Flood Claims	Repetitive Loss Dollars Paid ($ Historical)
Codington	371	338	5,154,664	33	74	1,326,207
Day	37	165	1,883,101	8	16	293,722
Hamlin	34	147	1,048,054	4	9	185,508
Minnehaha	112	77	428,416	10	21	94,423

Moody	23	40	224,909	3	7	81,815
Lake	128	104	941,529	3	6	81,511
Brown	628	269	776,720	7	14	58,364
Grant	36	17	149,974	2	4	43,136
Clark	8	8	162,850	1	2	38,500
Hughes Count	41	33	183,526	2	4	36,387
Davison	30	8	43,213	1	2	17,207
Pennington	361	76	79,166	1	2	12,069
Clay	6	2	4,881	1	2	4,881

Source: x and FEMA, "Policy and Loss Data by Community with County and State Data," March 31, 2007

Note:

*Includes insured and uninsured properties

3.3.4.5 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.

3.3.5 Winter Storms

3.3.5.1 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.

3.3.5.2 Vulnerability Factors

Prior Events—This rating is based on the number of past winter storms experienced by each county between 1993 and 2006 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.

To develop the prior event rating, the total range of past occurrences (21 to 59) was divided into 10 roughly equal ranges as shown in Table 3-40. The ranges were numbered 1 through 10 in ascending order.

Table 3-40: Winter Storm Prior Event Ratings

# of Past Occurrences	Rating
21-23	1
24-27	2
28-31	3
32-35	4
36-39	5
40-43	6
44-47	7
48-51	8
52-56	9

# of Past Occurrences	Rating
57-59	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-MH (residential, commercial, industrial, agricultural, religion, government, and education). The total range of building exposure ($49,715,000 to $8,442,273,000) was divided into 10 roughly equal ranges as shown in Table 3-41. The ranges were numbered 1 through 10 in ascending order.

Table 3-41: Winter Storm Building Exposure Ratings

Building Exposure ($000)	Rating
49,715-888,970	1
888,971-1,728,226	2
1,728,227-2,567,482	3
2,567,483-3,406,738	4
3,406,739-4,245,994	5
4,245,995-5,085,250	6
5,085,251-5,924,506	7
5,924,507-6,763,762	8
6,763,763-7,603,018	9
7,603,019-8,442,273	10

Population Density—Population density is determined by dividing a county's population by its land area. For this rating, 2006 U.S. Census Bureau population estimates were divided by the land area reported in the 2000 census. The total range of population densities (.5 to 201.7) was divided into 10 roughly equal ranges as shown in Table 3-42. The ranges were numbered 1 through 10 in ascending order.

Table 3-42: Population Density Ratings

Population Density	Rating
.5-20.5	1
20.6-40.6	2
40.7-60.7	3
60.8-80.8	4
80.9-100.9	5
100-120	6
121-141	7
142-162	8
163-183	9
183-201.7	10

A fourth factor, past winter storm damage, will 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 can not be approximated for each individual 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 (3 to 27) was divided into three equal ranges as shown in Table 3-43. The ranges were assigned a corresponding level of winter storm vulnerability: moderate, high, and very high.

Table 3-43: Winter Storm Vulnerability

Winter Storm Vulnerability Range	Winter Storm Vulnerability
3-10	Moderate
11-18	High
19-27	Very High

3.3.5.3 Results

Summary of Prior Event Ratings—The lowest number of recorded winter storms over this 14-year period was 21 in Custer County; the highest was 59 in Meade County. All counties in South Dakota experienced at least 21 winter storms in the past 14 years. Meade was the only county that received a rating of 10 and Custer was the only county that received a rating of 1. Eighty-three percent of the counties received ratings between 4 and 7. The counties that received a prior event rating greater than 6 are shown in Table 3-44. (Note: No data was available for Lawrence County)

Table 3-44:Counties with Winter Storm Prior Event Ratings Greater Than 6

County	# of Prior Events	Prior Event Rating
Aurora	44	7
Edmunds	44	7
Hutchinson	44	7
McCook	44	7
Turner	44	7
Brookings	44	7
Minnehaha	44	7
Moody	45	7
Spink	45	7
Bon Homme	46	7
Perkins	46	7
Lincoln	46	7
Marshall	47	7
Roberts	47	7
Harding	50	8
Butte	53	9
Meade	59	10

Table 3-47 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 3-45: 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 3-47 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 3-46.

Table 3-46: Counties with Population Density Ratings Greater Than 1

County	Population Density	Population Density Rating
Hughes	22.9	2
Lawrence	28.4	2
Union	29.9	2
Clay	31.3	2
Pennington	34.0	2
Brookings	35.5	2
Codington	38.3	2
Yankton	41.8	3
Davison	43.7	3
Lincoln	61.0	4
Minnehaha	201.7	10

Table 3-47 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.

3.3.5.4 Total Winter Storm Vulnerability and Estimate of Potential Loss

According to this methodology, while every South Dakota county is vulnerable to winter storms, only Minnehaha has a very high vulnerability, while Lincoln, Meade, Pennington, Brookings, Butte, and Yankton have high vulnerabilities. The remaining counties, 88 percent have moderate vulnerabilities (no data was available for Lawrence, but based on its proximity to high vulnerability counties it can be inferred to be high as well). Figure 3-25 illustrates the vulnerability of South Dakota counties to winter storms, and Table 3-47 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 357 winter storms (snow and ice events) in South Dakota between 1993 and 2006. Total property damage for these events is estimated at $195 million in 2006 dollars. This suggests that South Dakota experiences 25.5 winter storms and $14 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 14 injuries each year.

Future vulnerability
Minnehaha experienced the greatest population gain from 2000 – 2006 of all the counties in South Dakota. Of the counties with high vulnerability to winter storms, Meade, Pennington, Brookings, and Yankton counties identified increased population. Brookings also identified expansion of transportation systems. These growth and development trends must be taken into consideration when reviewing the vulnerability results below. Minnehaha, Meade, Pennington, Brookings, and Yankton counties continue to increase their vulnerability to winter storms as population and development increases.

Figure 3-25: Vulnerability of South Dakota Counties to Winter Storms

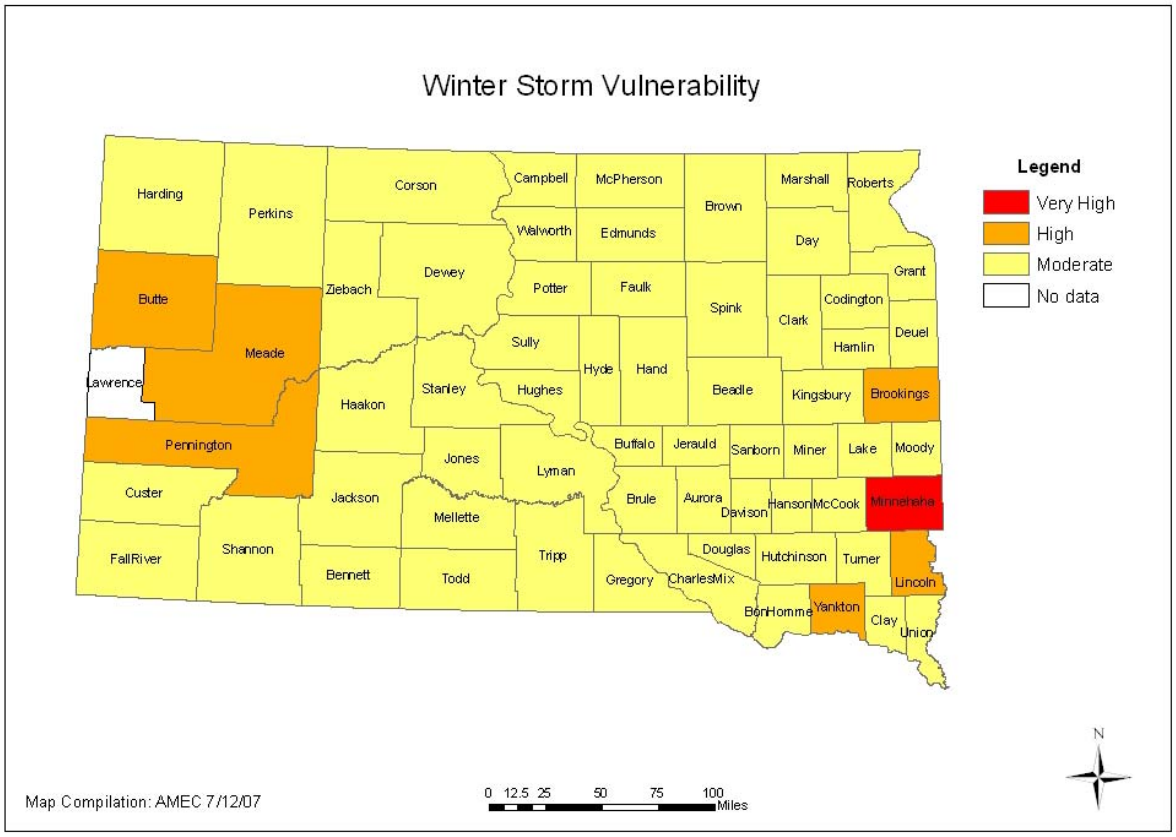


Table 3-47: Vulnerability of South Dakota Counties to Winter Storms (ranked by vulnerability)

County	Prior Event Rating	Building Exposure Valuation Rating	Population Density Rating	Winter Storm Vulnerability
Minnehaha	7	10	10	Very High
Lincoln	7	2	4	High
Meade	10	2	1	High
Pennington	4	6	2	High
Brookings	7	2	2	High
Butte	9	1	1	High
Yankton	6	2	3	High
Lawrence	n/a	2	2	High*
Brown	6	3	1	Moderate
Davison	5	2	3	Moderate
Harding	8	1	1	Moderate
Aurora	7	1	1	Moderate
Beadle	6	2	1	Moderate
Bon Homme	7	1	1	Moderate
Codington	5	2	2	Moderate
Edmunds	7	1	1	Moderate
Hutchinson	7	1	1	Moderate
Marshall	7	1	1	Moderate
McCook	7	1	1	Moderate
Moody	7	1	1	Moderate
Perkins	7	1	1	Moderate
Roberts	7	1	1	Moderate
Spink	7	1	1	Moderate
Turner	7	1	1	Moderate
Brule	6	1	1	Moderate
Charles Mix	6	1	1	Moderate
Clay	5	1	2	Moderate
Day	6	1	1	Moderate
Faulk	6	1	1	Moderate
Grant	6	1	1	Moderate
Hand	6	1	1	Moderate
Hanson	6	1	1	Moderate
Hughes	4	2	2	Moderate
Kingsbury	6	1	1	Moderate
Lake	6	1	1	Moderate
McPherson	6	1	1	Moderate
Union	5	1	2	Moderate

