Wyoming State Mitigation Plan
2016-2021

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Introduction

Purpose

The purpose of this mitigation plan is to identify activities which can reduce or eliminate the risk residents of Wyoming face from natural hazards. The hazard assessment portion of the plan represents extensive data gathering and analysis. This adds credibility to the quality of the hazard assessment and vulnerability analysis. The quality of the work enhances its value for application in future mitigation planning by the State of Wyoming, its counties and local jurisdictions for the purpose of reducing or eliminating long-term risk to human life and property from all hazards. The plan complies with the Disaster Mitigation Act of 2000 and supersedes a previously-approved plan.

Determining the level of risk a community faces depends in large measure on an understanding of what has or could happen. Due to infrequency of significant hazard events in Wyoming, residents are often unaware of the potential for loss of life and damage to property from hazards such as earthquakes, severe blizzards, and flooding. Today, only a small percentage of the state's population is aware of the tremendous impact the Blizzard of 1949 had on Wyoming and its neighboring states. Historical events recorded within this document are based on research of the most comprehensive data available and provide a foundation for the vulnerability analysis portion of the plan. The data and analyses can be useful to elected officials in establishing policy to mitigate hazards for the benefit of ensuing generations.

As defined by the Federal Emergency Management Agency, *mitigation* refers to any sustained action taken to reduce or eliminate long-term risk to people and property from hazards and their effects. Mitigation measures can include structural and nonstructural activities, such as ensuring homes are constructed away from flood plains, engineering bridges to withstand earthquakes, and creating and enforcing effective building codes to protect property from severe storms, earthquakes, floods, and other hazards. These activities can occur before, during, and after a disaster. Involvement of a wide range of participants in the planning process increases the feasibility and likelihood of implementing mitigation projects as resources become available.

Authority

The Wyoming Office of Homeland Security has been appointed by the Governor of Wyoming as the primary agency responsible for mitigating the effects of a disaster and preparing plans related to mitigation, response, and recovery. [§ 19-13-104(c)(i)] Wyoming Statute § 19-13-101 through § 19-13-414, referred to as 'The Wyoming Homeland Security Act,' further detail the authority and responsibilities of the Wyoming Office of Homeland Security. Additionally, this plan has been developed under the authority of and in compliance with the requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended, 42 U.S.C. 5121-5207 and Related Authorities. Wyoming will continue to 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 statutes as required in 44 CFR 13.11(d) and will submit the amended portions of the plan for approval, if required.

Adoption

An appropriate body in the state must adopt the plan. This could be, for example, the State Legislature or the governor, depending on the State's established procedures. States with hazard mitigation teams or councils may choose to use these bodies to adopt the plan. At a minimum, the plan must be endorsed by the director of the state agency responsible for preparing and implementing the plan, as well as the heads of other agencies with primary implementation responsibilities.

Adoption by the state demonstrates the state's commitment to fulfilling the mitigation objectives outlined in the plan and legitimizes the plan and authorizes the responsible agencies identified in the plan to execute their responsibilities.

Mitigation Plan Mission Statement and Goals

The following mission statement and goals outline the state's strategy for improving hazard resistance and community resilience through implementation of mitigation projects around the state:

Mission Statement

Reduce or eliminate risk to human life and property.

Goal 1

Continue to strengthen infrastructure and lifelines.

Goal 2

Continue to improve state and local capacity and capability to detect and/or warn of hazards before damage occurs.

Goal 3

Minimize economic losses resulting from impacts of hazards.

Goal 4

Reduce state and local costs of disaster response and recovery.

Mitigation Strategy Table

The following table is a summary of the Wyoming Mitigation Strategy as developed by the Wyoming Senior Advisory Committee Mitigation Sub-Committee. Detailed descriptions of these projects can be found in the Mitigation Strategy Chapter.

Table 1. Wyoming Mitigation Strategy Summary

Action #	Description	Responsible Agency	Timeframe	Cost Estimate	Priority Rank
1	Sponsor FEMA Mitigation Trainings	WOHS	2016-2021	$5k	High
2	Procure BCA Contractor	WOHS	2017-2018	$50-$100k	Medium
3	Public Education and Awareness Campaign	WPIO	2018	$10k	High
4	Develop GIS Layers for State and Local Risk Assessments	WSGS	2017	Staff Time	High

Action #	Description	Responsible Agency	Timeframe	Cost Estimate	Priority Rank
5	Improve Dam Failure Awareness	WSEO	2017-2021	Staff Time	Low
6	Promote Drought Education and Water Conservation	WWDC	2017-2021	Staff Time	Low
7	Retrofit Critical Facilities for Earthquake	WOHS	2018-2021	$25-$50k	Medium
8	Stabilize and Improve Local Floodplain Management	WOHS	2016-2021	Staff Time	High
9	Implement Flood Mitigation Projects	WOHS	2016-2021	$25k-$1mil.	High
10	Improve State and Federal Floodplain Management Coordination	WOHS	2016-2021	Staff Time	High
11	Improve Severe Weather Radar Coverage Statewide	WWRDSO	2016-2021	Staff Time	High
12	Improve Structural Resilience to Wind and Hail Damage	WOHS	2017-2021	Staff Time	Low
13	Monitor and Mitigate Landslide-Prone Areas	WSGS	2017-2021	$100-$500k	Low
14	Develop a Model Landslide Ordinance	WSGS	2018	$50k	Low
15	Abate Mine Subsidence	WDEQ	2016-2021	$100-$500k	Low
16	Build Tornado Shelters	WOHS	2017	$100k-$200k	Low
17	Improve Tornado Warning Systems	WOHS	2016-2021	$500k	High
18	Promote Firewise Program	WOHS	2016-2021	Staff Time	Medium
19	Manage Impacts of Windblown Deposits	WOHS	2016-2021	$1 million	Medium
20	Protect the Power Grid from Wind and Winter Storm	WOHS	2016-2021	$1-$5 mil	Medium
21	Prepare for Winter Storms	WOHS	2016-2021	Staff Time	Medium
22	Mitigate Road Closures due to Winter Storm and Wind	WOHS	2016-2021	$1-$5 mil	Medium

State Profile

Wyoming is located in the Rocky Mountain section of the western United States. Wyoming is bounded on the north by Montana, on the east by South Dakota and Nebraska, on the south by Colorado and Utah, and on the west by Utah, Idaho and Montana. Wyoming is one of three states entirely bounded by straight lines. From the north border to the south border it is 276 miles; from the east to the west border, 375 miles. Wyoming is the tenth (10th) largest state, with an area of 97,814 square miles but with the smallest population (50th) at 563,626, according to the 2010 census. Wyoming has several medium sized cities with concentrated populations and vast areas of extremely low population densities. Overall the population density is just under six persons per square mile. Cheyenne, the State Capital, is located in the southeast corner of the state and is the largest city with an estimated 2011 population of 60,096.

Industry

Wyoming is the leading coal-producing state and a leader in the production of petroleum and natural gas. Wyoming has the world's largest sodium carbonate (natrona) deposits and has the nation's second largest uranium deposits. Tourism ranks second of Wyoming's industries. Wyoming is historically considered farming and ranching community. These three industries round out the industries Wyoming relies upon. High-tech and manufacturing businesses are being recruited in an effort to diversify the state's economy.

Wyoming's economy is dependent upon mining (coal and trona), natural gas production, agriculture, and tourism. Critical infrastructure includes electrical power generation and transmission and the F.E. Warren Air Force Base, home of the 90th Space Wing. The largest recurring events include the University of Wyoming home football and basketball games, Cheyenne Frontier Days, and the Wyoming State Fair.

Geology

The Great Plains meet the Rocky Mountains in Wyoming. The state is a great plateau broken by a number of important mountain ranges. The highest point is Gannett Peak at 13, 804 feet and lowest point is the Belle Fourche River at 3,099 feet. The mean elevation of Wyoming is 6,700 feet. Approximately 47 percent of the state is owned by the federal government. The Rocky Mountains are located along the western edge, as are Yellowstone National Park and Grand Teton National Park. The Big Horn Mountains are in the north central part of the state with the Laramie Mountains extending from the central part of the state to the southeast. The Bear Lodge Mountains, which are part of the Black Hills, are located in the northeast part of the state. The south central part of Wyoming includes the Medicine Bow Mountains. There are ten National Forests including the Thunder Basin National Grasslands, two National Parks, two National Monuments, one National Historic Site, and one National Recreation Area.

Climate

Wyoming's climate is semiarid. Annual precipitation varies throughout the state from as little as five inches to as much as 45 inches a year, some in the form of rain and some in snow. Because of its elevation, Wyoming has a relatively cool climate; the normal mean temperature is 45° Fahrenheit. However, Wyoming's climate can include extreme temperature highs and lows. Above 6,000 feet temperatures rarely exceed 100° F. The highest recorded temperature of 116° occurred at Bitter Creek in Sweetwater County. For most of the state, the mean maximum July high temperatures range from 85°

to 95°. Average July lows range from 50° to 60°. In the summer, parts of the state can experience temperatures above 100° and in the winter, extended temperatures below 0° are common. Wyoming experiences a lot of wind. The average wind speed is 12.9 mph. Heavy snowstorms, blizzards, floods, tornados and wildland fires are naturally-occurring disasters typical for Wyoming.

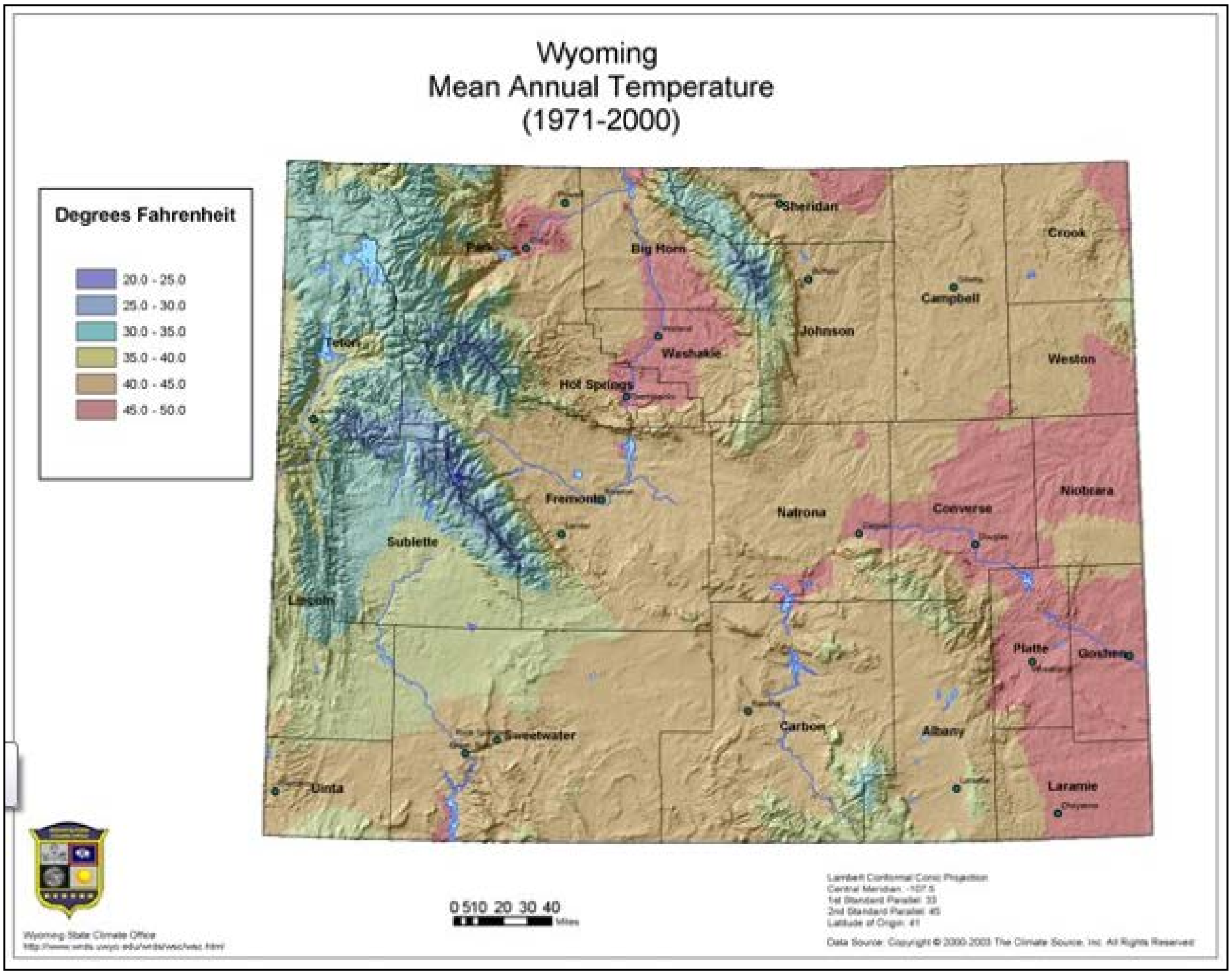


Figure 1. Mean Annual Temperatures Wyoming

Government

Wyoming is divided into 23 counties and eight Homeland Security Regional Response areas, with 99 incorporated municipalities. There is one Indian Reservation located in the central portion of the state. Public Safety agencies include 23 sheriff offices, 56 police departments, 134 fire departments, 66 ambulance agencies and 41 dispatch centers. The State of Wyoming has 11 agencies with public safety roles including law enforcement, corrections, health, livestock, state parks, transportation, forestry, fire marshal, state engineer and homeland security.

Transportation

Three interstate highways transect the state, Interstate 80 along the southern portion of the state, Intestate 25 runs from the southeast to the north central and bisects with Interstate 90 which runs through the northeastern part of the state. The Union Pacific Railroad runs east to west along the southern portion of the state. Burlington Northern Sante Fe Railroad has a northern route across the northeast part of Wyoming and a north south route from the northeast to the southeast, which is shared with the Union Pacific Railroad.

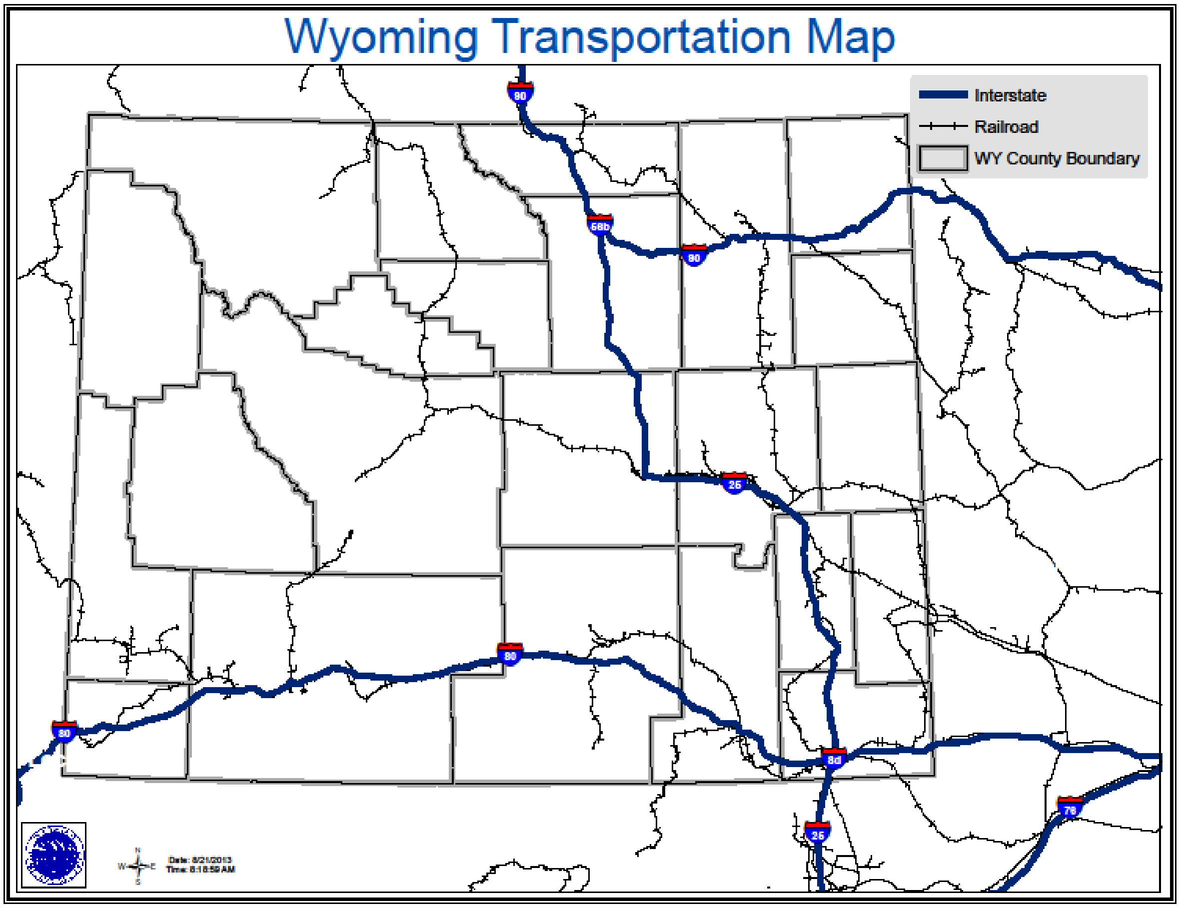


Figure 2. Major Wyoming Transportation Routes

Planning Process

The Wyoming State Geological Survey generated the original 2005 Plan. The 2005 Plan emphasized a thorough multi-hazard assessment which was augmented through the planning process resulting in the 2008 Plan. The 2011 Plan update was the cumulative result of the previous plans, information acquired from a public survey, and earthquake hazard updates based on a FEMA HAZUS-Earthquake software project, utilized to examine earthquake hazard and risk in Wyoming. This 2016 update builds on previous years' mitigation plans by utilizing subject matter expertise to correct and update many of the hazard chapters. Hazard occurrences have been updated so all incidents to date are reflected in the plan.

The 2016 Wyoming State Mitigation Plan was developed under the direction of the State Hazard Mitigation Officer (SHMO), but is the product of cooperation among local, state, and federal partners over a period of several years. A complete list of the individuals involved is included the Appendix. How the various stakeholders were involved in the development of the plan follows:

1. A Senior Advisory Committee was established by the Governor. It appointed a Mitigation Sub-Committee charged with participating in the development of the plan. The Mitigation Sub-Committee met on November 16, 2015 to review the results of the risk assessment, confirm the capability assessments, and develop the new Mitigation Strategy and Plan Maintenance Procedure. It was then asked to provide additions and changes to the Mitigation Action Plans and complete a final prioritization of the mitigation actions.

The Senior Advisory Committee Mitigation Sub-Committee members are listed in the **Table 2** below:

Table 2. Senior Advisory Committee Mitigation Sub-Committee Members

Name	Title	Agency
Doug Miyamoto	Director	Department of Agriculture
Ken Shultz	Assistant Chief Engineer for Operations	Department of Transportation
Kelly Ruiz	Public Information Officer	Office of Homeland Security
Larry Green	Security Unit Chief	Office of Homeland Security
Bill Morse	School Safety Preparedness Specialist	Office of Homeland Security
Scott Ramsay	WIPP Program Manager/Radiological Officer	Office of Homeland Security
Mark Young	Statewide Interoperability	Public Safety Communications Commission

Name	Title	Agency
	Governing Board	
Bob Symons	Statewide Interoperable Coordinator	Public Safety Communications Commission

2. The State Hazard Mitigation Officer hosted a webinar with Wyoming state and local Stakeholders that included the County Coordinators, responsible for developing Local Mitigation Plans, as well as representatives of Wyoming state agencies involved in mitigation, on October 19, 2015. During the webinar the Stakeholders reviewed the updated risk assessment and comments related to local planning priorities, hazard descriptions, and hazard event impacts and losses, were incorporated. The stakeholders provided much appreciated assistance with hazard data, and reviewed and provided input into the state and Local Mitigation Capability Assessments. Finally, the stakeholders were asked to complete worksheets where they ranked hazard impacts and reviewed the draft mitigation strategy, adding actions and assigning responsible agencies. A complete list of stakeholders is included in the Appendix.

3. Throughout 2014, the SHMO conducted face-to-face meetings with subject matter experts that contributed to the risk assessment.

4. As opportunities arose, typically in meetings and classroom settings throughout 2013, the public and emergency management professionals were asked to participate in a hazard ranking survey. A contact list for each state, federal, local, and public entity has been established. The list is composed of the chain-of-command for each agency or organization, and typically contains the director, deputy director, and key division heads. Those entities are contacted for key decisions and input, including plan review. Public input will be further pursued as the draft plan and final, approved plan will be posted on the Wyoming Office of Homeland Security's website, with opportunities to provide feedback available on the site.

5. The draft plan was reviewed by the Director of the Wyoming Office of Homeland Security (WOHS) and was made available on the WOHS web site for 45 days prior to adoption. A point of contact and directions for submitting comments is provided on the website. As a living document, comments can be received and processed throughout the life of the plan. Public input is encouraged and welcomed. The current plan update will incorporate comments prior to adoption.

The mitigation planning process is incorporated into the development of the Threat Hazard Identification and Risk Assessment (THIRA), the State Preparedness Report (SPR), the State Operations Plan, the State Recovery Plan, the Wyoming Department of Health's Joint Risk Assessment (JRA), and others. This is accomplished through internal and inter-agency planning meetings and discussions, references to the mitigation plan while in response and recovery operations, and through direct reference within other plans.

Local Plan Integration

The local plans were reviewed extensively for incorporation into the Risk Assessment and Mitigation Strategy. It has been helpful to incorporate locally-proposed mitigation actions into the State Plan, thereby validating the state's mitigation goals. The process to integrate local plans in Wyoming is simplified by the small number of plans (23); re-reading the results of the risk assessment and the mitigation action tables was completed by the SHMO and FEMA staff as part of the technical assistance when developing the updated State Plan.

Updating the Risk Assessment

FEMA Region VIII provided technical assistance to the Wyoming State Plan Update in the form of data collection, GIS analysis and map creation, and methodology and findings descriptions. This included assessing state asset vulnerabilities, future growth projections, an analysis of social vulnerability, and the local risk assessment roll-up. Risk assessments were also updated for the flood, wildfire, earthquake, and weather related hazards. Data used for the risk assessment was collected from WYDOT, Bridger-Teton Avalanche Center, WY State Engineer's Office, US. Bureau of Reclamation, NOAA, WY State Climate Office, University of Wyoming, USGS, WY Geological Survey, FEMA, SHELDUS, WOHS, and WY State Forestry Division.

Risk Assessment

The risk assessment presents the current statewide overview of potential losses to guide implementation of mitigation measures, to prioritize jurisdictions most at risk from natural disasters, and to integrate data provided in local risk assessments.

This chapter starts with an overview section that describes Wyoming's people and property, hazard identification and risk factor methodology, and information about local mitigation plans and risk assessment roll-up. Risk assessment data, analyses, and findings are then detailed by hazard and are organized into the following sections:

- Description
  - History and Probability of Future Events
- Vulnerability and Loss Estimates
  - Local Risk Assessments
  - Statewide Risk Assessment
  - Changes in Development
  - State Facilities at Risk
  - Risk Factor

The Vulnerability Summary of this report summarizes the findings of the risk assessment with risk factor rankings and a statewide overview of potential losses and most vulnerable jurisdictions by hazard.

Population Projections and Development Trends

The 2010 census data provides the most complete available population data. It was utilized in the last update and is not further updated in this planning cycle. The 2010 Census reveals Wyoming has experienced higher percentage growth greater than experienced throughout the United States. Wyoming's growth rate over the past ten years exceeded 14 percent while the national growth rate was only 9.7 percent. Despite Wyoming's faster paced growth, it remains predominately rural with a population density of not quite six persons per square mile and a total population of 563,626.

Table 3. Population Change[1]

State or Region	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
Population	145,965	194,402	225,565	250,742	290,529	330,066	332,416	469,557	453,588	493,782	563,626
Percent Change	57.7%	33.2%	16.0%	11.2%	15.9%	13.6%	0.7%	41.3%	-3.4%	8.9%	14.1%

[1] http://2010.census.gov/2010census/data/index.phpa (Accessed 5/3/2011)

State or Region	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
People per sq. mile	1.5	2.0	2.3	2.6	3.0	3.4	3.4	4.8	4.7	5.1	5.8
Density Rank	50	50	50	50	50	50	51	51	51	51	51

Wyoming remains the state with the smallest population. Laramie County in the southeast corner, and Natrona County, in the center of the state, are the most populated counties, followed by Campbell, Fremont, and Sweetwater Counties.

After twenty years of losing population (1970-1990) or maintaining a fairly steady population (1990-2000), the 2010 Census revealed Wyoming's population overall has increased at a slightly greater rate than the U.S. population overall in the years between 2000 and 2010. Two counties experienced a loss in population; two counties experienced a greater-than 25 percent increase in population, with the majority of the state's counties increasing in population by between 5 percent-16 percent. **[See Appendix A**]

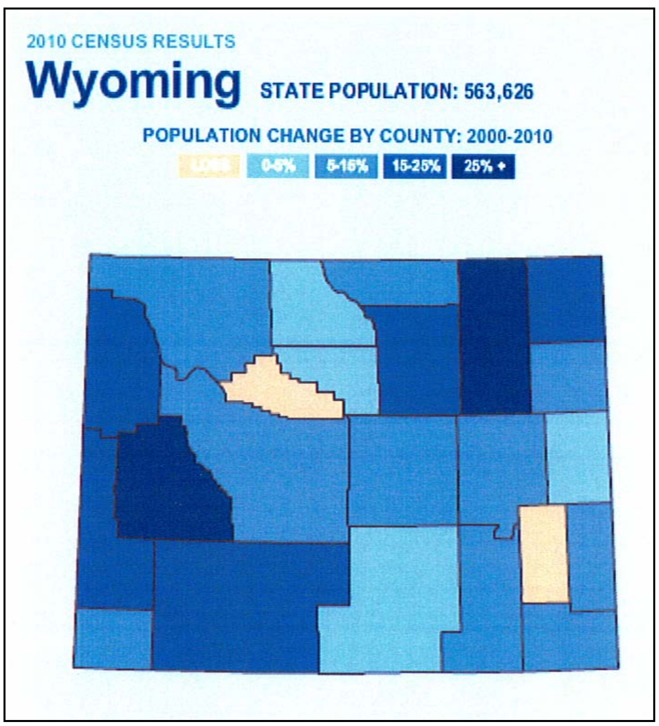


Figure 3. Population Change by County[2]

[2] http://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf (Accessed 5/3/2011)

The following map and table show population projection figures by county, as reported by the Wyoming Administration and Information, Economic Analysis Division (http://eadiv.state.wy.us/pop/). The table is sorted by estimated growth percent between 2010 and 2030. Percent growth was calculated using the following equation: Population Growth = (2030 Pop – 2010 Pop)/2010 Pop *100. Highest growth rates are expected in Sublette and Campbell Counties. This data is used in the plan to consider how changes in development might impact vulnerability and loss estimates across jurisdictions for all hazards in Wyoming.

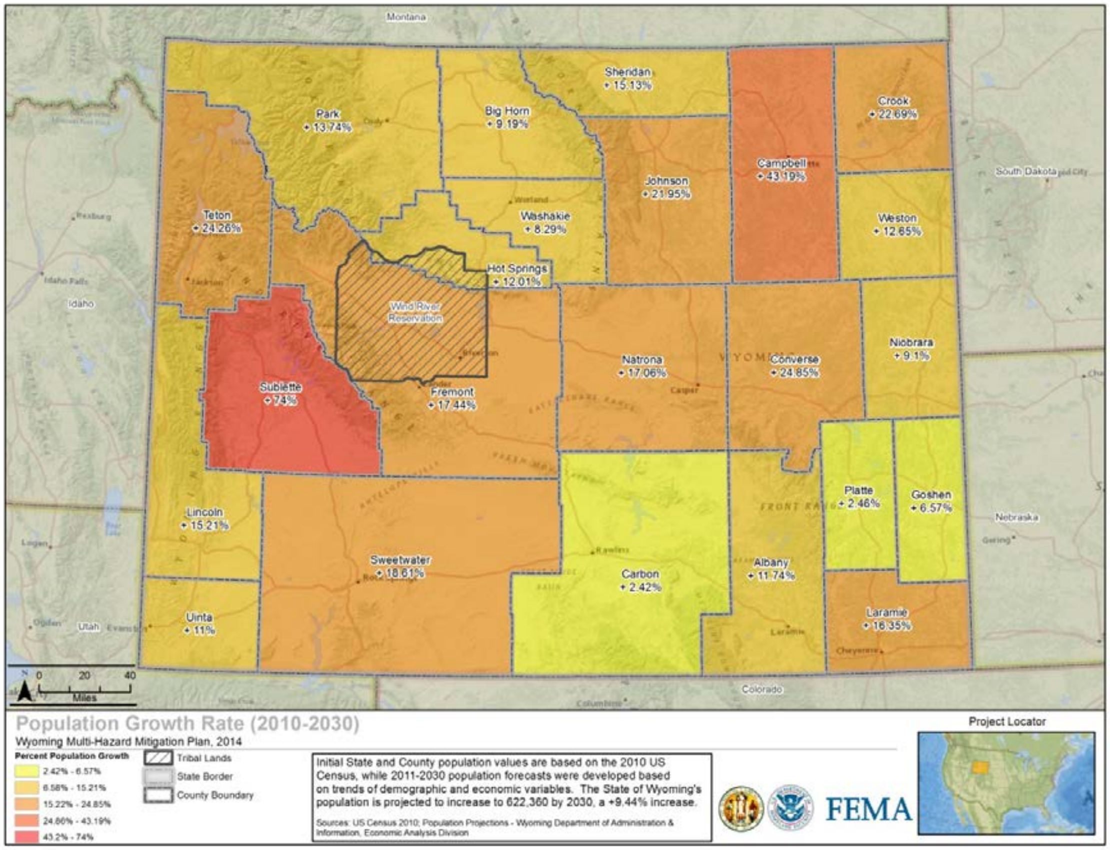


Figure 4. Anticipated Population Growth Rate 2010-2030

Table 4. Population Projections 2010-2030

Rank	County	2010	2020	2030	Percent Growth (2010-2030)
1	Sublette County	10,247	13,880	17,830	74.00%
2	Campbell County	46,133	56,890	66,060	43.19%
3	Converse County	13,833	15,950	17,270	24.85%
4	Teton County	21,294	23,360	26,460	24.26%
5	Crook County	7,083	8,040	8,690	22.69%

Rank	County	2010	2020	2030	Percent Growth (2010-2030)
6	Johnson County	8,569	9,450	10,450	21.95%
7	Sweetwater County	43,806	49,280	51,960	18.61%
8	Fremont County	40,123	44,360	47,120	17.44%
9	Natrona County	75,450	82,490	88,320	17.06%
10	Laramie County	91,738	99,710	106,740	16.35%
11	Lincoln County	18,106	19,170	20,860	15.21%
12	Sheridan County	29,116	31,380	33,520	15.13%
13	Park County	28,205	30,440	32,080	13.74%
14	Weston County	7,208	7,900	8,120	12.65%
15	Hot Springs County	4,812	5,310	5,390	12.01%
16	Albany County	36,299	38,910	40,560	11.74%
17	Uinta County	21,118	22,580	23,440	11.00%
18	Big Horn County	11,668	12,350	12,740	9.19%
19	Niobrara County	2,484	2,660	2,710	9.10%
20	Washakie County	8,533	9,130	9,240	8.29%
21	Goshen County	13,249	13,960	14,120	6.57%
22	Platte County	8,667	8,780	8,880	2.46%
23	Carbon County	15,885	16,380	16,270	2.42%
	TOTALS	**563,626**	**622,360**	**668,830**	**18.67%**

Development in Wyoming is driven by employment opportunities. Development also tends to focus within already-existing population centers. The table below shows building permitting over the ten-year period from 2001 through 2010 and documents development throughout the state. Based on building permitting, the counties experiencing the greatest development are Laramie, Natrona, Campbell, and Albany Counties.

The most significant increase in mineral extraction employment between 2000 and 2010 was experienced in Campbell County. Campbell County saw an increase of 3,060 employees in mineral extraction, which represents a 67.83 percent increase. Campbell County was followed by Uinta (696), Sublette (667), Converse (524) and Fremont Counties (386). Driven by employment increases, Campbell County has seen the most significant increase in development, followed by Laramie and Natrona Counties where the largest population centers are located.

Table 5. Building Permits 2001-2010 for State of Wyoming[3]

County *(does not include municipalities)*	Annual County Building Permits in 'Total Units Constructed' 2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	10-Year Total
Albany	283	163	271	410	594	329	264	172	132	172	2790
Big Horn	7	11	6	17	8	20	23	37	16	14	159
Campbell	105	144	159	129	273	222	1002	349	349	317	3049
Carbon	37	28	33	60	65	58	96	55	24	18	474
Converse	13	16	54	18	58	34	115	103	38	23	472
Crook	28	30	31	24	21	33	27	10	14	4	222
Fremont	107	45	65	66	85	53	54	43	32	21	571
Goshen	4	2	6	17	11	14	13	8	27	6	108
Hot Springs	1	3	1	5	5	7	8	5	0	1	36
Johnson	25	70	25	15	25	43	47	24	5	12	291
Laramie	319	478	779	876	872	509	316	202	387	238	4976
Lincoln	218	204	180	212	261	200	207	100	62	49	1693
Natrona	140	300	174	284	444	423	429	419	412	807	3832
Niobrara	0	0	1	4	4	3	0	3	3	4	22
Park	118	179	210	242	187	252	244	201	144	118	1895
Platte	12	12	14	42	47	41	32	28	12	19	259
Sheridan	102	112	287	200	175	373	339	230	86	121	2025
Sublette	76	88	95	93	185	238	263	114	44	42	1238
Sweetwater	38	48	63	216	260	268	472	245	351	147	2108
Teton	211	197	292	301	308	291	232	216	89	115	2252
Uinta	58	58	56	63	95	106	328	87	55	45	951
Washakie	2	3	10	7	9	10	25	6	5	1	78
Weston	3	4	2	16	5	10	19	12	7	7	85
Annual Totals	1907	2195	2814	3317	3997	3537	4555	2669	2294	2301	

Projected future growth information was obtained from the Wyoming Administration and Information Economic Analysis Division. Three tables outlining projected growth from 2010 through 2030 are located in **Appendix L**.

Another proxy of future population growth is projected school enrollment, as reported by the Wyoming Department of Education. The table below uses 10 years of trailing data in order to project statewide capacity. The department collects this data as is reported to them by school districts on the first school

[3] http://censtats.census.gov/cgi-bin/bldgprmt/bldgsel.pl (Accessed 7/31/2013)

day in October of each year. Data switches from actual enrollment to projected enrollment at the 2015 mark so future projections as shown are a reflection of past trends

Enrollments reflect (to some extent) statewide economic conditions in the past, but are increasingly limited in reflecting immediate and future economic changes the further out from actual data that projections go. In other words, without anticipation of future factors outside of actual student enrollment that can have an impact on whether or not those trends continue.

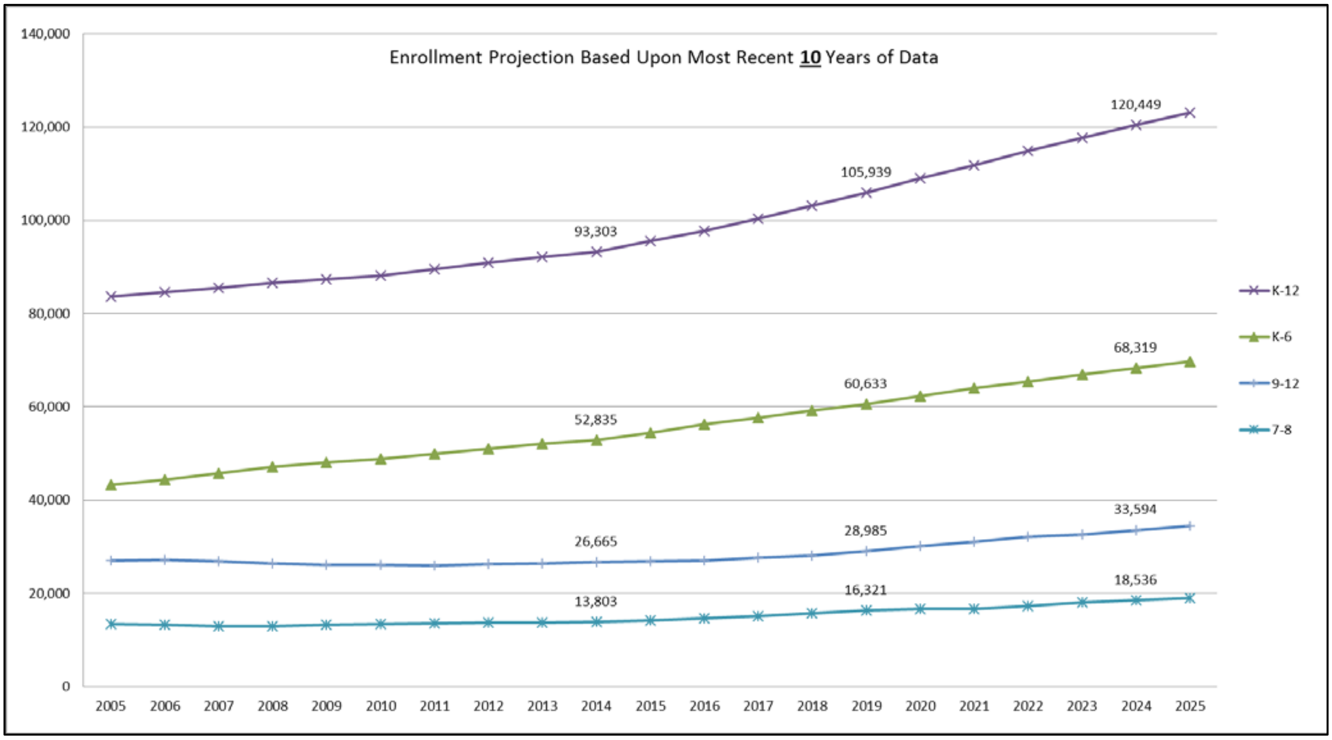


Figure 5. Projected School Enrollment

Social Vulnerability

People are vulnerable to both natural and human-caused hazards. Vulnerability is further exacerbated by socio-economic factors. Data available through the 2010 Census was used to develop Wyoming's social vulnerability status, both at the census block level and at the county level.