County	Prior Event Rating	Building Exposure Valuation Rating	Population Density Rating	Winter Storm Vulnerability
Clark	5	1	1	Moderate
Douglas	5	1	1	Moderate
Gregory	5	1	1	Moderate
Hyde	5	1	1	Moderate
Jackson	5	1	1	Moderate
Jerauld	5	1	1	Moderate
Jones	5	1	1	Moderate
Lyman	5	1	1	Moderate
Miner	5	1	1	Moderate
Potter	5	1	1	Moderate
Sully	5	1	1	Moderate
Walworth	5	1	1	Moderate
Bennett	4	1	1	Moderate
Buffalo	4	1	1	Moderate
Campbell	4	1	1	Moderate
Corson	4	1	1	Moderate
Deul	4	1	1	Moderate
Dewey	4	1	1	Moderate
Haakon	4	1	1	Moderate
Hamlin	4	1	1	Moderate
Tripp	4	1	1	Moderate
Ziebach	4	1	1	Moderate
Fall River	3	1	1	Moderate
Mellette	3	1	1	Moderate
Sanborn	3	1	1	Moderate
Shannon	3	1	1	Moderate
Stanley	3	1	1	Moderate
Todd	3	1	1	Moderate
Custer	1	1	1	Moderate

* Inferred based on proximity to other high vulnerability counties

3.3.6 Wildfire

3.3.6.1 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:

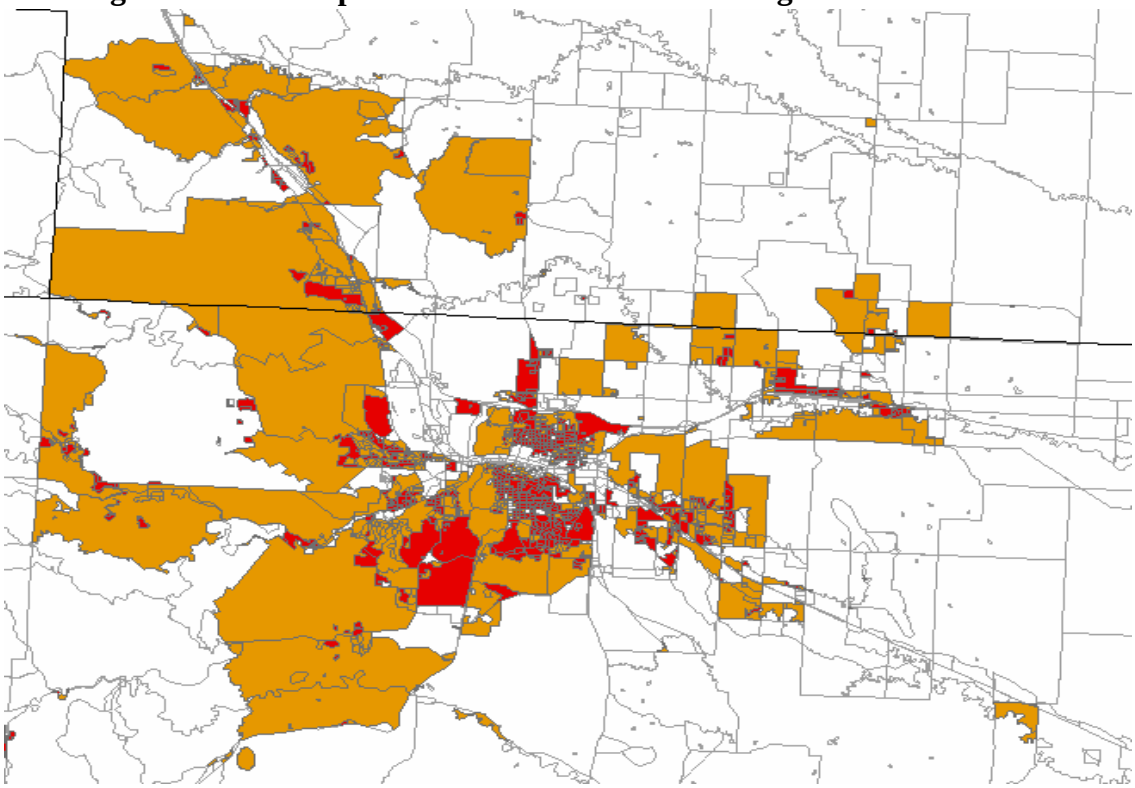
High Risk Threat Zone (areas of various housing unit density within areas of high vegetation)
- High Density Intermix
- Medium Density Intermix
- High Density Interface

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 3-26 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 3-26: Example of Fire Risk Zones in Pennington and Meade Counties



3.3.6.2 Total Wildfire Vulnerability and Estimate of Potential Loss

The results of the GIS analysis are presented in Table 3-48. Pennington County has the highest building count by far (over 25,000) compared to the other six counties.

Table 3-48: 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 2006, South Dakota received 10 fire management assistance declarations from FEMA, which provided financial support for fire suppression. Fire suppression costs for these 13 years totaled $11,647,391 (see the fire management assistance declarations in Table 3B Presidential Declarations). This averages out to $895,953 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 3-49 indicates the counties most vulnerable to wildland and prairie fires (from 2004 plan updated with 2005 HAZUS valuations and 2006 population).

Table 3-49: Wildland and Prairie Fire Exposure

County	Estimated Building Replacement Value (HAZUS-MH) ($)	Population (2000 Census)	Exposure Per Capita ($)
Bennett	107,491,000	3543	30,339
Butte	371,011,000	9374	39,579
Corson	108,451,000	4288	25,292
Custer	366,242,000	7944	46,103
Dewey	195,413,000	6112	31,972
Fall River	349,693,000	7304	47,877
Gregory	236,817,000	4268	55,487
Haakon	117,692,000	1864	63,139
Harding	68,578 000	1205	56,911
Jackson	91,910,000	2900	31,693
Jones	59,183,000	1067	55,467
Lawrence	1,146,222,000	22685	50,528
McPherson	153,359,000	2565	59,789
Meade	1,081,493,000	24425	44,278
Mellette	66,131,000	2099	31,506
Pennington	4,682,628,000	94338	49,637
Perkins	157,676,000	3025	52,124
Shannon	302,389,000	13824	21,874
Todd	221,610,000	1038	213,497
Ziebach	59,086,000	2706	21,835

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.

3.3.7 Drought

As discussed in the profile, the entire State of South Dakota is vulnerable to drought, but in different ways. While drought is a recognized hazard in South Dakota, historical data on losses and impacts is not readily available to support further vulnerability and loss estimation at this time.

3.3.8 Tornadoes

3.3.8.1 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.

3.3.8.2 Vulnerability Factors

Prior Events—This rating is based on the number of past tornadoes experienced by each county between 1950 and 2006 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 (6 to 74) was divided into 10 roughly equal ranges as shown in Table 3-50. The ranges were numbered 1 through 10 in ascending order.

Table 3-50: Tornadoes Prior Event Ratings

# of Past Occurrences	Rating
6-12	1
13-19	2
20-26	3
27-33	4
34-40	5
41-47	6
48-54	7
55-61	8
62-68	9
69-74	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-MH (residential, commercial, industrial, agricultural, religion, government, and education). The total range of building exposure ($49,715,000 to $8,442,273,000) was divided into 10 roughly equal ranges as shown in Table 3-51. The ranges were numbered 1 through 10 in ascending order.

Table 3-51: Tornadoes Building Exposure Ratings

Building Exposure ($000)	Rating
49,715-888,970	1
888,971-1,728,226	2
1,728,227-2,567,482	3
2,567,483-3,406,738	4
3,406,739-4,245,994	5
4,245,995-5,085,250	6
5,085,251-5,924,506	7
5,924,507-6,763,762	8
6,763,763-7,603,018	9
7,603,019-8,442,273	10

Population Density—Population density is determined by dividing county's population by its land area. For this rating, 2006 U.S. Census Bureau population estimates were divided by the land area reported in the 2000 census. The total range of population densities (.5 to 201.7) was divided into 10 roughly equal ranges as shown in Table 3-52. The ranges were numbered 1 through 10 in ascending order.

Table 3-52: Population Density Ratings

Population Density	Rating
.5-20.5	1
20.6-40.6	2
40.7-60.7	3
60.8-80.8	4
80.9-100.9	5
100-120	6
121-141	7
142-162	8
163-183	9
183-201.7	10

Past Tornado Damage—This rating is based on the property damage for the tornadoes that occurred in South Dakota between 1950 and 2006 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 2006 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). Dollar values were not inflated to 2007 because 2007 conversion factors are just estimates. The inflated values suggest that the state received $608,129,447 (2006 dollars) in tornado damage between 1950 and 2006, which averages out to approximately $10,668,938 per year.

The total range of past tornado damage ($104,586 to $138,638,424) was divided into 10 roughly equal ranges as shown in Table 3-53. The ranges were numbered 1 through 10 in ascending order.

Table 3-53: Past Tornado Damage Ratings

Past Tornado Damage ($)	Rating
104,586-13,597,951	1
13,597,952-27,811,335	2
27,811,336-41,664,719	3
41,664,720-55,518,103	4
55,518,104-69,371,487	5
69.387,488-83,224,871	6
83,224,872-97,078,255	7
97,078,256-110,931,639	8
110,931,640-124,785,024	9
124,785,025-138,638,424	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 3-54. 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 3-54: Tornado Vulnerability

Tornado Vulnerability Range	Tornado Vulnerability
4-11	Moderate
12-19	High
20-27	Very High

3.3.8.3 Results

Summary of Prior Event Ratings—The lowest number of recorded tornadoes over this 57-year period was 6 in Jones County; the highest was 74 in Brown County. All counties in South Dakota experienced at least six tornadoes in the past 57 years (see Figure 3-12 in Section 3.2.3). Brown County had by far the most and was the only county that received a rating of 10. Seventeen percent of the counties received ratings of 1, 32 percent received ratings of 2, 23 percent received ratings of 3, and 11 percent received ratings of 4. The counties that received a prior event rating greater than 4 are shown in Table 3-55.

Table 3-55: Counties with Tornadoes Prior Event Ratings Greater Than 4

County	# of Prior Events	Prior Event Rating
Perkins	34	5
Hutchinson	34	5
Lyman	35	5
McCook	37	5
Kingsbury	38	5
Meade	38	5
Pennington	39	5
Minnehaha	39	5
Charles Mix	40	5
Turner	41	6
Lincoln	50	7
Brown	74	10

Table 3-59 in the Total Tornado Vulnerability section shows prior event ratings for all South Dakota counties. A spreadsheet that includes the corresponding values can be found in Appendix 3E South Dakota Tornado Vulnerability.

Summary of Building Exposure Event Ratings—According to HAZUS-MH, the lowest building exposure was $49,715,000 in Buffalo County; the highest was $8,442,273,000 in Minnehaha County. Minnehaha was the only county to receive a 10 rating. The next highest rating was a 6 for Pennington County. The remainder of the counties received ratings between 1 and 3. Nearly 82 percent of the counties received a rating of 1. The counties that received a building exposure greater than 1 are shown in Table 3-56.

Table 3-56: Counties with Tornadoes 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 3-59 in the Total Tornado Vulnerability section shows building exposure ratings for all South Dakota counties. A spreadsheet that includes the corresponding values can be found in Appendix 3E South Dakota Tornado 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 3-57.

Table 3-57: Counties with Population Density Ratings Greater Than 1

County	Population Density	Population Density Rating
Hughes	22.9	2
Lawrence	28.4	2
Union	29.9	2
Clay	31.3	2
Pennington	34.0	2
Brookings	35.5	2
Codington	38.3	2
Yankton	41.8	3
Davison	43.7	3
Lincoln	61.0	4
Minnehaha	201.7	10

Table 3-59 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.

Summary of Past Tornado Damage Ratings—During the 57-year period, Lincoln County incurred the most tornado damage: $138,638,424. Jerauld County incurred the least: $104,586. Lincoln was the only county to receive a rating of 10. Turner County, with $45,256,974 in damage, received a rating of 4, while the other counties received ratings between 1 and 3. Eighty percent of the counties received a rating of 1. Those counties that received a rating higher than 1 are listed in Table 3-58. Figure 3-27 shows the distribution of tornado damage across the state between 1950 and 2006.

Table 3-58: Counties with Past Tornado Damage Ratings Greater Than 1

County	Past Tornado Damage	Past Tornado Damage Ratings
Pennington	15,913,290	2
Tripp	16,538,980	2
Custer	17,007,007	2
Hand	17,513,259	2
Codington	18,937,464	2
Beadle	19,213,205	2
Gregory	19,538,998	2
Minnehaha	24,869,871	2

County	Past Tornado Damage	Past Tornado Damage Ratings
Yankton	25,247,942	2
Buffalo	36,043,918	3
McCook	38,402,268	3
Turner	45,256,974	4
Lincoln	138,638,424	10

Figure 3-27: Tornado Damage 1950-2006

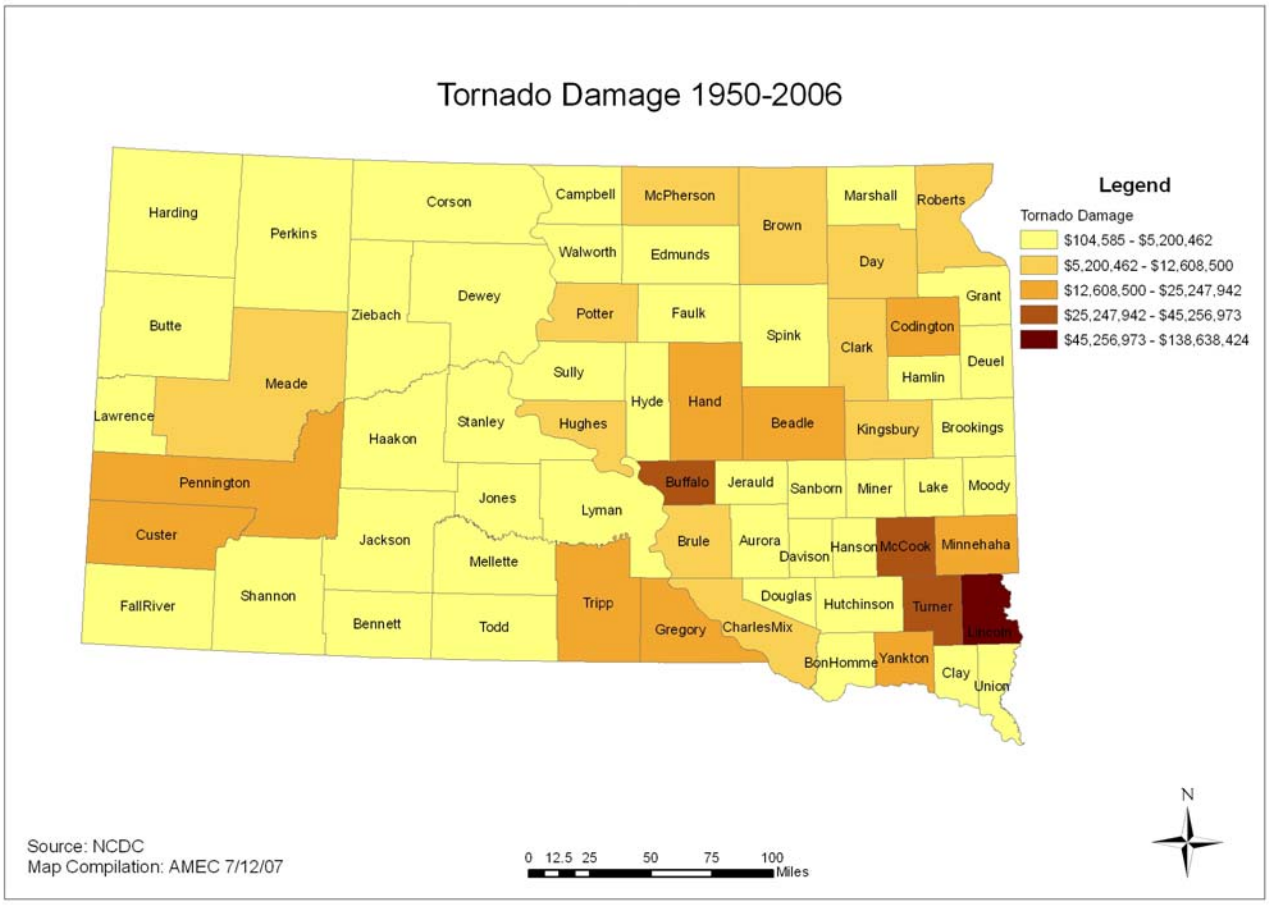


Table 3-59 in the Total Tornado Vulnerability section shows past tornado damage ratings for all South Dakota counties. A spreadsheet that includes the corresponding values can be found in Appendix 3E South Dakota Tornado Vulnerability.

3.3.8.4 Total Tornado Vulnerability and Estimate of Potential Loss

According to this methodology, while every South Dakota county is vulnerable to tornadoes, only Minnehaha and Lincoln County have very high vulnerabilities. Brown, Pennington, and Turner counties have high vulnerabilities. The remainder of the counties, 92 percent, have moderate vulnerabilities. Figure 3-28 illustrates the vulnerability of South Dakota counties to tornadoes, and Table 3-59 shows all the South Dakota counties ranked by total tornado vulnerability along with their four vulnerability factor ratings.

Future vulnerability

Minnehaha experienced the greatest population gain from 2000 – 2006 of all the counties in South Dakota. Of the counties with high vulnerability to winter storms, Pennington and Turner counties identified increased population. These growth and development trends must be taken into consideration when reviewing the vulnerability results below. Minnehaha, Pennington, and Turner counties continue to increase their vulnerability to tornados as population and development increases.

Figure 3-28: Tornado Vulnerability

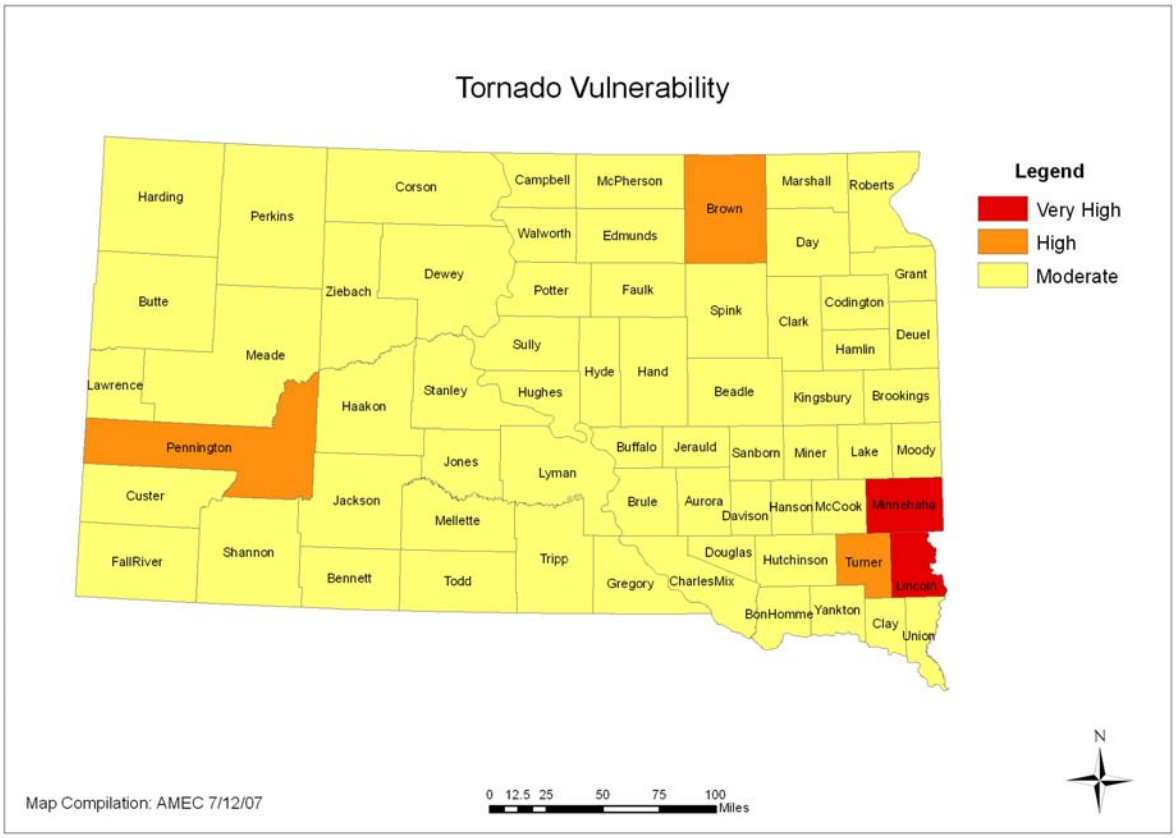


Table 3-59: Vulnerability of South Dakota Counties to Tornadoes (ranked by vulnerability)