The table below (**Table 6**) compares Wyoming counties to one another, ranking them according to social vulnerability. There is a level of uncertainty in the creation of an index, both with the margin of error in Census data as well as with the creation of an index. Caution should be taken by the user.

Table 6. Social Vulnerability Score by County

County	County FIPS	Social Vulnerability Score	County Rank
Fremont	56013	1.89	1
Laramie	56021	1.46	2
Albany	56001	1.23	3
Washakie	56043	1.21	4
Natrona	56025	1.19	5
Goshen	56015	1.18	6
Hot Springs	56017	1.16	7
Johnson	56019	1.14	8
Sweetwater	56037	1.09	9
Big Horn	56003	1.08	10
Weston	56045	1.05	11
Carbon	56007	1.00	12
Uinta	56041	0.98	13
Crook	56011	0.91	14
Converse	56009	0.91	15
Campbell	56005	0.89	16
Platte	56031	0.89	17
Park	56029	0.88	18
Sheridan	56033	0.83	19
Sublette	56035	0.82	20
Niobrara	56027	0.69	21
Lincoln	56023	0.61	22
Teton	56039	0.11	23

Methodology

A copy of the Social Vulnerability Spreadsheet, calculated by Census Block is located in this plan as Appendix T. Wyoming's social vulnerability was calculated in the following manner:

Nineteen census variables were pulled from the U.S. Census Bureau and the American Community Survey for the State of Wyoming at the census block group level. Values were normalized for population, households (excluding *Median Housing Value*, *Median Contract Rent*, and *Household Median Income*) depending on the variable. For example, *Total Population Under 5* was divided by *Total Population* and *Total Number of Households with No Vehicles* was divided by *Total Households*. A maximum-minimum transformation was then performed to reduce the data between the values of 0-1. The values were then summed (added or subtracted based upon the cardinally of the variable as shown below) to create an additive vulnerability index. Positive variables increase social vulnerability; negative variables decrease social vulnerability. Each census block group results in a score which creates a range of social vulnerability, highest to lowest. There is a level of uncertainty in the creation of an index, both with the margin of error in Census data as well as with the creation of an index. Caution should be taken by the user.

Census Variables with Cardinality

Census 2010

1. Total Population (+)
2. Total Households (+)
3. Total White (-)
4. Total Black (+)
5. Total Asian (-)
6. Total Native American (+)
7. Total Other Races (+)
8. Total Hispanic (+)
9. Total Population Under 5 (+)
10. Total Population Under 16 (+)
11. Total Population Over 65 (+)

American Community Survey

12. Total Renters (+)
13. Median Housing Value (-)
14. Median Contract Rent (-)
15. Total Mobile Homes (+)
16. Total Households Linguistically Isolated (+)
17. Total Households in Poverty (+)
18. Household Median Income (-)
19. Total Households with No Vehicles (+)

Figure 6 below documents social vulnerability across the state. **Figure 7** extracts the vulnerability data of four major communities in Wyoming and pictures locations within the community which may be more vulnerable to hazards based on socio-economic factors.

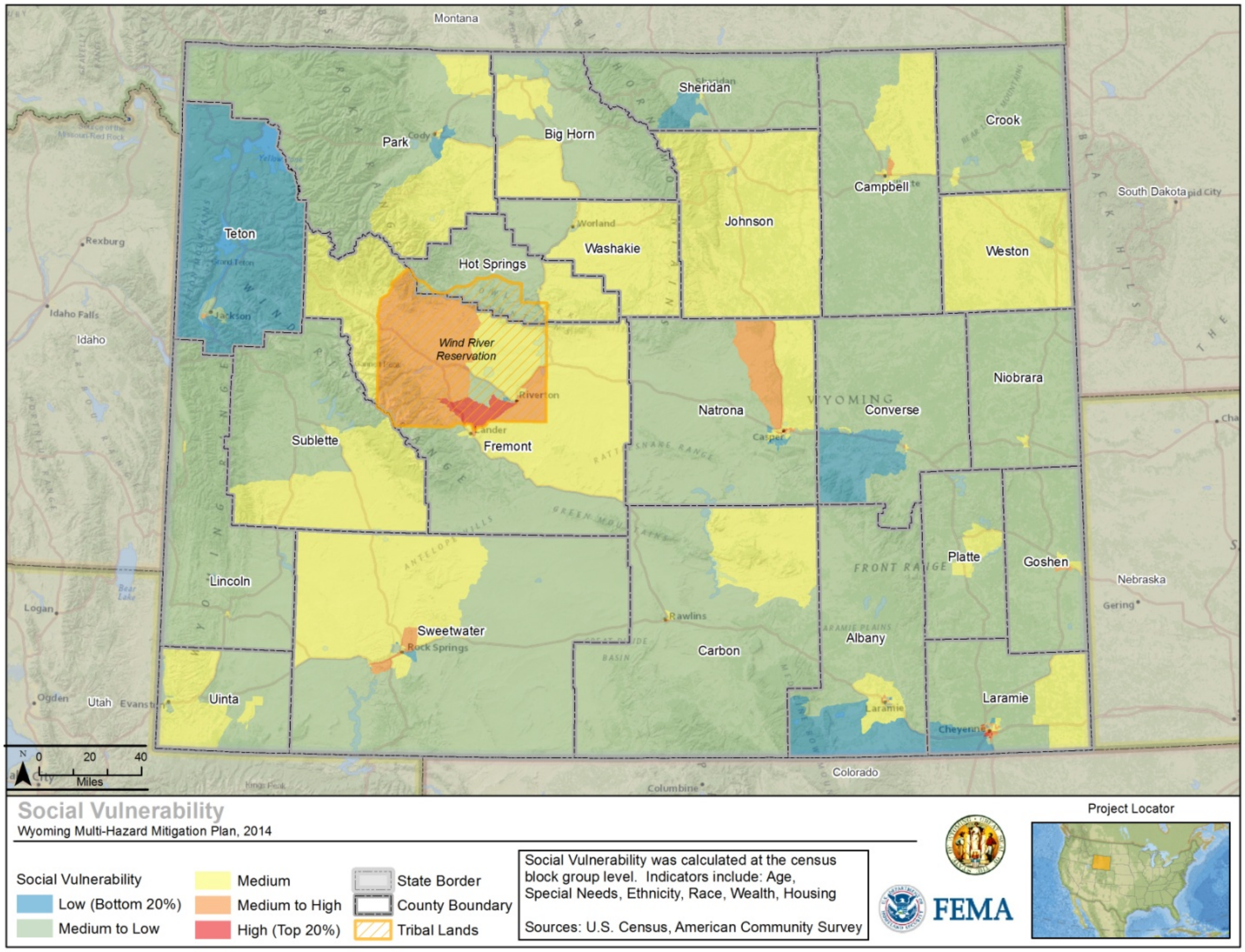


Figure 6. Wyoming Social Vulnerability

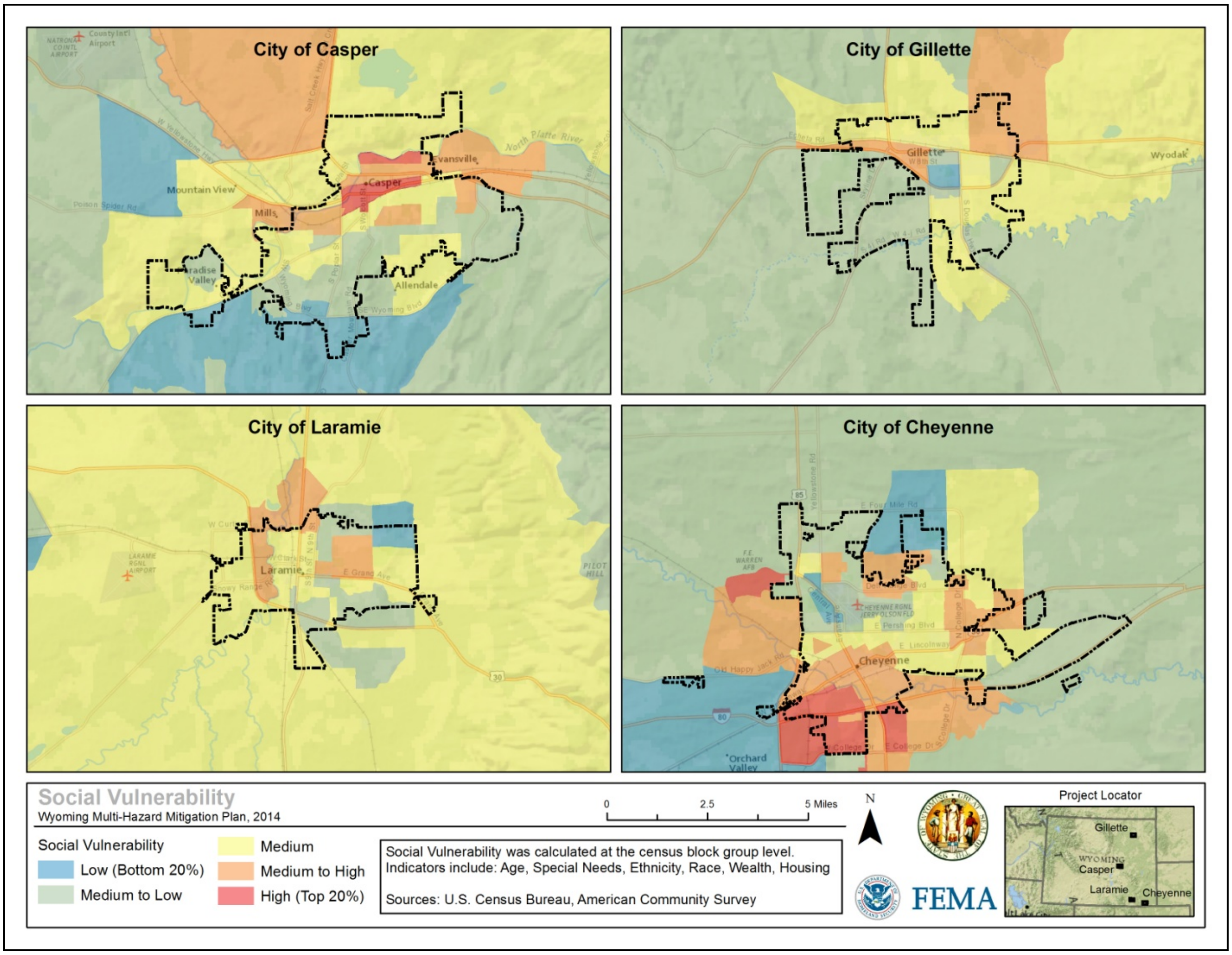


Figure 7. Social Vulnerability Casper, Cheyenne, Gillette, Laramie

State Facility Inventory

A database of state owned and operated facilities was created for use in this plan. Data was compiled from the Wyoming Office of Homeland Security (WOHS) AandI Risk Management Division and the Wyoming Geographic Information Science Center (WyGISC). Data from WyGISC was provided as GIS point locations and the WOHS data was geocoded when there was address attributes available. Asset data is available with the state as GIS data and includes the following attributes: Agency, Location, Ocutype, Critical, Sqft, YearBltAqd, Address, City, County, Confidence, Building Value, Content Value, and Total Value. Note that of the 3,846 state facilities, about 1,000 have approximate locations in the GIS data. Facilities that didn't have address or latitude and longtitude information were not included in the inventory.

In early 2014, WOHS indicated whether each of the state facilities is critical or non-critical based on agency and facility type. The rating is based on the function that the facility serves for the agency, school, dept, etc. For example, among the University of Wyoming buildings, WOHS marked residential facilities, hazmat facilities, communications, transit facilities, physical plants as critical. The following map and tables show facilities by county and by agency.

This data is used in the plan to consider vulnerability and loss estimation of state facilities across jurisdictions for all hazards in Wyoming. State facility vulnerability and loss estimate discussions are general and should be further refined in the next plan update and before scoping a related mitigation project.

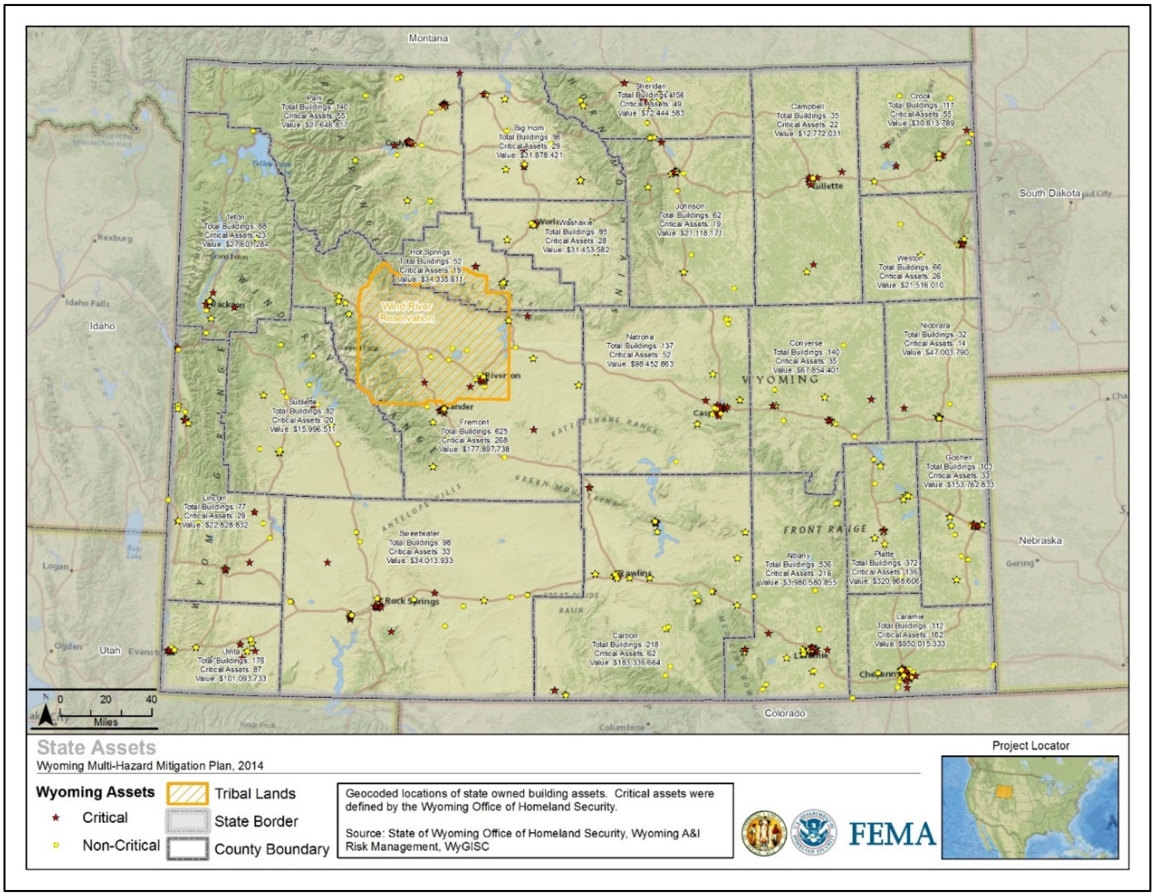


Figure 8. State Facility Inventory Map

Table 7. State Facility Inventory by County

County	Facility Count	Value	Critical Facility Count	Value (Critical Only)
Albany	539	$4,124,691,505	213	$1,120,491,667
Big Horn	97	$34,456,229	29	$7,037,896
Campbell	35	$13,027,472	22	$11,708,789
Carbon	218	$187,003,370	62	$88,208,591
Converse	143	$84,047,002	35	$25,379,563
Crook	117	$31,430,060	55	$5,242,418
Fremont	624	$181,572,084	268	$106,476,111
Goshen	103	$156,838,094	33	$127,492,529
Hot Springs	52	$35,022,326	19	$28,804,469
Johnson	62	$21,540,521	19	$15,042,734
Laramie	326	$1,026,248,596	162	$695,984,018
Lincoln	78	$23,446,677	29	$10,465,809
Natrona	140	$95,834,229	52	$29,518,686
Niobrara	33	$49,568,494	14	$40,429,095

County	Facility Count	Value	Critical Facility Count	Value (Critical Only)
Park	140	$28,199,747	55	$9,857,830
Platte	371	$327,377,924	135	$35,621,485
Sheridan	158	$75,125,472	49	$44,661,632
Sublette	82	$16,316,434	20	$8,377,998
Sweetwater	99	$35,135,027	33	$21,027,611
Teton	88	$28,153,304	23	$16,932,803
Uinta	176	$103,115,616	87	$68,635,792
Washakie	95	$32,082,653	28	$17,526,650
Weston	66	$21,946,331	26	$9,615,457
Statewide	3,842	$6,732,179,167	1,468	$2,544,539,633

Losses to State Facilities

State owned and operated facility losses from natural hazard events were collected from WOHS, Administration and Information Risk Management and from the University of Wyoming and are summarized by agency in the table below. Losses are further sorted and included in state facilities at risk sections by hazard where applicable.

Table 8. State Facility Losses to Natural Hazard Events (2/20/2011-9/24/2015)

Agency	Number of Events	Losses
Attorney General	1	$ -
Department of Administration and Information	20	$ 1,371,361
Department of Corrections	22	$ 26,899
Department of Environmental Quality	1	$ -
Department of State Parks and Cultural Resources	28	$ 475,720
Judicial District 8	1	$ -
Secretary of State	1	$ 5,900
State Engineer	1	$ -
University of Wyoming	3	$ 552,934
Wyoming Department of Agriculture	4	$ -
Wyoming Department of Health	10	$ 29,462
Wyoming Department of Transportation	8	$ 3,113
Wyoming Fish and Game Department	30	$ 128,133
Wyoming Military Department (Adjutant General)	3	$ 8,199
Wyoming Office of Tourism Board	1	$ 1,633
Wyoming State Geological Survey	1	$ -
Total	135	$ 2,603,355

Hazard Identification

Wyoming identified the fourteen hazards shown in the table below for analysis in the 2015 Mitigation Plan update.

Table 9. Top State Hazards

Hazards
Avalanche
Dam Failure
Drought
Earthquake
Expansive Soils
Flood
Hail
Landslide
Lightning
Mine Subsidence
Tornado
Wildfire
Wind
Winter storm

The wind hazard was not previously considered. Wind is considered part of daily living in Wyoming and is dealt with in that manner—daily—and rarely thought of as a hazard. Upon further consideration of natural hazards, however, it would be remiss to fail to include wind in the analysis.

There is also a section of the risk assessment called *Additional Hazards of State Concern* that includes information on Liquefaction, Space Weather, Windblown Deposit, and Technological and Human-Caused hazards. These hazards are considered in this update but due to limited data and information does not include a full risk assessment section.

Space weather has a limited daily impact. However, it has the potential to severely impact communications and the electrical grid. Should space weather restrict communications during a disaster of another type, the results could be catastrophic.

Past Events Summary

Hazards analyzed in detail are those that have recurrence intervals less than 10,000 years and those not related specifically to health issues. The hazards analyzed are dam failure, drought, earthquakes, expansive soils, floods, hail, landslides, lightning, mine subsidence, snow avalanches, tornadoes, wildland fire, wind, and winter storms and blizzards. The Hazards and Vulnerability Research Institute at the University of South Carolina hazard event data was used to enhance the quality of this plan. Their information is housed in the Spatial Hazard Events and Losses Database for the United States (SHELDUS).[4]

The SHELDUS data has been organized into tables. The first presents an overview of loss-causing hazard events in the state and in each county (**Table 10**) and the second summarizes the number of events by event type (**Table 11**). SHELDUS data is incorporated throughout this plan and can be found in hazard-specific descriptions which follow.

Historical losses provide a picture of potential future losses, informing estimated future losses to structures, infrastructure and critical facilities. Historical losses also inform mitigation actions, allowing strategic focus of mitigation funding where it will do the greatest good.

Table 10. Loss-Causing Events by County and Statewide Totals (1960-2015)

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Albany	152	70	10	$3,753,839	$393,982	$4,147,821
Big Horn	131	6	2	$8,117,008	$1,137,271	$9,254,278
Campbell	197	29	5	$90,192,407	$16,565	$90,208,972
Carbon	129	45	14	$1,700,446	$74,760	$1,775,206
Converse	137	23	6	$5,588,000	$40,994	$5,628,995
Crook	166	10	2	$13,209,148	$37,660	$13,246,808
Fremont	242	103	10	$22,544,945	$1,071,329	$23,616,274
Goshen	170	8	3	$7,898,708	$1,740,832	$9,639,540
Hot Springs	81	16	2	$6,677,985	$67,854	$6,745,839
Johnson	129	45	2	$7,770,224	$618,704	$8,388,928
Laramie	320	181	18	$129,401,344	$6,678,198	$136,079,542
Lincoln	120	39	8	$6,168,383	$425,813	$6,594,196
Natrona	202	63	2	$21,929,678	$74,413	$22,004,090
Niobrara	135	25	1	$7,518,256	$22,944	$7,541,200
Park	174	47	13	$9,125,387	$1,298,863	$10,424,249
Platte	181	27	1	$4,217,531	$290,948	$4,508,479
Sheridan	93	3	1	$5,927,415	$573,704	$6,501,119
Sublette	103	37	9	$4,102,076	$42,313	$4,144,389
Sweetwater	119	43	6	$2,646,305	$14,050	$2,660,355
Teton	159	101	26	$6,073,606	$5,979	$6,079,585

[4] Hazard event data obtained from SHELDUS is listed below and can be found at the following web site: (http://webra.cas.sc.edu/hvriapps/sheldus_setup/sheldus_login.aspx).

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Uinta	54	1	1	$349,768	$0	$349,768
Washakie	93	2	2	$6,775,498	$1,209,271	$7,984,768
Weston	138	6	0	$10,671,207	$5,960	$10,677,167
Statewide	**3,425**	**933**	**143**	**$382,359,165**	**$15,842,405**	**$398,201,571**

Table 11. Loss-Causing Event Summary by Hazard

Hazard	Number of Events	Injuries	Fatalities	Property Damage	Crop Damage	Total Damage
Avalanche*	143	30	32	$15,000	$0	$15,000
Flood*	267	79	20	$109,649,400	$2,163,005	$111,812,405
Fog	5	30	2	$46,000	$0	$46,000
Hail*	391	15	-	$146,115,017	$10,083,950	$156,198,967
Landslide*	18	-	-	$1,238,000	$0	$1,238,000
Lightning*	232	141	33	$2,867,350	$103,000	$2,970,350
Tornado*	172	78	4	$14,294,650	$169,500	$14,464,150
Wildfire*	32	11	3	$8,356,000	$0	$8,356,000
Wind*	1,357	174	13	$19,365,716	$2,214,950	$21,580,666
Winter Storm*	808	374	36	$80,412,033	$1,108,000	$81,520,033
Grand Total	**3,425**	**933**	**143**	**$382,359,165**	**$15,842,405**	**$398,201,571**

**Hazard Identified in Risk Assessment*

In the following two pie charts, (**Figure 9** and **Figure 10**) it is interesting to compare the percentage of events to the monetary losses experienced. Though hail ranks 4th in number of events at nine percent, it ranks first in losses, exceeding all other hazards. Severe wind, though it ranks first in number of events, represents only three percent of total losses, ahead of only three other hazards: wildfire, lightning, and landslide. Given these statistics, one might conclude Wyoming residents have successfully mitigated many of the impacts from severe wind. Further, it appears there is room for improvement in mitigating the impact from hail events. The bar graph below further analyzes injuries and fatalities resulting from Wyoming natural hazards **(Figure 11)**.

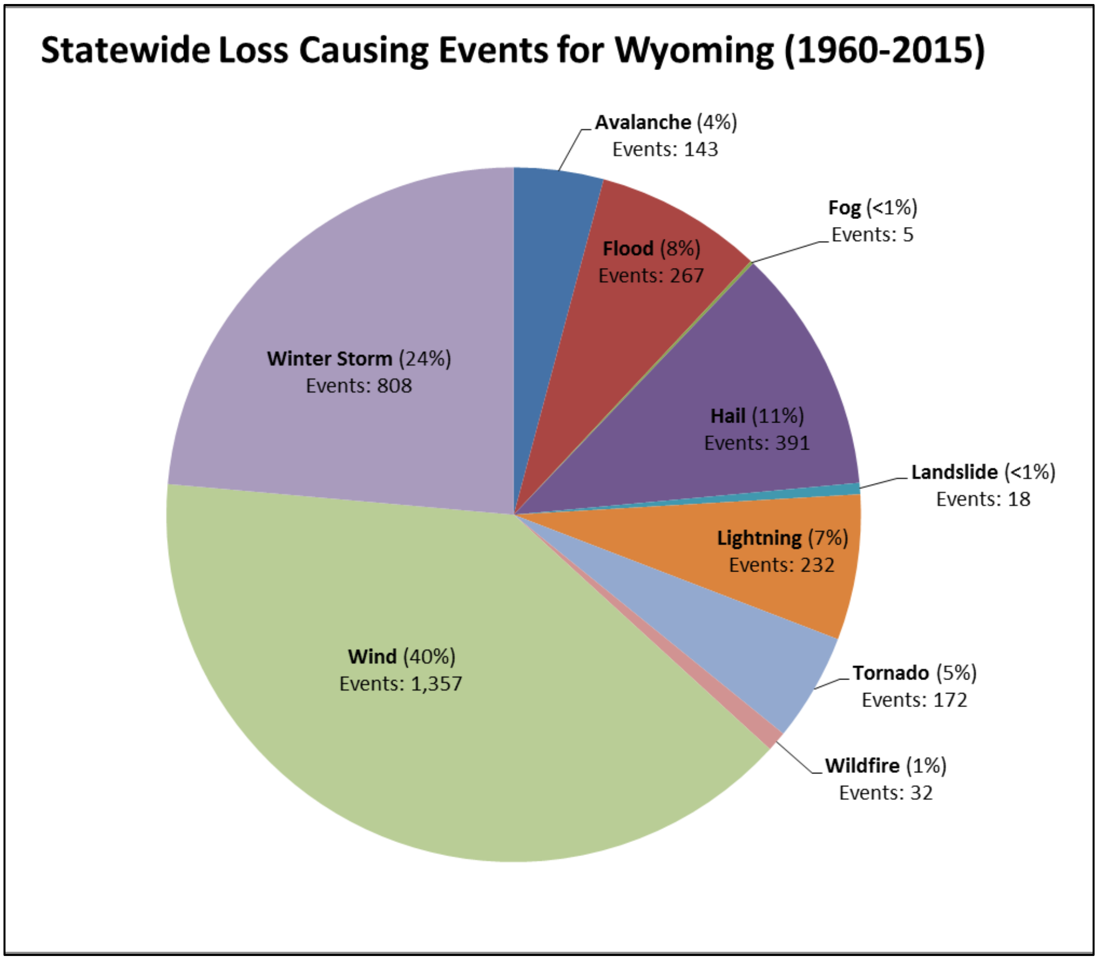


Figure 9. Statewide Loss Causing Events - SHELDUS

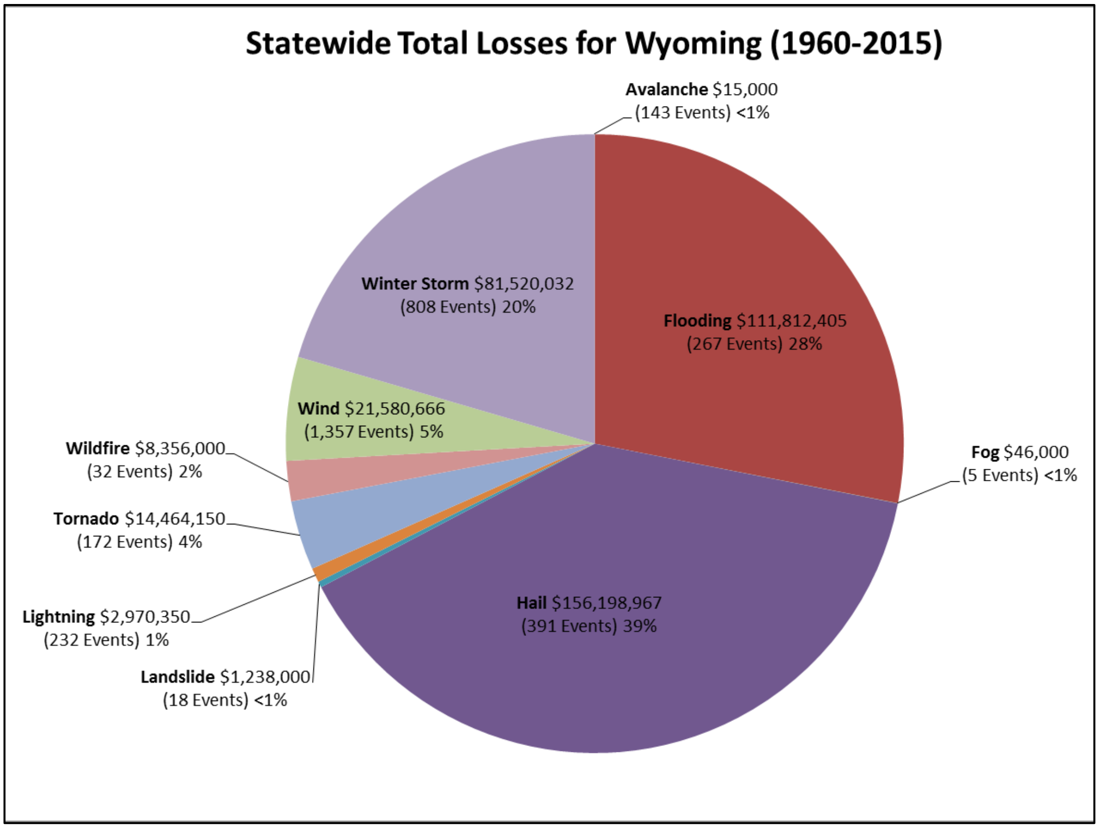
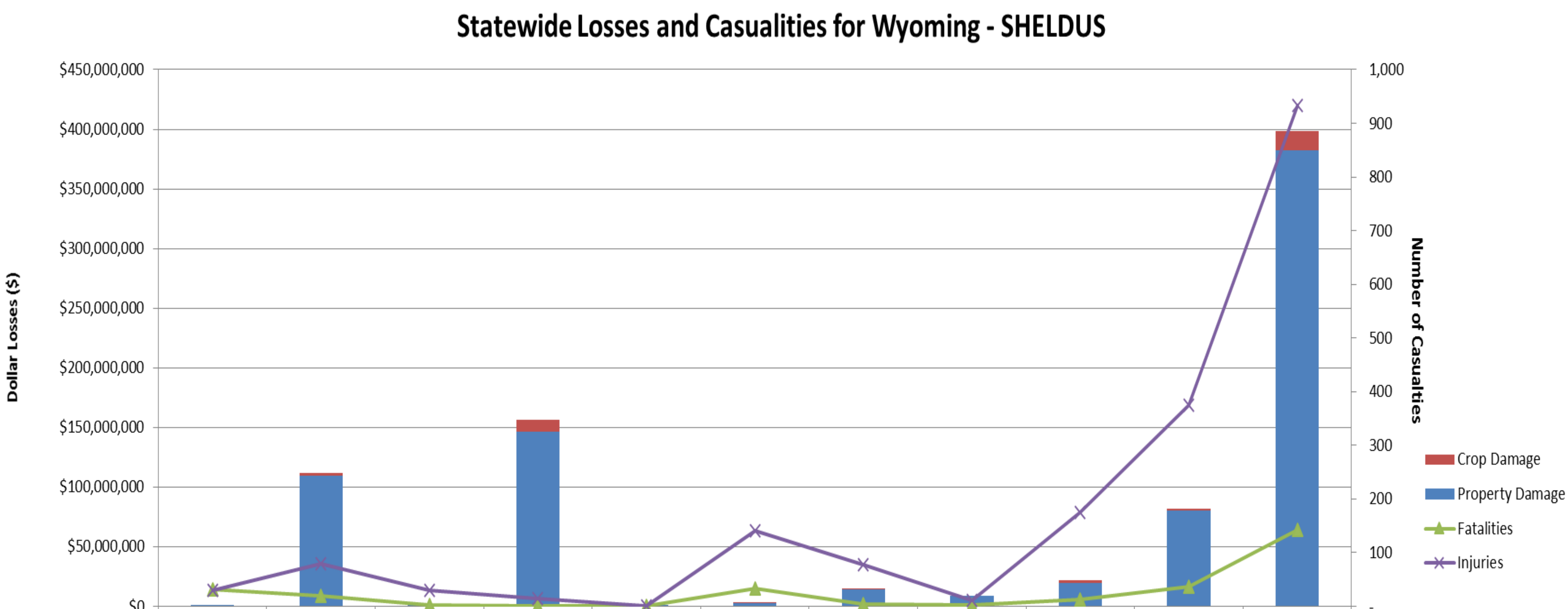


Figure 10. Statewide Total Losses- SHELDUS



	Avalanche	Flood	Fog	Hail	Landslide	Lightning	Tornado	Wildfire	Wind	Winter Storm	Grand Total
Crop Damage	$0	$2,163,005	$0	$10,083,950	$0	$103,000	$169,500	$0	$2,214,950	$1,108,000	$15,842,405
Property Damage	$15,000	$109,649,400	$46,000	$146,115,017	$1,238,000	$2,867,350	$14,294,650	$8,356,000	$19,365,716	$80,412,033	$382,359,165
Fatalities	32	20	2	-	-	33	4	3	13	36	143
Injuries	30	79	30	15	-	141	78	11	174	374	933

Figure 11. Statewide Losses and Casualties - SHELDUS

To further focus on the list of identified hazards for this plan, **Table 13** presents a list of all presidentially-declared disaster and emergency declarations occurring in Wyoming since 1963. The list further defines the hazards posing the greatest risk to property, residents and visitors in the State of Wyoming. Wyoming has experienced 26 presidentially-declared disasters or emergency declarations since 1963.

Table 12. Disaster Declarations

Disaster Number	Incident Period	Date Declared	Incident	Counties Impacted	Programs Declared
FEMA-155-DR-WY	July 4, 1963	July 4,1963	Heavy Rains and Flooding		PA/HMGP
FEMA-557-DR-WY	May 29, 1978	May 29, 1978	Severe Storms, Flooding, and Mudslides	Big Horn, Campbell, Converse, Crook, Hot Springs, Johnson, Natrona, Niobrara, Park, Sheridan, Washakie and Weston	IA/PA/HMGP
FEMA-591-DR-WY	July 19, 1979	July 19, 1979	Severe Storms and Tornadoes	Laramie	IA/PA/HMGP
FEMA-740-DR-WY	August 7, 1985	August 7, 1985	Severe Storms, Hail, Flooding	Laramie	IA/PA/HMGP
FEMA-1268-DR-WY	October 5-9, 1998	February 17, 1999	Severe Winter Storm	Goshen and Niobrara	PA/HMGP
FEMA-1351-DR-WY	October 31, 2000 - November 20, 2000	December 13, 2000	Winter Storm	Crook, Goshen, Platte and Weston	PA/HMGP
FEMA-1599-DR-WY	August 12, 2005	August 22, 2005	Tornado	Campbell	IA/HMGP
FEMA-1923-DR-WY	June 4-18, 2010	July 14, 2010	Flooding	Fremont and Platte	PA/HMGP

Disaster Number	Incident Period	Date Declared	Incident	Counties Impacted	Programs Declared
FEMA-4007-DR-WY	May 18, 2011 - July 8, 2011	July 22, 2011	Severe Storms, Flooding, and Landslides	Albany, Big Horn, Carbon, Crook, Fremont, Goshen, Johnson, Lincoln, Platte, Sheridan, Sweetwater, Teton, Uinta, Washakie and Weston	PA/HMGP
FEMA-4227-DR-WY	May 24, 2015 - June 6, 2015	July 7, 2015	Severe Storms and Flooding	Albany, Johnson, Niobrara and Platte	IA/PA/HMGP

Table 13. Emergency Declarations

Disaster Number	Incident Period	Date Declared	Incident	Counties Impacted	Programs Declared
FEMA-3043-EM-WY	June 15, 1977	June 15, 1977	Drought	Lincoln, Sublette, Sweetwater, and Uinta	PA (Category A & B)
FEMA-3092-EM-WY	February 10, 1987	September 4, 1987	Methane Gas Seepage		PA (Category A & B)

Table 14. Fire Management Assistance Declarations[5]

Disaster Number	Incident Period	Date Declared	Incident	Counties Impacted	Programs Declared
FEMA-2315-FM-WY	July 30, 2000 - August 3, 2000	July 31, 2000	Dead Horse Fire	Natrona	PA (Category B)
FEMA-2367-FM-WY	July 26, 2001 - August 8, 2001	July 26, 2001	Green Knoll Fire	Teton	PA (Category B)
FEMA-2370-FM-WY	July 31, 2001 - August 8, 2001	August 1, 2001	Elk Mountain #2 Fire	Weston	PA (Category B)
FEMA-2382-FM-WY	September 5-8, 2001	September 6,2001	McFarland Divide Fire	Crook	PA (Category B)

5 http://www.fema.gov/disasters/grid/state-tribal-government/74?field_disaster_type_term_tid_1=All and WOHS

Disaster Number	Incident Period	Date Declared	Incident	Counties Impacted	Programs Declared
FEMA-2427-FM-WY	June 18, 2002 to July 7, 2002	June 18, 2002	Hensel Fire	Albany and Converse	PA (Category B)
FEMA-2436-FM-WY	June 29, 2002 to July 12, 2002	July 1, 2002	Reese Mountain Fire	Albany	PA (Category B)
FEMA-2460-FM-WY	August 29, 2002 to September 15, 2002	August 31, 2002	Commissary Ridge Fire	Lincoln	PA (Category B)
FEMA-2512-FM-WY	November 19-20, 2003	November 20, 2003	Tongue River Fire	Sheridan	PA (Category B & H)
FEMA-2654-FM-WY	July 13-24, 2006	July 14, 2006	Thorn Divide Fire Complex	Crook	PA (Category B & H)
FEMA-2665-FM-WY	August 14-25, 2006	August 14, 2006	Jackson Canyon Fire	Natrona	PA (Category B & H)
FEMA-2719-FM-WY	August 12-21, 2007	August 12, 2007	Little Goose Fire	Sheridan	PA (Category B & H)
FEMA-2992-FM-WY	June 29, 2012 - July 9, 2012	June 29, 2012	Arapahoe Fire	Albany, Converse, and Platte	PA (Category A-B & H)
FEMA-2993-FM-WY	July 1-7, 2012	July 2, 2012	Squirrel Creek Fire	Albany	PA (Category A-B & H)
FEMA-2995-FM-WY	July 1-7, 2012	July 3, 2012	Oil Creek Fire	Weston	PA (Category B & H)
FEMA-5014-FM-WY	September 9-16, 2012	September 9, 2012	Sheep Herder Hill Fire	Natrona	PA (Category B & H)
FM-5115	-	October 11, 2015	Station Fire	Natrona	-

The majority of Wyoming's counties have completed their own multi-hazard mitigation plan, with hazards addressed at the local level. Hazards presented in the local plans were reviewed and information mined from them is presented in this state-level multi-hazard mitigation plan. Not all hazards identified by the State Plan are hazards addressed within the individual counties' plans. The level of perceived risk varies hazard-to-hazard and county-to-county.