County	Prior Event Rating	Building Exposure Valuation Rating	Population Density Rating	Damage Rating	Tornado Vulnerability
Minnehaha	5	10	10	2	Very High
Lincoln	7	2	4	10	Very High
Brown	10	3	1	2	High
Pennington	5	6	2	2	High
Turner	6	1	1	4	High
McCook	5	1	1	3	Moderate
Yankton	3	2	3	2	Moderate
Codington	4	2	2	2	Moderate
Beadle	4	2	1	2	Moderate
Meade	5	2	1	1	Moderate
Perkins	5	1	1	1	Moderate
Lyman	5	1	1	1	Moderate
Tripp	4	1	1	2	Moderate
Kingsbury	5	1	1	1	Moderate
Hutchinson	5	1	1	1	Moderate
Charles Mix	5	1	1	1	Moderate
Clay	4	1	2	1	Moderate
Davison	2	2	3	1	Moderate
Brookings	3	2	2	1	Moderate
Buffalo	2	1	1	3	Moderate
Hand	3	1	1	2	Moderate
Todd	4	1	1	1	Moderate
Fall River	4	1	1	1	Moderate
Spink	4	1	1	1	Moderate
Union	3	1	2	1	Moderate
Lawrence	2	2	2	1	Moderate
Sully	3	1	1	1	Moderate
Bennett	3	1	1	1	Moderate
Haakon	3	1	1	1	Moderate
Douglas	3	1	1	1	Moderate
Sanborn	3	1	1	1	Moderate
Miner	3	1	1	1	Moderate
McPherson	3	1	1	1	Moderate
Clark	3	1	1	1	Moderate
Gregory	2	1	1	2	Moderate
Brule	3	1	1	1	Moderate
Day	3	1	1	1	Moderate

County	Prior Event Rating	Building Exposure Valuation Rating	Population Density Rating	Damage Rating	Tornado Vulnerability
Roberts	3	1	1	1	Moderate
Hughes	1	2	2	1	Moderate
Harding	2	1	1	1	Moderate
Jackson	2	1	1	1	Moderate
Corson	2	1	1	1	Moderate
Faulk	2	1	1	1	Moderate
Stanley	2	1	1	1	Moderate
Dewey	2	1	1	1	Moderate
Potter	2	1	1	1	Moderate
Edmunds	2	1	1	1	Moderate
Deul	2	1	1	1	Moderate
Marshall	2	1	1	1	Moderate
Shannon	2	1	1	1	Moderate
Walworth	2	1	1	1	Moderate
Hamlin	2	1	1	1	Moderate
Bon Homme	2	1	1	1	Moderate
Custer	1	1	1	2	Moderate
Butte	2	1	1	1	Moderate
Grant	2	1	1	1	Moderate
Lake	2	1	1	1	Moderate
Ziebach	1	1	1	1	Moderate
Jones	1	1	1	1	Moderate
Mellette	1	1	1	1	Moderate
Campbell	1	1	1	1	Moderate
Hyde	1	1	1	1	Moderate
Jerauld	1	1	1	1	Moderate
Hanson	1	1	1	1	Moderate
Aurora	1	1	1	1	Moderate
Moody	1	1	1	1	Moderate

To estimate potential losses to tornadoes, historic loss data was analyzed. According to the National Climatic Data Center Storm Events database, there were 1,485 tornadoes in South Dakota between 1950 and 2006. Total property damage for these events is estimated at $608 million in 2006 dollars. There were 18 deaths and 449 injuries in this time period. This suggests that South Dakota experiences 26 tornadoes, $10.7 million in tornado property losses, and eight injuries each year. The total historic losses and annualized losses by county are presented in Table 3-60. 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.

Table 3-60: Annualized Losses from Tornadoes

County	Total Events	Total Property Damage (inflated to 2006 $)	Annualized Losses ($)	Total Building Exposure	Loss Ratio
Lincoln	50	138,638,424	2,432,253	1,223,753,000	0.0020
Turner	41	45,256,974	793,982	448,137,000	0.0018
McCook	37	38,402,268	673,724	291,957,000	0.0023
Buffalo	13	36,043,918	632,349	49,715,000	0.0127
Yankton	22	25,247,942	442,946	1,215,039,000	0.0004
Minnehaha	39	24,869,871	436,314	8,442,273,000	0.0001
Gregory	18	19,538,998	342,789	236,817,000	0.0014
Beadle	30	19,213,205	337,074	900,970,000	0.0004
Codington	29	18,937,464	332,236	1,253,341,000	0.0003
Hand	24	17,513,259	307,250	220,948,000	0.0014
Custer	12	17,007,007	298,369	366,242,000	0.0008
Tripp	27	16,538,980	290,158	293,246,000	0.0010
Pennington	39	15,913,290	279,181	4,682,628,000	0.0001
Brown	74	12,608,501	221,202	1,890,100,000	0.0001
Hughes	12	11,529,764	202,277	893,330,000	0.0002
McPherson	20	11,517,053	202,054	153,359,000	0.0013
Brule	21	10,600,757	185,978	271,976,000	0.0007
Kingsbury	38	10,591,344	185,813	302,197,000	0.0006
Clark	23	10,022,585	175,835	214,998,000	0.0008
Roberts	21	8,358,179	146,635	504,780,000	0.0003
Potter	17	7,456,085	130,809	200,750,000	0.0007
Charles Mix	40	7,375,318	129,392	386,117,000	0.0003
Day	21	7,237,877	126,980	419,006,000	0.0003
Meade	38	5,950,301	104,391	1,081,493,000	0.0001
Lake	19	5,200,462	91,236	616,086,000	0.0001
Miner	21	4,378,485	76,816	141,778,000	0.0005
Brookings	24	4,347,522	76,272	1,366,448,000	0.0001
Clay	28	4,335,119	76,055	609,659,000	0.0001
Bon Homme	18	4,152,709	72,855	356,357,000	0.0002
Shannon	18	4,128,598	72,432	302,389,000	0.0002
Union	21	4,016,242	70,460	811,268,000	0.0001
Marshall	13	3,983,183	69,880	283,827,000	0.0002
Walworth	16	2,944,265	51,654	316,909,000	0.0002
Bennett	22	2,835,931	49,753	107,491,000	0.0005
Campbell	12	2,757,237	48,373	81,598,000	0.0006
Perkins	34	2,228,931	39,104	157,676,000	0.0002
Todd	31	1,980,502	34,746	221,610,000	0.0002

County	Total Events	Total Property Damage (inflated to 2006 $)	Annualized Losses ($)	Total Building Exposure	Loss Ratio
Corson	18	1,916,496	33,623	108,451,000	0.0003
Butte	13	1,838,824	32,260	371,011,000	0.0001
Lawrence	15	1,769,231	31,039	1,146,222,000	0.0000
Hutchinson	34	1,756,870	30,822	353,478,000	0.0001
Fall River	27	1,657,331	29,076	349,693,000	0.0001
Douglas	21	1,605,233	28,162	124,068,000	0.0002
Hanson	10	1,597,117	28,020	137,487,000	0.0002
Davison	18	1,436,700	25,205	922,126,000	0.0000
Mellette	12	1,180,000	20,702	66,131,000	0.0003
Spink	32	1,099,387	19,287	380,103,000	0.0001
Sanborn	20	1,088,597	19,098	124,880,000	0.0002
Haakon	21	820,176	14,389	117,692,000	0.0001
Grant	17	765,897	13,437	379,825,000	0.0000
Moody	9	719,572	12,624	318,576,000	0.0000
Hamlin	17	682,619	11,976	320,017,000	0.0000
Ziebach	9	672,740	11,802	59,086,000	0.0002
Lyman	35	645,183	11,319	172,173,000	0.0001
Jackson	18	598,530	10,501	91,910,000	0.0001
Dewey	18	498,238	8,741	195,413,000	0.0000
Faulk	15	408,584	7,168	115,365,000	0.0001
Stanley	18	337,818	5,927	135,988,000	0.0000
Sully	20	278,611	4,888	92,608,000	0.0001
Hyde	9	238,142	4,178	82,465,000	0.0001
Harding	15	177,105	3,107	68,578,000	0.0000
Deul	18	169,063	2,966	260,247,000	0.0000
Aurora	11	159,592	2,800	143,836,000	0.0000
Jones	6	124,378	2,182	59,183,000	0.0000
Edmunds	18	124,275	2,180	215,929,000	0.0000
Jerauld	8	104,586	1,835	128,318,000	0.0000
Total	**1,485**	**608,129,447**	**10,668,941**	**38,357,127,000**	**n/a**

3.3.9 Wind

3.3.9.1 Methodology

To assess the vulnerability of each of South Dakota's counties to wind 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. The factors are described below.

3.3.9.2 Vulnerability Factors

Prior Events—This rating is based on the number of past wind events experienced by each county between 1955 and 2006 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 wind event is considered thunderstorm winds or high winds as identified in the National Climatic Data Center's database that occurred between April 1 and September 30 in each of the given years (see the description of the wind events that affect South Dakota in Section 3.2.6 Wind Profile).

To develop the prior event rating, the total range of past occurrences (26 to 196) 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: Wind Prior Event Ratings

# of Past Occurrences	Rating
26-42	1
43-59	2
60-76	3
77-93	4
94-110	5
111-127	6
128-144	7
145-161	8
162-178	9
179-196	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-MH (residential, commercial, industrial, agricultural, religion, government, and education). The total range of building exposure ($49,715,000 to $8,442,273,000) was divided into 10 roughly equal ranges as shown in Table 3-62. The ranges were numbered 1 through 10 in ascending order.

Table 3-62: Wind Building Exposure Ratings

Building Exposure ($000)	Rating
49,715-888,970	1
888,971-1,728,226	2
1,728,227-2,567,482	3
2,567,483-3,406,738	4
3,406,739-4,245,994	5
4,245,995-5,085,250	6
5,085,251-5,924,506	7
5,924,507-6,763,762	8
6,763,763-7,603,018	9
7,603,019-8,442,273	10

Population Density—Population density is determined by dividing county's population by its land area. For this rating, 2006 U.S. Census Bureau population estimates were divided by the land area reported in the 2000 census. The total range of population densities (.5 to 201.7) was divided into 10 roughly equal ranges as shown in Table 3-63. The ranges were numbered 1 through 10 in ascending order.

Table 3-63: Population Density Ratings

Population Density	Rating
.5-20.5	1
20.6-40.6	2
40.7-60.7	3
60.8-80.8	4
80.9-100.9	5
100-120	6
121-141	7
142-162	8
163-183	9
183-201.7	10

A fourth factor, past wind damage, will 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 can not 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 (3 to 30) was divided into three roughly equal ranges as shown in Table 3-64. The ranges were assigned a corresponding level of wind vulnerability: moderate, high, and very high.

Table 3-64: Wind Vulnerability

Wind Vulnerability Range	Wind Vulnerability
3-11	Moderate
12-20	High
21-30	Very High

3.3.9.3 Results

Summary of Prior Event Ratings—The lowest number of recorded wind events over this 52-year period was 26 in Lawrence County; the highest was 196 in Pennington County. All counties in South Dakota experienced at least 26 wind events in the past 52 years (see Figure 3-13 in Section 3.2.6). Pennington, Meade, and Minnehaha were the only counties that received a rating of 10. Lawrence, Aurora, Buffalo, Douglas, Gregory, Jerauld, Jones, McPherson, and Mellette received ratings of 1. Ratings of 2 and 3 were the most common, with 29 and 26 percent of counties respectively. The counties that received a prior event rating greater than 4 are shown in Table 3-65.

Table 3-65: Counties with Wind Prior Event Ratings Greater Than 4

County	# of Prior Events	Prior Event Rating
Minnehaha	186	10
Pennington	196	10
Meade	189	10
Brown	169	9
Beadle	161	8
Hughes	134	7
Lincoln	104	5
Davison	99	5
Edmunds	101	5
Haakon	95	5
Harding	106	5

Table 3-68 in the Total Wind 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 Wind Vulnerability.

Table 3-66: Counties with Wind 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

County	Building Exposure ($000)	Building Exposure Rating
Brookings	1,366,448	2
Brown	1,890,100	3
Pennington	4,682,628	6
Minnehaha	8,442,273	10

Table 3-68 in the Total Wind Vulnerability section shows building exposure ratings for all South Dakota counties. A spreadsheet that includes the corresponding values can be found in Appendix 3F South Dakota Wind 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 3-67.

Table 3-67: Counties with Population Density Ratings Greater Than 1

County	Population Density	Population Density Rating
Hughes	22.9	2
Lawrence	28.4	2
Union	29.9	2
Clay	31.3	2
Pennington	34.0	2
Brookings	35.5	2
Codington	38.3	2
Yankton	41.8	3
Davison	43.7	3
Lincoln	61.0	4
Minnehaha	201.7	10

Table 3-68 in the Total Wind Vulnerability section shows population density ratings for all South Dakota counties. A spreadsheet that includes the corresponding values can be found in Appendix 3F South Dakota Wind Vulnerability.

3.3.9.4 Total Wind Vulnerability and Estimate of Potential Loss

According to this methodology, while every South Dakota county is vulnerable to wind, only Minnehaha has a very high vulnerability, while Pennington, Brown, and Meade have high vulnerabilities. The remaining counties, 94 percent, have moderate vulnerabilities. Figure 3-29 illustrates the vulnerability of South Dakota counties to wind, and Table 3-68 shows all the South Dakota counties ranked by total wind vulnerability along with their three vulnerability factor ratings.

Future vulnerability
Minnehaha experienced the greatest population gain from 2000 – 2006 of all the counties in South Dakota. Of the counties with high vulnerability to winter storms, Pennington and Meade counties identified increased population. These growth and development trends must be taken into consideration when reviewing the vulnerability results below. Minnehaha, Pennington, and Meade counties continue to increase their vulnerability to wind as population and development increases.

Figure 3-29: Wind Vulnerability

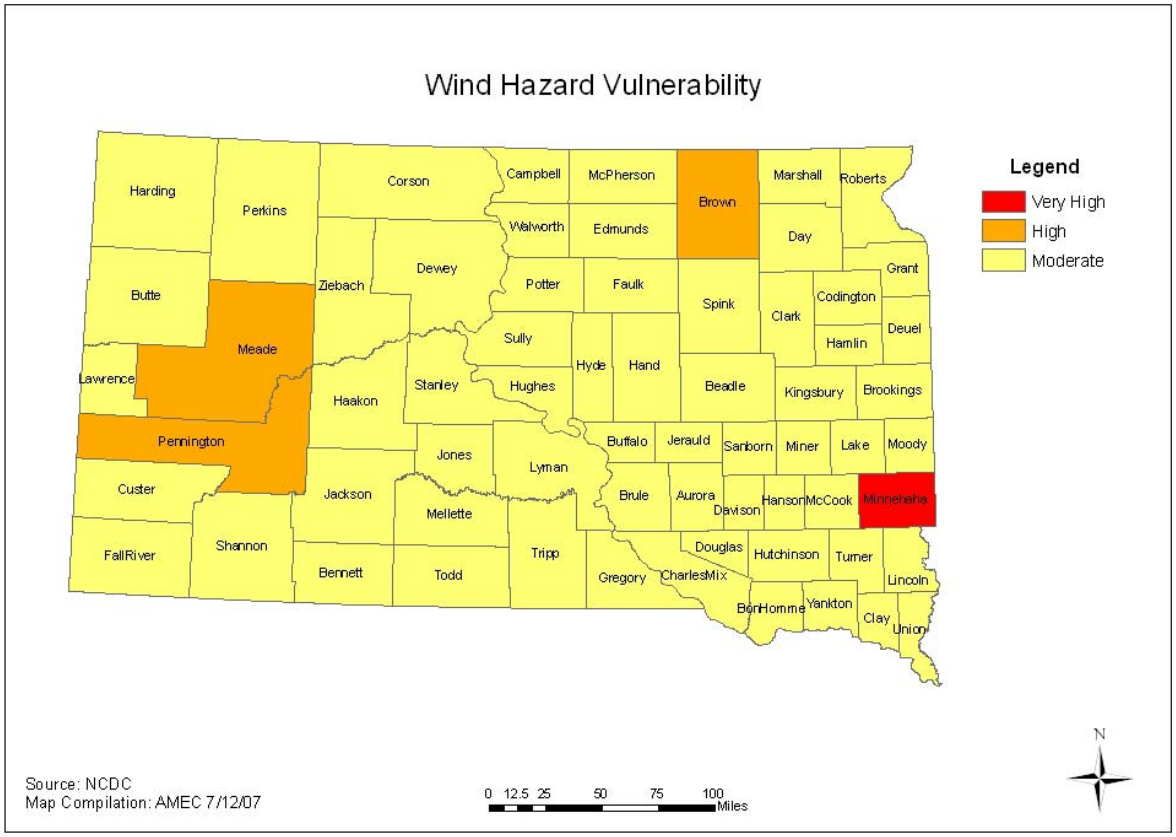


Table 3-68: Vulnerability of South Dakota Counties to Wind (ranked by vulnerability)

County	Prior Event Rating	Building Exposure Valuation Rating	Population Density Rating	Wind Vulnerability
Minnehaha	10	10	10	Very High
Pennington	10	6	2	High
Brown	9	3	1	High
Meade	10	2	1	High
Beadle	8	2	1	Moderate
Hughes	7	2	2	Moderate
Lincoln	5	2	4	Moderate
Davison	5	2	3	Moderate
Yankton	4	2	3	Moderate
Brookings	4	2	2	Moderate
Codington	4	2	2	Moderate
Edmunds	5	1	1	Moderate
Haakon	5	1	1	Moderate
Harding	5	1	1	Moderate
Butte	4	1	1	Moderate
Day	4	1	1	Moderate
Kingsbury	4	1	1	Moderate
Perkins	4	1	1	Moderate
Spink	4	1	1	Moderate
Tripp	4	1	1	Moderate
Union	3	1	2	Moderate
Walworth	4	1	1	Moderate
Bon Homme	3	1	1	Moderate
Brule	3	1	1	Moderate
Charles Mix	3	1	1	Moderate
Clay	2	1	2	Moderate
Corson	3	1	1	Moderate
Custer	3	1	1	Moderate
Faulk	3	1	1	Moderate
Hand	3	1	1	Moderate
Hutchinson	3	1	1	Moderate
Lake	3	1	1	Moderate
Lawrence	1	2	2	Moderate
Lyman	3	1	1	Moderate
Marshall	3	1	1	Moderate
McCook	3	1	1	Moderate
Shannon	3	1	1	Moderate
Stanley	3	1	1	Moderate

County	Prior Event Rating	Building Exposure Valuation Rating	Population Density Rating	Wind Vulnerability
Turner	3	1	1	Moderate
Ziebach	3	1	1	Moderate
Bennett	2	1	1	Moderate
Campbell	2	1	1	Moderate
Clark	2	1	1	Moderate
Deul	2	1	1	Moderate
Dewey	2	1	1	Moderate
Fall River	2	1	1	Moderate
Grant	2	1	1	Moderate
Hamlin	2	1	1	Moderate
Hanson	2	1	1	Moderate
Hyde	2	1	1	Moderate
Jackson	2	1	1	Moderate
Miner	2	1	1	Moderate
Moody	2	1	1	Moderate
Potter	2	1	1	Moderate
Roberts	2	1	1	Moderate
Sanborn	2	1	1	Moderate
Sully	2	1	1	Moderate
Todd	2	1	1	Moderate
Aurora	1	1	1	Moderate
Buffalo	1	1	1	Moderate
Douglas	1	1	1	Moderate
Gregory	1	1	1	Moderate
Jerauld	1	1	1	Moderate
Jones	1	1	1	Moderate
McPherson	1	1	1	Moderate
Mellette	1	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 85.7 wind events, $8 million in wind losses, and approximately two injuries each year.