Local Risk Assessment Summary

Risk rankings by hazard were pulled from local hazard mitigation plan risk assessments. Data was pulled from the most recent versions of local plans (this includes expired plans that have not been updated). Mitigation plan status and expiration dates are listed in Chapter 2 Planning Process.

Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. Risk rankings in local plans were reviewed by each of the local planning teams, steering committees, and public to ensure they reflect local hazards and risk and adjusted as necessary. The following matrix (**Figure 12)** shows risk rankings by county and for the City of Rock Springs. Statewide maps depicting this data by county are included in hazard sections to show local perception of hazards and risks across the state. Maps were not created for expansive soils, snow avalanche, subsidence, and wind hazards as there is limited information on those hazards.

	Dam Failure	Drought	Earthquake	Expansive Soils	Flood	Hail	Landslide	Lightning	Snow Avalanche	Subsidence	Tornado	Wildfire	Wind	Winter storm
Albany	L	H	M	N	H	H	L	H	M	L	M	H	M	H
Big Horn	H	M	L	N	M	M	N	N	N	N	H	H	H	M
Campbell	L	M	M	N	M	M	M	M	N	N	H	H	N	H
Carbon	N	H	M	N	M	M	L	L	M	L	M	H	L	H
Converse	L	H	M	N	M	M	L	N	N	N	M	M	N	M
Crook	M	H	L	L	M	M	L	M	N	M	M	H	N	H
Fremont	N	H	M	N	M	N	M	N	N	N	N	H	N	H
Goshen	M	H	L	N	L	H	N	M	N	N	M	H	N	N
Hot Springs	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Johnson	H	M	M	L	H	H	L	H	N	L	H	H	N	H
Laramie	M	H	M	N	H	H	N	L	N	N	H	H	H	H
Lincoln	M	H	H	N	M	M	L	L	L	L	M	H	M	M
Natrona	N	M	M	L	H	N	N	N	N	L	M	M	N	M
Niobrara	L	H	L	N	L	H	L	H	N	N	H	H	L	H
Platte	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Park	L	H	M	N	M	H	M	M	L	N	M	H	N	M
Sheridan	M	H	L	N	M	M	M	M	N	L	M	H	N	H
Sublette	L	H	H	N	M	N	M	M	M	N	N	M	N	H
Sweetwater	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Teton	M	H	M	L	M	M	H	H	N	L	M	H	L	H
Uinta	M	H	M	N	M	N	N	N	N	N	N	L	N	H
Washakie	M	H	M	N	H	M	L	N	L	N	M	H	L	M
Weston	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Rock Springs	N	M	M	N	M	N	M	N	N	M	H	L	N	H

Figure 12. Risk Rankings from Local Mitigation Plan Risk Assessments

Avalanche

Description

Wyoming is one of the top-ranking states for avalanche hazard because of its weather and mountainous terrain coupled with outdoor recreation. Skiers, snowboarders, and snowmobile operators are most commonly associated with avalanche hazards. However, motorists and others not engaging in recreation are also at risk of being caught in an avalanche. An avalanche is defined as a large mass of snow, ice, earth, rock, or other material in swift motion down a mountainside or over a precipice (Merriam-Webster).

Avalanche risk is greatest in western Wyoming where there are mountain ranges and steep slopes.

Figure 13. Jackson Peak Avalanche (November 2013)[6]

The Wyoming Department of Transportation (WYDOT) published the Snow Avalanche Atlas in 2004 which profiles avalanche paths in Lincoln, Sublette, and Teton Counties that can impact state and federal highways. Each of the 43 avalanche paths are documented with a photo, milepost, and description including frequency interval and history.

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[6] Bridger-Teton Avalanche Center Photos

The following map shows areas in Teton County where snow avalanches have been reported in dark red and areas where snow avalanches could occur in lighter red. This data was compiled in 1973 from residents of the Town of Jackson as well as avalanche specialists from the U.S. Forest Service, Department of Geology at Montana State University, U.S. Forest Service, and U.S. Geological Survey.

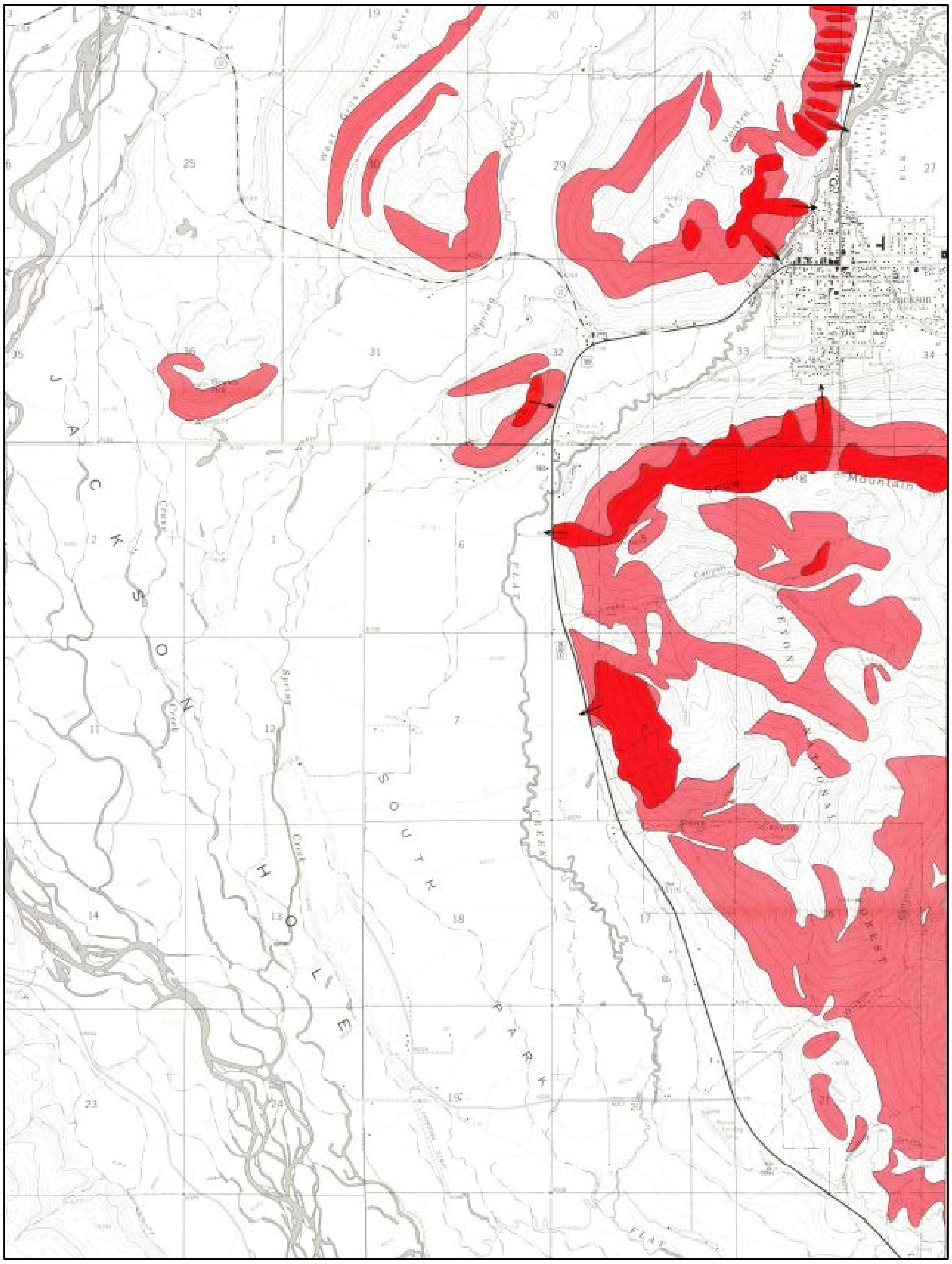

Figure 14. Snowslide Possibilities near Jackson, Wyoming

Avalanches cause two primary impacts—road blocks and death or injury. Since 1994 there has been a trend of at least one fatality per year. Fatalities are the best-documented impact related to avalanches and are significant simply because of the nature of the hazard. Furthermore, there are costs associated with "search and rescue" and removal of the deceased. The major costs associated with road blocks are snow removal and traffic diversion, which both necessitate personnel and equipment. Another less frequent issue is the cost associated with rescuing motorists involved in an avalanche.

History and Probability of Future Events

The following table lists loss-causing avalanche events and associated damage by county, collected from SHELDUS and NCDC past events databases.

Table 15. Avalanche Events, Casualties, and Damage by County and Statewide (1960-2015)

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Albany	1	-	1	-	-	-
Big Horn	-	-	-	-	-	-
Campbell	-	-	-	-	-	-
Carbon	1	-	1	-	-	-
Converse	-	-	-	-	-	-
Crook	-	-	-	-	-	-
Fremont	19	3	3	-	-	-
Goshen	-	-	-	-	-	-
Hot Springs	2	0	0	-	-	-
Johnson	-	-	-	-	-	-
Laramie	-	-	-	-	-	-
Lincoln	35	6	6	$5,000	-	$5,000
Natrona	3	3	-	-	-	-
Niobrara	-	-	-	-	-	-
Park	2	0	0	-	-	-
Platte	-	-	-	-	-	-
Sheridan	-	-	-	-	-	-
Sublette	35	6	6	$5,000		$5,000
Sweetwater	-	-	-	$0	$0	$0
Teton	44	11	16	$5,000	-	$5,000
Uinta	-	-	-	-	-	-
Washakie	1	-	1	-	-	-

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Weston	-	-	-	-	-	-
Statewide	**143**	**30**	**32**	**$15,000**	**$0**	**$15,000**

Avalanche fatalities provide the best indicator for locations of where events occur and what populations are most threatened. According to the Colorado Avalanche Information Center statistics for the past 62 years (1950-2012), Wyoming ranks sixth among the eight states with the most avalanche fatalities.

In the past ten years, Wyoming's ranking has improved slightly, with 26 of the 278 avalanche-related deaths occurring in Wyoming. This places Wyoming 7th in the list and represents 9 percent of avalanche deaths in the U.S. between the 2003/4 and 2012/13 snow seasons.

A historical list of avalanche events resulting in deaths is attached as **Appendix O**. There have been 11 avalanche fatalities in Wyoming since the last mitigation plan update three years ago, with a total of 88 recorded fatalities since 1918.

Avalanche deaths occur primarily in the backcountry where access is limited and the recreating public enjoys recreational pursuits in beautiful terrain. Typically deaths result from an avalanche triggered by those recreating in mountainous areas where the snow pack is unstable and on a steep slope. The two activities generating by far the greatest number of fatal avalanches in Wyoming are skiing and snowmobiling (**Figure 15**).

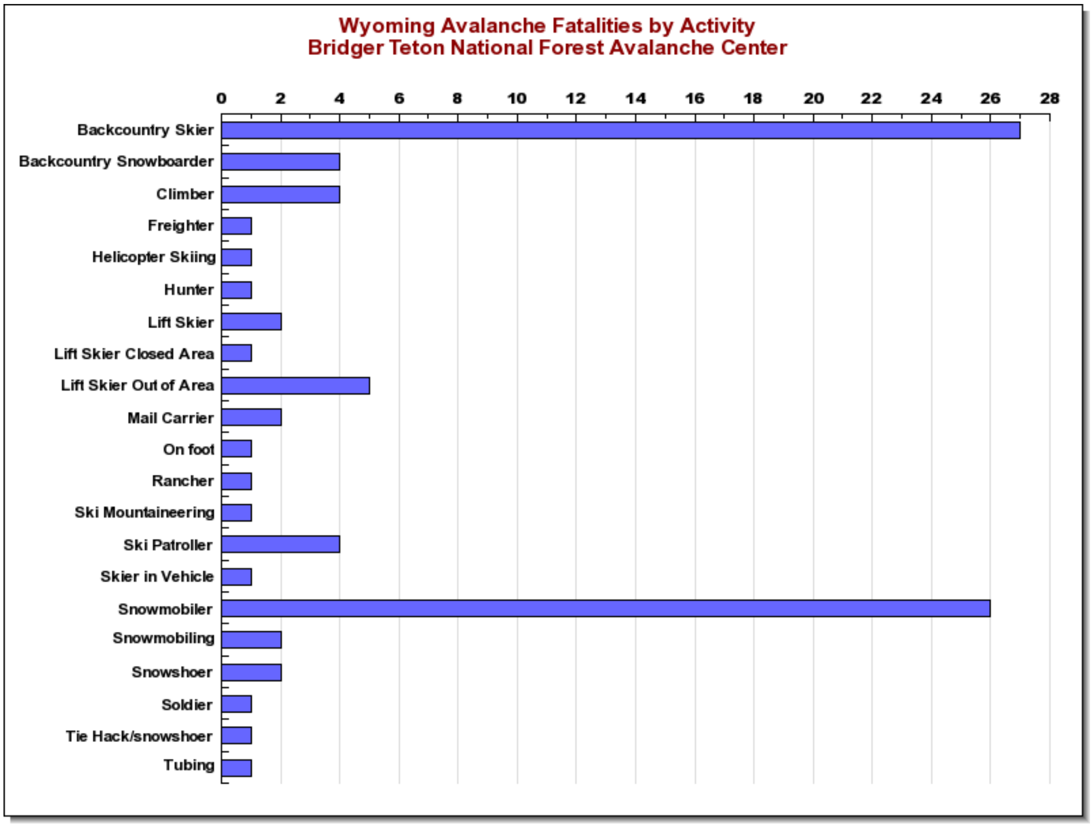

Figure 15. Wyoming Avalanche Fatalities by Activity

Figure 16[7] shows the majority of fatalities occurred in western Wyoming, with most in the Teton area. The Teton area presents an increased population of outdoor enthusiasts; an increased population engaging in extreme winter sports; and the high angle, avalanche-prone character of the terrain.

[7] http://www.jhavalanche.org/fatalityGraph/type/activity (Accessed 3/26/2014)

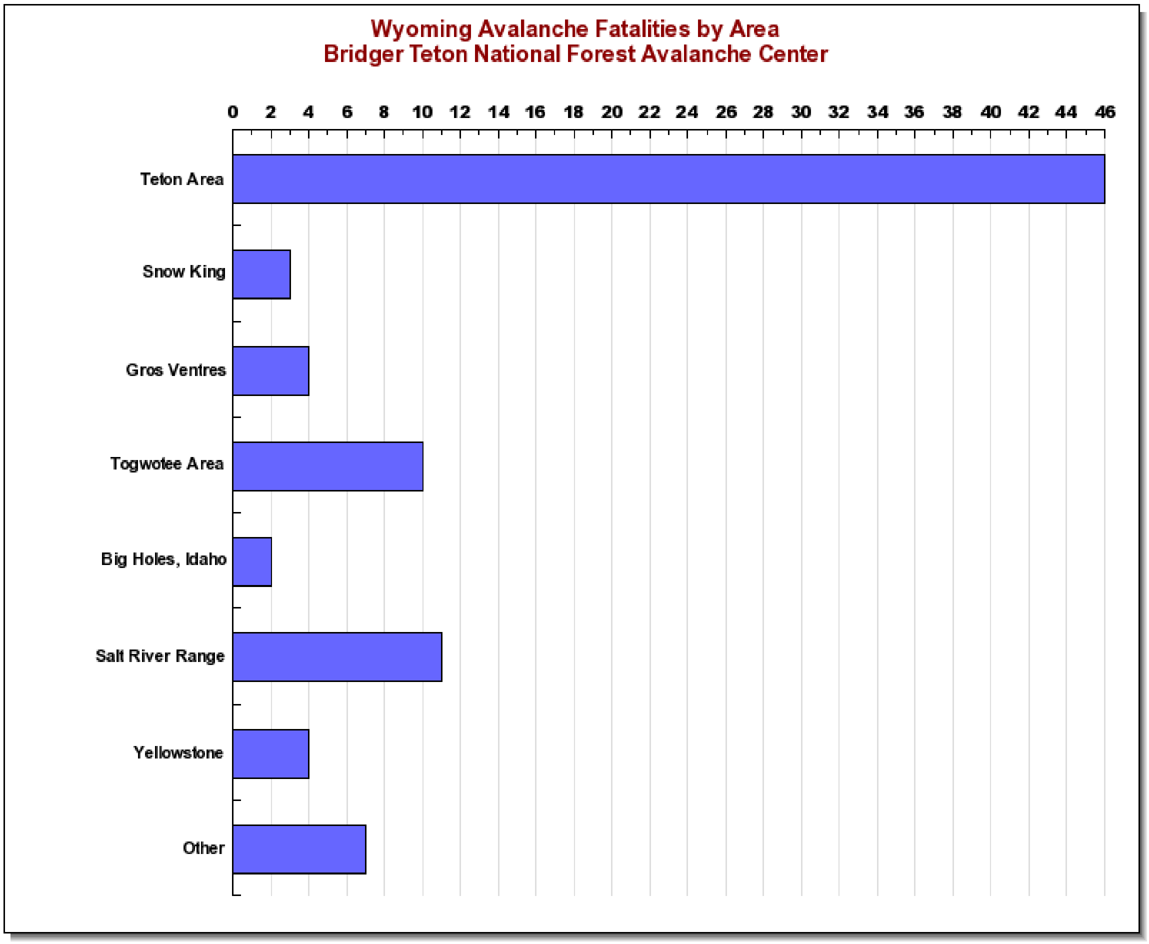

Figure 16. Wyoming Avalanche Fatalities by Area

The table below shows counts of avalanche fatalities by area and also by activity or travel. Data was pulled from the Bridger Teton National Forest Avalanche Center on 11/2/2015.

Table 16. Avalanche Fatalities by Area and by Activity

Avalanche Area	Activity/Travel	Fatalities	Total Fatalities
Absarokas & Togwotee Pass/Continental Divide Trails	Backcountry Skier	2	10
	Climber	1	
	Hunter	1	
	Snowmobiler	4	
	Snowmobiling	1	
	Tie Hack/snowshoer	1	
Big Horn Range	Backcountry Skier	1	1
Gros Ventre Range	Backcountry Skier	4	4

Avalanche Area	Activity/Travel	Fatalities	Total Fatalities
Salt River and Wyoming Ranges	Backcountry Skier	1	13
	Helicopter Skiing	1	
	Snowmobiler	10	
	Snowshoer	1	
Sierra Madre Range	Snowmobiler	2	1
Snow King Mountain	Lift Skier Out of Area	2	3
	Ski Patroller	1	
Snowy Range	Backcountry Skier	1	5
	Snowmobiler	3	
	Tubing	1	
Teton Range, Snake River Range & Jackson Hole	At work	1	49
	Backcountry Skier	16	
	Backcountry Snowboarder	4	
	Climber	3	
	Freighter	1	
	Lift Skier	**2**	
	Lift Skier Closed Area	1	
	Lift Skier Out of Area	3	
	Mail Carrier	2	
	On foot	1	
	Rancher	1	
	Ski Mountaineering	3	
	Ski Patroller	3	
	Skier in Vehicle	1	
	Snowmobiler	6	
	Snowmobiling	1	
Yellowstone	Backcountry Skier	2	4
	Snowshoer	1	
	Soldier	1	
		Statewide Total	90

Figure 17 shows the greatest number of avalanche fatalities in the U.S. occur in the 20-30 year age group. This age group tends to be more focused on strenuous, outdoor activities, and therefore it follows that this age group would be more susceptible to this risk.

Because avalanches are typically a back-country hazard in mountainous areas and do not typically occur in populated areas, there is limited risk to significant portions of the population. The one segment of the population most vulnerable to avalanche danger is individuals taking advantage of winter recreation opportunities in the mountains, typically skiers, snow boarders and snowmobilers. Skiers and snow boarders recreating within developed ski areas are less vulnerable to avalanche hazards, as ski area staff ensure known avalanche hazard areas within their boundaries are mitigated utilizing various methods. Those most vulnerable are those drawn to recreate outside developed ski areas where mitigation efforts may or may not be taken.

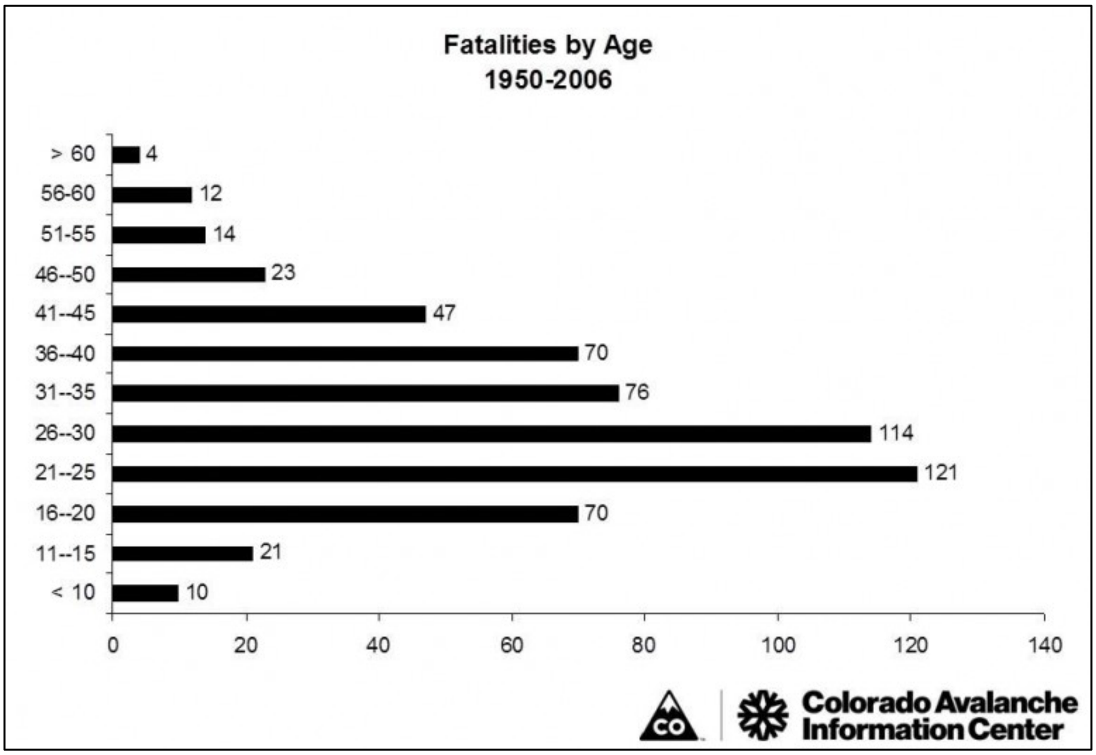

Figure 17. U.S. Avalanche Fatalities by Age[8]

Probability

Avalanche event frequency is calculated statewide and by county below and is based on loss-causing events, 1960-2015, collected from SHELDUS and NCDC databases.

Table 17. Avalanche Event Frequency

County	Total Events	Time Period	Frequency	Probability

[8] http://avalanche.state.co.us/accidents/statistics-and-reporting (Accessed 3/26/2014)

County	Total Events	Time Period	Frequency	Probability
Albany	1	-	2%	Occasional
Big Horn	-	-	0%	Unlikely
Campbell	-	-	0%	Unlikely
Carbon	1	-	2%	Occasional
Converse	-	-	0%	Unlikely
Crook	-	-	0%	Unlikely
Fremont	19	-	34%	Likely
Goshen	-	-	0%	Unlikely
Hot Springs	2	-	4%	Occasional
Johnson	-	-	0%	Unlikely
Laramie	-	-	0%	Unlikely
Lincoln	35	55.5yrs	63%	Likely
Natrona	3	-	5%	Occasional
Niobrara	-	-	0%	Unlikely
Park	2	-	4%	Occasional
Platte	-	-	0%	Unlikely
Sheridan	-	-	0%	Unlikely
Sublette	35	-	63%	Likely
Sweetwater	-	-	0%	Unlikely
Teton	44	-	79%	Likely
Uinta	-	-	0%	Unlikely
Washakie	1	-	2%	Occasional
Weston	-	-	0%	Unlikely
Statewide	143	55.5yrs	3%	Likely

Highly Likely = Value 4
143 Reported ÷ 55.5 years = 2.6 Avalanche events every year or a >100.0 % annual probability of an Avalanche event

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazards taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. Six counties profiled avalanche in local plan risk assessments; Albany, Carbon, and Sublette ranked the risk as medium and Lincoln, Park, and Washakie ranked the risk as low.

Large population areas are not typically subject to avalanche risk, leading to a low risk categorization by local jurisdictions. Many counties located on the plains do not address snow avalanches as a hazard within their plan which would be expected of counties without the steep slopes.

Statewide Risk Assessment

Most loss causing avalanche events have happened in Lincoln, Sublette, and Teton Counties. The following counties have experienced fatalities as a result of avalanche events: Albany, Carbon, Fremont, Lincoln, Sublette, Teton, and Washakie.

Changes in Development

Of the counties that identified avalanche as medium risk in local risk assessments and have the most loss causing events in the state, Sublette County has the highest projected rate of population increase. Sublette County has the highest projected rate of population increase in the state; Towns of Big Piney, Marbleton, and Pinedale have a projected increase of 74percent.

In the case of development's impact on avalanche risk, this is one area where the risk actually seems to diminish as areas are developed. This is true, not because of development itself, but because of mitigation efforts undertaken to protect the population within developed areas. Avalanche is recognized as a hazard and mitigated in avalanche-prone locations throughout the state where development exists. Avalanche areas known to have the potential to interfere with highways and roads are typically mitigated prior to endangering residents.

State Facilities at Risk

There are 626 state facilities in Fremont County, 78 in Lincoln, 82 in Sublette, and 99 in Sweetwater that might be at risk to the avalanche hazard. Proximity of state facilities and the avalanche hazard should be studied for the next plan update.

Transportation corridors are particularly at risk to landslides in northwestern Wyoming.

There were no recorded losses to state facilities from landslides.

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 18. Avalanche Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	*2.5*	*Moderate*
Snow Avalanche	4.0	1.6	1.4	3.3	1.4		

Dam Failure

Description

Figure 18. Photo from Wyoming State Engineer's Office Web[9]

Wyoming has more than 30,000 dams and reservoirs, and sizes range from more than one million acre-feet in Pathfinder and Seminoe reservoirs located above Casper to small coalbed methane and stock reservoirs scattered throughout the state. Of these dams, only 1,518 rise to the 'Safety of Dam' (SOD) size which is defined, generally, as either greater than 20 feet tall or holding more than 50 acre feet of water. The dams and reservoirs serve an important role for Wyoming residents and industry.

Water remains a critical resource throughout the state. Water conservation is accomplished in part through the utilization of dams. Dams control flooding and conserve water for summer months when rainfall is limited. The use of dams is significant to Wyoming's water management. Most counties have multiple dams located within their borders, each of which represent both a hazard to property and residents, as well as a benefit to the community.

The U.S. Bureau of Reclamation controls most of the larger dams in the state. The dams and reservoirs have inundation maps maintained by the U.S. Bureau of Reclamation in

[9] https://sites.google.com/a/wyo.gov/seo/surface-water (Accessed 8/14/2013)

preparation for potential dam failure. Because of security concerns, inundation data is not available to the public, making the study and analysis of inundation areas for the purposes of publication within this plan unproductive.

Dams rarely fail, either completely or partially, but when they do it may be a life and safety hazard for those downstream. Wyoming State Statutes 41-3-307 through 41-3-317 legislate the safety of dams and the role the state plays in ensuring their safety.

Overtopping failures result from uncontrolled flow of water over, around, and adjacent to the dam. Approximately 70 percent of failures are from floods and overtopping. Older dams are most susceptible to overtopping failure. Foundation and structural failures are usually tied to seepage through the foundation of the main structure of the dam. Seepage or piping accounts for about 12 percent of dam failure. Deformation of the foundation or settling of the embankment can also result in dam failure. Below is a chart of dam failure causes provided by the Association of State Dam Safety Officials.

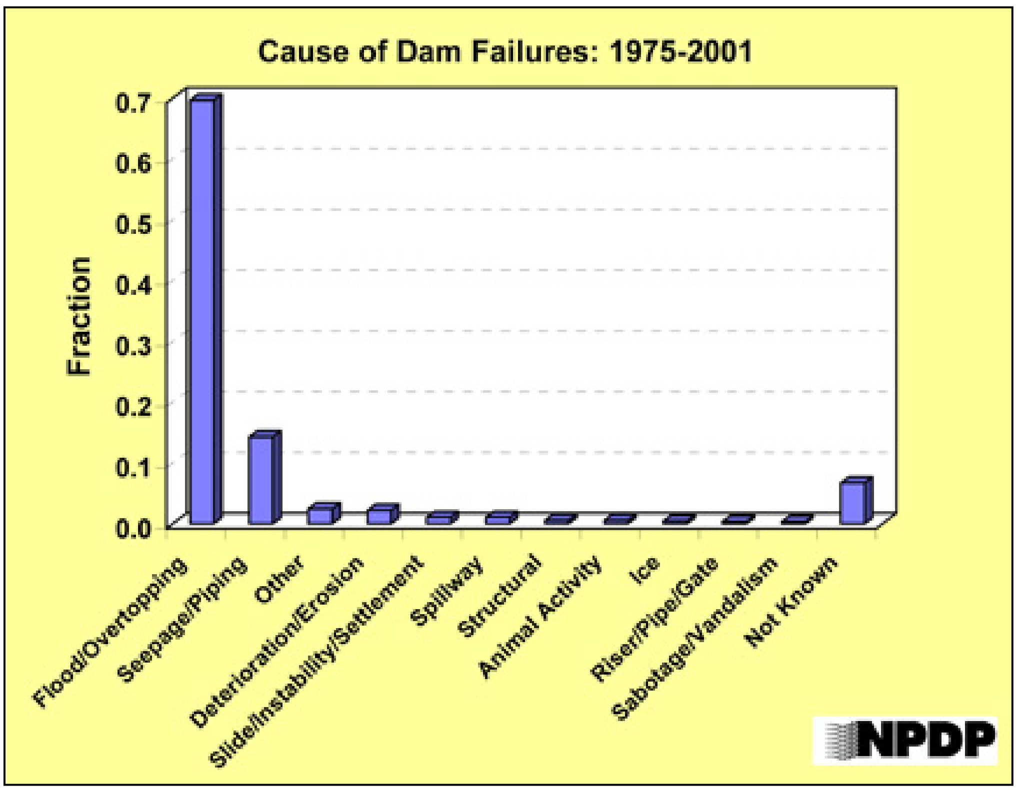

Figure 19. Dam Failure Causes[10]

[10] http://www.damsafety.org/news/?p=412f29c8-3fd8-4529-b5c9-8d47364c1f3e#FailureCauses (Accessed September 4, 2013)

The Wyoming State Engineer's Office (WSEO) regulates dams more than 20 feet high or with a storage capacity of 50 acre-feet or more, although smaller dams are also regulated if the potential for failure indicates a need. According to the WSEO web site[11], as of 2011 the WSEO regulates 1,518 dams. As a part of the regulatory process the WSEO inspects these dams once every five years. Of these dams, 81 are rated high hazard, 109 are rated significant hazard, and 1,328 are rated low hazard.

The U.S. Army Corps of Engineers (USACE) completed inspections of nonfederal dams in 1981. The four-year project included compiling an inventory of about 50,000 dams nationally, and conducting a review of each state's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of dams. Evaluation of each dam and assigning a hazard potential based on the downstream effects should one of the dams fail was also part of the inventorying process.

Dams are classified based upon hazard potential. This classification is based on the consequences if a dam were to fail, not on the potential of failure, or the existing condition of the dam. The dams were rated (1) high, (2) significant, and (3) low hazard. The Corps of Engineers based the hazard potential designation on such items as acre-feet capacity of the dam, distance from nearest community downstream, population density of the downstream community, and age of the dam. High hazard dams would, in case of dam failure, likely cause loss of life. Significant hazard dams would, in case of failure, likely cause significant property damage, but no loss of life. Failure of a low hazard dam would likely cause only minimal property damage. Hazard potential classification is no guarantee of safety.

Table 19 was provided by the WSEO and lists high hazard dams in the state, sorted by county, and indicates whether an Emergency Action Plan is in place. There are a total of 87 high hazard dams in the state and ten are without an emergency action plan. **Table 20** summarizes counts of high hazard dams by county.

Table 19. High Hazard Dams Emergency Action Plan Availability

NAME	COUNTY	EAP
ROB ROY	ALBANY	Y
SHELL CREEK	BIG HORN	Y
ADELAIDE	BIG HORN	Y
LEAVITT	BIG HORN	N
WESTSIDE	CAMPBELL	N
COW CREEK LAKE	CARBON	Y
SEMINOE	CARBON	Y
ENL. TURPIN PARK	CARBON	Y

[11] http://www.damsafety.org/map/state.aspx?s=51 (Accessed 8/13/2013)

NAME	COUNTY	EAP
SPRING CREEK (ENLARGEMENT)	CARBON	Y
SOUTH SPRING CREEK LAKE	CARBON	Y
HOG PARK MAIN DAM	CARBON	Y
HOG PARK SADDLE DAM NO. 1	CARBON	Y
HOG PARK SADDLE DAM NO. 2	CARBON	Y
HIGH SAVERY	CARBON	Y
NORTH SPRING CREEK	CARBON	N
LAPRELE	CONVERSE	Y
KEYHOLE	CROOK	Y
WASHINGTON MEMORIAL	CROOK	Y
BULL LAKE	FREMONT	Y
SHOSHONE LAKE	FREMONT	Y
ENLARGEMENT OF WORTHEN MEADOWS	FREMONT	Y
BOYSEN	FREMONT	Y
PILOT BUTTE	FREMONT	Y
O S W	FREMONT	Y
WASHAKIE DIKE NO. 2	FREMONT	Y
WASHAKIE DIKE NO. 1	FREMONT	Y
WASHAKIE DIKE NO. 3	FREMONT	Y
WASHAKIE DAM	FREMONT	Y
ENTERPRISE	FREMONT	Y
ANCHOR	FREMONT	Y
SNYDER CREEK DETENTION	FREMONT	N
SPRING CANYON	GOSHEN	N
LAKE DESMET (NORTH DAM)	JOHNSON	Y
WILLOW PARK	JOHNSON	Y
TIE HACK	JOHNSON	Y
LAKE DESMET (A,B,C & SPILLWAY DIKES)	JOHNSON	Y
BIG HORN DIKE B	JOHNSON	Y
DULL KNIFE	JOHNSON	Y
CLOUD PEAK	JOHNSON	Y
BIG HORN DIKE A	JOHNSON	Y
LAKE DESMET (SOUTH DAM)	JOHNSON	Y
HEALY	JOHNSON	Y
BIG HORN DIKE C	JOHNSON	N
KEARNEY LAKE	JOHNSON	N
UPPER VAN TASSELL	LARAMIE	Y
GRANITE SPRINGS	LARAMIE	Y
CRYSTAL LAKE	LARAMIE	Y
CAREY DETENTION	LARAMIE	Y
LAKE VIVA NAUGHTON	LINCOLN	Y
KEMMERER	LINCOLN	Y

NAME	COUNTY	EAP
FONTENELLE	LINCOLN	Y
ALCOVA	NATRONA	Y
EASTGATE	NATRONA	Y
EASTDALE CREEK DETENTION NO.2	NATRONA	Y
PATHFINDER	NATRONA	Y
PATHFINDER DIKE	NATRONA	Y
MC MURRY NO. 4	NATRONA	Y
CARDINE KEITH	NATRONA	Y
UPPER SUNSHINE	PARK	Y
LOWER SUNSHINE	PARK	Y
GREYBULL VALLEY (1st ENL.)	PARK	Y
BUFFALO BILL	PARK	Y
DIAMOND CREEK DIKE	PARK	Y
GUERNSEY	PLATTE	Y
GLENDO DIKE NO. 2	PLATTE	Y
GLENDO DIKE NO. 3	PLATTE	Y
GLENDO	PLATTE	Y
GLENDO DIKE NO. 1	PLATTE	Y
GRAYROCKS	PLATTE	Y
SIBLEY	SHERIDAN	Y
TWIN LAKES NO. 1	SHERIDAN	Y
WINDY DRAW	SHERIDAN	Y
BIG GOOSE PARK (3RD ENL.)	SHERIDAN	Y
DOME LAKE NO. 1	SHERIDAN	Y
SAWMILL	SHERIDAN	Y
WAGNER	SHERIDAN	N
PADLOCK NO. 1 A FIVE MILE	SHERIDAN	N
NEW FORK LAKE	SUBLETTE	Y
MIDDLE PINEY	SUBLETTE	N
EDEN NO. 1	SWEETWATER	Y
UPPER DELTA BASIN ENLARGEMENT	SWEETWATER	Y
GRASSY LAKE	TETON	Y
JACKSON LAKE	TETON	Y
MEEKS CABIN	UINTA	Y
WOODRUFF NARROWS	UINTA	Y
SULPHUR CREEK	UINTA	Y
TENSLEEP	WASHAKIE	Y

Table 20. High Hazard Dams by County

County	Count
ALBANY	1
BIG HORN	3
CAMPBELL	1
CARBON	10
CONVERSE	1
CROOK	2
FREMONT	13
GOSHEN	1
JOHNSON	12
LARAMIE	4
LINCOLN	3
NATRONA	7
PARK	5
PLATTE	6
SHERIDAN	8
SUBLETTE	2
SWEETWATER	2
TETON	2
UINTA	3
WASHAKIE	1
TOTAL	87

The following map shows all dams in the state, as maintained by the USACE in the National Inventory of Dams. Locations of high hazard dams are not shown due to security restrictions.

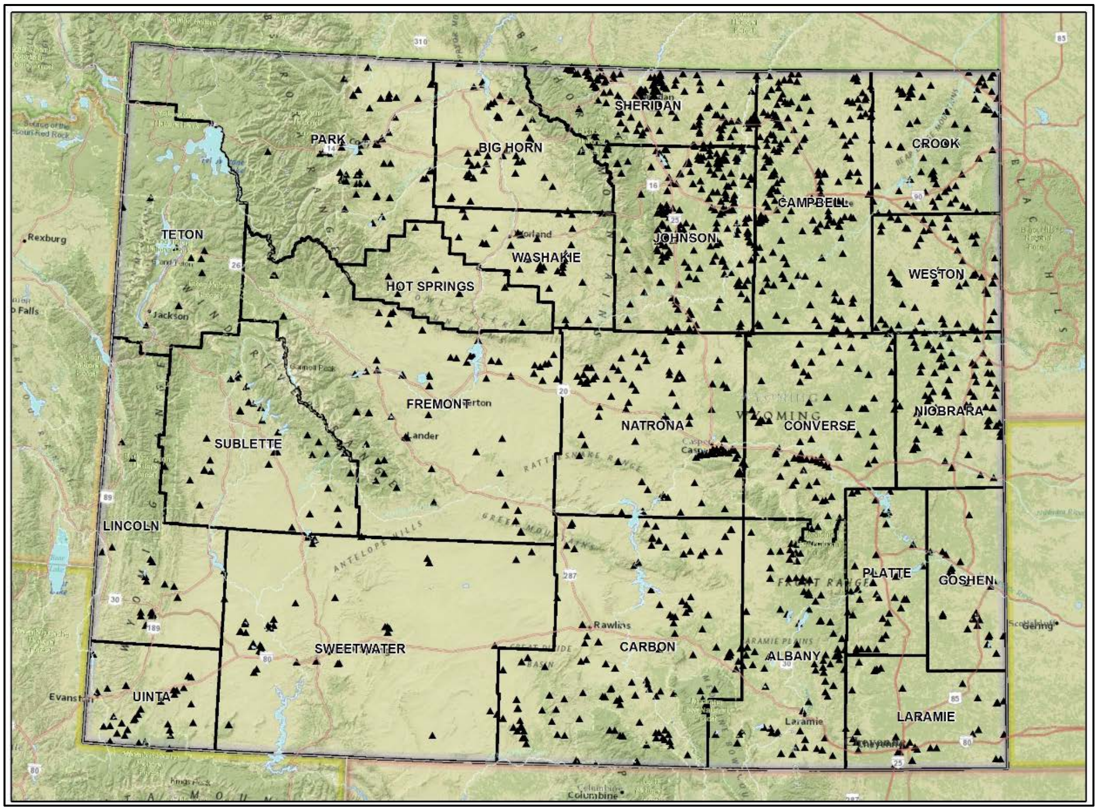

Figure 20. 2015 National Inventory of Dams

History and Probability of Future Events

There have been a small number of dam failures in Wyoming, some of which have caused loss of life and damage to property (**Appendix H**). The most significant dam failures in terms of loss of life were in 1906 and 1927. On March 1, 1906, flooding along the North Platte River near Casper resulting from snow/ice melt caused a diversion dam to fail. A stream returned to its natural channel with a culvert too small to handle the flood, causing the water to rise against a railroad embankment. The embankment failed. Twelve were killed in a train wreck when the railroad bridge was damaged.

Probably the most infamous flash flood in Teton County's recorded history is the Kelly Flood. On June 23, 1925, part of the northern face of Sheep Mountain became unstable after weeks of heavy rain and slid into the Gros Ventre River. The 50 million cubic yards of sedimentary rock formed a natural dam 200 feet high and 400 yards wide that created Lower Slide Lake. On May 18th, 1927, a portion of the natural dam broke causing a flash flood to rush down the Gros Ventre River. The flood was at least 6 feet deep for at least 25 miles downstream, and wiped out the town of Kelly six miles downstream. Six people died, and many others lost everything they owned. http://www.tetonwyo.org/em/docs/images/gros_ventre_slide_large.jpg

Fifteen miles downstream in Wilson, Wyoming six feet of water inundated the town and hundreds of farm animals died. In narrower sections of the Snake River near Hoback, flood waters rose as much as 50 feet. The next day the waters reached Idaho Falls,Idaho and covered lowland sections there. When all was said and done, damages totaled $500,000, which would be more than $27 million in today's dollars. You can still see the bald rock on the north face of Sheep Mountain (Sleeping Indian) is still visible as a reminder of this tragic event.[12]

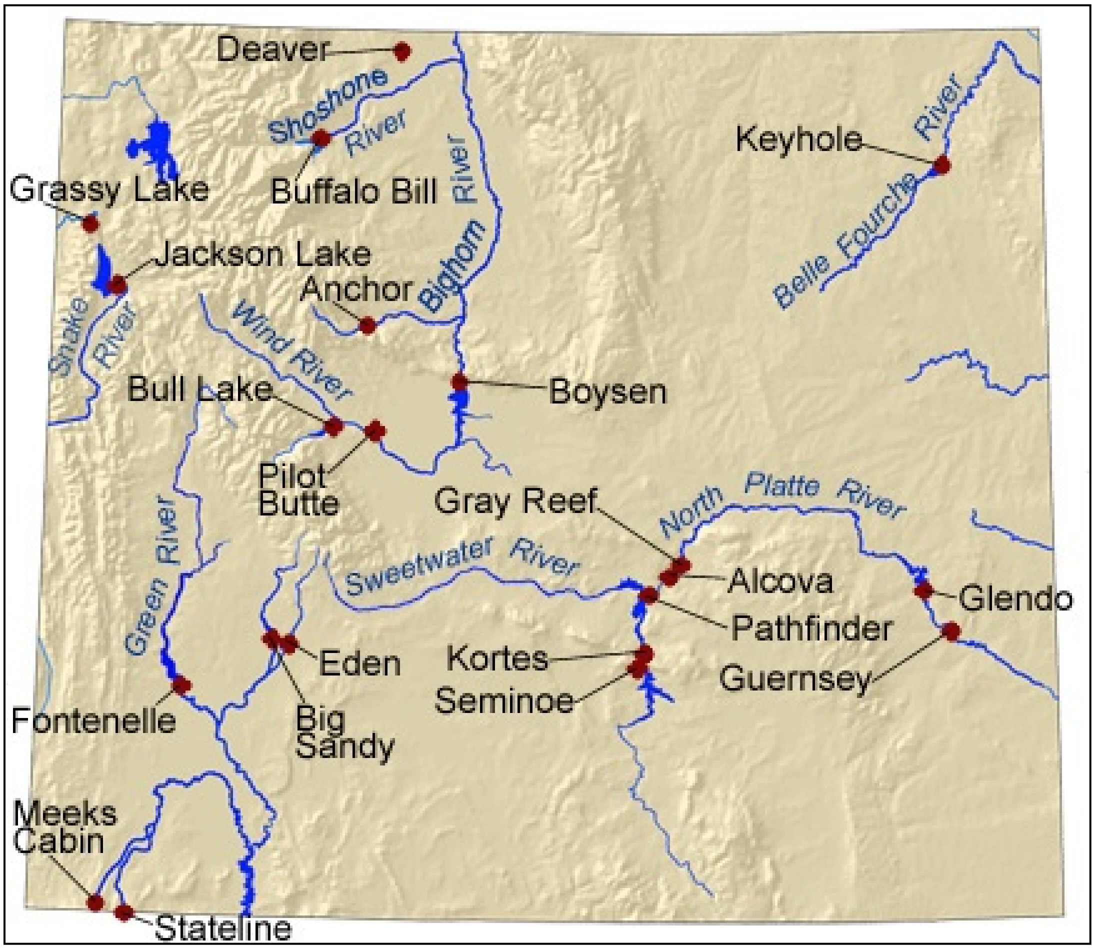

Figure 21. Wyoming Dams Managed by U.S. Bureau of Reclamation[13]

The most costly dam failure in Wyoming occurred on May 14, 1984. High runoff from melting snow in the mountains of southern Wyoming and northern Colorado resulted in

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[12] http://www.tetonwyo.org/em/topics/flash-flood/201706 (Accessed 10/1/2013)
[13] http://www.usbr.gov/projects/FacilitiesByState.jsp?StateID=WY (Accessed 8/14/2013)

the failure of the Highline Dam near Baggs. A 4-foot wall of water poured down a canyon. There was an estimated $5 million in damage to the area, including damage to a water treatment plant, crops, fences, irrigation systems, and structures. Four hundred people were forced to evacuate. Twenty-six homes and trailers were damaged. Recovery response was from the Small Business Administration, Civil Defense, Red Cross, and the Army Corps of Engineers.

To date there have been no Presidential Emergency Declarations in Wyoming as the result of a dam failure. Additionally, there have been no state-level emergency declarations in Wyoming as the result of a dam failure.

The Wyoming State Engineer's Office (WSEO) was contacted August 14, 2013 and indicates no dam failures have occurred in Wyoming since the mitigation plan was last updated, which puts the most recent Wyoming dam failure in 2010. There was a small incident in Sublette County in the summer of 2013, when an avalanche introduced logs to the Middle Piney Lake. The logs blocked the outlet, causing the water to rise.

Out of more than 1,400 dams statewide, only 24 have failed over the past 107 years, with only two of those leading to $1 million or more in damage. (**Appendix H**)

Figure 22. Middle Piney Lake June 10, 2013. Photos curtesy of Wyoming State Engineers Office

Probability

Likely = Value 3
24 dam failures ÷ 107 years = 1 dam failure every five (5) years or a 22.4% annual probability of dam failure

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. The map below shows these rankings by county to demonstrate local perception of risk across the state.

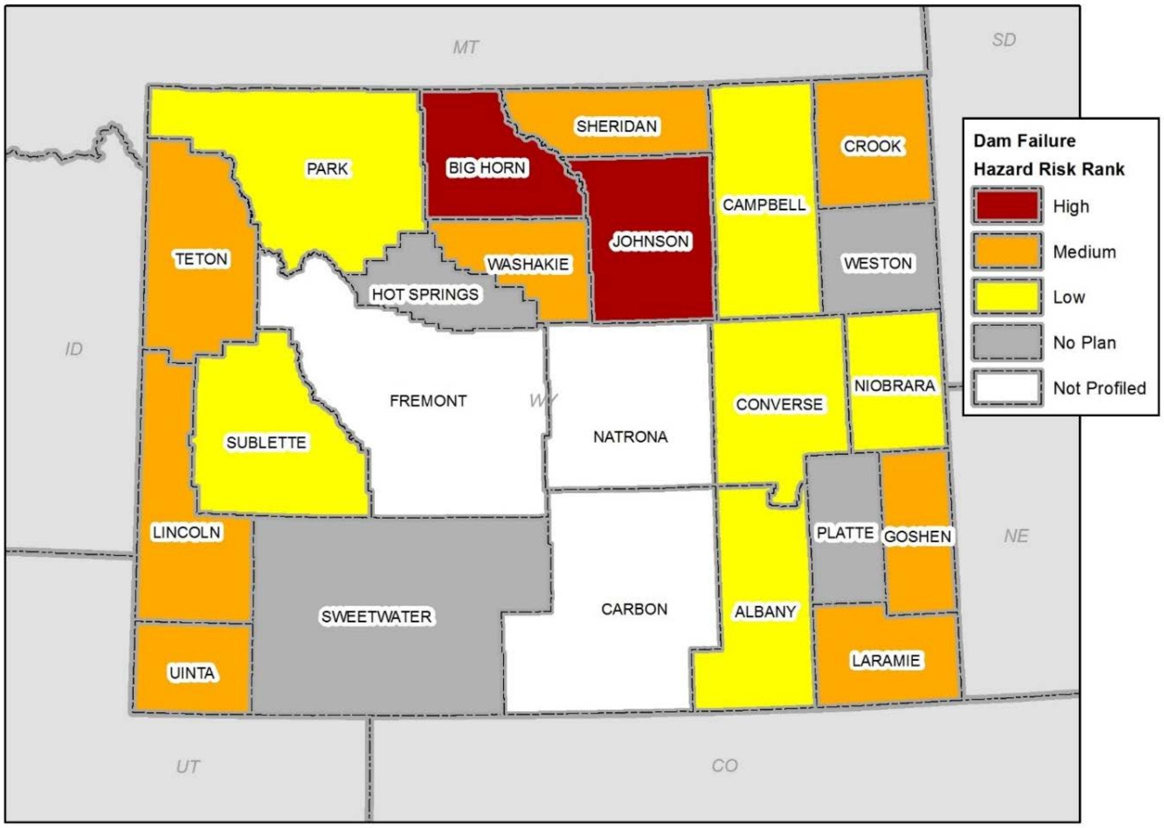


Figure 23. Dam Hazard Risk Rankings from Local Hazard Mitigation Plan Risk Assessments

Johnson and Big Horn Counties have cited that dam failure is a high risk hazard in their local risk assessments.

Statewide Risk Assessment

There are ten high hazard dams in Carbon County, 13 in Fremont County, and 12 in Johnson County. If a high hazard dam were to fail, impacts will occur in downstream communities and sometimes cross county boundaries. For example, Sheridan County reported that failure of Kearney and Willow Park dams would result in significant impacts to the community of Story in Sheridan County as well as impacts to Johnson County.

Based on historic impacts, areas most at risk to dam failure are near Casper along the North Platte River in Natrona County and near Baggs under the Highline Dam in Carbon County.

Impacts to a dam failure will be downstream of the dam and similar to flood impacts, based on depth and velocity of the inundation. Risk will be dependent on the depth and velocity of water and its proximity to people and property.

Changes in Development

There are several high hazard dams in Johnson County, the state's 6th fastest growing county. These dams are close to Buffalo, the county's largest city that has a projected population increase of 22 percent.

State Facilities at Risk

There are 62 state facilities with a value of more than $21 million in Johnson County that may be threatened by the dam failure hazard. Of those facilities, 35 are in the City of Buffalo.

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 21. Dam Failure Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	2.7	*Moderate*
Dam Failure	3.0	2.6	2.6	2.9	2.6		

Drought

Description

Unlike other disasters that quickly come and go, drought's long-term unrelenting destruction has been responsible for mass migrations and lost civilizations. Drought occurs in four stages and is defined as a function of its magnitude (dryness), duration, and regional extent. Severity, the most commonly used term for measuring drought, is a combination of magnitude and duration.

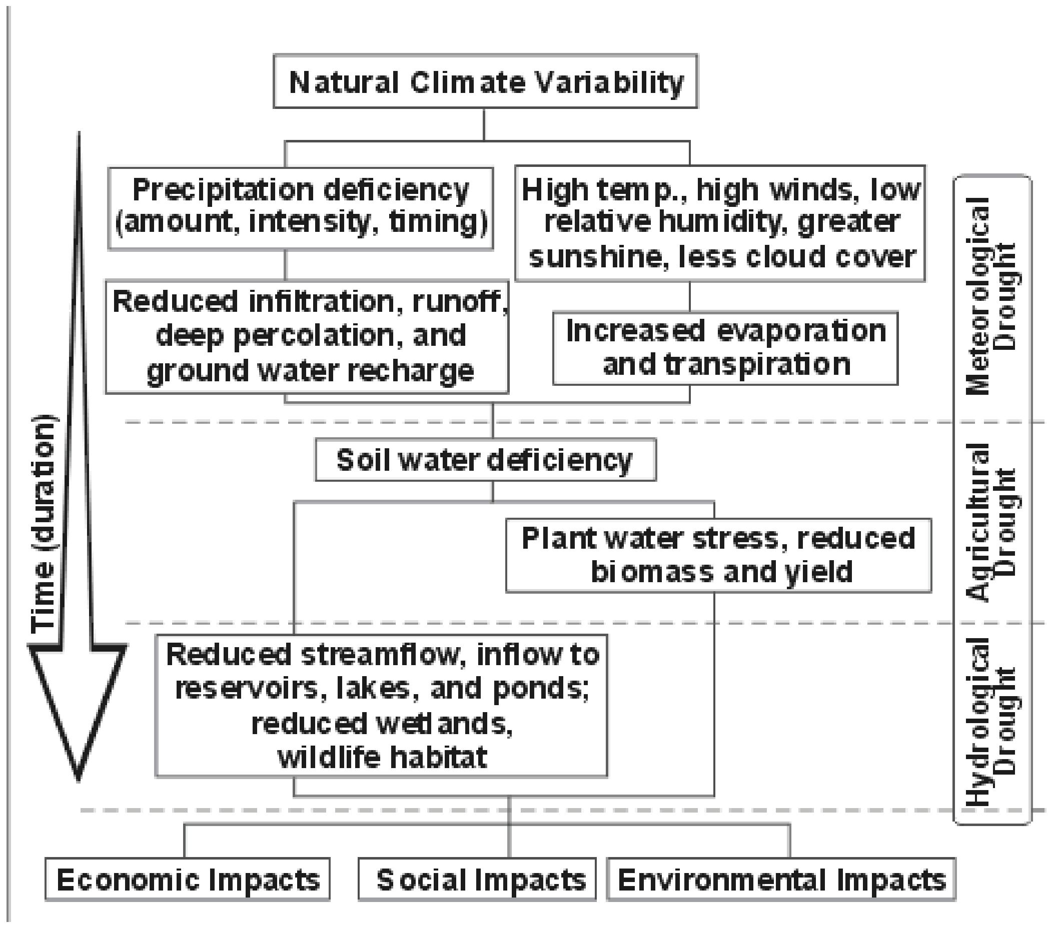


Figure 24. Drought Flow Chart[14]

The first stage of drought is known as a meteorological drought. The conditions at this stage include any precipitation shortfall of 75 percent of normal for three months or longer. This criterion can be misleading if all the precipitation falls in a very short time period resulting in floods. Additionally, winter precipitation is usually two to six times less than summer precipitation and these so-called

[14] http://www.nws.noaa.gov/os/brochures/climate/DroughtPublic2.pdf (Accessed 9/3/2013)

seasonal droughts are normal in Wyoming's semiarid climate. Conditions are often made worse with high temperatures, high winds, low humidity, and greater sunshine; all of these factors contribute to increased evaporation and transpiration and result in reduced soil infiltration, runoff, deep percolation, and groundwater recharge.

The second stage is known as agricultural drought. Soil moisture is deficient to the point where plants are stressed and biomass (yield) is reduced. The third stage is the hydrological drought. Reduced stream flow (inflow) to reservoirs and lakes is the most obvious sign that a serious drought is in progress. The fourth stage is the socioeconomic drought. This final stage refers to the situation that occurs when physical water shortage begins to affect people.

As these stages evolve over time, the impacts to the economy, society, and environment converge into an emergency situation. Without reservoir water to irrigate farms, food supplies are in jeopardy. Without spring rains for the prairie grasslands, open range grazing is compromised. Without groundwater for municipalities, the hardships to communities result in increases in mental and physical stress as well as conflicts over the use of whatever limited water is available. Without water, wetlands disappear. The quality of any remaining water decreases due to its higher salinity concentration. There is also an increased risk of fires, and air quality degrades as a result of increased soil erosion in strong winds (blowing dust).

Drought conditions can vary considerably from region to region and location to location within Wyoming. There are multiple factors impacting moisture levels throughout the state, two of which are Wyoming's widely-varied topography and the size of the state. Wyoming lays claim to terrain consisting of mountains, rolling hills and plains, and Wyoming is ranked 10th among the states for its size with 97,818 square miles. Wyoming ranges in height from a mere 3,099 feet above sea level at the Belle Fourche River to 13,804 feet above sea level at Gannett Peak in the Wind River Mountain Range, with the continental divide running from north to south through the state[15]. Moisture content varies significantly across the state due to the interaction of Wyoming's terrain with moisture content traveling across the state in weather systems. Weather systems containing rain and snow tend to interact significantly with Wyoming's terrain, and this of course, results in varied moisture from one side of the state to the other. Drought does seem to be cyclical in nature throughout Wyoming's history, though it can be expected to vary region to region within each drought cycle. Drought is addressed in an overall, state-level perspective throughout this chapter, rather than through the lens of a regional perspective. There is however, attention made to each local county's perspective of the drought hazard through review of local multi-hazard mitigation plans and extrapolation of data from them. It can be noted, all counties within Wyoming recognize drought as a local hazard, though the perceived intensity of its risk is varied.

[15] http://www.netstate.com/states/geography/wygeography.htm

History and Probability of Future Events

Drought Measurement

There are several methods for determining drought. One of the most popular is known as the Palmer Drought Severity Index (PDSI). Wayne Palmer developed this index in the 1960s; temperature and rainfall information are used in a formula to determine dryness. It has become the semi-official drought index. However, in the west much of the surface water is derived from mountain snowpack [i.e., the snow-water equivalent (SWE) as measured at a number of snow telemetry (SNOTEL) sites.

The PDSI is a "meteorological drought" index that responds to weather conditions that have been abnormally dry or abnormally wet. The index is calculated based on precipitation, temperature, and available water content (AWC) of the soil. The Palmer Index varies from +6.0 to -6.0 with a classification scale indicating relative meteorological and hydrological development cycles. **Table 22** reflects the range and extent of the PDSI classification system. There are concerns about the number of data points used to calculate the index as well as the accuracy of the data used.

Table 22. Palmer Drought Severity Index Classification System

4.00 to 6.00	Extremely wet
3.00 to 3.99	Very wet
2.00 to 2.99	Moderately wet
1.00 to 1.99	Slightly wet
0.50 to 0.99	Incipient wet spell
0.49 to -0.49	Near normal
-0.50 to -0.99	Incipient dry spell
-1.00 to 1.99	Mild drought
-2.00 to -2.99	Moderate drought
-3.00 to 3.99	Severe drought
-4.00 to -6.00	Extreme drought

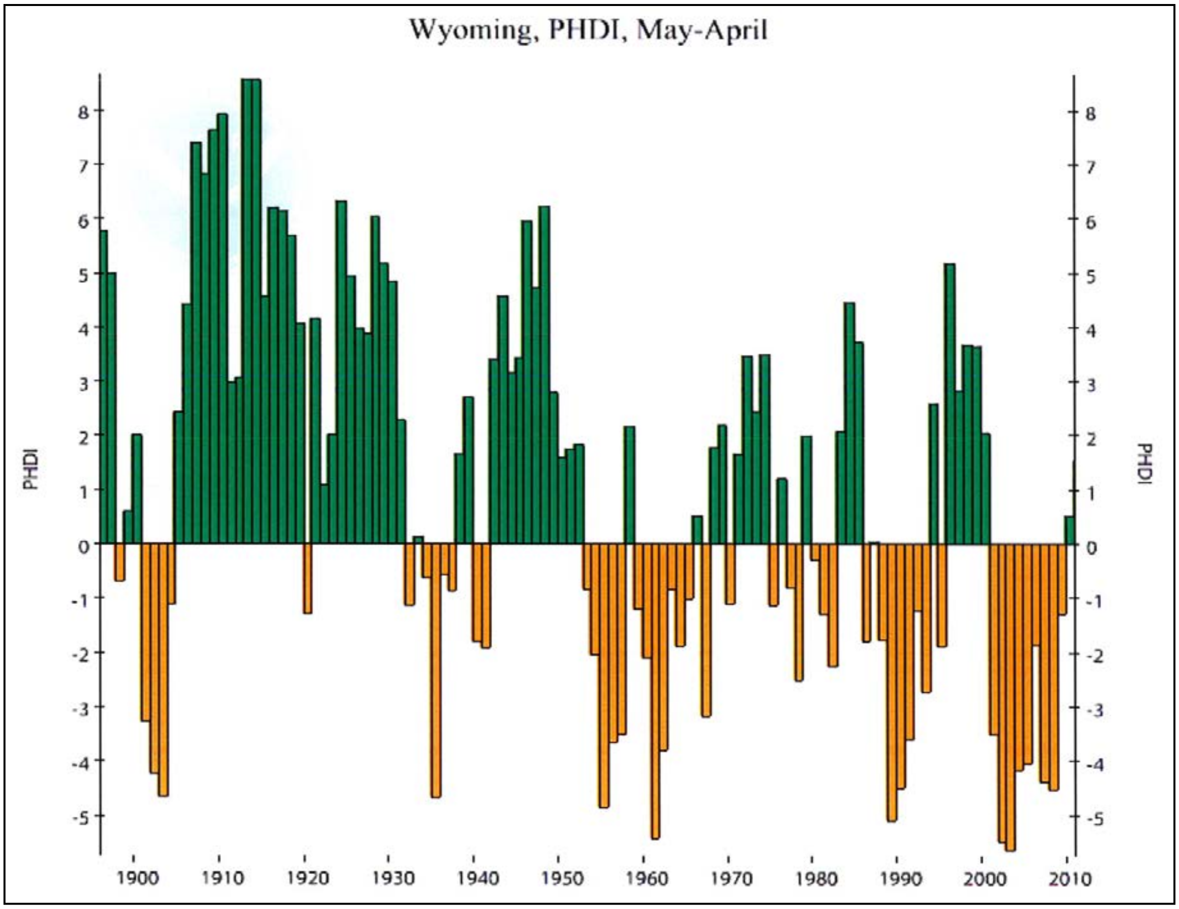


Figure 25. Palmer Hydrological Drought Index (PHDI) 1896-2011

The initial estimates are not considered as accurate as later updates. In Wyoming, the Palmer Index should be used with caution since much of surface water is derived from mountain snow pack and the PDSI does not use this as an input to the index. Additionally, the values selected for quantifying the intensity of drought and for determining a start and end of a drought were selected based on Palmer's study of central Iowa and western Kansas.

Another popular index used to determine drought is the Standardized Precipitation Index (SPI). This index measures the precipitation departure using the 1971 through 2000 average monthly totals. At this time the SPI is available for Wyoming, but there are concerns about the number of data points used to calculate the index as well as the accuracy of the data used. At this time the SPI is of limited use in Wyoming and should be used with caution.

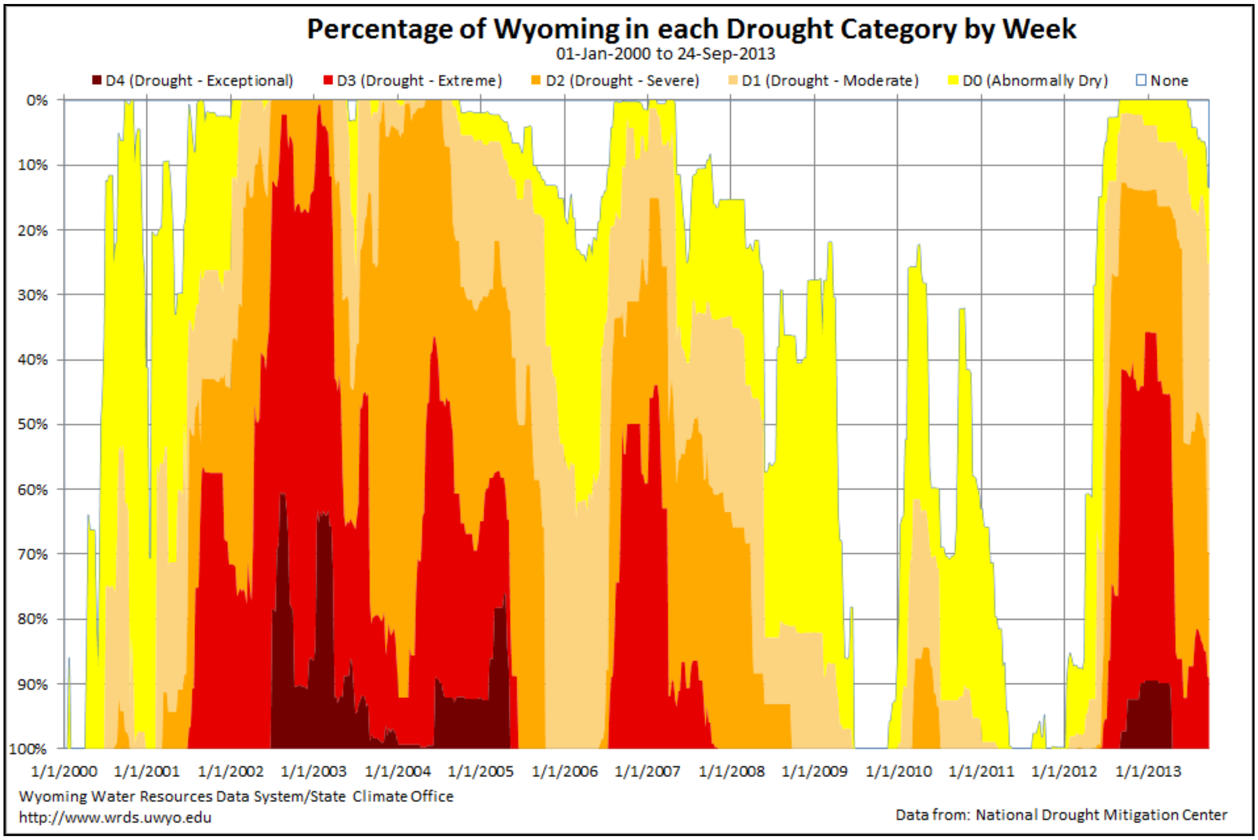


Figure 26. Percentage in Drought Category by Week[16]

The Surface Water Supply Index (SWSI) was developed to complement the Palmer Index. The objective of the SWSI is to incorporate both hydrological and climatological features into a single index, and is intended to be an indicator of surface water conditions where mountain snowpack is a major component.

Four inputs are required for the SWSI: snow pack, stream flow, precipitation, and reservoir storage. Because it is dependent on the season, the SWSI is computed with only snow pack, precipitation, and reservoir in the winter months; stream flow replaces snow pack in the equation during the summer months. Like the Palmer Index, the SWSI is centered on zero and ranges from +4.2 to - 4.2, as shown in **Table 23** and in the map following.

[16] http://www.wrds.uwyo.edu/sco/drought/droughttimeline.html (Accessed 10/1/2013)

Table 23. Surface Water Supply Index Classification System

Range	Scale
+3.0 to +4.0+	Extremely wet
+2.0 to +3.0	Moderately wet
+1.0 to +2.0	Slightly wet
-1.0 to +1.0	Near average
-2.0 to -1.0	Slightly dry
-3.0 to -2.0	Moderately dry
-3.0 to -4.0-	Extremely dry

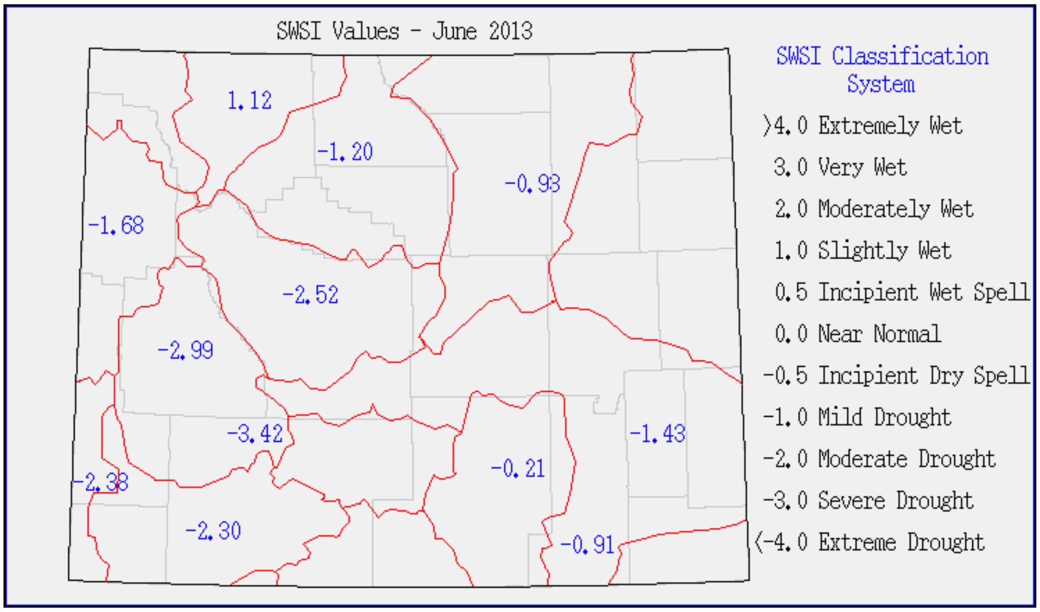


Figure 27. Wyoming Surface Water Supply Index June 2013[17]

The Surface Water Supply Index (SWSI) is computed using only surface water supplies for the drainage. **(See Figures 27 and 28)**. The computation includes reservoir storage, if applicable, plus the forecast runoff. The index is purposely created to resemble the Palmer Drought Index, with normal conditions centered near zero. Adequate and excessive supply has a positive number and deficit water supply has a negative values. Soil moisture and forecast precipitation are not considered as such, but the forecast runoff may consider these values. When comparing **Figures 27 to 28,** it is obvious that one year can make a significant difference in surface water supply in Wyoming.

[17] http://www.wrds.uwyo.edu/wrds/nrcs/swsimap/swsimap.html (Accessed 8/29/2013

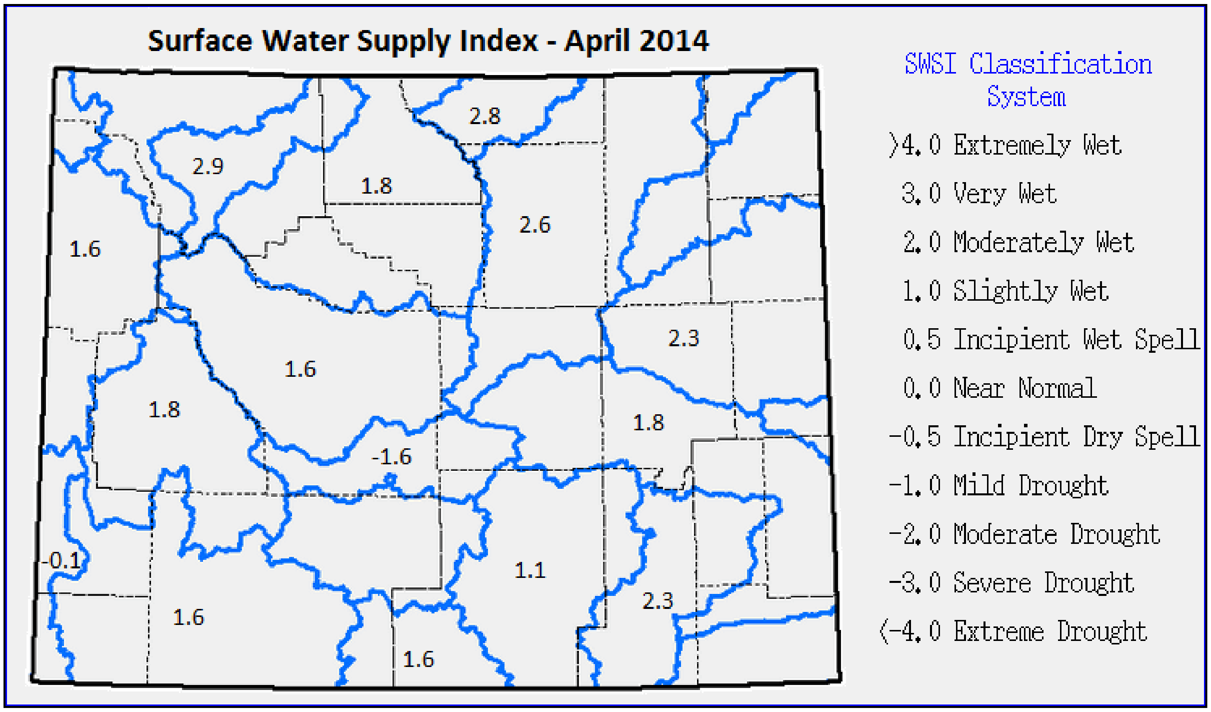


Figure 28. Wyoming Surface Water Supply Index April 2014[18]

Another index used to measure drought involves soil moisture. This is a highly complex element that is difficult to accurately determine because there are few weather stations that directly measure surface and subsurface moisture and because precipitation and soil type are highly variable over a given region. Additionally, accuracy of direct measurement deteriorates when the soil temperature is below freezing. However, remote sensing from satellites can indicate the health of vegetation by measures of greenness, which can be used to indirectly determine soil moisture.