3.3.10 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 2006 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 628 transportation incidents involving hazardous materials between 1971 and 2006. The total cost of damage associated with these incidents was approximately $5,729,979. This suggests that South Dakota experiences 17.5 transportation incidents involving hazardous materials and $159,000 in related damage each year. Twelve of the incidents were rail related, 13 were air, and the remaining 603 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.

3.3.11 Landslides and Mudflows

Information regarding previous landslides and mudflows 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 (Section 3.2.8). Available data does not support further refinement of vulnerability to landslides and mudflows based on historic losses.

3.3.12 Earthquake

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 – 2006 of all the counties in South Dakota. Areas with high development will continue to be the areas most vulnerable to structural damage from earthquakes.

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 containing 653 records was made available for analysis during this plan's update in 2007. Improvements to the database could include the addition of a building valuation field and a standardized classification of facility type. At the time this plan was prepared the database included the following types of facilities:

- Educational/School
- Electric power
- Emergency services
- Energy
- Hydro Electric
- Hospitals
- Law Enforcement
- Natural Gas
- Communication
- Aviation
- Community Water
- 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 2007, 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 Appendix 3H South Dakota State Facilities as Figures 3H-1 through 3H-4.

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. The emergency facilities HAZUS-MH layers are shown in Appendix 3H, Figure 3H-5.

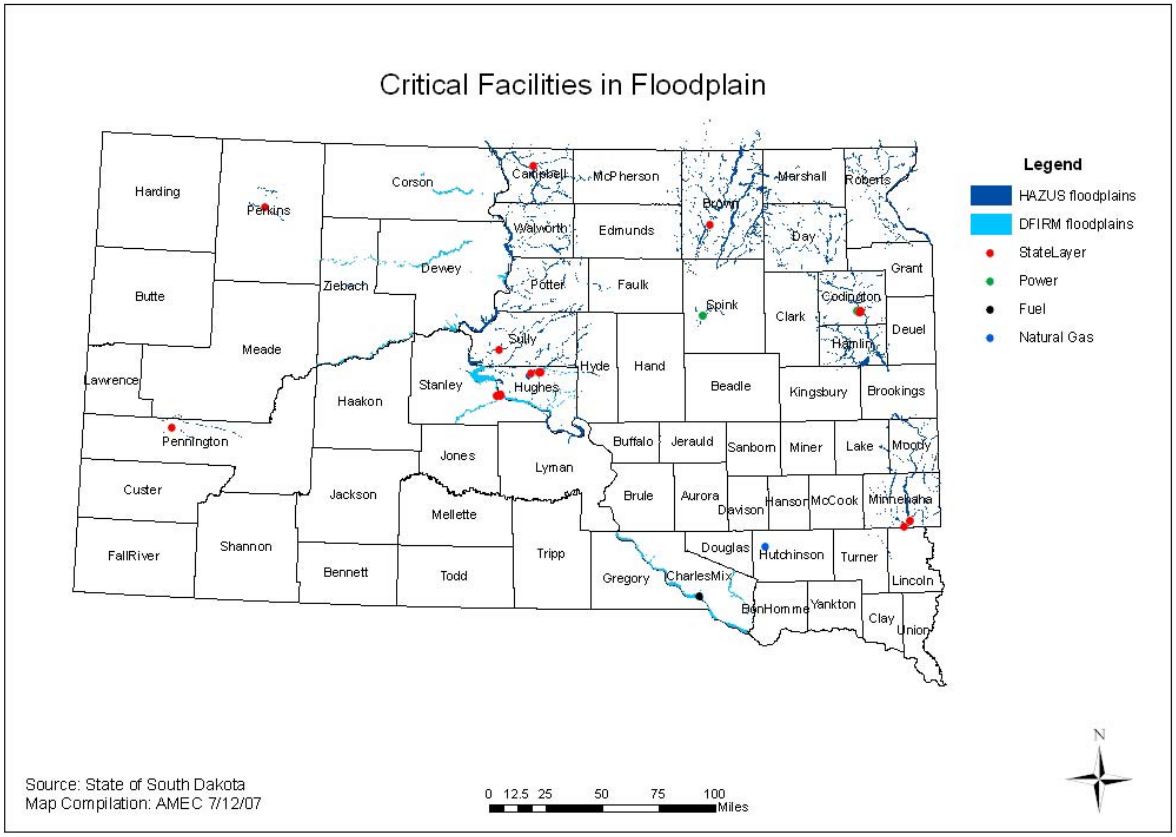
In HAZUS-MH there are utility and infrastructure data sets that are considered 'lifeline' inventory. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural 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.

3.4.1 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 3-30 illustrates critical facilities and their relationship to floodplains. Table 3H-A in Appendix 3H illustrates the numbers and names of facilities in the floodplain, by county. 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 3-30: South Dakota Critical Facilities Flood Analysis



3.4.1.1 Analysis of Dams

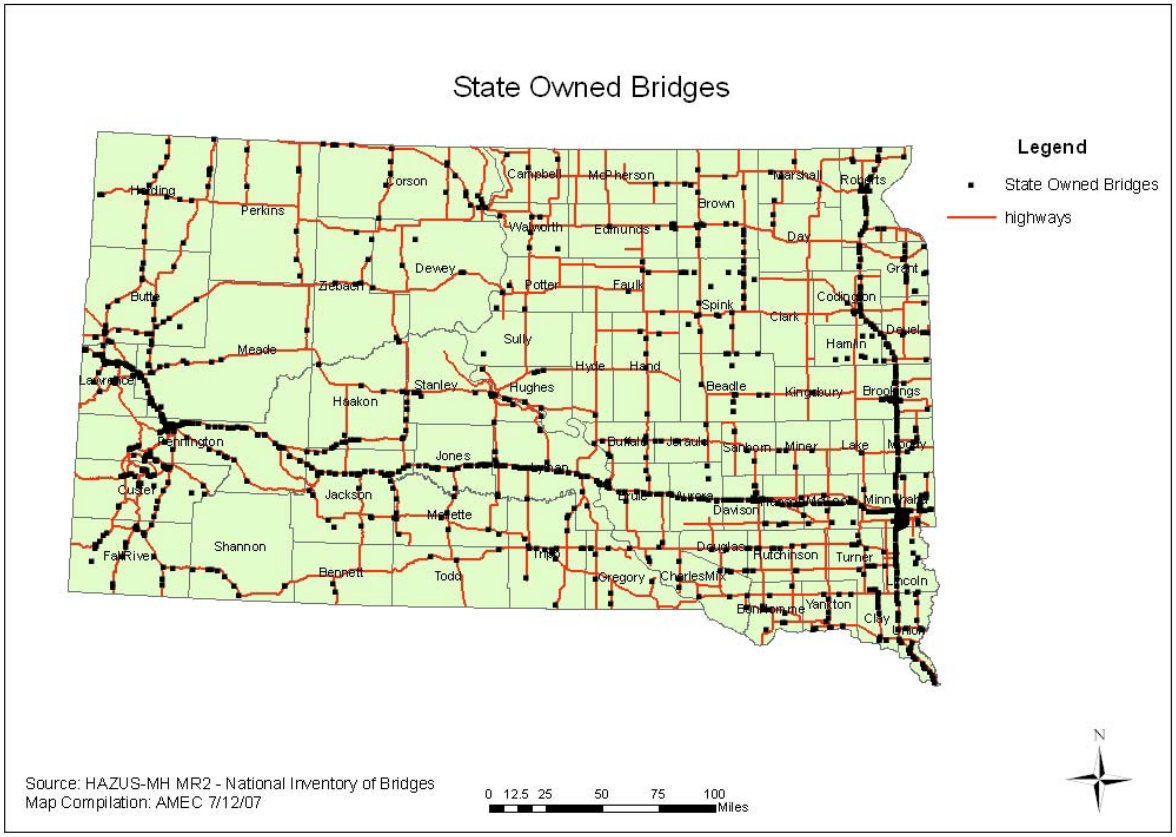
According to information from the South Dakota Department of Natural Resources and the National Inventory of Dams, there are approximately 21 high hazard dams in South Dakota that do not have emergency action plans, only two of which are state owned: Kroetch in Haakon County and Brunning No. 1 in Mellette County. The majority of the 21 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. The largest (based on normal storage volume) of the high hazard dams without emergency action

plans are the Grizzly Gulch dam in Lawrence County owned by Homestake Mining Company and the White Clay dam in Shannon County owned by the Oglala Sioux Tribe. Figure 3-3 in Section 3.2.1 Flood Hazard Profile illustrates the high and significant hazard dams in South Dakota. The State of South Dakota owns approximately 200 of the roughly 2,500 dams in the state. The majority of these dams are low hazard dams.