The final ingredients for determining drought are past accumulation and the amount of precipitation forecasted. In Wyoming, the April and May precipitation is critical for adequate prairie grassland growth. If the rains are late, the summer heat will reduce or completely eliminate any yield. Since rangeland is not normally irrigated, the short-term, spring weather forecast must be accurate to ensure the most effective management of these lands. Farmers who depend on irrigation will know if drought can be expected if the April 1 snow pack is below normal and if the reservoirs are below 80 percent of their long term average levels. Percent of capacity of reservoirs is not a good standard to use because every reservoir's water level varies widely from one another throughout the year due to different management practices and environmental conditions. For example, water quality and endangered species protection requires

[18] http://www.wrds.uwyo.edu/wrds/nrcs/swsimap/swsimap.html (Accessed 4/16/2014)

managers to maintain minimum downstream outflow. There are also large inactive conservation reserves and dead water allocations in reservoirs that are part of total capacity but cannot be used in any way.

According to the Wyoming State Climate Office, Water Resources Data System Wyoming is the 5th driest state in the Union, and drought is a constant threat in our region. Since 1999, much of Wyoming has been gripped by moderate to severe drought. The intensity of this drought event has varied from year to year, and counties or regions within the state have experienced varying levels of drought impacts. However, this drought has been a significant event by any measure, and Wyoming will continue to feel its effects for years to come. Conditions have eased somewhat beginning in mid-2008, but a near decade with warm temperatures and relatively little precipitation has left us very vulnerable.[19]

Longtime residents indicate they remember streams drying up in the 1930s and 1950s. According to instrument records, there have been only seven multi-year (three years or longer) statewide droughts since 1895 (**Table 24**), although single wet years like 1957 (and probably 2005) have broken longer periods of drought (1952-1964 and 1999-present) into two separate events by this definition, making quantification of impacts difficult. Based on statewide average annual precipitation each of the drought periods is ranked as follows:

Table 24. Recent Worst Multi-Year Statewide Drought

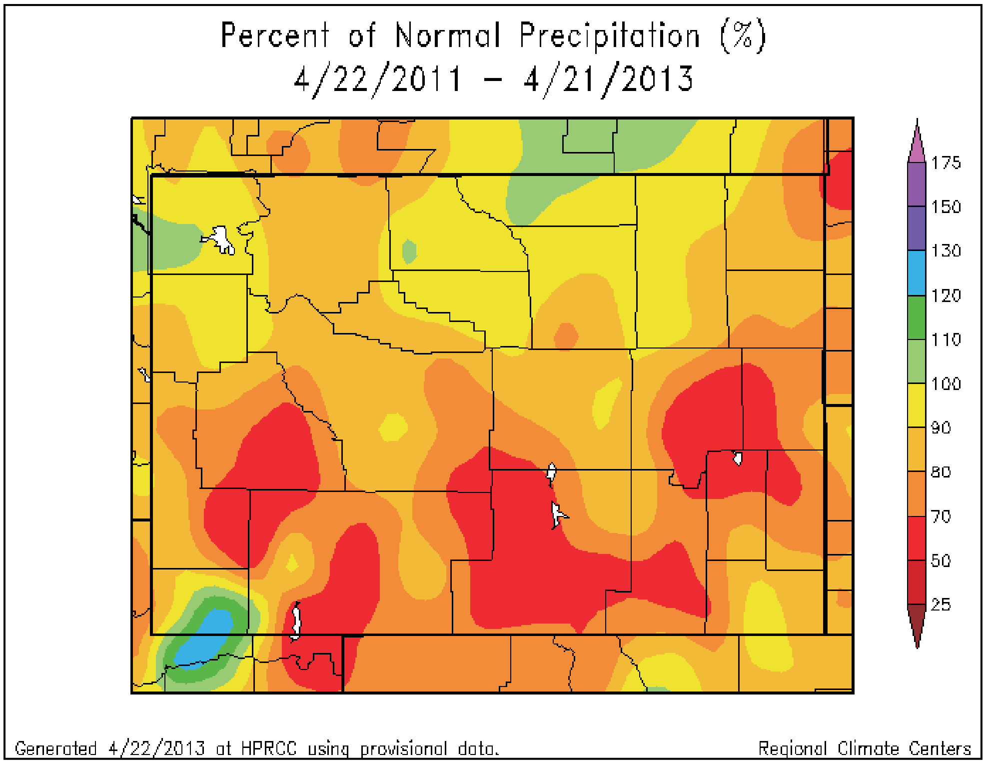
Drought Period	Average Annual Precipitation (Inches)	Percent of 1895-2006 Average Annual Precipitation (13.04")
1952-1956	10.65	81.69%
1900-1903	10.76	82.52%
1999-2004	11.07	84.89%
1987-1990	11.12	85.28%
1958-1964	11.67	89.49%
1974-1977	11.77	90.26%
1931-1936	11.79	90.41%

Widespread droughts in Wyoming, as determined from stream flow records, were most notable during three periods: 1929 to 1942, 1948 to 1962, and 1976 to 1982.

Two precipitation maps developed by the Wyoming Water Resources Data System[20] follow. The first map records the past 24 months' precipitation beginning in 2011 and compares them to normal levels. The

[19] http://www.wrds.uwyo.edu/sco/drought/drought.html (Accessed August 30, 2013)
[20] http://www.wrds.uwyo.edu

second map shows Wyoming received significantly less than normal moisture in the 12 months prior to April 2013.



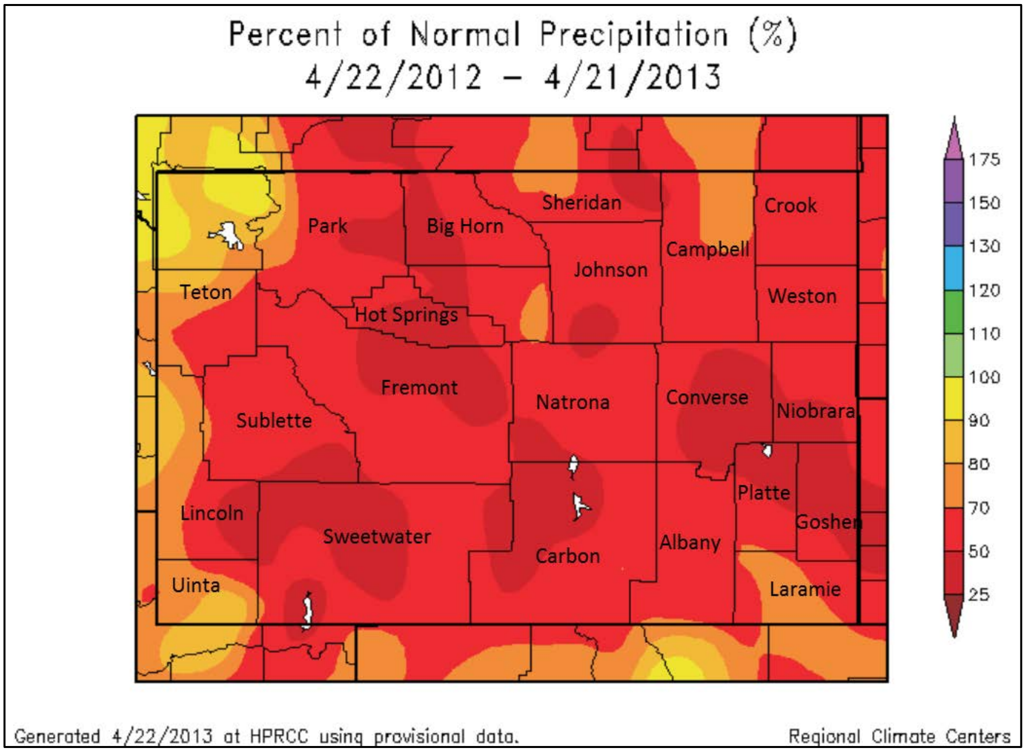


Figure 29. Percent of Normal Precipitation, 4/22/2011-4/21/2013

Pre-settlement Drought

Numerous studies from throughout the world demonstrate that instrumental weather records are insufficient for capturing the full range of climate that the people in any region should expect and plan for. This is particularly true for understanding extreme events like droughts. The length of these instrumental records rarely exceeds 100 years and, therefore, provides only a small sample of single- and multi-year drought events. Furthermore, instrumental records cannot effectively be used to examine long-term (>50-year) trends and cycles that may underlie year-to-year precipitation variability.

Most trees in the western U.S. produce a single layer of growth called a "tree-ring" for each year of their lives. During years of favorable climate, trees will produce wide rings compared to the narrower rings formed in years of unfavorable climate. Tree-rings, therefore, provide a means for developing long-duration climate records that can overcome most of the limitations inherent to instrumental observations. Tree-rings yield continuous, exact-dated proxies of climate that are highly replicated. When properly analyzed, tree-rings provide records of seasonal to annual climate, and can be used to assess climate variability on time scales of decades to millennia.

While tree-rings have commonly been used to reconstruct the climate of the southwestern U.S., the systematic use of these dendrochronological (literally the "science of tree time") techniques to understand Wyoming's climate is relatively new. One recent study from the Bighorn Basin shows the promise of such methods for understanding drought in Wyoming. In this study, wood samples were collected from 95 douglas fir, ponderosa pine, and limber pine trees at five sites in the Bighorn, Pryor, and Absaroka mountains (**Figure 30**). Samples from these trees were used to develop a record of annual precipitation spanning 1260 to 1998 A.D. Results from this study show that single-year dry events before the instrumental period (1895 to present) tended to be more severe than those after 1900 (**Figure 30**). In general, multi-year dry events were longer and more severe prior to 1900. Dry events in the late-13th to mid-18th centuries surpass both the magnitude and duration of any droughts seen in the Bighorn Basin after 1900. The 14th, 15th, and 16th centuries are also notable for large numbers of droughts having greater magnitude and duration than any events in the instrumental period.

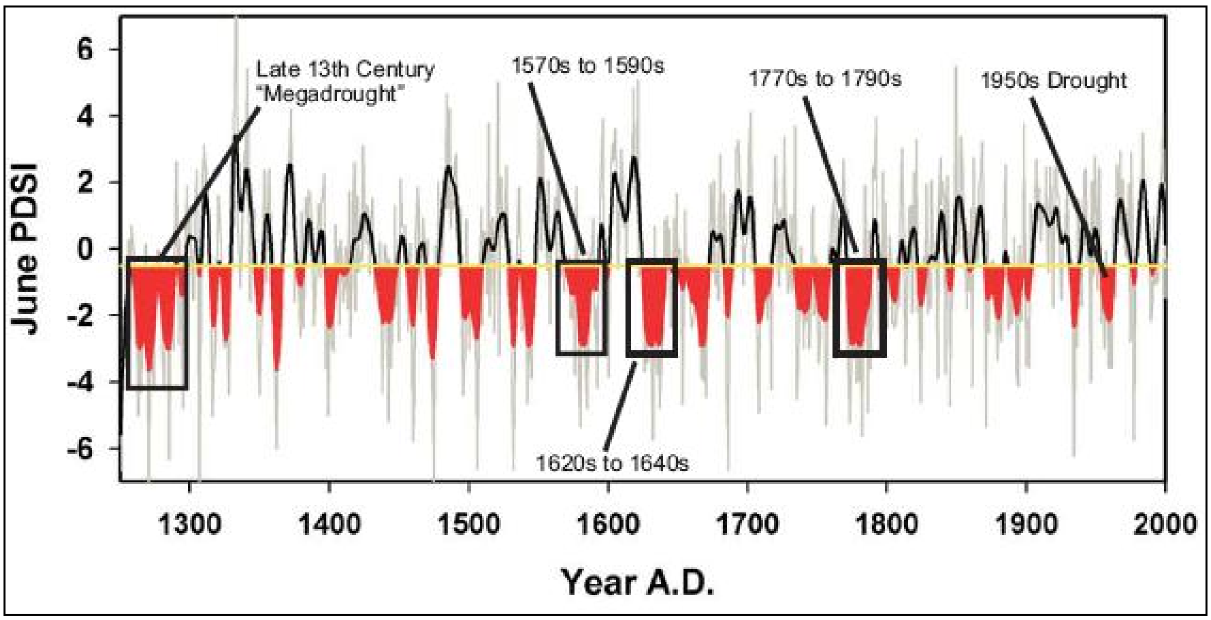


Figure 30. Reconstructed Annual Precipitation (in centimeters) for the Bighorn Basin Region

Annual values are shown in gray. The 10-year running average of precipitation is plotted against the long-term mean (yellow line) with multi-year droughts shown in red.

The 10-year running average of PDSI is plotted against the long term-mean (yellow line) with multi-year droughts shown in red.

Trees from the foothills of the northern Uinta Mountains and the southern Salt Range provide insights on drought variability in southwestern Wyoming. **Figure 31** shows reconstructed PDSI values for the Green River Basin region from 1250 to 2000 A.D. High PDSI values indicate wet conditions while negative values represent droughts. Estimates for PDSI values prior to the instrumental period (1895 to present) were derived from the measurement of limber pine and pinion pine tree-rings at four sites surrounding the basin. Samples from 102 trees (both living and dead) are included in the reconstruction.

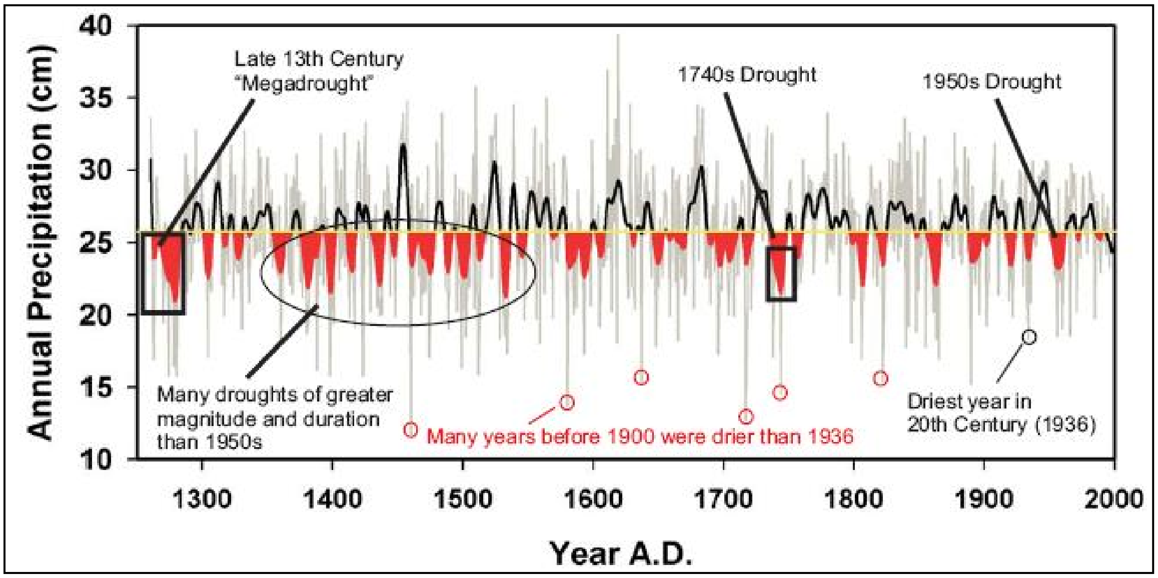


Figure 31. Reconstructed (June) PDSI values for the Green River Basin region.

While the 20th Century dry-events recorded in these trees were quite severe, several droughts prior to instrumental period (*e.g.*, 1576 to 1590, 1620 to 1637, and 1773 to 1786) likely equaled or exceeded their duration. A number of pre-instrumental droughts, particularly those in the 1500s through mid-1600s, were of greater magnitude or severity than any dry events after the early 1900s. The late-13th Century is particularly notable for the occurrence of a severe 50-year drought.

These and other tree-ring studies from throughout the region suggest that severe, long-duration (>10-year) droughts are a common feature of Wyoming's climate and the climate of the Rocky Mountain West at large. While the droughts of the 1930s and 1950s were extreme events in terms of their social and economic impacts on Wyoming, the tree-ring record shows that the climate system is capable of producing longer and stronger droughts. Moreover, in some areas (*i.e.*, southwest Wyoming), parts of the 20th Century were marked by wetter than average conditions. This means that predictions of future water availability based on stream gauge and instrumental weather observations during these years may be biased by abnormally high precipitation.

Overall, long dry spells are a normal part of life in Wyoming. This knowledge should, in turn, affect how we plan for Wyoming's economic and agricultural development. We must also incorporate this fact into our management of natural resources and include severe, sustained droughts in our plans for timber production, wildland and prescribed fires, non-native plant invasions, and water resources. Planning efforts should consider a wide range of climate scenarios, including droughts of different lengths, magnitudes, and intensities. Such scenarios may be derived from long-term proxies of climate variability such as those provided by tree-rings, but might also be obtained from model simulations of past and future climates. In any case, we must consider severe, sustained droughts to be an inevitable part of Wyoming's future.

Instrumentation Record

As a whole, Wyoming's precipitation record from 1895 to 2006 reveals that, for the first half of the 20th Century (except for the Dust Bowl years of the 1930s), there was generally a surplus of moisture. During the second half of the century there was a trend of increased periods of drought (**Figures 32 and 33**).

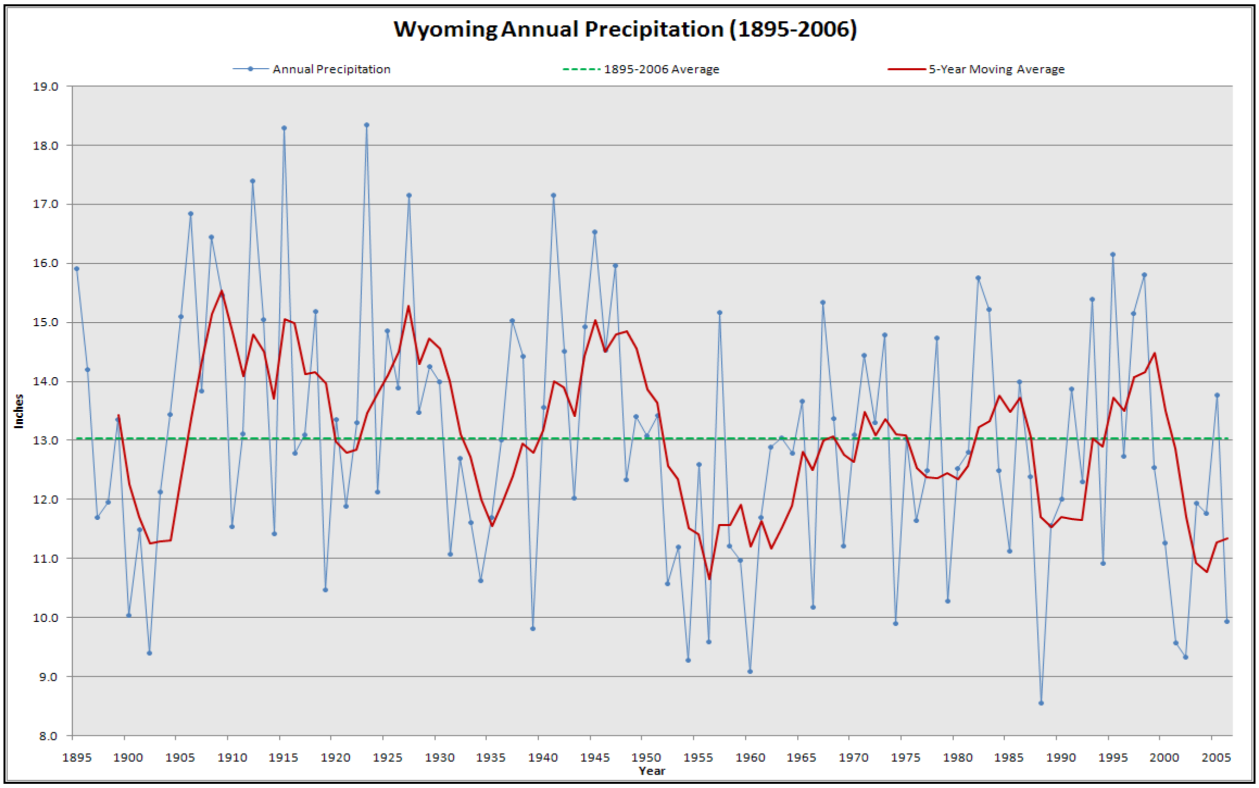


Figure 32. Wyoming Annual Precipitation (1895 through 2006)[21]

[21] National Climatic Data Center

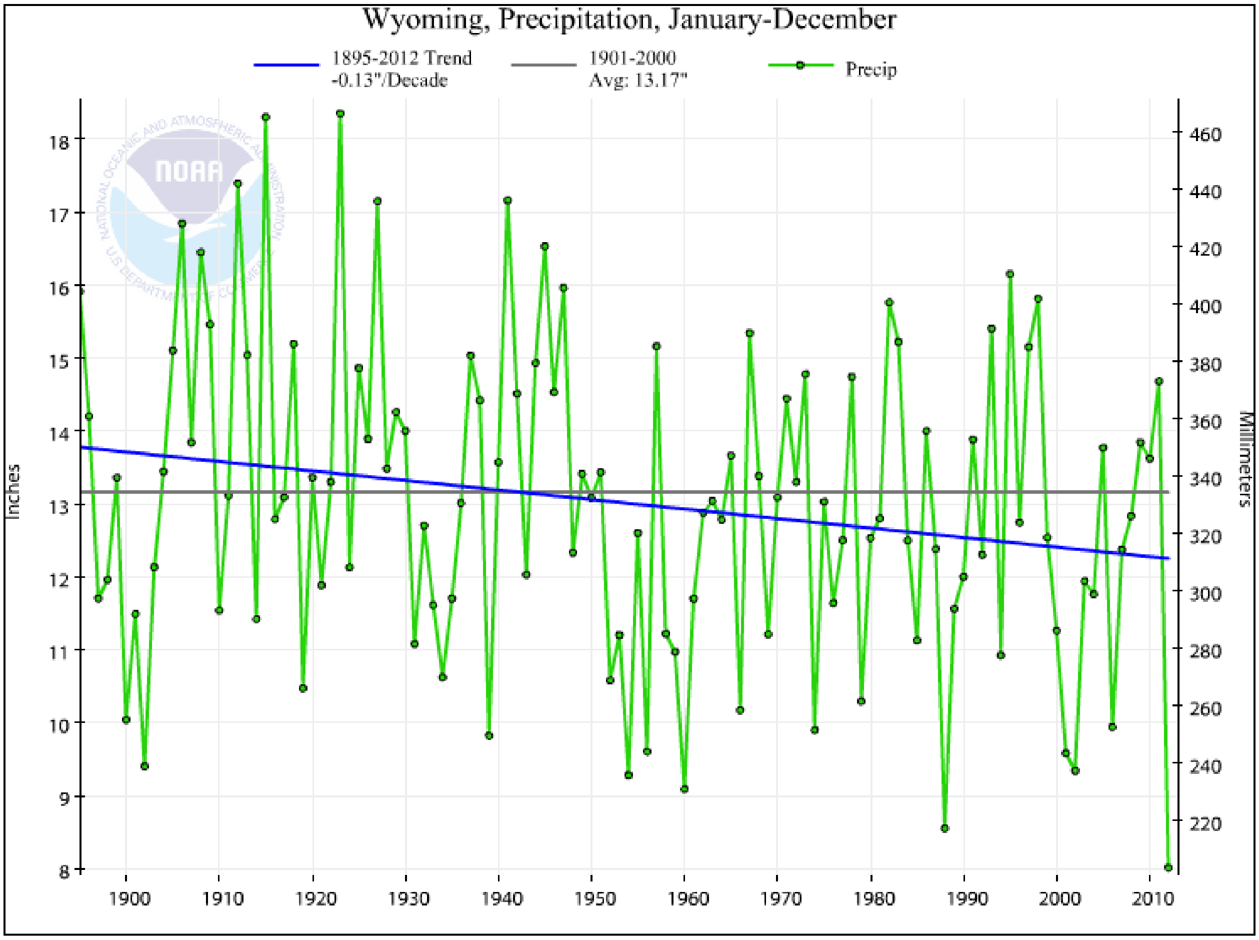


Figure 33. Wyoming Precipitation 1895 thru 2012[22]

Based upon **Figures 32** and **33**, the drought of 1999 to 2009 is as significant, if not more significant than any other drought in the last 100 years. The *Wyoming State Climate Office*, indicates that the most significant droughts in the last century, in terms of annual statewide precipitation averages, were in 1952 to 1956, 1900 to 1903, and 1999 to 2004. In order to determine which drought period had the most significant impact on Wyoming, crop production and livestock inventory data for the 1952 to 1956 and 1999 to 2004 periods were compared. 1957 and 2005 were wetter years, with annual statewide precipitation totals above the 1895-2006 average. Those two years were used as endpoints for the droughts that started in 1952 and 1999 respectively. In both cases, the following years saw a return to

[22] http://www.ncdc.noaa.gov/cag/time-series/us (Accessed 8/30/2013)

drier conditions. Because of this, for the most recent drought impacts were also calculated for 2005 and 2006, and are included in summary tables.

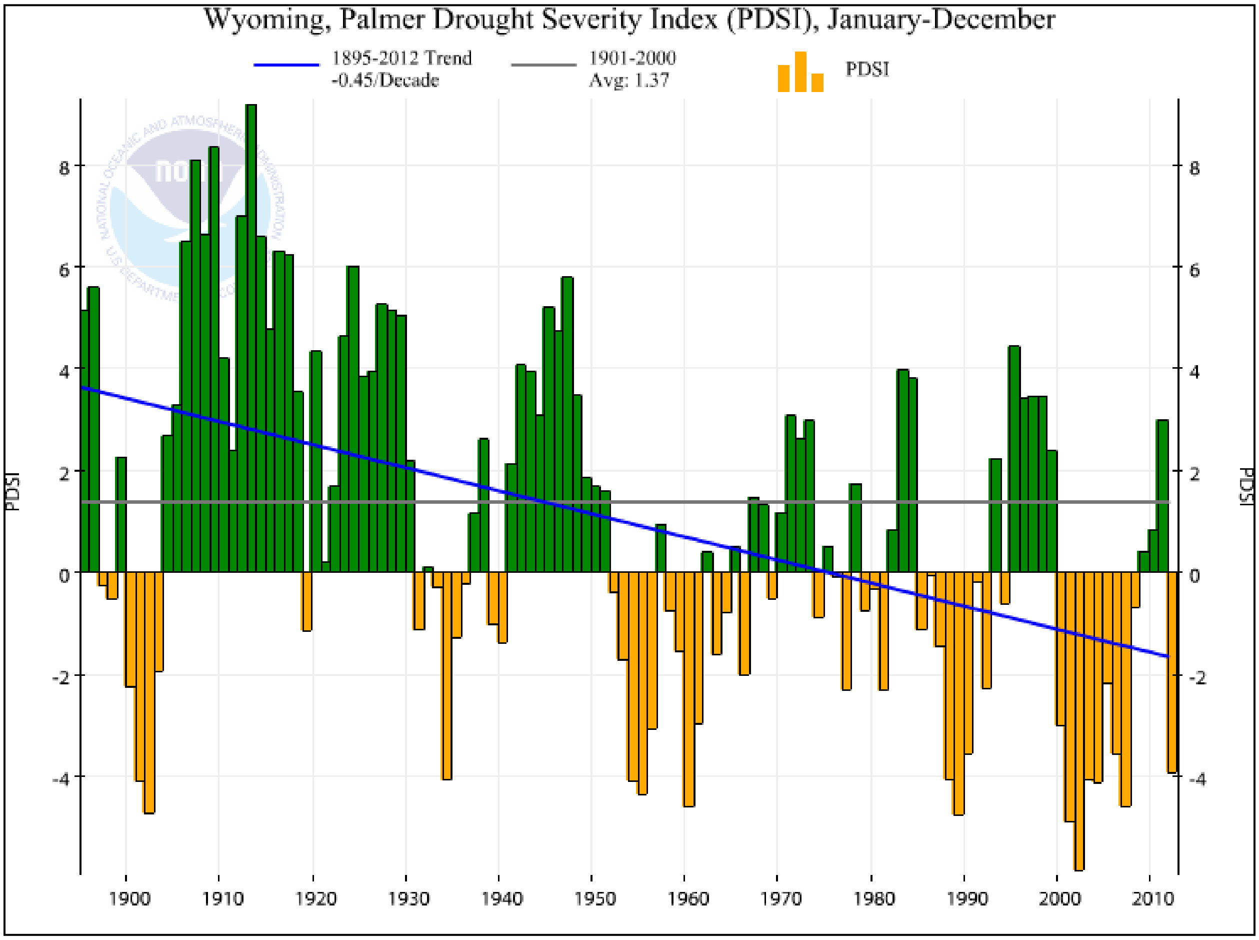


Figure 34. Palmer Drought Severity Index 1985 through 2013[23]

Since the last update to the plan, precipitation improved briefly (**Figure 34**). The improvement in precipitation was immediately reflected in the value of Wyoming's crop and livestock production (bar graph below).

[23] http://www.ncdc.noaa.gov/cag (Accessed 8/30/2013)

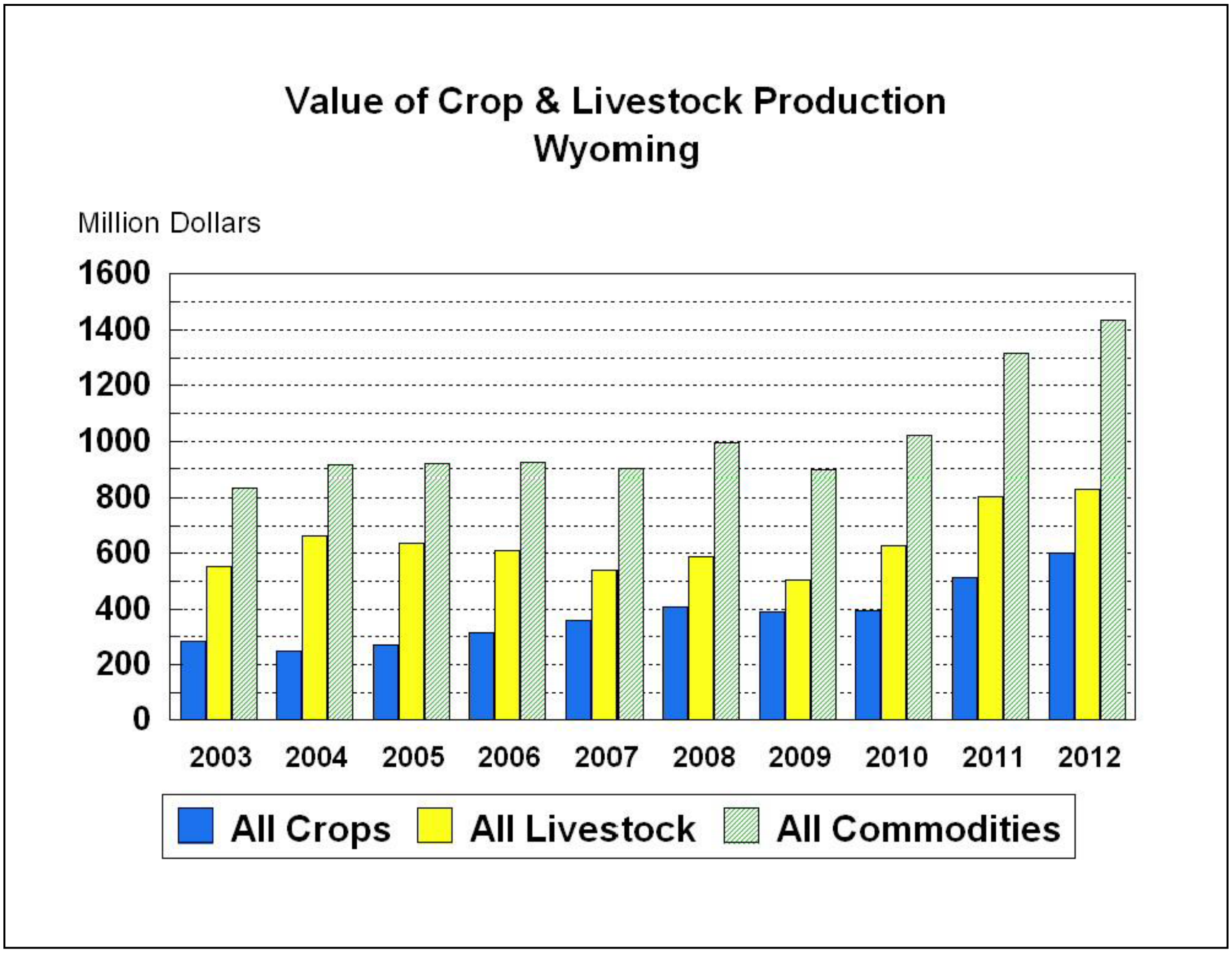


Figure 35. Crop and Livestock Value[24]

Probability

Likely = 3
50 Drought Years Reported ÷ 117 years = 43 % annual probability of drought

[24] http://www.nass.usda.gov/Statistics_by_State/Wyoming/Publications/Farm_Numbers_and_Economic_Data/bull-29.pdf (Accessed August 30, 2013)

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. The map below shows these rankings by county to demonstrate local perception of risk across the state.

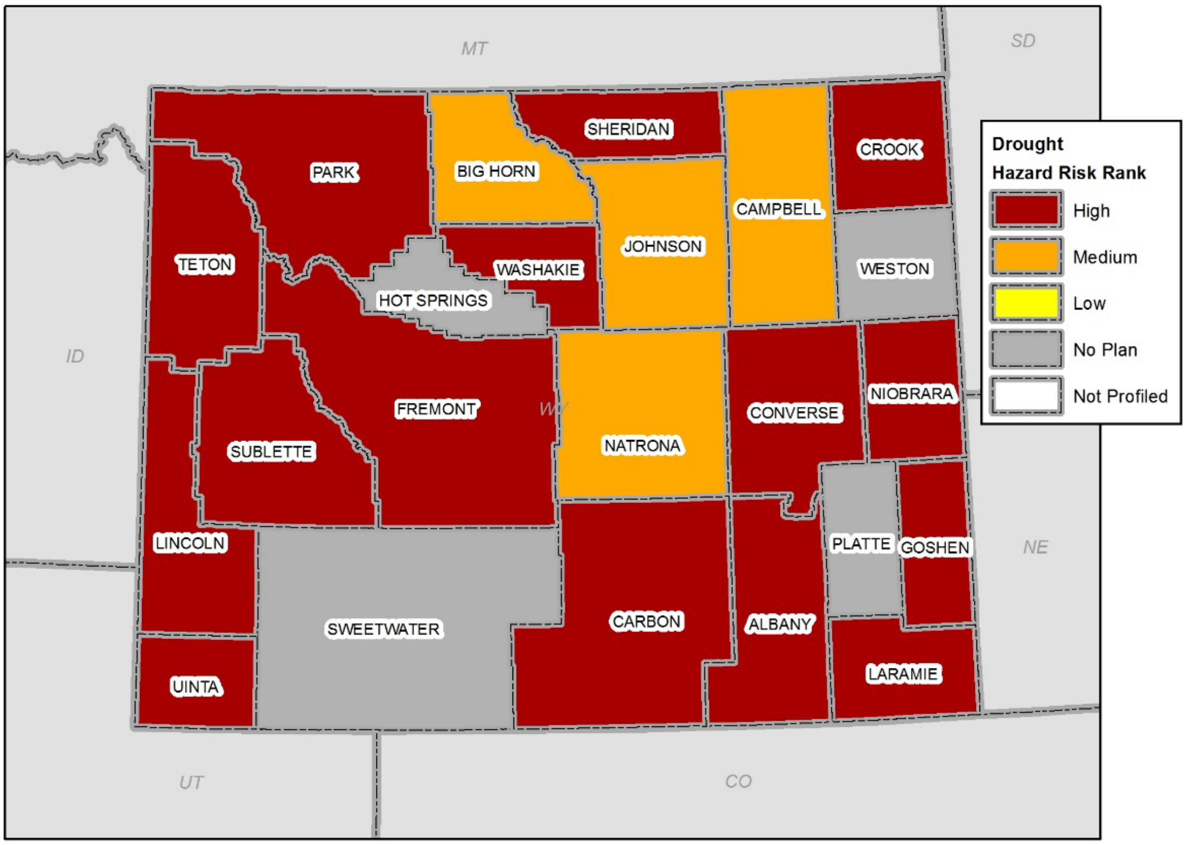


Figure 36. Drought Risk Rankings from Local Hazard Mitigation Plan Risk Assessments

Most of Wyoming's local multi-hazard mitigation plans reflect much of the information contained in the state plan. It can be noted those counties with a greater agricultural economic base have a greater recognition of the economic impact drought has on their communities.

All but four counties consider drought to rank as a 'high' hazard within their borders in local risk assessments.

Statewide Risk Assessment

According to Percent of Normal Precipitation map shown above, the 12 months from April 2012 to 2013 Wyoming received significantly less than normal moisture. Moisture precipitation levels during this recent drought were over 25 percent lower than normal over significant areas of Big Horn, Hot Springs, Fremont, Sweetwater, Carbon, Converse, Niobrara, Platte, and Goshen Counties.

The Wyoming Surface Water Supply Index of April 2014 above shows driest conditions in southern Fremont County.

Changes in Development

Of the most vulnerable counties to drought, as described above, the County with the highest rate of projected growth is Converse County. The City of Douglas is within the lowest moisture precipitation zone, compared to normal, in the 2012/2013 drought. It has the highest population of jurisdictions in the County with a projected increase of 24.8 percent between 2010 and 2030.

State Facilities at Risk

Drought risk is significant across the state. State facilities may be most threatened where precipitation has been lowest; this includes 97 in Big Horn, 52 in Hot Springs, 624 in Fremont, 99 in Sweetwater, 218 in Carbon, 143 in Converse, 33 in Niobrara, 371 in Platte, and 103 in Goshen Counties.

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 25. Drought Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	2.7	*Moderate*
Drought	3.0	1.7	3.6	1.4	3.8		

Earthquake

Description

The American Heritage Dictionary defines an earthquake as "a sudden movement of the earth's crust caused by the release of stress accumulated along geologic faults or by volcanic activity.[25]" The most common types of earthquakes are caused by movements along faults and by volcanic forces, although they can also result from explosions, cavern collapse, and other minor causes not related to slowly accumulated strains.

Earthquakes are common in Wyoming and are likely to continue to occur in Wyoming in the future. Official earthquake records have been kept for only the past 140 years. In that time some 47,000 earthquakes have been recorded in Wyoming. Only a small percentage of those have been felt by people. Historically, earthquakes have occurred in every county in Wyoming (**Figure 42** shows those 5.0 magnitude or greater). Most Wyoming earthquakes occur in the western third of the state.

The first reported earthquake occurred in Yellowstone National Park in July of 1871 (Case and Green, 2000). The first earthquake known to originate in Wyoming occurred on June 25, 1894, near Casper. The 1894 earthquake near Casper caused dishes to fall to the floor and a number of people were thrown from their beds.[26] The largest earthquake recorded to date in Wyoming happened on August 18th, 1959 in Yellowstone National Park. It registered as a magnitude 6.5 temblor and is considered to be an aftershock of the Ms 7.5 Hegben Lake, Montana Earthquake (Stover, 1993). Yellowstone National Park is one of the more seismically active areas in the United States, and the vast majority of earthquakes in Wyoming occur there.

Earthquakes have many attributes, with magnitudes and intensities being the most common. Magnitudes are instrumentally determined measures of the amount of energy released during an earthquake. Each step increase in magnitude is roughly equivalent to a release of 32 times more energy. Intensities are a subjective measure of how an earthquake was felt. As a result, an earthquake with a single magnitude can have variable intensity associated with it, depending on the distance an observer is from the earthquake source and the response of surficial features. An abbreviated intensity scale is presented in **Table 26**.

Table 26. Abridged Modified Mercalli Intensity Scale

Intensity	Intensity description
I	Not felt except by a very few under especially favorable circumstances.
II	Felt only by a few persons at rest on upper floors of buildings. Delicately suspended objects may swing.
III	Felt noticeably indoors, especially on upper floors. Standing automobiles rock slightly.

[25] http://www.thefreedictionary.com/earthquake (Accessed 10/25/2013)
[26] http://earthquake.usgs.gov/earthquakes/states/wyoming/history.php (Accessed 10/8/2013)

Intensity	Intensity description
	Vibration like passing truck.
IV	During the day felt indoors by many, outdoors by few. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing automobiles rocked noticeably.
V	Felt by nearly everyone, many awakened. Some dishes and windows broken; cracked plaster in a few places; unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster and damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage minor in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built structures; some chimneys broken. Noticed by persons driving cars.
VIII	Damage slight in specially designed structures; considerable in ordinary buildings with partial collapse; great in poorly built structures. Chimneys and walls fall. Heavy furniture overturned. Well water changes. Persons driving cars disturbed.
IX	Damage considerable in specially designed structures; frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud.
XI	Few (masonry) structures remain. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII	Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown into the air.

Minor structural damage or damage to objects on walls or shelves does not typically occur until intensity V is reached. It is more difficult to determine at what magnitude damage may occur, as the orientation of a fault plane, the depth of the rupture on the fault, the bedrock, and surficial sediments all affect the transmission and attenuation of seismic waves.

Wyoming's Earthquake Sources

Most Wyoming earthquakes outside of Yellowstone National Park occur as a result of movement on faults. If the fault has moved within the Quaternary Period, or last 1.6 million years, the fault is considered to have a greater potential to be the source of future large earthquakes (Machette, 2004). Quaternary faults that show movement over the past 10,000 years are considered to be "active." Of the approximately 80 Quaternary faults in Wyoming (**Figure 37**), 26 are considered to be "active." The best known "active" fault in Wyoming is the Teton fault near Jackson.

Active faults can be exposed at the surface (**Figure 37**) or deeply buried with no significant surface expression. Historically, no Wyoming earthquakes have been associated with exposed active faults. In general, the exposed active faults, however, have the potential to generate the largest earthquakes. As a result it is important to understand both exposed and buried active faults in order to generate a realistic seismological characterization of the state.

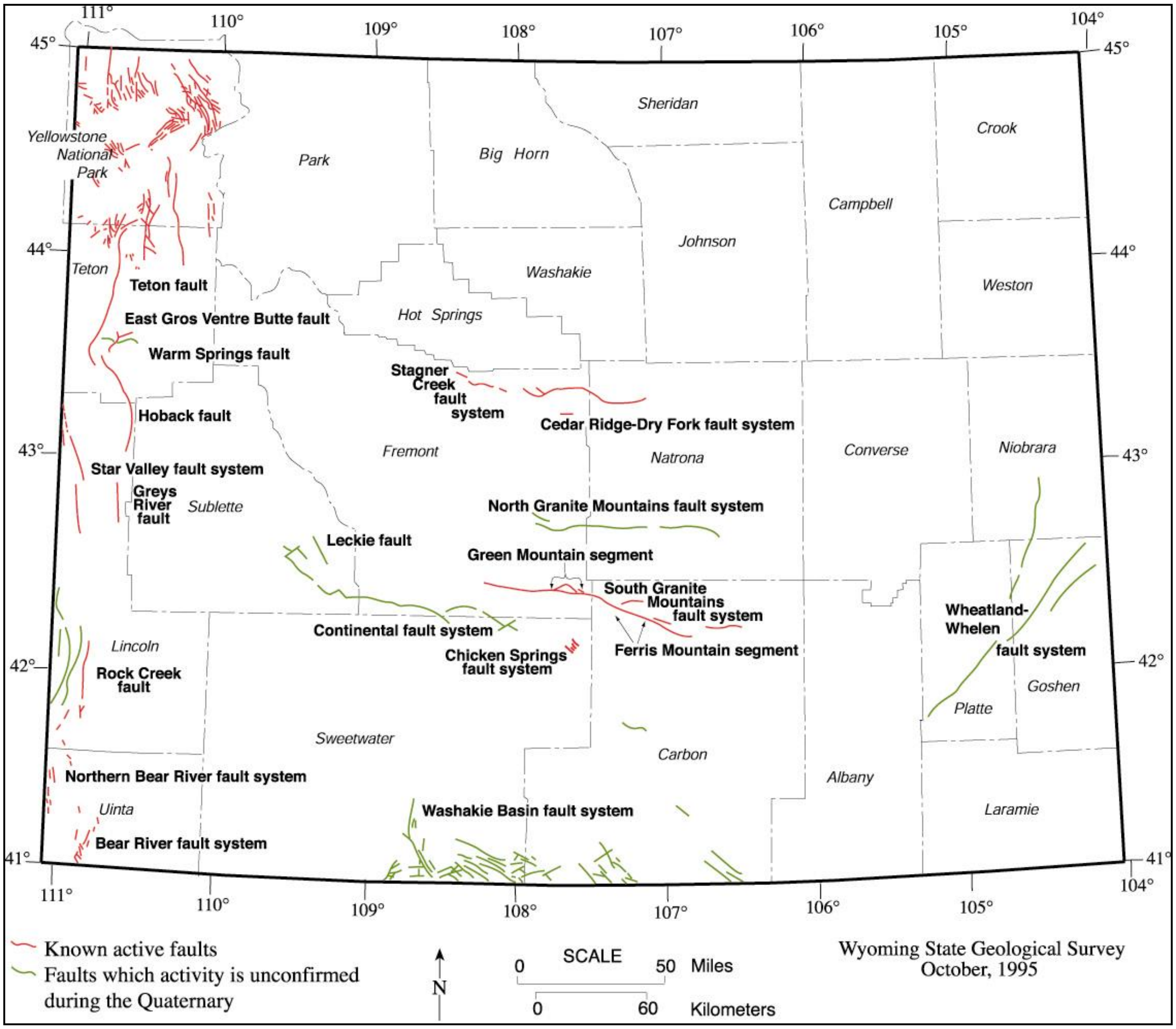


Figure 37. Exposed Known or Suspected Active Faults in Wyoming

Many of the exposed active faults, including the Teton fault, Star Valley fault, Greys River fault, Rock Creek fault, and the Bear River fault system in western Wyoming are capable of generating magnitude 7.0 to 7.5 earthquakes, and are considered to be overdue for reactivation.

In central Wyoming, the Stagner Creek fault system near Boysen Reservoir and the South Granite Mountain fault system near Jeffrey City, are both capable of generating magnitude 6.5 to 6.75 earthquakes. The Cedar Ridge-Dry Fork fault system near Lysite has limited evidence indicating it may be active, and may be capable of a magnitude 6.7 to 7.1 earthquake. The Chicken Springs fault system near Bairoil is capable of generating magnitude 6.5 to 6.7 earthquakes.

Historically, Wyoming's earthquakes are tied to faults that are buried. Buried faults that have never broken the surface, are generally considered to be capable of generating up to magnitude 6.5 earthquakes. Since the distribution of the buried faults is not well known, it is assumed that earthquakes up to magnitude 6.5 can occur anywhere in the state. The probability of such an earthquake is lowest in the southeast and northeast corners of the state, although a magnitude 6.2 to 6.6 earthquake did occur in 1882 between Laramie and Estes Park, Colorado.

One of the primary tools used in modeling the effects of earthquakes on regions or states are probabilistic acceleration maps generated by the U.S. Geological Survey (USGS). The USGS publishes probabilistic acceleration maps for 500-, 1000-, and 2500-year time frames. The maps show what accelerations may be met or exceeded in those time frames by expressing the probability that the accelerations will be met or exceeded in a shorter time frame. For example, a 10 percent probability that acceleration may be met or exceeded in 50 years is roughly equivalent to a 100 percent probability of exceedance in 500 years. This example is similar in principle to a 500 year flood.

The USGS recently generated new probabilistic acceleration maps for Wyoming. The maps are for 500-year (10 percent probability of exceedance in 50 years), 1000-year (5 percent probability of exceedance in 50 years), and 2500-year (2 percent probability of exceedance in 50 years) periods. Until recently, the 500-year map was often used for planning purposes for average structures, and was the basis of the most current Uniform Building Code. The International Building Code uses a 2500-year map as the basis for building design. The 2500-year map was updated in 2008 and is shown in **Figure 38**. The 2500-year map below reflects current perceptions on seismicity in Wyoming. The USGS is updating seismic hazard maps for the conterminous U.S. which are expected to be released in early 2014. In many areas of Wyoming, ground accelerations shown on the USGS maps may be increased due to local soil composition. For example, if fairly soft, saturated sediments are present at the surface, and seismic waves are passed through them, surface ground accelerations will usually be greater than would be experienced if only bedrock was present. In this case, the ground accelerations shown on the USGS maps would underestimate the local hazard, as they are based upon accelerations that would be expected if firm soil or rock were present at the surface. Intensity values can be found in **Table 26**.

A comparison between the 2500-year probabilistic acceleration map (**Figure 38**) and the intensity chart (**Table 26**) indicates the largest intensity earthquake expected in Wyoming could be Intensity IX. The Jackson area, Star Valley and parts of Uinta County could experience an Intensity VIII to IX earthquake. Portions of central Wyoming could have earthquakes with intensities as great as VII.

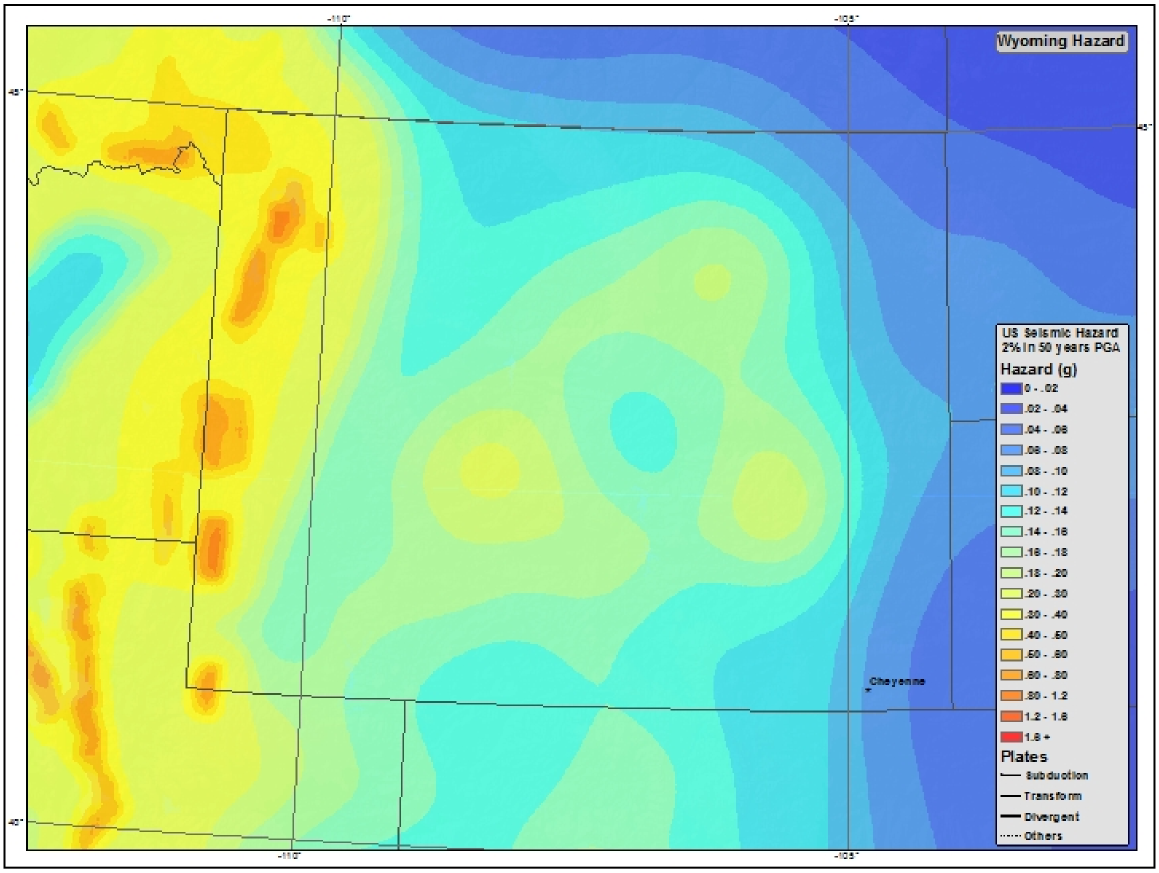


Figure 38. 2500-Year Probabilistic Acceleration Map of Wyoming[27]

Liquefaction

Liquefaction, in laymen's terms, is when wet soil behaves like a liquid during the shaking caused by an earthquake. A more scientific explanation of liquefaction would be: An event which occurs when water-saturated materials are exposed to seismic waves. Seismic waves may compact the material (i.e. silts and sands), increasing the interior pore water pressure within the material mass. When the pore pressure rises to about the pressure of the weight of the overlying materials, liquefaction occurs. If the liquefaction occurs near the surface, the soil bearing strength for buildings, roads, and other structures may be lost. Buildings can tip on their side, or in some cases sink. Roads can shift and become unstable to drive on. If the liquefied zone is buried beneath more competent material, cracks may form in the overlying material, and the water and sand from the liquefied zone can eject through the cracks as slurry.

[27] http://earthquake.usgs.gov/earthquakes/states/wyoming/hazards.php (Accessed 10/14/2013)

There have been few documented cases of liquefaction in Wyoming, in part due to the abundance of coarse-grained sediments in the alluvial deposits. The most notable event was during the 1959 Hebgen Lake.

Figure 39. Effect of Liquefaction in Christchurch New Zealand, February 2011 Earthquake[28]

Earthquake (magnitude 7.5) in the West Yellowstone area. Fissures opened in many fields through which water and sand were ejected. Evidence of liquefaction appears in the Teton Mountain area (Dean Ostenaa, U.S. Bureau of Reclamation, personal communication, 1986). **Figure 40** shows areas in Wyoming that could experience liquefaction during an intense earthquake. Areas shown have sands and coarse silts that are less than 10,000 years in age and are within 30 feet of the surface. Portions of the Bear River Valley, Star Valley, Snake River Valley, Yellowstone National Park, Yellowstone River Valley, and the New Fork River Valley, as well as portions along the Wind and Bighorn rivers, have the necessary components to experience liquefaction.

[28] http://en.wikipedia.org/wiki/Soil_liquefaction (Accessed 2/28/2014)

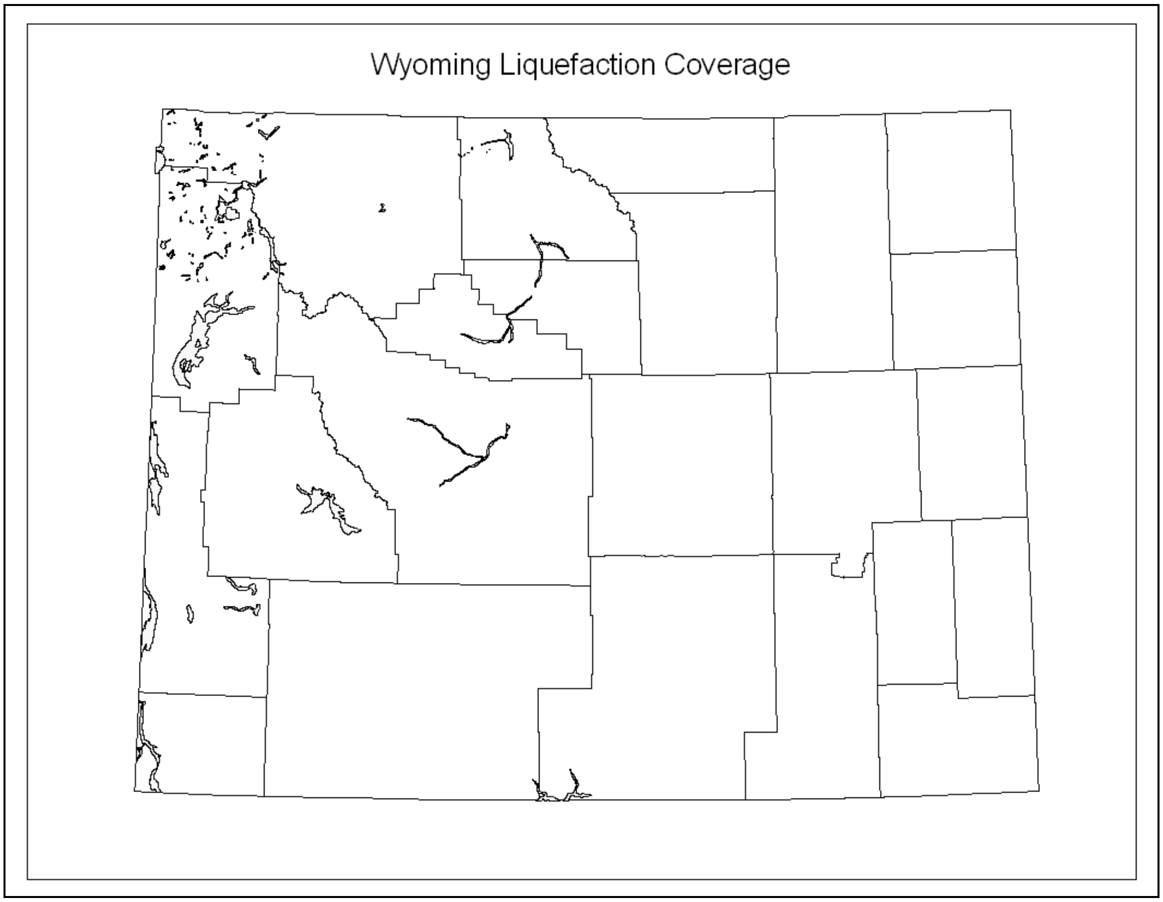


Figure 40. Potential Liquefaction Areas in Wyoming

There has been little, if any, reported damage from liquefaction in Wyoming. No damage was reported from the Hebgen Lake earthquake due to the remote location of both the earthquake and the resulting liquefaction.

A large earthquake could possibly create a significant amount of liquefaction-related damage to property in western Wyoming. As part of the plan update process in 2008 the WSGS calculated the exposure value for buildings which may occur within areas prone to liquefaction. Liquefaction prone areas were digitized and the liquefaction prone areas layer was digitally crossed with census block building values. In some cases, a liquefaction prone area boundary dissected a census block. In that case, the proportional value of the buildings in the census block was assigned to the liquefaction prone area. If a census block was within a liquefaction prone area, then the values of all the buildings in the census block are assigned. The values derived by county are shown in **Figure 41**.

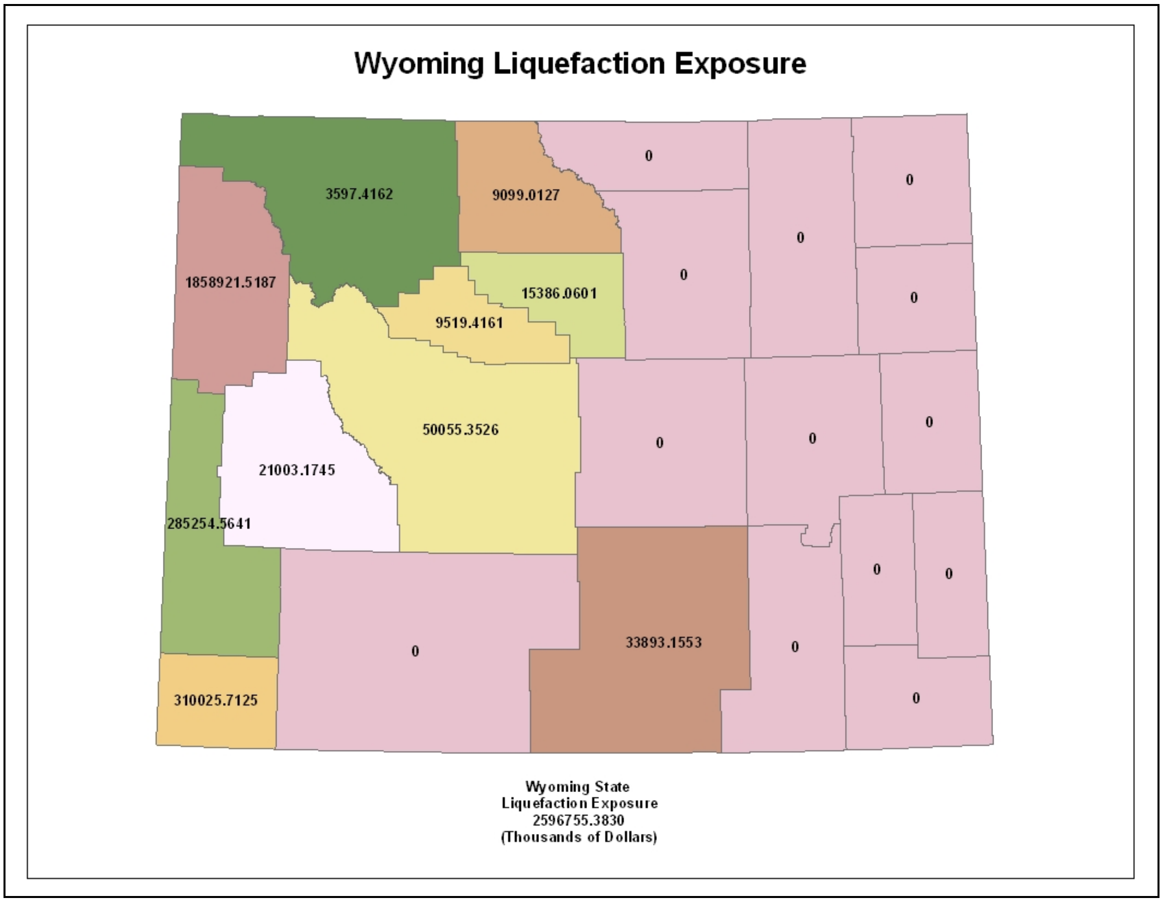


Figure 41. Liquefaction Exposure

History and Probability of Future Events

Earthquakes in Wyoming have also been associated with mine-related activities. In the early to mid-1900s, there were seismic events associated with coal mines beneath Rock Springs and Reliance in Sweetwater County. In many cases there was uncertainty as to whether a mine collapse generated a seismic event or whether an earthquake caused a mine collapse. In 1995, the collapse of a part of the Solvay trona mine near Green River generated a magnitude 5.3 earthquake. There have been numerous other mine-related events in Sweetwater County that have generated small earthquakes.

A dynamic magma chamber beneath Yellowstone National Park, combined with regional tectonic forces, results in significant seismic activity. Many of the earthquakes are associated with movement of hydrothermal fluids in the subsurface. Some deeper earthquakes may be related to fluids within or around the magma chamber. Earthquakes which may be related to active faults also occur in the park. Yellowstone is a super-volcano, and it has explosively erupted 0.64 million, 1.3 million, and 2.1 million years ago. The explosive eruptions led to the formation of three giant calderas, the collapse of which led to the formation of faults. In addition, after major eruptions, resurgent domes formed within the calderas. The doming process led to the formation of other faults. As a result, many of the faults in Yellowstone are not considered major threats. There are other faults, however, that are easily capable of generating magnitude 6.5+ earthquakes.

The August 17,1959 Hebgen Lake-Red Canyon earthquake sequence, (magnitude 7.5, intensity X) occurred just west of Yellowstone National Park, near Hebgen Lake, Montana and was the largest earthquake in the U.S. intermountain region in historic time.. That earthquake is a model for the type of earthquakes that can occur in western Wyoming. Even though Wyoming has not experienced a magnitude 7.5 earthquake within its borders in the last 140 years, the potential does exist.

Wyoming has experienced two significant earthquake swarms in Yellowstone Park in recent years. The first occurred between December 2008 and January 2009. The second earthquake swarm began on January 15, 2010, diminished to near-background levels by the end of February, 2010 and picked up somewhat in early April, 2010. These earthquakes were not significant in terms of damage or magnitude, but were noted because of their frequency in a short period of time. Smaller earthquake swarms occur in Yellowstone Park relatively frequently and are not necessarily signs of an imminent eruption or major earthquake. The most recent significant earthquake since the last plan update occurred in Fremont County September 21, 2013. The epicenter of the M4.9 earthquake was nine miles west of Ft. Washakie, Wyoming. The USGS event 'Did You Feel It?' web page shows 217 people went on line to say they felt the quake, with a maximum intensity IV reported.

A detailed description of Wyoming's seismological characterizations by county can be found through the Wyoming Water Resources Data System website.[29] The earthquake history of Wyoming is only 140 years, with earthquakes recorded only beginning in 1882. Within the 130-year record, there are gaps for the late 19th Century and first half of the 20th Century. After the Hebgen Lake earthquake in 1959, however, monitoring in Wyoming started to improve. Prior to the 1950s, most earthquakes were detected and located by personal reports. Since the 1950s, earthquakes are more commonly located by seismometers.

Every county in Wyoming has experienced an earthquake. Those of magnitude 5.0 or greater are reflected on **Figure 42**.

[29] http://www.wrds.uwyo.edu/wrds/wsgs/hazards/quakes/seischar/seischar.html (Confirmed 10/8/2013)

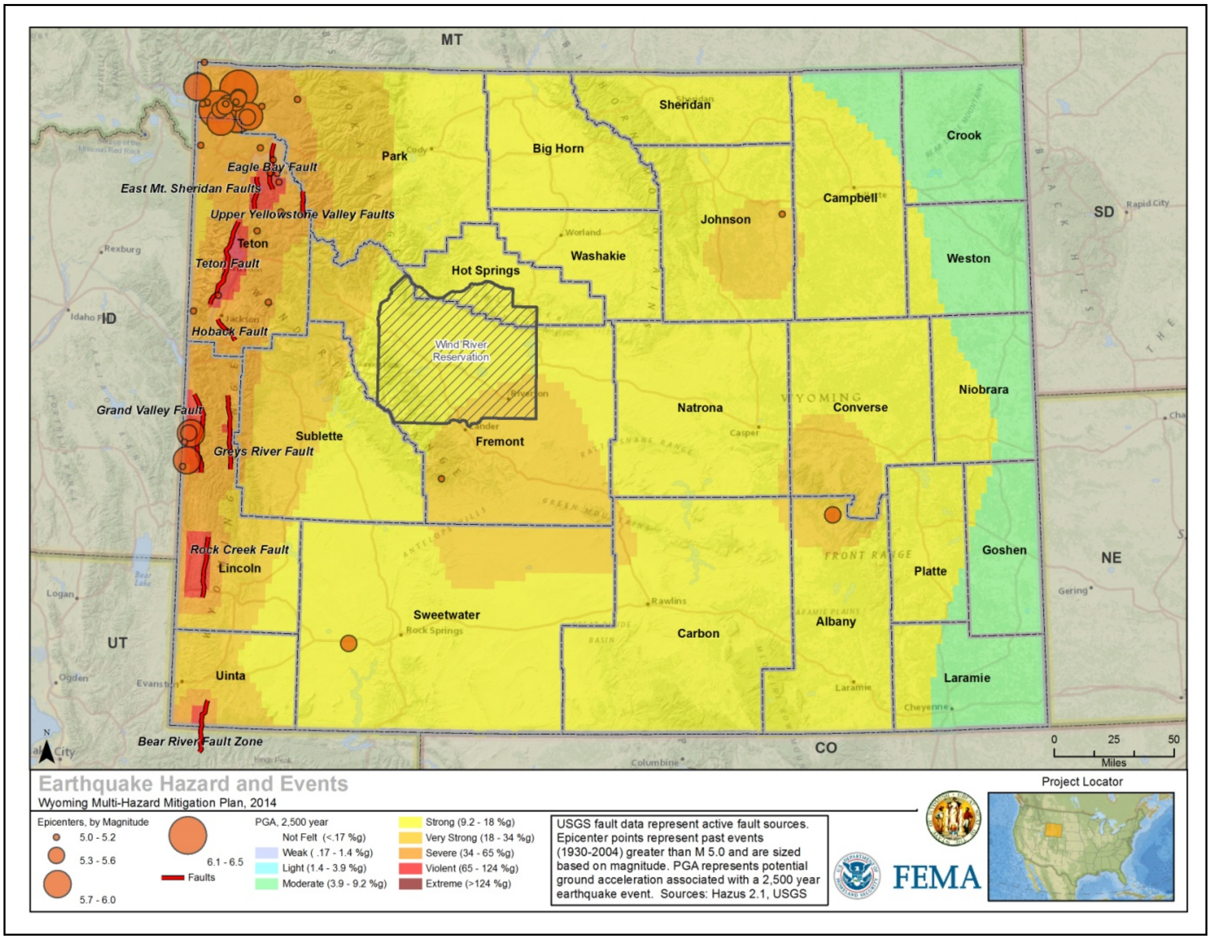


Figure 42. Wyoming Seismicity 1930 – 2004, Magnitude 5.0 and Greater

An attenuated seismic history of Wyoming, including earthquakes with intensities of V or greater, magnitudes of 5.0 or greater, or earthquakes with smaller assigned intensities or magnitudes that did cause some type of damage is presented in **Appendix I**.

The earthquake history referenced above does not give a complete picture of the earthquake potential in Wyoming. As mentioned previously, the history incorporates only 140 years, and cannot reflect all possible earthquakes or earthquake sources in Wyoming. The exposed active faults mentioned above have all been modeled to determine what effects they may have on the areas around them if they reactivate. A detailed analysis of the potential effects of the faults can be obtained through the Wyoming Water Resources Data System website.[30]

[30] http://www.wrds.uwyo.edu/wrds/wsgs/hazards/quakes/seischar/seischar.html (Confirmed 10/16/2013)

Probability

Likely = Value 3
91 earthquakes ÷ 131 years = 1 earthquake (Magnitude 5 or greater) every 1.44 years or a 69.4% annual probability of a damaging earthquake

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. The map below shows these rankings by county to demonstrate local perception of risk across the state.

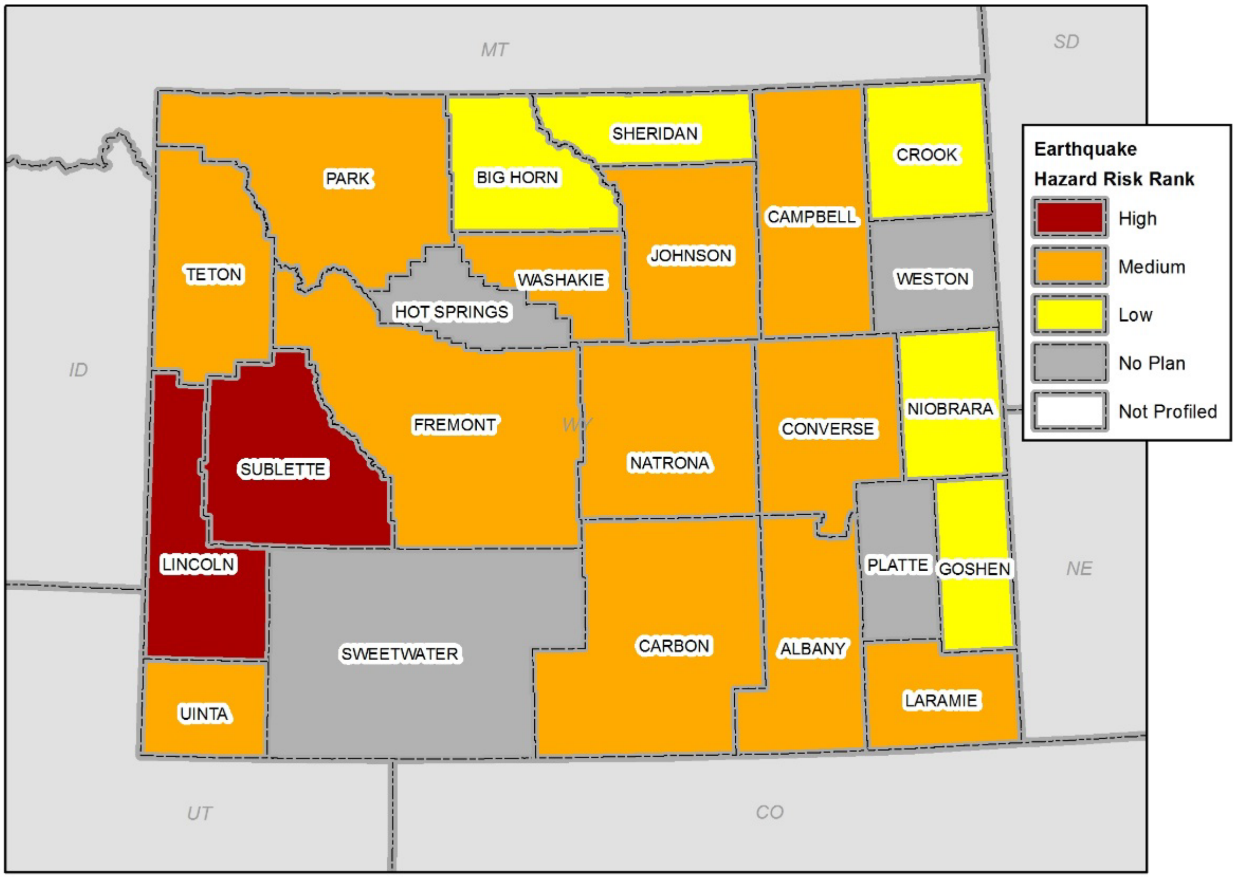


Figure 43. Earthquake Risk Rankings from Local Hazard Mitigation Plan Risk Assessments

A review of the local plans shows they have utilized the most accurate earthquake data available at the time their plan was written. Most also utilize maps contained within the Wyoming State Multi-Hazard Mitigation Plan. In February, 2011 each county was offered new, scenario-based HAZUS-MH information in draft form. The information provided utilized HAZUS estimates in scenario-based calculations. As mentioned earlier, the HAZUS-MH data has been finalized and published. It is expected that those counties impacted by potential earthquake hazards in Wyoming (most counties) will utilize this best available data in their next local plan update.

Table 27 shows the county rankings for building exposure values tied to liquefaction prone areas. A single earthquake event would not likely cause liquefaction in all potential areas of an individual county. As a result, the county figures are useful primarily for comparison of potential between counties. The values do reflect the value of buildings exposed to the hazard.