3.4.1.2 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 3-31: 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

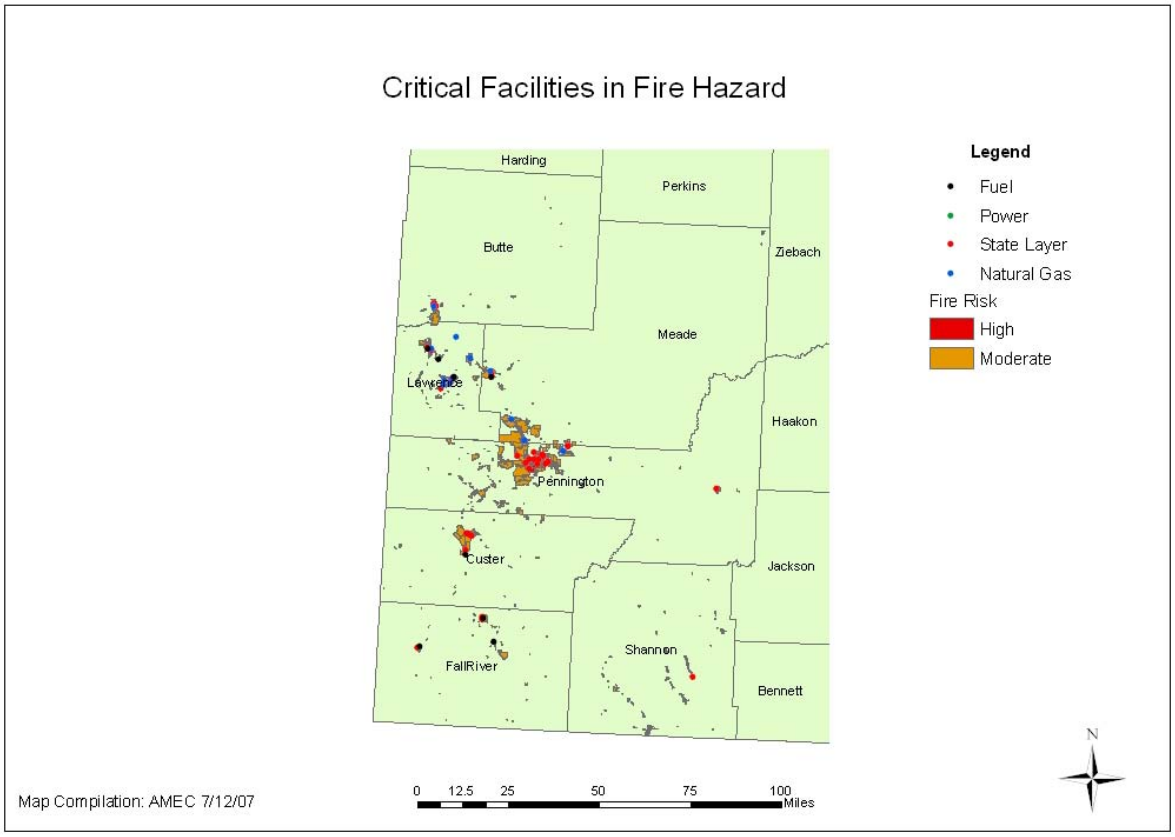
were the number of repeated culvert washouts and replacements on gravel roads from multiple flood disasters. Location and loss information from the FEMA Public Assistance program should be incorporated in future updates to this plan.

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.

3.4.2 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 3-32 and descriptions of the facilities are listed in Table 3H-B in Appendix 3H.

Figure 3-32: South Dakota Critical Facilities Wildfire Analysis



3.4.3 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 (StateLayer,

Power, Natural Gas, and Fuel) was quantified in each of these counties. The results are displayed in Table 3-69. 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 3-69: State Facilities in Counties Vulnerable to Winter Storm, Wind, and Tornado Hazards

COUNTY	Winter Storm Vulnerability	Wind Vulnerability	Tornado Vulnerability	StateLayer 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).

3.4.4 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.

3.4.5 Hazardous Materials

Resources and data did not support a detailed vulnerability and loss estimation for hazardous material impacts on state facilities during the 2007 update to this plan.

3.4.6 Landslides and Mudflows

Resources and data did not support a detailed vulnerability and loss estimation for landslides and mudflow impacts on state facilities during the 2007 update to this plan.

3.4.7 Earthquakes

History has proven that earthquakes have not caused significant damage in the State of South Dakota. A 2500 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.

3.4.8 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 3-1 in Section 3.1 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 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. 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.

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SECTION 4 MITIGATION STRATEGIES

This section outlines the State's strategy for reducing the losses identified in the risk assessment. It has been significantly revised in comparison to the original 2004 State of South Dakota Multi-Hazard Mitigation Plan. In lieu of developing specific goals for each identified hazard and listing priorities for meeting those goals (as in the previous plan), this 2007 State of South Dakota Multi-Hazard Mitigation Plan contains a strategy comprised of goals, objectives, and actions. 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 meeting of the State Hazard Mitigation Team, the group considered the preliminary results of the local and state vulnerability assessments to determine the following five goals. 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.

The following goals were developed to assist the State in maintaining its priority to support local mitigation efforts.

Goals:

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

SDOEM collaborated with the SHMT to develop one or more objectives for each goal and specific actions to reach those objectives. The goals and objectives are listed in Table 4-1. The mitigation actions are detailed in Section 4.4 Mitigation Measures.

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 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 floodway*
Objective 2.4	*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*
Objective 3.2	*Reduce the number of power outages due to winter/ice storms*

Goal 4	Reduce impacts to the economy, the environment, and cultural resources from hazards
Objective 4.1	*Reduce loss to environment and cultural resources*

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 June 26, 2007 documents the process for the State's administration of hazard mitigation funding.

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. Details on the quarterly report process are included in Appendix E.

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. Topics discussed recently are LOMA/LOMRs, how to complete and review a floodplain permit, and ordinance adoption. In 2008, the workshop will focus on how to read an elevation certificate and Flood Insurance Rate Map.

SDOEM currently has 17 Digital Flood Insurance Rate Map (DFIRM) projects in various stages. All, except one, of these projects are development of countywide DFIRMs. All of these projects will be effective by March 2009. FEMA has completed 11 DFIRM projects in South Dakota. FEMA is currently working on completing three countywide DFIRMs and one community DFIRM for South Dakota. FEMA and SDOEM hope to start seven additional counties in 2008. By September 30, 2010, FEMA and SDOEM will have DFIRMs in 36 out of 66 counties. Most of the remaining counties either do not have any FEMA determined floodplains or the community does not participate in the NFIP.

According to The National Flood Insurance Program Community Status Book at www.fema.gov/fema/csb.shtm, there were a total of 205 communities throughout the State of South Dakota participating in the National Flood Program at the time this plan was prepared. The list of participating communities is included as Appendix C.

The State NFIP Coordinator provides information at commission meetings to communities that currently do not participate in the NFIP Program. The state has recently submitted four NFIP applications to FEMA.

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
The South Dakota Office of Emergency Management has contacted the one severe repetitive loss property within the state on numerous occasions over the past three years. 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. SDOEM also sent out an email directly to the City of Watertown describing the possibility of funding for the one severe repetitive loss property.

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 3.4.11 Analysis of Dams.

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, Mead, Lawrence, Butte, and Stanley Counties have effective CWPPs. Perkins and Fall River Counties are developing CWPPs.

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/government/adoption.html. As of the 2007 State of South Dakota Multi-Hazard Mitigation Plan update, the following jurisdictions have adopted the International Building Code and the International Residential Code among other International Codes: Aberdeen, Fort Pierre, Hot

Springs, Hughes County, Huron, Lead, 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 may improve the integration of mitigation practices throughout the state by continuing to work with the Rural Electric Cooperatives, other utilities, and additional state agencies to 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 H.

State Agency Capabilities
No changes to state policies were made since the previous plan was developed (in 2004). The additional members on the SHMT (added by executive order in 2007) have been beneficial to the development of this plan.

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

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. The FEMA – approved local mitigation plans at the time covered 60 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	42
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	31
Regular dam and culvert inspections and maintenance	26
Catalogue and track hazardous materials incidents	25
Equipment to respond to hazardous materials incidents	24
Increased security, communication, and educational outreach to prevent terrorism	23
Public Awareness Campaigns / CERT / Citizen Corp	22

A complete inventory of the capabilities identified in the local plans is included in Appendix F. 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 the meantime, 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 F.

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 are 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.

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 following pages contain mitigation actions identified by the State Hazard Mitigation Team to meet the goals and objectives outlined in Section 4.1. The mitigation actions listed here are new to this plan update. The original plan completed in 2004 identified project types, based on the State's priorities, through historical data and future potential disaster events. This updated plan identified specific mitigation actions linking to the goals and objectives.

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.

Mitigation Action Prioritization

The State Hazard Mitigation Team rated each action with a level of priority (High, Medium, Low) as described below.

- **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.

- **Medium** priority actions are educational, outreach, maintenance actions. They are small mitigation projects that would minimize severity but not mitigation hazards completely.

- **Low** priority actions are generally the responsibility of the local community. The State supports these projects, but is often unable to provide financial assistance.

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 2011. The State Hazard Mitigation Team understands that the 2011 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. For reference purposes and future prioritizing purposes the local mitigation actions identified in the FEMA-approved local mitigation plans at the time of this update are included as Appendix G.

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 I contains a Mitigation Action Tracking Matrix intended as a tools for the SHMT and SHMO to track the progress of the identified actions as well as to capture new mitigation actions during the life of this plan.

South Dakota State Hazard Mitigation Plan 2008 Goals/Objectives	
Goal 1	**Reduce injuries and loss of life from hazards**
Objective 1.1	Reduce the number of injuries/fatalities by 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 floodway
Objective 2.4	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 the losses that will cause facility damage/loss
Objective 3.2	Reduce the number of power outages due to winter/ice storms
Goal 4	**Reduce impacts to the economy, the environment, and cultural resources from hazards**
Objective 4.1	Reduce loss to environment and cultural resources
Goal 5	**Support and assist local/tribal mitigation capabilities and efforts**
Objective 5.1	Encourage locals to participate in reducing impacts of incidents

Problem Statement	There are an insufficient number of existing shelters in hazardous areas.
Description	**Action 1.1A – 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 ☐ Landslides and Mudflows ☐ Earthquakes
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

Problem Statement	Many communities throughout the state have inadequate existing warning systems.
Description	**Action 1.1B – 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

Problem Statement	Many communities throughout the state have inadequate existing warning systems.
Description	**Action 1.1C – 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 ☐ Landslides and Mudflows ☐ Earthquakes
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

Problem Statement	Many communities do not mandate or enforce zoning requirements. As a result, tie downs for mobile homes are commonly installed improperly.
Description	**Action 1.1D – 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 ☐ Landslides and Mudflows ☐ Earthquakes
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

Problem Statement	No requirements or zoning exists for safe rooms.
Description	**Action 1.1E – 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 ☐ Landslides and Mudflows ☒ Earthquakes
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

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	**Action 1.1F – 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

Problem Statement	A statewide floodplain regulation does not exist.
Description	**Action 1.1I – Suggest a statewide floodplain regulation –** Coordinate with the appropriate regulatory bodies to develop a statewide floodplain ordinance.
Priority	☐ High ☐ Medium ☒ Low
Hazard	☒ Flood ☐ Winter Storm ☐ Wildfire ☐ Drought ☐ Tornadoes ☐ Wind ☐ Hazardous Materials ☐ Landslides and Mudflows ☐ Earthquakes
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