Table 27. Exposure by County, Liquefaction

County	Exposure Value (USD)
Teton	$1,858,921,520
Uinta	$310,025,710
Lincoln	$285,254,565
Fremont	$50,055,350
Carbon	$33,893,155
Sublette	$21,003,175
Washakie	$15,386,060
Hot Springs	$9,519,420
Bighorn	$9,099,015
Park	$3,597,420
Albany	$0
Campbell	$0
Converse	$0
Crook	$0
Goshen	$0
Johnson	$0
Laramie	$0
Natrona	$0
Niobrara	$0
Platte	$0
Sheridan	$0
Sweetwater	$0
Weston	$0
TOTAL	**$2,596,755,390**

Statewide Risk Assessment

16 Earthquake Scenarios, WGS

Earthquake activity in Wyoming has prompted the Wyoming State Geological Survey to undertake a study modeling loss estimations for 16 earthquake scenarios in 2011. The scenarios included four random event scenarios run on the basis of data from historic earthquakes that occurred near Casper, Gillette, Laramie Peak, and Estes Park, Colorado. Each of the historic, random event earthquake scenarios registered a 6.0 magnitude. The Estes Park Scenario was based on an event occurring in 1882, the Casper area event in 1897, and the Gillette and Laramie Peak events in 1984.

The Wyoming Geological Survey also included 12 fault-based scenarios in their study, based on the information in the following table:

Table 28. Fault Based Earthquake Scenarios

Quaternary fault	Scenario magnitude
Bear River fault system	6.9
Chicken Springs fault system	6.5
Eagle Bay fault system	6.8
East Mount Sheridan fault system	6.4
Grand Valley fault system	7.1
Greys River fault	7.1
Hoback fault	6.6
Rock Creek fault	7.0
South Granite fault system	6.8
Stagner Creek fault system	6.8
Teton fault	7.2
Upper Yellowstone fault system	6.5

The fault-based scenarios were run using two methods. Three of the fault based scenarios, the South Granite Mountain fault system, the Stagner Creek fault system, and the Chicken Springs fault system, used WSGS soil maps and default HAZUS-MH® models to provide loss estimates. The remaining nine faults were run with the help of the U. S. Geological Survey (USGS). The USGS provided shakemaps, which model ground shaking parameters on the basis of complex attenuation functions.

The random event scenarios are based on historic events, and although the data provided is beneficial, the odds of an earthquake happening in the exact location of each scenario are extremely low. On the other hand the fault based scenarios are based on faults that have been deemed potential sources of earthquakes. It is impossible to say when an earthquake can occur, but fault sources point to where large destructive earthquakes would happen. This study is not all-inclusive, but does provide valuable information for planning purposes. Scenario regions cover only those areas that would experience potentially damaging modeled ground motions (> 3.5%g). Areas outside the region boundaries would undoubtedly experience shaking from the earthquake; but structural damage would not be expected.[31]

The HAZUS-MH, scenario-based study has been published and is available to emergency managers around the state and to the public by accessing a web site hosted by the Wyoming Geological Survey.[32] The report is incorporated into this plan through reference.

The scenarios include information regarding the likelihood of damage to local and regional infrastructure, including fire stations, police stations, sheriffs' offices, schools, and hospitals. The

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[31] Wyoming Geological Survey, "Wyoming Earthquake Hazard and Risk Analysis: HAZUS-MH Loss Estimations for 16 Earthquake Scenarios", p. 4-5.

[32] http://ims.wsgs.uwyo.edu/hazus/Default.aspx, (Confirmed 10/14/2013)

scenarios reflect anticipated functionality of each infrastructure system immediately following the scenario earthquake, on day seven following the earthquake and one month after the earthquake. Additional information provided includes anticipated households displaced or seeking temporary shelter, electrical outages anticipated, number of households without potable water, debris generated by the scenario and economic losses resulting from three categories: buildings, transportation and utilities.

The information provided in the report allows for more informed exercising of responses and more complete, concrete information for proposed earthquake mitigation projects undertaken both locally and statewide.

The map below (**Figure 44**) shows epicenter locations of the scenarios, sized by total loss. Epicenters on map are labeled with total loss and if applicable, life-threatening injuries and fatalities. The attached table shows losses by scenario and by county. This helps compare scenario impacts at the state level and highlight the relative severity of each of these across the state.

The map is followed by **Table 29** which summarizes county economic losses in the scenarios.

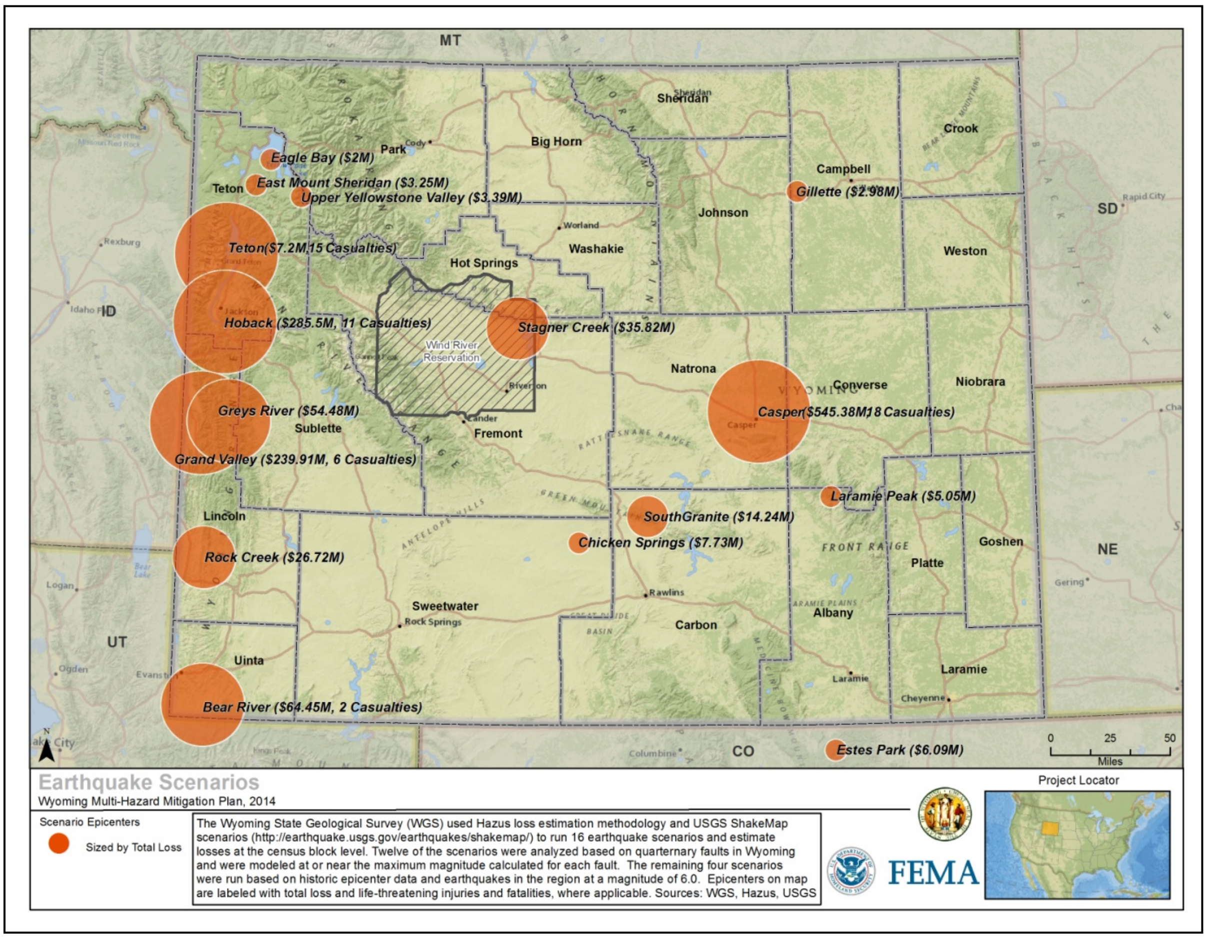


Figure 44. Earthquake Scenario Epicenters

Table 29. WGS Earthquake Scenario Summary (values in thousands), 2015 Valuations

Total county loss > $1M highlighted in red, table sorted by overall loss by county

	Bear River	Casper	Chicken Springs	Eagle Bay	East Mt. Sheridan	Estes Park	Gillette	Grand Valley*	Greys River*	Hoback	Laramie Peak	Rock Creek	South Granite	Stagner Creek	Teton	Upper Yellowstone Valley	County Totals
Teton	$ -	$ -	$ -	$ 1,778	$ 3,280	$ -	$ -	$ -	$ 556	$289,805	$ -	$ -	$ -	$ -	$377,407	$ 3,370	$ 676,197
Natrona	$ -	$555,335	$ 87	$ -	$ -	$ -	$ 1	$ -	$ -	$ -	$ 2,300	$ -	$ 3,052	$ -	$ -	$ -	$ 560,775
Lincoln	$ 65,736	$ -	$ -	$ -	$ -	$ -	$ -	$244,708	$ 53,903	$ 1,107	$ -	$ 27,240	$ -	$ -	$ 310	$ -	$ 393,004
Fremont	$ -	$ -	$ 786	$ -	$ 12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 117	$ 17,141	$ 723	$ 5	$ 18,785
Hot Springs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 17,539	$ -	$ -	$ 17,539
Carbon	$ -	$ 6	$ 3,386	$ -	$ -	$ 9	$ -	$ -	$ -	$ -	$ 34	$ -	$ 8,690	$ -	$ -	$ -	$ 12,126
Sweetwater	$ 1	$ -	$ 3,632	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1	$ 2,670	$ -	$ -	$ -	$ 6,305
Albany	$ -	$ 1	$ -	$ -	$ -	$ 5,085	$ -	$ -	$ -	$ -	$ 364	$ -	$ -	$ -	$ -	$ -	$ 5,450
Converse	$ -	$ 927	$ -	$ -	$ -	$ -	$ 2	$ -	$ -	$ -	$ 2,303	$ -	$ -	$ -	$ -	$ -	$ 3,232
Campbell	$ -	$ 3	$ -	$ -	$ -	$ -	$ 2,394	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,397
Washakie	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,848	$ -	$ -	$ 1,848
Sublette	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,112	$ 297	$ -	$ 6	$ -	$ -	$ 235	$ -	$ 1,649
Laramie	$ -	$ -	$ -	$ -	$ -	$ 1,114	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,114
Park	$ -	$ -	$ -	$ 266	$ 30	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6	$ 1	$ 89	$ 392
Johnson	$ -	$ 13	$ -	$ -	$ -	$ -	$ 270	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 284
Platte	$ -	$ -	$ -	$ -	$ -	$ 1	$ -	$ -	$ -	$ -	$ 154	$ -	$ -	$ -	$ -	$ -	$ 155
Sheridan	$ -	$ -	$ -	$ -	$ -	$ -	$ 55	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 55
Uinta	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8	$ -	$ -	$ -	$ -	$ 8
Big Horn	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Crook	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Goshen	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Niobrara	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Weston	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Scenario Totals	$ 65,737	$556,286	$ 7,892	$ 2,044	$ 3,322	$ 6,209	$ 2,722	$244,708	$ 55,571	$291,209	$ 5,155	$ 27,255	$ 14,530	$ 36,534	$378,676	$ 3,464	

*'Direct Economic Losses for Buildings' report was not available for Grand Valley and Greys River scenarios. Total scenario loss estimate was therefore attributed to counties based on percent of buildings with complete damage as listed in 'Building Damage by County by General Occupancy' report.

2500 yr Probabilistic Earthquake Scenario

HAZUS 2.1 was used to develop losses associated with a 2,500 year probabilistic earthquake scenario for the State of Wyoming. This scenario uses USGS probabilistic seismic contour maps to model ground shaking with a 2 percent probability of being exceeded in 50 years. Total losses include building, contents, inventory, and income-related losses.

The following table lists total loss, loss ratio (total loss/total building inventory value), and ranges of casualties within severity levels. HAZUS provides casualty estimates for 2 a.m., 2 p.m., and 5 p.m. to represent periods of the day that different sectors of the community are at their peak occupancy loads. The casualty ranges represent the lowest to highest casualties within these times of day. Casualty severity levels are described as follows;

- Level 1: Injuries will require medical attention but hospitalization is not needed
- Level 2: Injuries will require hospitalization but are not considered life-threatening
- Level 3: Injuries will require hospitalization and can become life-threatening if not promptly treated
- Level 4: Victims are killed by the earthquake

The table is sorted and ranked by total loss.

Table 30. 2500-Year Probabilistic Scenario Loss Estimates, 2015 Valuations

Rank	County	Total Loss ($M)	Loss Ratio	Casualties Level 1	Level 2	Level 3	Level 4
1	Teton	$654	27%	150-300	40-90	0-20	30-Oct
2	Lincoln	$528	63%	190-220	50-60	0-20	20-Oct
3	Natrona	$268	11%	50-60	10	0	0
4	Uinta	$247	18%	90-120	20-30	0-10	0-10
5	Sweetwater	$181	19%	50	10	0	0
6	Fremont	$115	25%	20	0	0	0
7	Laramie	$105	4%	20	0	0	0
8	Sheridan	$84	9%	20	0	0	0
9	Albany	$81	21%	20	0	0	0
10	Campbell	$79	14%	20	0	0	0
11	Park	$79	1%	20-Oct	0	0	0
12	Sublette	$74	6%	20	0-10	0	0
13	Carbon	$64	1%	10	0	0	0
14	Converse	$50	28%	10	0	0	0
15	Washakie	$28	1%	10	0	0	0
16	Big Horn	$26	4%	0-10	0	0	0
17	Johnson	$25	1%	0-10	0	0	0
18	Platte	$20	3%	0	0	0	0
19	Hot Springs	$20	1%	0	0	0	0
20	Goshen	$11	1%	0	0	0	0

Rank	County	Total Loss ($M)	Loss Ratio	Casualties Level 1	Level 2	Level 3	Level 4
21	Weston	$7	0%	0	0	0	0
22	Crook	$5	1%	0	0	0	0
23	Niobrara	$4	1%	0	0	0	0
	Total	**$2,755**					

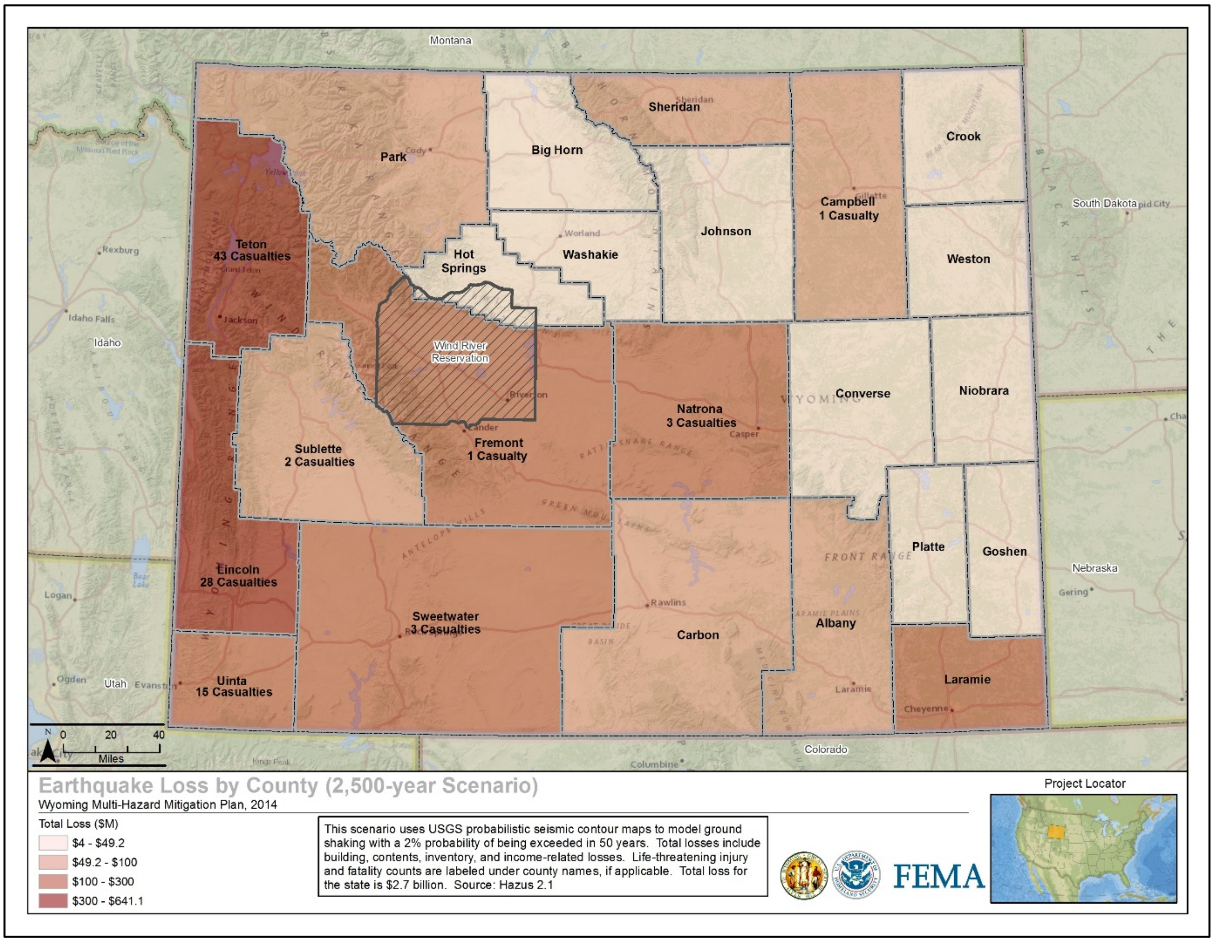


Figure 45. 2500-Year Probabilistic Earthquake Scenario Loss by County

The tables below (**Tables 31**) show local critical facilities most at risk to the 2500-yr probabilistic earthquake scenario in the following categories: schools, care facilities, police stations, and fire stations. HAZUS determines critical facility damage states on a site-specific basis (i.e., ground motion parameters are computed at the location of the facility) and the purpose is to estimate the expected loss of functionality for each facility. Top 25 facilities at risk for each critical facility type were pulled from HAZUS results based on lowest percentage of functionality on day 1 after the modeled earthquake. Each list includes the name, address, county and the percentages of functionality on days 1 and 14 after the earthquake.

Table 31. Top 25 at Risk to 2,500-yr Earthquake Scenarios

Schools (Sorted by lowest to highest functionality on day 1 after earthquake)

					% of Functionality	
Name	Address	City	County	Number of Students	On Day 1	On Day 14
SWIFT CREEK LEARNING CENTER	222 EAST 4TH AVENUE	AFTON	Lincoln	772	2%	8%
OSMOND ELEMENTARY	3120 STATE HIGHWAY 241	AFTON	Lincoln	287	2%	8%
STAR VALLEY HIGH SCHOOL	445 WEST SWIFT CREEK LANE	AFTON	Lincoln	704	2%	8%
STAR VALLEY MIDDLE SCHOOL	999 WARRIOR WAY	AFTON	Lincoln	366	2%	8%
AFTON ELEMENTARY	175 EAST 4TH AVENUE	AFTON	Lincoln	396	2%	8%
C-BAR-V RANCH	3850 NORTH WILDERNESS DRIVE	WILSON	Teton	125	4%	17%
REGION V BOCES	3850 NORTH WILDERNESS DRIVE	WILSON	Teton	25	4%	17%
COKEVILLE HIGH SCHOOL	300 PINE	COKEVILLE	Lincoln	90	4%	12%
COKEVILLE ELEMENTARY	250 NORTH SAGE	COKEVILLE	Lincoln	122	4%	12%
HOLDAWAY ELEMENTARY	250 VAN NOY PARKWAY	THAYNE	Lincoln	327	4%	13%
KELLY ELEMENTARY	FOURTH STREET	KELLY	Teton	446	5%	20%
JACKSON ELEMENTARY	155 NORTH JEAN STREET	JACKSON	Teton	420	5%	23%
JOURNEYS SCHOOL OF THE TETON SCIENCE SCHOOL			Teton	151	6%	23%
METCALF ELEMENTARY	US HIGHWAY 89	ETNA	Lincoln	259	6%	16%
WILSON ELEMENTARY	5200 HHR RANCH ROAD	WILSON	Teton	227	9%	31%
BONDURANT ELEMENTARY	14224 SOUTH US HIGHWAY 189/191	BONDURANT	Sublette	379	11%	26%
					% of Functionality	
Name	Address	City	County	Number of Students	On Day 1	On Day 14

COLTER ELEMENTARY	1855 HIGH SCHOOL ROAD	JACKSON	Teton	344	11%	35%
JACKSON HOLE HIGH SCHOOL	1910 WEST HIGH SCHOOL ROAD	JACKSON	Teton	637	11%	35%
JACKSON HOLE MIDDLE SCHOOL	1230 SOUTH PARK LOOP ROAD	JACKSON	Teton	493	11%	35%
SUMMIT HIGH SCHOOL	100 MIDDLE SCHOOL ROAD	JACKSON	Teton	50	11%	35%
JACKSON HOLE CHRISTIAN ACADEMY		JACKSON	Teton	190	11%	35%
DAVIS MIDDLE SCHOOL	837 NO NAME STREET	EVANSTON	Uinta	337	11%	27%
EVANSTON HIGH SCHOOL	701 WEST CHEYENNE DRIVE	EVANSTON	Uinta	847	11%	27%
CLARK ELEMENTARY	600 13TH STREET	EVANSTON	Uinta	209	11%	27%
UINTA MEADOWS ELEMENTARY	90 CHEYENNE DRIVE	EVANSTON	Uinta	446	11%	27%

Care Facilities (Sorted by lowest to highest functionality on day 1 after earthquake)

					% of Functionality	
Name	**Address**	**City**	**County**	**Number of Beds**	**On Day 1**	**On Day 14**
STAR VALLEY MEDICAL CENTER	901 ADAMS STREET	AFTON	Lincoln	15	3%	16%
SAINT JOHNS HOSPITAL	625 EAST BROADWAY	JACKSON	Teton	42	7%	35%
TETON YOUTH AND FAMILY SERVICES VAN VECK	510 SOUTH CACHE DRIVE	JACKSON	Teton	0	14%	48%
					% of Functionality	
Name	**Address**	**City**	**County**	**Number of Beds**	**On Day 1**	**On Day 14**
EVANSTON REGIONAL HOSPITAL	190 ARROWHEAD DRIVE	EVANSTON	Uinta	42	15%	46%
SOUTH LINCOLN MEDICAL CENTER	711 ONYX STREET	KEMMERER	Lincoln	116	17%	50%
MEMORIAL HOSPITAL - SWEETWATER	1200 COLLEGE	ROCK SPRINGS	Sweetwater	99	54%	87%

	DRIVE					
MEMORIAL HOSPITAL OF CARBON COUNTY	2221 WEST ELM STREET	RAWLINS	Carbon	35	61%	90%
HOT SPRINGS COUNTY MEMORIAL HOSPITAL	150 EAST ARAPAHOE STREET	THERMOPOLIS	Hot Springs	49	63%	91%
MOUNTAIN VIEW REGIONAL HOSPITAL	6550 EAST SECOND STREET	CASPER	Natrona	0	64%	92%
CENTRAL WYOMING COUNSELING CENTER - NEW	837 EAST C STREET	CASPER	Natrona	0	65%	92%
CENTRAL WYOMING COUNSELING CENTER - NEW	1514 EAST 12TH STREET	CASPER	Natrona	0	65%	92%
WYOMING MEDICAL CENTER	1233 EAST 2ND STREET	CASPER	Natrona	201	65%	92%
MEMORIAL HOSPITAL OF CONVERSE COUNTY	111 SOUTH 5TH STREET	DOUGLAS	Converse	34	67%	93%
WASHAKIE MEDICAL CENTER	400 SOUTH 15TH STREET	WORLAND	Washakie	30	67%	93%
JOHNSON COUNTY HEALTHCARE CENTER	497 WEST LOTT STREET	BUFFALO	Johnson	25	69%	94%
LANDER REGIONAL HOSPITAL	1320 BISHOP RANDALL DRIVE	LANDER	Fremont	81	72%	94%
					% of Functionality	
Name	**Address**	**City**	**County**	**Number of Beds**	**On Day 1**	**On Day 14**
RIVERTON MEMORIAL HOSPITAL	2100 WEST SUNSET DRIVE	RIVERTON	Fremont	70	73%	94%
SOUTH BIG HORN COUNTY HOSPITAL	388 UNITED STATES HIGHWAY 20 SOUTH	BASIN	Big Horn	0	73%	95%
CATHEDRAL HOME FOR CHILDREN	4989 NORTH 3RD STREET	LARAMIE	Albany	0	74%	95%

CAMPBELL COUNTY MEMORIAL HOSPITAL	501 SOUTH BURMA AVENUE	GILLETTE	Campbell	90	75%	96%
IVINSON MEMORIAL HOSPITAL	255 NORTH 30TH STREET	LARAMIE	Albany	99	75%	96%
WEST PARK HOSPITAL	707 SHERIDAN AVENUE	CODY	Park	46	75%	94%
NORTH BIG HORN HOSPITAL DISTRICT	1115 LANE 12	LOVELL	Big Horn	15	75%	96%
PLATTE COUNTY MEMORIAL HOSPITAL	201 14TH STREET	WHEATLAND	Platte	43	76%	96%
SHERIDAN MEMORIAL HOSPITAL	1401 WEST 5TH STREET	SHERIDAN	Sheridan	88	76%	96%

Police Station (Sorted by lowest to highest functionality on day 1 after earthquake)

				% of Functionality	
Name	**Address**	**City**	**County**	**On Day 1**	**On Day 14**
AFTON POLICE DEPARTMENT	416 SOUTH WASHINGTON STREET	AFTON	Lincoln	1%	11%
LINCOLN COUNTY SHERIFFS OFFICE - AFTON	421 JEFFERSON STREET	AFTON	Lincoln	1%	12%
COKEVILLE POLICE DEPARTMENT	110 PINE STREET	COKEVILLE	Lincoln	3%	21%
THAYNE POLICE DEPARTMENT	115 PETERSEN PARKWAY	THAYNE	Lincoln	5%	27%
				% of Functionality	
Name	**Address**	**City**	**County**	**On Day 1**	**On Day 14**
ALPINE POLICE DEPARTMENT	121 UNITED STATES HIGHWAY 89	ETNA	Lincoln	23%	59%
NATIONAL PARK SERVICE - BRIDGER-TETON NA	25 ROSECRANS DRIVE	JACKSON	Teton	24%	65%
NATIONAL PARK SERVICE - BRIDGER-TETON NA	340 NORTH CACHE DRIVE	JACKSON	Teton	24%	65%
TETON COUNTY SHERIFFS OFFICE	180 SOUTH KING STREET	JACKSON	Teton	24%	65%
JACKSON POLICE DEPARTMENT	150 EAST PEARL AVENUE	JACKSON	Teton	24%	65%

WYOMING GAME AND FISH DEPARTMENT - JACKS	420 NORTH CACHE DRIVE	JACKSON	Teton	24%	65%
WYOMING HIGHWAY PATROL - JACKSON	1040 EAST EVANS ROAD	JACKSON	Teton	33%	74%
UINTA COUNTY SHERIFFS OFFICE / UINTA COUNTY	77 COUNTY ROAD 109	EVANSTON	Uinta	36%	73%
EVANSTON POLICE DEPARTMENT	1148 FRONT STREET	EVANSTON	Uinta	37%	74%
NATIONAL PARK SERVICE - BRIDGER-TETON NATIONAL PARK	20255 UNITED STATES HIGHWAY 287	MORAN	Teton	40%	79%
KEMMERER POLICE DEPARTMENT	222 STATE HIGHWAY 233	KEMMERER	Lincoln	43%	78%
UNITED STATES FOREST SERVICE - KEMMERER	308 UNITED STATES HIGHWAY 189	KEMMERER	Lincoln	43%	78%
LINCOLN COUNTY SHERIFFS OFFICE / LINCOLN	1032 BEECH AVENUE	KEMMERER	Lincoln	43%	78%
DIAMONDVILLE POLICE DEPARTMENT	20 UNITED STATES HIGHWAY 30	KEMMERER	Lincoln	46%	80%
LA BARGE POLICE DEPARTMENT	222 LA BARGE STREET	LA BARGE	Lincoln	56%	86%
WYOMING HIGHWAY PATROL - PINEDALE	1551 WEST PINE STREET	PINEDALE	Sublette	60%	88%
MOUNTAIN VIEW POLICE DEPARTMENT	405 STATE HIGHWAY 414	MOUNTAIN VIEW	Uinta	62%	89%
				% of Functionality	
Name	Address	City	County	On Day 1	On Day 14
WYOMING GAME AND FISH DEPARTMENT - PINED	432 EAST MILL STREET	PINEDALE	Sublette	63%	89%
SUBLETTE COUNTY SHERIFFS OFFICE / SUBLET	35 1/2 SOUTH TYLER AVENUE	PINEDALE	Sublette	63%	89%
LYMAN POLICE DEPARTMENT	100 EAST SAGE STREET	LYMAN	Uinta	66%	91%
BAIROIL POLICE DEPARTMENT	1101 ANTELOPE DRIVE	BAIROIL	Sweetwater	70%	93%

Fire Stations (Sorted by lowest to highest functionality on day 1 after earthquake)

Name	Address	City	County	% of Functionality On Day 1	On Day 14
AFTON VOLUNTEER FIRE DEPARTMENT	191 SOUTH WASHINGTON STREET	AFTON	Lincoln	1%	11%
BEAR RIVER FIRE PROTECTION DISTRICT / CO	110 PINE STREET	COKEVILLE	Lincoln	3%	21%
THAYNE AND RURAL VOLUNTEER FIRE DEPARTMENT	256 NORTH MAIN STREET	THAYNE	Lincoln	5%	27%
UINTA COUNTY FIRE PROTECTION DISTRICT -	18151 STATE HIGHWAY 150 SOUTH	EVANSTON	Uinta	5%	27%
COLTER BAY FIRE DEPARTMENT - GRAND TETON	COLTER BAY VILLAGE ROAD	MORAN	Teton	11%	44%
MOOSE FIRE DEPARTMENT - GRAND TETON NATIONAL PARK	UNITED STATES HIGHWAY 191	MOOSE	Teton	18%	57%
TETON VILLAGE SPECIAL FIRE DISTRICT	7648 GRANITE LOOP ROAD	TETON VILLAGE	Teton	21%	61%
ALPINE FIRE DEPARTMENT	220 MAIN STREET	ETNA	Lincoln	23%	60%
				% of Functionality	
Name	Address	City	County	On Day 1	On Day 14
JACKSON HOLE FIRE AND EMERGENCY MEDICAL	60 EAST PEARL AVENUE	JACKSON	Teton	24%	65%
JACKSON HOLE FIRE AND EMERGENCY MEDICAL	2505 NORTH MOOSE-WILSON ROAD	WILSON	Teton	29%	70%
JACKSON HOLE FIRE AND EMERGENCY MEDICAL	CENTRAL STREET	MORAN	Teton	29%	70%
JACKSON HOLE FIRE AND EMERGENCY MEDICAL	1315 NORTH WEST STREET	WILSON	Teton	30%	71%
JACKSON HOLE FIRE AND EMERGENCY MEDICAL	3230 SOUTH ADAMS CANYON ROAD	JACKSON	Teton	31%	72%
BONDURANT VOLUNTEER FIRE COMPANY	14245 UNITED STATES HIGHWAY 189	BONDURANT	Sublette	34%	71%

JACKSON HOLE FIRE AND EMERGENCY MEDICAL	10995 UNITED STATES HIGHWAY 89	JACKSON	Teton	35%	76%
UINTA COUNTY FIRE PROTECTION DISTRICT -	1136 FRONT STREET	EVANSTON	Uinta	37%	74%
UINTA COUNTY FIRE PROTECTION DISTRICT -	99 HAYDEN AVENUE	EVANSTON	Uinta	37%	74%
UINTA COUNTY FIRE PROTECTION DISTRICT -	72 STATE HIGHWAY 89	EVANSTON	Uinta	37%	74%
YELLOWSTONE NATIONAL PARK FIRE DEPARTMEN	EAST ENTRANCE ROAD	YELLOWSTONE NATIONAL PARK	Park	42%	81%
JACKSON HOLE FIRE AND EMERGENCY MEDICAL	15 ALTA SCHOOL ROAD	ALTA	Teton	42%	81%
KEMMERER FIRE DEPARTMENT	1225 CORAL STREET	KEMMERER	Lincoln	43%	78%
UINTA COUNTY FIRE PROTECTION DISTRICT – State	508 COUNTY ROAD 107	EVANSTON	Uinta	47%	81%
				% of Functionality	
Name	**Address**	**City**	**County**	**On Day 1**	**On Day 14**
UINTA COUNTY FIRE PROTECTION DISTRICT -	9637 STATE HIGHWAY 89 NORTH	BEAR RIVER	Uinta	48%	82%
KENDALL VALLEY VOLUNTEER FIRE DEPARTMENT	2470 STATE HIGHWAY 352	CORA	Sublette	51%	83%
DANIEL VOLUNTEER FIRE COMPANY	12956 UNITED STATES HIGHWAY 189	DANIEL	Sublette	53%	85%

Assessment of Potential Earthquake Damage

Hazards U.S. (HAZUS) is nationally standardized, geographic information systems (GIS)-based, risk assessment and loss estimation computer program originally designed in 1997 to provide the user with an estimate of the type, extent, and cost of damages and losses that may occur during and following an earthquake. HAZUS was developed for the Federal Emergency Management Agency (FEMA) by the National Institute of Building Sciences (NIBS). There have been a number of versions of HAZUS generated by FEMA, with HAZUS Multi-Hazard (HAZUS-MH) being the most recent release. HAZUS-MH incorporates a flood and hurricane wind module with the previously existing earthquake module.

HAZUS was originally designed to generate damage assessments and associated ground motions based largely upon analysis at the census-tract level. Census tracts average 4000 inhabitants, with the tract boundaries usually representing visible features. HAZUS-99 calculated a ground motion value for the centroid of a census tract and applied that value to the entire tract. The calculations are based on USGS National Seismic Hazard Maps. In many of the western states, census tracts are very large, and parts of the tracts may be subjected to ground shaking that is considerably different than the value at the centroid. In 2003 and 2004, FEMA Region VIII and their subcontractor on HAZUS, PBS&J from Atlanta, have worked closely with the Wyoming Geological Survey and the Wyoming Office of Homeland Security to develop a census-block-based analysis for HAZUS-MH in Wyoming. Census blocks are a subdivision of census tracts. Many blocks correspond to individual city blocks bounded by streets, but blocks—especially in rural areas—may include many square miles and may have some boundaries that are not streets. Ground motion values for Wyoming can now be calculated at the centroid of census blocks.

The results of the probabilistic 2004 HAZUS-MH analysis for each county are presented in **Table 32**. Probabilistic loss estimates reflect total damage/loss exposure for each county based on maximum ground motions modeled from the USGS 2500-year (2 percent probability of exceedance in 50 years) model. They do not reflect losses for a specific seismic event within or near each county. The probabilistic loss estimates may significantly over-estimate actual losses sustained from an individual earthquake. The data shows aggregated loss potential, rather than potential losses for a specific event.

There are two methods of ranking counties to determine where earthquake impacts may be the greatest. Either the loss ratios or total damage figures can be used (**Table 33**). The loss ratio is determined by dividing the sum of the structural and non-structural damage by the total building value for the county. The loss ratio is a better measure of impact for a county as it gives an indication of the percent of damage to buildings. The total damage figure by itself does not reflect the percentage of building damage. If a county has a number of valuable buildings, such as Laramie County, small damage to a number of valuable buildings may result in a higher total damage figure that may be found in a county with fewer, less expensive buildings with a higher percentage of damage.