Problem Statement	Electrical safety is a concern after many disasters due to fallen power lines.
Description	**Action 1.1J –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 ☒ Landslides and Mudflows ☒ Earthquakes
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

Problem Statement	Built structures exist in hazard prone areas.
Description	**Action 2.1A – 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 ☐ Landslides and Mudflows ☐ Earthquakes
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 communites, USCOE, DOT
Target Completion Date	ongoing

Problem Statement	Built structures exist in flood prone areas.
Description	**Action 2.1B – 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 ☐ Landslides and Mudflows ☐ Earthquakes
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

Problem Statement	Built structures exist in flood prone areas.
Description	**Action 2.1C – 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 ☐ Landslides and Mudflows ☐ Earthquakes
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
Responsible Department	DENR, DPS, local communities, USCOE
Target Completion Date	ongoing

Problem Statement	Not all structures susceptible to high risk hazards throughout the state are identified.
Description	**Action 2.1D – Identify structures that are susceptible to different hazards (i.e. flooding, tornadoes, drought) –** 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

Problem Statement	Wildfires cause losses to communities, private citizens, and the forest.
Description	**Action 2.2A – 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 ☐ Landslides and Mudflows ☐ Earthquakes
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

Problem Statement	Communities are at risk of being threatened by wildfire outbreaks.
Description	**Action 2.2B – 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 ☐ Landslides and Mudflows ☐ Earthquakes
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

Problem Statement	Structures are threatened by wildfires because the forest is next to the structures at risk.
Description	**Action 2.2C – 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 ☐ Landslides and Mudflows ☐ Earthquakes
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

Problem Statement	Local planning and zoning are not strict enough or are non-existent in communities.
Description	**Action 2.3A – 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 ☐ Landslides and Mudflows ☒ Earthquakes
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

Problem Statement	The public always need to be reminded of the hazards in their communities in order to be self-prepared.
Description	**Action 3.1A – 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

Problem Statement	Many communities have adopted the International Building Codes (IBC) but have existing structures built prior to the enforcement of these standards.
Description	**Action 3.1B – Retrofitting 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

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	**Action 3.1C – 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

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	**Action 3.1D – 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

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.
Description	**Action 3.2A** – **Power line burial** – Continue support of power line burial through local project applications.
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☐ Hazardous Materials ☒ Landslides and Mudflows ☒ Earthquakes
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

Problem Statement	The state experiences a lot of power outage due to storms.
Description	**Action 3.2B** – **Spoilers** – Support the installation of spoilers through local project applications.
Priority	☐ High ☒ Medium ☐ Low
Hazard	☐ Flood ☒ Winter Storm ☐ Wildfire ☐ Drought ☐ Tornadoes ☐ Wind ☐ Hazardous Materials ☐ Landslides and Mudflows ☐ Earthquakes
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

Problem Statement	The state experiences a lot of power outage due to storms.
Description	**Action 3.2C – 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

Problem Statement	The state experiences a lot of power outage due to storms.
Description	**Action 3.2D – 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

Problem Statement	Many agencies forget to contact other agencies before beginning a project to ensure it will comply with their regulations.
Description	**Action 4.1A – 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

Problem Statement	The State has been in a drought for many years so soil nutrients are limited.
Description	**Action 4.1B – 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 ☐ Landslides and Mudflows ☐ Earthquakes
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

Problem Statement	Many communities and property owners do not have insurance on their property.
Description	**Action 4.1C – Promote insurance –**
Priority	☒ High ☐ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☒ Wildfire ☒ Drought ☒ Tornadoes ☒ Wind ☒ Hazardous Materials ☒ Landslides and Mudflows ☒ Earthquakes
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

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	**Action 4.1D – Encourage removal of debris near bridges and culverts –**
Priority	☐ High ☒ Medium ☐ Low
Hazard	☒ Flood ☒ Winter Storm ☐ Wildfire ☐ Drought ☒ Tornadoes ☒ Wind ☐ Hazardous Materials ☐ Landslides and Mudflows ☐ Earthquakes
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

Problem Statement	Local/tribal governments have been discouraged with regard to hazard mitigation projects due to participation requirements and changing rules/regulations.
Description	**Action 5.1A – 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

Problem Statement	Local/Tribal governments lack the personnel and experience to meet hazard mitigation plan requirements.
Description	**Action 5.1B – 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 ☒ Landslides and Mudflows ☒ Earthquakes
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

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**

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.

- **South Dakota Department of Transportation (DOT)**
- **FEMA Assistance of Firefighters Grant Program**
- **Office of Domestic Preparations (ODP)**
- **Resource Conservation and Development District Funding (RCD)**
- **Rural Development Grant and Loan Program**
- **School Districts**
- **Rural Water Systems (RWS)**
- **(SDDED)**
- **(SDEMD)**

- **Siouxland Interstate Metropolitan Planning Council (SIMPCO)**
- **Red Cross**
- **Salvation Army**
- **United States Department of Agriculture (USDA)**
- **United States Geological Survey (USGS)**
- **National Weather Service (NWS)**

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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.*

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 plan was prepared 60 counties had FEMA approved hazard mitigation plans. 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 June 26, 2007, the SHMO coordinates review of each project application for funding eligibility. 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. The SHMT determines priority of funding by evaluating each project using the Project Evaluation Sheet. This sheet (included on the following page) enables the SHMT to objectively review each project in terms of federal criteria and the pre-determined state goals. With this Hazard Mitigation Plan update the SHMT has modified the project review process to include the STAPLE/E Selection Criteria. These criteria 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.

Since the approval of the 2004 State Hazard Mitigation Plan the State of South Dakota has approved funding for multiple mitigation projects. The State has seen reductions in power line damage during severe weather due to the completion of power line burial projects. Communities with detention ponds are experiencing reduced flooding occurrences.

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.

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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___

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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: _____

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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?

Recent Technical Assistance and Funding (SHMO activities since the prior hazard mitigation plan)

Section 2.3 details the projects that have been approved through the mitigation funding mechanisms. In addition to these processes, the State Hazard Mitigation Officer has coordinated several technical assistance activities. These include trainings for G318, Benefit Cost Analysis training, and Tribal planning assistance.

February 3-4th 2005: Benefit Cost Analysis Workshop

November 13 – 17th 2006: G318 Training

This training covered PDM Planning, PDM Application Development, Acquisitions, Benefit Costs, E-grants, and project development techniques. A complete agenda is included in Appendix C.

November 14-15th 2006: G318 Training

This training covered planning & sustainability, organizing resources, assessing risks, developing mitigation plans and implementing mitigation plans. A complete agenda is included in Appendix C.

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….*

Forty-eight (48) local hazard mitigation plans covering 60 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
- Mitigation Actions

Section 3.1.3 discusses the consideration of the hazards identified in the local plans. Section 4.3 discusses the common capabilities identified in the local plans. The goals represented in the local plans were summarized and presented to the State Hazard Mitigation Team at SHMT Meeting #2. They were taken into consideration during the development of the goals identified in Section 4.1. The estimated losses, where provided, were integrated into the Risk Assessment (Chapter 3 of this plan). Table 3-22 in Section 3.3.1 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. A compilation of all the mitigation actions in the local plans is provided as Appendix G. These will be used as references for the State Hazard Mitigation Team during project application reviews as well as future plan updates. The mitigation actions and goals of the local mitigation plans are taken into consideration when determining the priorities for the state mitigation plan.

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 5-1 summarizes the most vulnerable counties for each of the identified hazards. 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 Most vulnerable counties to identified hazards

Natural Hazard (in order of priority)	Most Vulnerable Counties
Flood	Minnehaha, Pennington, Codington, Brown
Winter Storm	Minnehaha, Lincoln, Meade, Pennington, Brookings, Butte, Yankton
Wildfire	Bennett, Butte, Corson, Custer, Dewey, Fall River, Gregory, Haakon, Harding, Jackson, Jones, Lawrence, McPherson, Meade, Mellette, Pennington, Perkins, Shannon, Todd, Ziebach
Drought	All counties
Tornado	Minnehaha, Lincoln, Brown, Pennington, Turner
Wind	Minnehaha, Pennington, Brown, Meade
Hazardous Materials	Minnehaha, Pennington, Lincoln, Brown, Codington, and Southeastern South Dakota
Landslides and Mudflows	Lawrence, Pennington, Areas in the Black Hills
Earhquake	Pennington, Minnehaha, Lawrence

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. There are 4 county plans currently being reviewed by FEMA. The remaining 57 counties have approved hazard mitigation plans. One native american tribe has an approved plan.

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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.*

Since the 2004 Plan was approved, the State Hazard Mitigation Team has been amended to include additional agencies and the Governor, by executive order, has appointed this team responsible for the maintenance and implementation of the plan. The process for maintaining the plan was loosely defined in 2004. Given this update of the state hazard mitigation plan, the process was successful. The State Hazard Mitigation Team has a successful process for meeting and implementing mitigation actions after every declared disaster. For the next three-year cycle prior to the next formal plan update, the SHMT intends to hold meetings every six months to review the progress of the identified mitigation actions and note any relevant updates to the plan. (Note: There were no actions for the SHMT to monitor progress on from the 2004 plan.) Annually the SHMT will 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.

At every meeting of the SHMT, the team will evaluate the plan for appropriate revisions. This will include updating the Mitigation Action Tracking Matrix to monitor progress on the identified Mitigation Actions. This matrix is included as Appendix I and is intended to be a working document throughout the life of this plan.

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) Mitigation Action Tracking Matrix (Appendix I). 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 E. 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 SHMO will review the completed mitigation projects every six months and cross check them with the Mitigation Actions Tracking Matrix (Appendix I) plan to note progress. Additional projects approved which pertain to the goals and objectives of this plan will be documented and listed for inclusion in the next plan update to demonstrate the State's accomplishments toward natural hazard mitigation.

Prior to the three-year required plan update, in addition to the regular SHMT meetings, the prominent members of SDOEM, namely Kristi Turman, Director, Jason Bauder, Disaster Assistance Manager, Michelle Saxman, NFIP coordinator, and Cindy Maszk, State Hazard Mitigation Officer 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 2008 – 2011,
- 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 2011.

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.

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