Statewide, HAZUS-MH analyses were generated in 2004 using both a census-tract and a census block method of analysis. The statewide results of both methods of analysis for building damage (structural and non-structural) follow:

Statewide Building Damage - Census Block Analysis: $2,436,291,000
Statewide Building Damage - Census Tract Analysis: $2,054,470,000

Table 32. HAZUS-MH Summary by County

County	Capital Stock Losses (Thousands of Dollars)				Loss Ratio (%)	Income Losses (Thousands of Dollars)				Total Loss (Thousands of Dollars)
	Structural	Non-structural	Contents	Inventory		Relocation	Capital-related	Wages	Rental	Loss
Albany	9,714	36,865	13,946	151	2.32	276	2,717	3,198	4,210	71,078
Big Horn	3,470	12,203	4,647	65	2.43	84	533	694	963	22,660
Campbell	5,116	20,093	9,419	282	1.37	144	1,484	2,013	1,592	40,144
Carbon	7,140	26,320	10,480	170	3.08	190	2,120	2,700	1,810	50,920
Converse	6,054	24,172	9,787	185	4.15	152	984	1,303	1,845	44,482
Crook	836	2,640	896	17	1.04	21	107	139	211	4,867
Fremont	14,890	61,030	24,640	460	3.75	380	2,920	3,940	3,190	111,450
Goshen	2,168	6,982	2,543	69	1.13	57	392	528	623	13,364
Hot Springs	3,038	10,871	4,176	52	4.20	82	799	1,149	969	21,136
Johnson	3,293	13,062	5,514	94	3.40	86	557	648	1,066	24,320
Laramie	13,605	47,839	17,577	233	1.25	406	3,926	4,402	4,976	92,963
Lincoln	65,670	225,594	64,429	2,538	31.08	1,211	8,579	10,359	15,347	391,727
Natrona	36,764	137,379	57,269	1,149	3.99	981	9,890	13,033	12,245	268,911
Niobrara	423	1,585	617	12	1.20	12	72	83	132	2,935
County	Capital Stock Losses (Thousands of Dollars)				Loss Ratio (%)	Income Losses (Thousands of Dollars)				Total Loss (Thousands of Dollars)
	Structural	Non-structural	Contents	Inventory		Relocation	Capital-related	Wages	Rental	Loss
Park	11,430	42,694	15,289	429	2.98	285	5,173	6,217	4,487	86,004
Platte	1,875	6,894	2,697	36	1.60	51	326	418	554	12,850
Sheridan	7,830	29,154	12,057	233	2.09	213	1,898	2,402	2,636	56,423
Sublette	9,654	30,667	9,436	222	8.24	206	2,438	3,052	2,665	58,340
Sweetwater	12,782	50,213	20,753	542	2.84	313	2,180	2,514	3,719	93,017
Teton	92,477	359,169	110,323	2,402	24.72	1,821	37,784	43,975	34,030	681,981

Uinta	39,912	135,111	38,841	1,007	15.84	782	5,888	8,741	11,004	241,284
Washakie	4,115	13,761	5,656	134	3.54	99	904	1,019	1,236	26,925
Weston	897	3,016	1,085	21	0.96	26	147	266	302	5,760

Table 33. County Impact in Order of Ratio Losses and Dollar Losses

County	Loss ratio	Total loss (thousands of dollars)
Lincoln	31.08	391,727
Teton	24.72	681,981
Uinta	15.84	241,284
Sublette	8.24	58,340
Hot Springs	4.20	21,136
Converse	4.15	44,482
Natrona	3.99	268,911
Fremont	3.75	111,450
Washakie	3.54	26,925
Johnson	3.40	24,320
Carbon	3.08	50,920
Park	2.98	86,004
Sweetwater	2.84	93,017
Big Horn	2.43	22,660
Albany	2.32	71,078
Sheridan	2.09	56,423
Platte	1.60	12,850
Campbell	1.37	40,144
Laramie	1.25	92,963
Niobrara	1.20	2,935
Goshen	1.13	13,364
Crook	1.04	4,867
Weston	0.96	5,760

County	Total loss (thousands of dollars)	Loss ratio
Teton	681,981	24.72
Lincoln	391,727	31.08
Natrona	268,911	3.99
Uinta	241,284	15.84
Fremont	111,450	3.75
Sweetwater	93,017	2.84
Laramie	92,963	1.25
Park	86,004	2.98
Albany	71,078	2.32
Sublette	58,340	8.24
Sheridan	56,423	2.09
Carbon	50,920	3.08
Converse	44,482	4.15
Campbell	40,144	1.37
Washakie	26,925	3.54
Johnson	24,320	3.4
Big Horn	22,660	2.43
Hot Springs	21,136	4.2
Goshen	13,364	1.13
Platte	12,850	1.6
Weston	5,760	0.96
Crook	4,867	1.04
Niobrara	2,935	1.2

Using the loss ratios in **Table 33**, Lincoln, Teton, Uinta, and Sublette counties would have the most significant impact from earthquakes. This is consistent with probabilistic acceleration maps, and projected damage potential from exposed active fault models. Total dollar loss in those counties is projected to be nearly $1.4 billion.

The second most impacted areas would be Hot Springs, Converse, Natrona, Fremont, Washakie, Johnson, Carbon, Park, and Sweetwater counties. Total dollar loss in those counties is projected to be just over $657.4 million.

The third most impacted areas would be Big Horn, Albany, Sheridan, Platte, and Campbell counties. Total dollar loss in those counties is projected to be about $203.2 million.

The counties with the least impact would be Laramie, Niobrara, Goshen, Crook, and Weston counties. Total dollar loss in those counties is projected to be almost $119.9 million. This is consistent with probabilistic acceleration maps, and projected damage potential from exposed active fault models.

Changes in Development

The four counties at highest risk to earthquake according to the 2500-year analysis are Lincoln, Teton, Uinta, and Sublette. Sublette is the fastest growing county is Wyoming with a projected growth rate of 74 percent between 2010 and 2030. Incorporated jurisdictions in Sublette County include Big Piney, Marbleton, and Pinedale and all have a projected increase of >73 percent.

When compared to the percentage of population increase in the state, it is noted those counties in zones where earthquakes are most prevalent, the western part of the state, are experiencing some of the most significant growth. This would indicate earthquake hazards do not appear to significantly modify growth patterns within Wyoming. It would also lead one to draw the conclusion that in the event of a significant earthquake, those counties experiencing greater growth within their boundaries will have greater need of critical infrastructure like hospitals, police and fire departments, which are likely to be operating at a decreased capacity. The draw on critical infrastructure from surrounding areas may also be taxed.

However, the areas in the west tend to be populated by those better able to address the demands of an emergency because of low density and greater resilience of the population.

The percentage of developable lands within a county located in high hazard areas was calculated, a matrix was created and the hazard was mapped showing where growth rates intersect with a high percentage of developable lands. This was done using the population growth rates by county (**Appendix L**). With this matrix approach in the map below, counties with darker blue shading represent those with higher population growth rates, while dark red shading represents those with a higher percentage of developable hazard area. The darker the purple shading represents the overlap of high population growth rates and developable hazard areas.

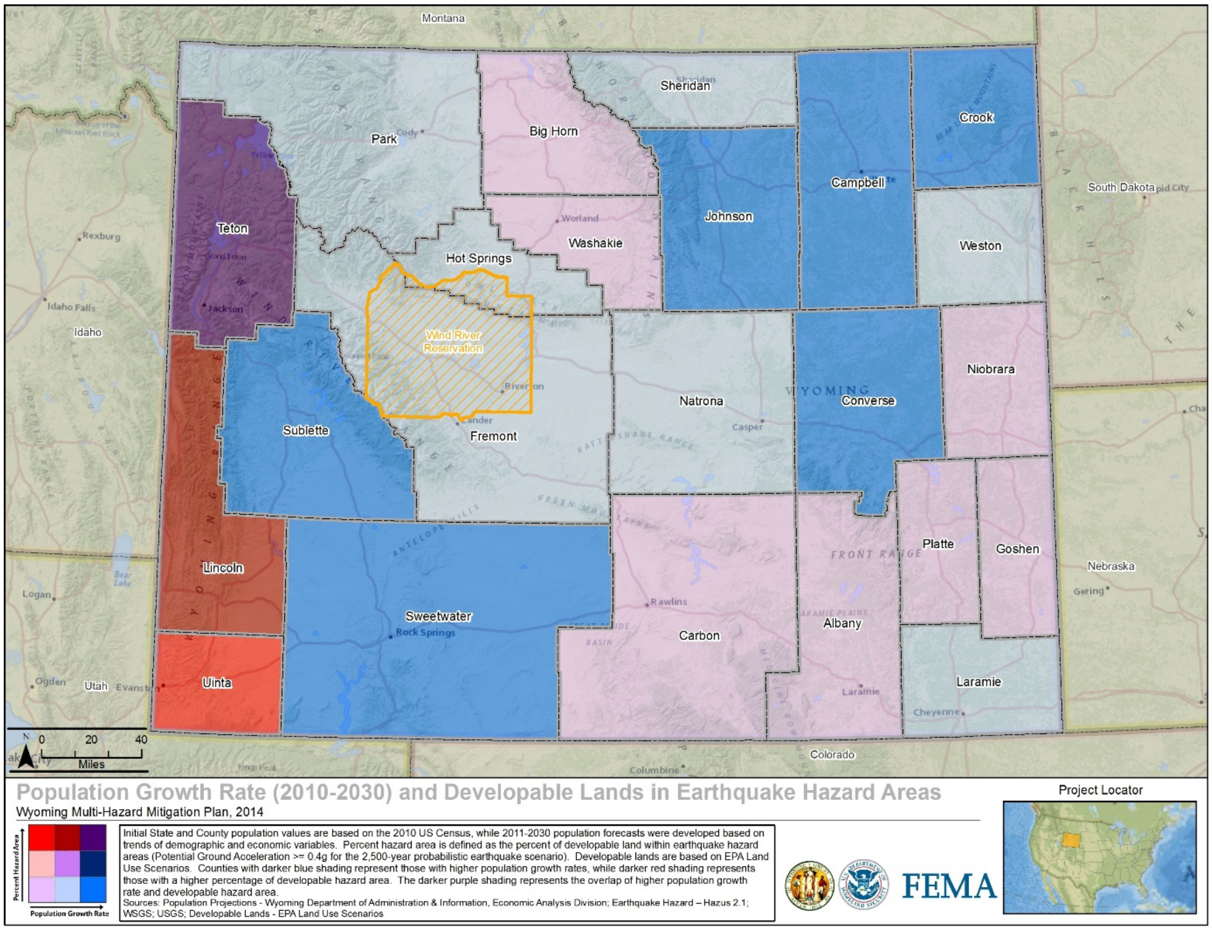


Figure 46. Population Growth Rate and Developable Land in Earthquake Hazard Areas

State Facilities at Risk

The Hazus Advanced Engineering Building Module (AEBM) was used to estimate losses and casualties for Wyoming state buildings based on the USGS 2008 National Earthquake Hazard Maps associated with the 2,500 year return period ground motions. The AEBM uses attributes related to number of occupants, building and contents value, building construction type and seismic design levels. This analysis was completed in 2007 and loss estimates have been inflated to reflect 2013 building costs. The 2014 state building dataset does not include adequate attributes to analyze using the AEBM. The state will work to continually update and improve their buildings dataset to continually refine future analysis.

The following table shows the top 25 state buildings at risk to earthquake, based on the AEBM study. Table is sorted by highest to lowest total economic loss.

Table 34. Top 25 State Buildings at Risk to Earthquake

Building Name	Address	County	Total Economic Loss
St Pen.-Housing Unit S	2900 Higley Blvd	Carbon	$4,760,564
St Hospital # 23- Correction Complex	831 Highway 150 S Box	Uinta	$3,882,926
St Hospital # 33-Adult Care Fclty.	831 Highway 150 S Box	Uinta	$3,465,817
Capitol Bldg-Offices, Meeting Rooms	200 W 24th St	Laramie	$3,213,184
WYDOT Office-Office, Shop	1040 E Evans Rd	Teton	$3,164,499
Herschler Bldg-Offices, Cafeteria	122 W 25th St	Laramie	$2,030,279
WGF District Hdqt.-Offices	420 N Cache St	Teton	$1,467,117
WYDOT-Engr., Mech., & Maint.	310 N Washington	Lincoln	$1,269,747
St Hospital # 18-Campbell/Uinta Clinic	831 Highway 150 S Box	Uinta	$1,115,798
St Hospital # 10-Teton/Sweetwater	831 Highway 150 S Box	Uinta	$1,026,324
St Hospital # 5-Natrona/Laramie Hall	831 Highway 150 S Box	Uinta	$1,010,534
St Pen.-Medium Security Support	2900 Higley Blvd	Carbon	$993,429
St Hospital #17-Bighorn/Goshen Admis	831 Highway 150 S Box	Uinta	$982,903
WGF-DOT Purchase	380 N Cache	Teton	$965,797
St Pen.-Kitchen, Warehouse	2900 Higley Blvd	Carbon	$918,428
St Hospital # 4-Fremont/Albany Old Dorm	831 Highway 150 S Box	Uinta	$905,270
St Hospital # 6-Admin. Bldg	831 Highway 150 S Box	Uinta	$882,902
St Hospital # 3-Lincoln/Platte Halls	831 Highway 150 S Box	Uinta	$869,744
St Pen.-Medium Security Inmate Housing	2900 Higley Blvd	Carbon	$867,112
St Pen.-Maximum Security Inmates	2900 Higley Blvd	Carbon	$838,165
Emerson Bldg-Tech Wing	2001 Capitol	Laramie	$821,059
St. Pen. - Maximum Security	2900 Higley Blvd	Carbon	$809,217
Supreme Court Build-Library, Courtrooms	2301 Central	Laramie	$781,585
St Hospital #7-Admin. Offices	831 Highway 150 S Box	Uinta	$771,059
Armory	350 E 6th Ave	Lincoln	$713,164

In addition to the AEBM study described above, the 2014 state building dataset was compared to the 2,500 year probabilistic earthquake scenario potential ground acceleration. Using GIS, critical state buildings greater than 1,000 square feet were intersected with areas >0.4 PGA (%g) with 2 percent probability of being exceeded in 50 years (2500-yr return period). The following are the additional critical state buildings at high risk to earthquake:

- Game and Fish Warden Station North, 465 S. Cache St., Jackson, Teton County
- Game and Fish Warden Station South, 345 Deloney St., Jackson, Teton County

- Game and Fish Old District 1 Office, 360 N. Cache St., Jackson, Teton County

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 35. Earthquake Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	2.9	*Moderate*
Earthquake	3.0	2.8	2.8	3.6	2.4		

Expansive Soil

Description

Expansive soils are soils that expand when water is added, and shrink when they dry out. This continuous change in soil volume can cause homes built on this soil to move unevenly and crack. Each year in the United States, expansive soils cause $2.3 billion in damage to houses, other buildings, roads, pipelines, and other structures. This is more than twice the damage from floods, hurricanes, tornadoes, and earthquakes combined. (Kerrane) U.S. Housing and Urban Development (HUD) estimated $9 billion damages in 1981 resulting from expansive soils. It indicated that shrink-swell problems were the second most likely problem a homeowner would encounter, after insects.

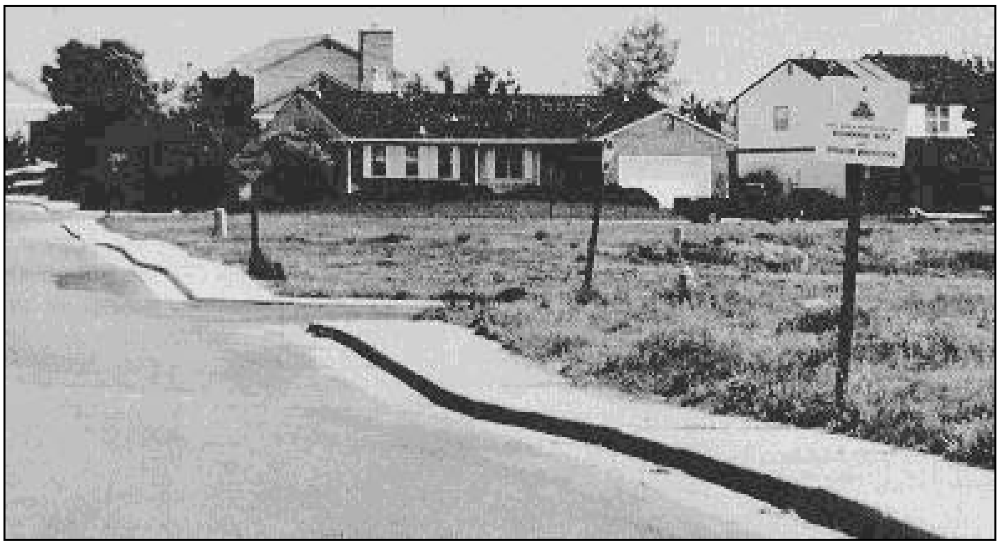


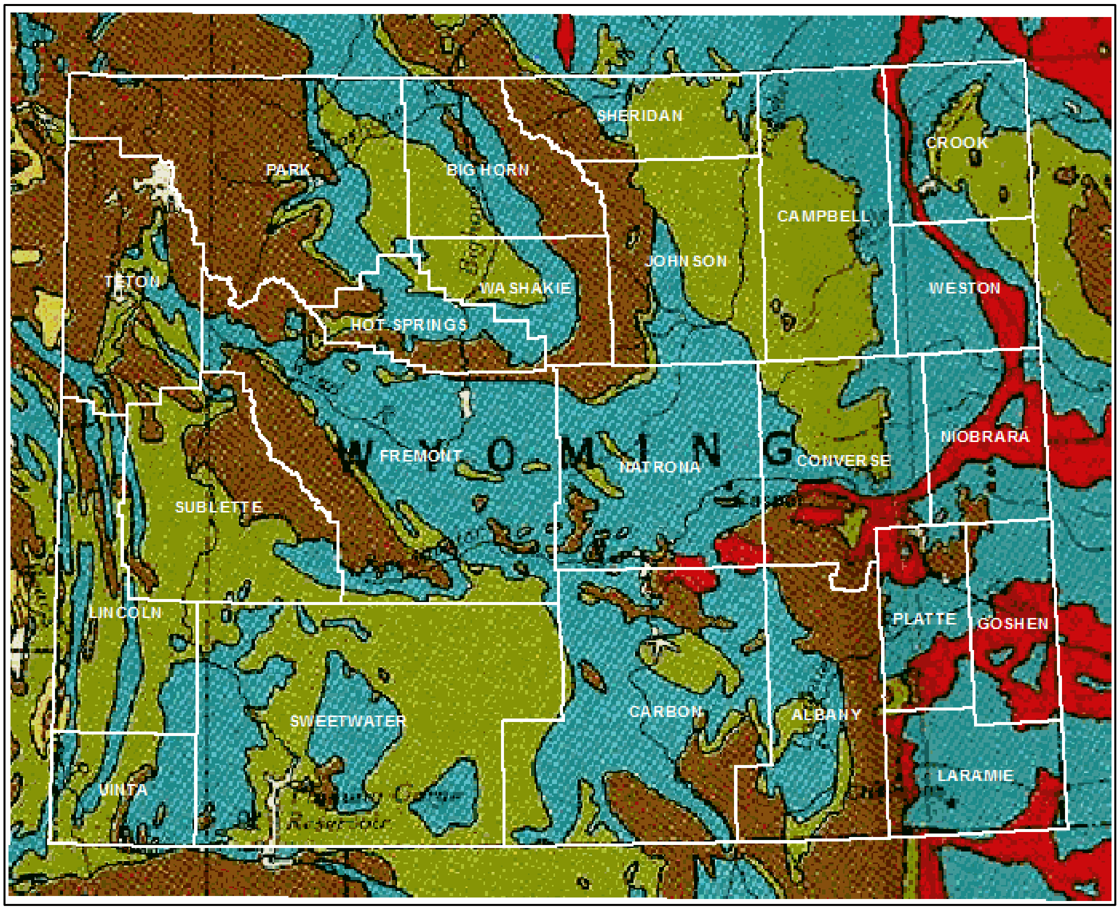
Figure 47. Damage to Sidewalk and Street Resulting from Expansive Soils

Some Wyoming clays have the potential to swell or shrink when transitioning between wet or dry. These clays are primarily montmorillonites. There is one type of montmorillonite, sodium montmorillonite (bentonite) that is especially prone to shrinking and swelling. Another montmorillonite, calcium montmorillonite, also shows some shrink-swell capabilities. Areas where these clays are known to be present are shown in **Figure 50**. All of the areas shown on the map are geological formations that contain bentonite, except for the Casper Mountain area in Natrona County where calcium montmorillonite is present. There are other areas in Wyoming with soils that have a shrink-swell component due to montmorillonites that are included in the soils. Those soils have not been completely mapped.

Figure 48. Clay Comparisons
A, initial view; B, after introduction of a small amount of water; C, 48 hour time lapse

The hazard these expansive soils create can be significant although they have, for the most part, been recognized and mitigated in urbanized areas. Many of the expansive soils do not create large areas of destruction; however, they can disrupt supply lines (i.e. roads, power lines, railways, and bridges) and damage structures. Expansive soils do not change size quickly. **(See Figure 48 above)** Observing damage in real-time can sometimes be difficult. Although damage may not occur in a matter of minutes, it still has potential to severely damage structures and roads over time if not sufficiently mitigated.

Figure 49. Expansive Soils under Very Dry Conditions Result in Desiccation Cracks



Red	High Potential for High Swell
Blue	Likely Potential for Mod. To High Swell
Green	Moderate Potential for Some to Low Swell
Brown	Low Potential for Swell

Figure 50. Wyoming Expansive Soils[33]

[33] Edgar, 2002

Potential vs. Realized Swell

Many soils and rocks have the potential to swell. That is a function of its mineralogy. The actual swelling will be caused by a change in the environment in which the material exists.

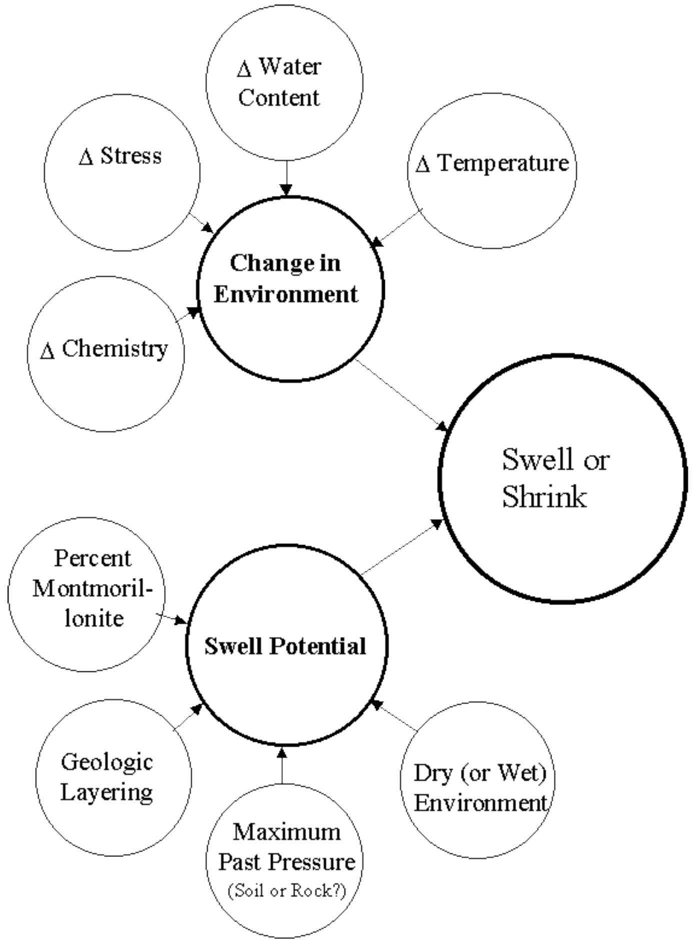


Figure 51. Soil Swell Potential

History and Probability of Future Events

Very little work has been done to study the extent of expansive soils in Wyoming. Although there have been instances in the Casper area where foundations and other concrete work have fractured and been displaced, historical accounts of actual damaging events caused by expansive soils have been difficult to locate. Even less is known about expansive soil locations outside of the Casper area.

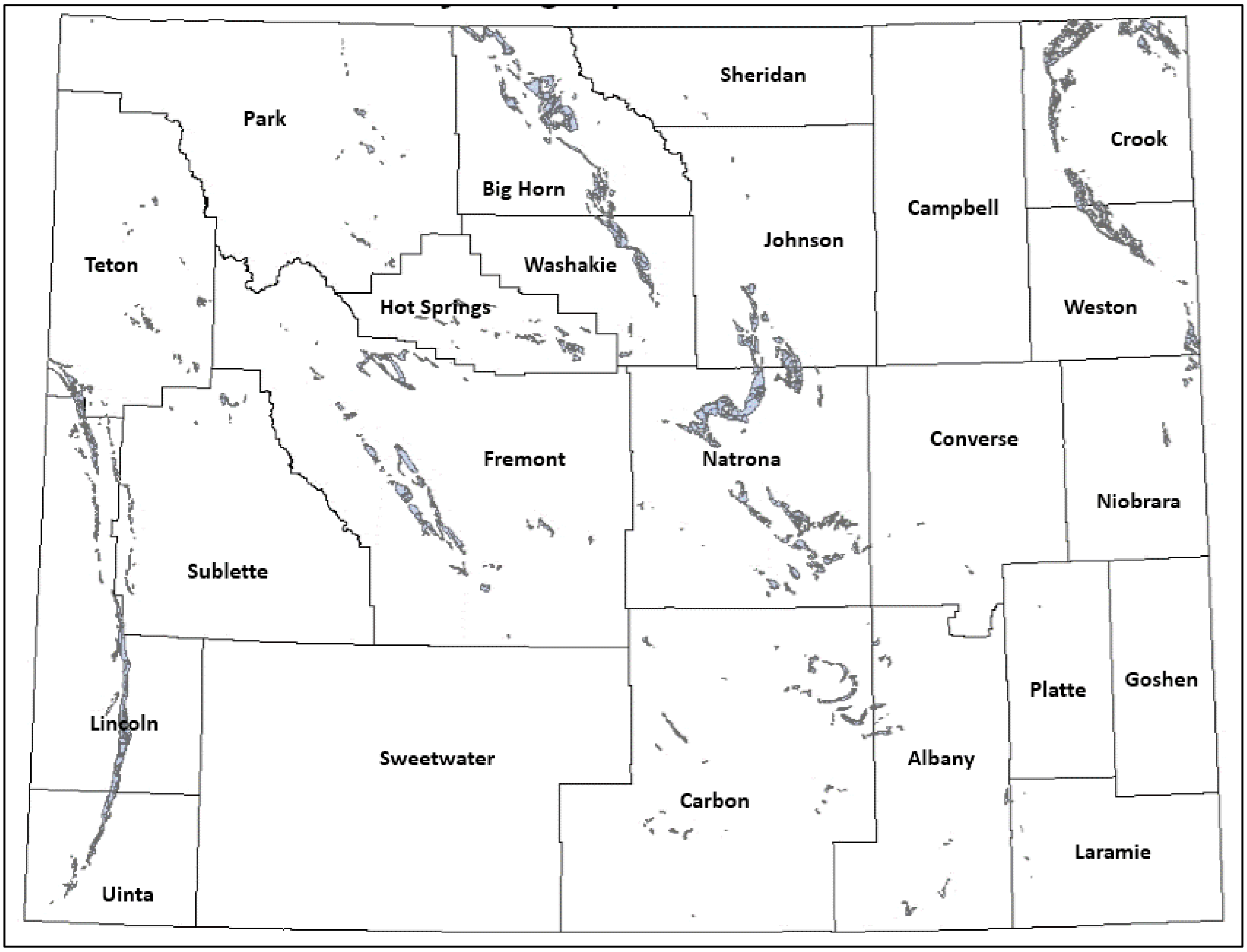


Figure 52. Thomas Edgar's Map of Wyoming Expansive Soils

As seen on **Figure 50** and the map presented in Thomas Edgar's technical paper **(Figure 52)** there are other areas in the state where expansive soils are present. This includes the eastern slope of the Wind River Mountains, the eastern side of the Bighorn Basin, the flanks of the Black Hills, and along the eastern edge of the Overthrust belt in north central Lincoln and Uinta counties. Very few reports regarding expansive soils have been described from these areas.

Probability

Unlikely = Value 1
Limited # Reported ÷ Unknown # years = Unknown % annual probability of a damaging expansive soils

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. Four counties profiled expansive soils in local plan risk assessments and each of them ranked the risk as low.

A review of Wyoming's local plans reflects little recognition of the hazard expansive soil. This would appear to be indicative of either a lack of information or the absence of this hazard in Wyoming's counties. Those who address the hazard within their plan have utilized data researched and available to them through the State Multi-Hazard Mitigation Plan. You will note the lack of documented instances of damage. Therefore it stands to reason this hazard would not be addressed locally.

Statewide Risk Assessment

As previously mentioned, damage from known expansive soil areas (namely the Casper area) has been poorly documented. Collecting a dollar estimate of damage caused by expansive soils has proven difficult, if not impossible. It is estimated that there has been less than $5 million of actual expansive soil related damage in the Casper area and the rest of the state.

There are two measurements used for calculating future impacts, historic dollar damages, and building exposure values. There are not enough current data to accurately estimate historic damages.

For the 2008 update to the State Plan, the Wyoming State Geological Survey (WSGS) calculated the building exposure value for buildings that may occur within the areas of expansive soils. All expansive soils mapped have been digitized and the expansive soils layer was then digitally crossed with Census block building values. In the event of an expansive soil boundary dissecting a census block, the proportional value of the buildings in the census block will be assigned to the expansive soil. In a case where a census block is within an expansive soil, the combined values of all the buildings in the census block are assigned. The values derived by county are shown in **Figure 53**. The rank of counties based upon expansive soil building exposure values is shown in **Table 36**. These damage estimates assume an instantaneous event, which would damage all of the property on suspected expansive areas at one time. The information was not updated due to both the lack of historically-documented damage and a lack of further, additional expansive soil inundation information.

The loss scenario pictured and outlined in the map and table below is extremely unlikely, meaning the exposed damage estimates are most likely vastly overstated. It is far more likely damage from expansive soils will be individual events, which will cause damage to a small number of buildings or road segments over time.

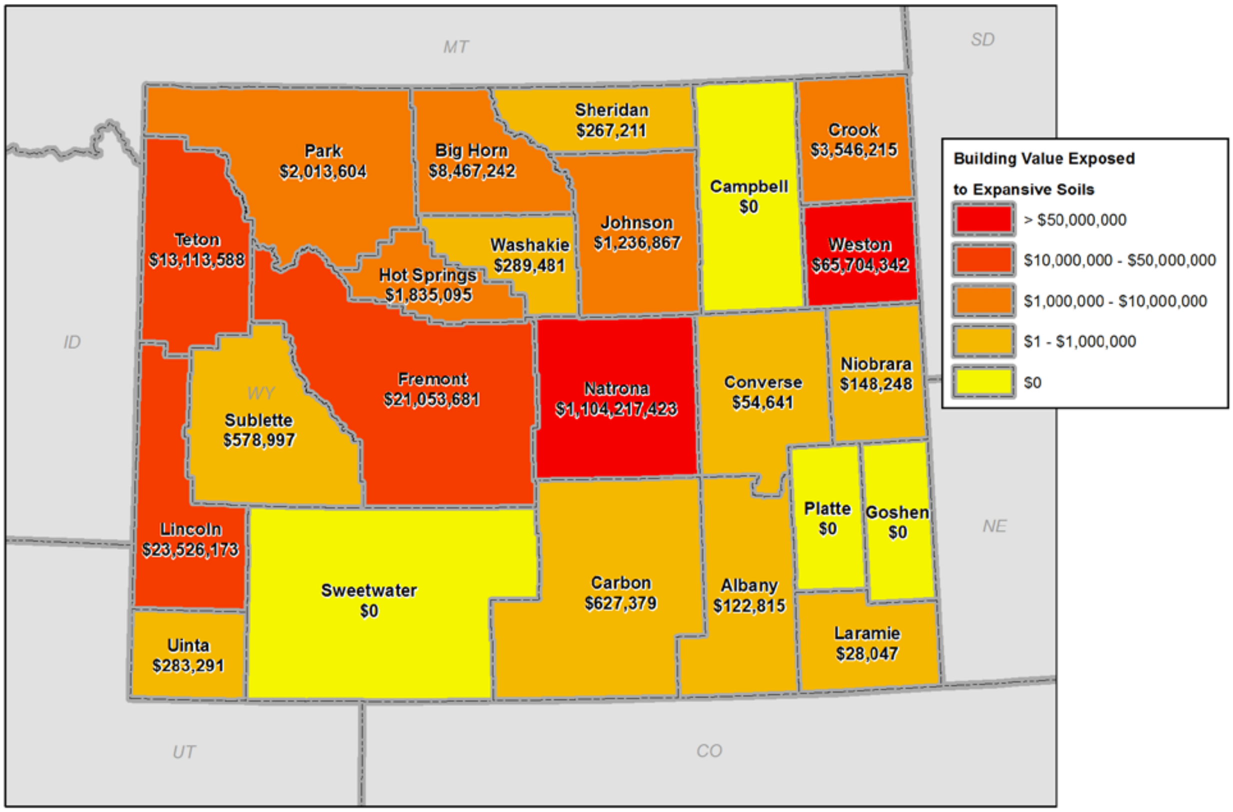


Figure 53. Building Exposure to Shrinking-Swelling Clays

Table 36. Building Exposure by County for Expansive Soils in Wyoming

County	Exposure value (USD)
Natrona	1,104,217,423
Weston	65,704,342
Lincoln	23,526,173
Fremont	21,053,681
Teton	13,113,588
Bighorn	8,467,242
Crook	3,546,215
Park	2,013,604
Hot Springs	1,835,095
Johnson	1,236,867
Carbon	627,379
Sublette	578,997
Washakie	289,481

County	Exposure value (USD)
Uinta	283,291
Sheridan	267,211
Niobrara	148,248
Albany	122,815
Converse	54,641
Laramie	28,047
Campbell	0
Goshen	0
Sweetwater	0
Platte	0
TOTAL	$1,247,114,339

Given the risk associated with expansive soils is most likely to be to a small number of individual structures and short road segments over time, loss of life is not associated with expansive soils, and the risk to structures and infrastructure appears to be vastly overstated, it was determined not to further address population vulnerability as associated with the hazard of expansive soils within the state. Should this hazard be determined to be of greater significance in the future, more attention will be given in the State's Multi-Hazard Mitigation Plan to the vulnerability of Wyoming's population as it relates to expansive soils.

In the unlikely event expansive soils are determined to be a significant hazard in Wyoming, the risk may most greatly impact areas where development is occurring and the potential for damage is increased as a result of construction completed without mitigation efforts addressing expansive soils.

According to the 2010 census, current areas where the greatest percentage population increase is occurring within Wyoming are Sublette (>50%) and Campbell Counties (25 percent - 49.9 percent). According to the 2010 census, the counties experiencing the greatest numerical increase in population are Laramie and Campbell Counties increasing by 10,000 - 20,000 people over the past 10 years, equating to an additional 1-2 thousand persons per year. Development can be related to the population increase as issued building permits reflect the greatest housing development occurred in Laramie, Natrona, Campbell, and Albany Counties **(Table 5).** According to the maps depicting areas where expansive soils are most prevalent, Goshen and Niobrara Counties are most likely of the four to experience damage resulting from expansive soil **(Figure 53)** with limited-to-no exposure to expansive soil likely in the other two counties **(Figure 53)**.

Changes in Development

According to **Figure 50**, Goshen, Platte, Niobrara, and Converse have the most area with high potential for swelling soils. Of these, Converse County is projected to be the fastest growing and the City of Douglas, the county's largest jurisdiction, is within high potential for swelling soils.

State Facilities at Risk

State facilities in the counties listed above may have the highest vulnerability to expansive soils. There are 103 state facilities in Goshen, 371 in Platte, 33 in Niobrara, and 143 in Converse County. Based on the swelling soils map above, City of Douglas in Converse County and the City of Torrington in Goshen County have the largest clusters of state facilities in areas with high swelling soil potential.

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 37. Expansive Soil Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	1.6	*Low*
Expansive Soils	1.0	1.3	1.9	2.6	2.3		

Flood

Description

Flooding can and has caused significant damage in Wyoming and is one of the more significant natural hazards in the state (**Figure 54**[34]). It can cause millions of dollars in damage in just a few hours or days. Every county and many communities in the state have experienced some kind of flooding after spring rains, heavy thunderstorms, winter snow thaws, or ice jams. According to information available through SHELDUS, flooding is the second the second highest loss-generating natural hazard in the state, exceeded only by hail.

A flood, as defined by the National Flood Insurance Program (NFIP), is a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of waters, unusual and rapid accumulation or runoff of surface waters from any source, or a mudflow. Floods can be slow or fast rising, but generally develop over a period of many hours or days.

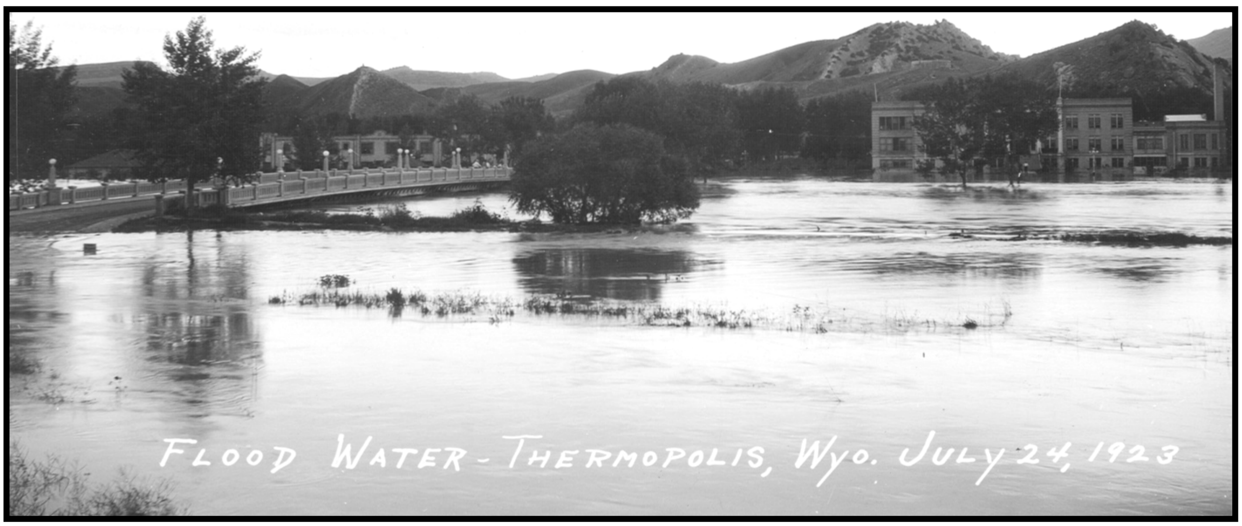


Figure 54. Big Horn River at Thermopolis, July 24, 1923.

Floods can also occur with little or no warning and can reach full peak in only a few minutes. Such floods are called flash floods. A flash flood usually results from intense storms dropping large amounts of rain within a brief period. Floods can occur for reasons other than precipitation or rapidly melting snow including ice jams and natural or man-made dam failures, both of which have occurred in Wyoming.

[34] Photo courtesy of Wyoming State Archives

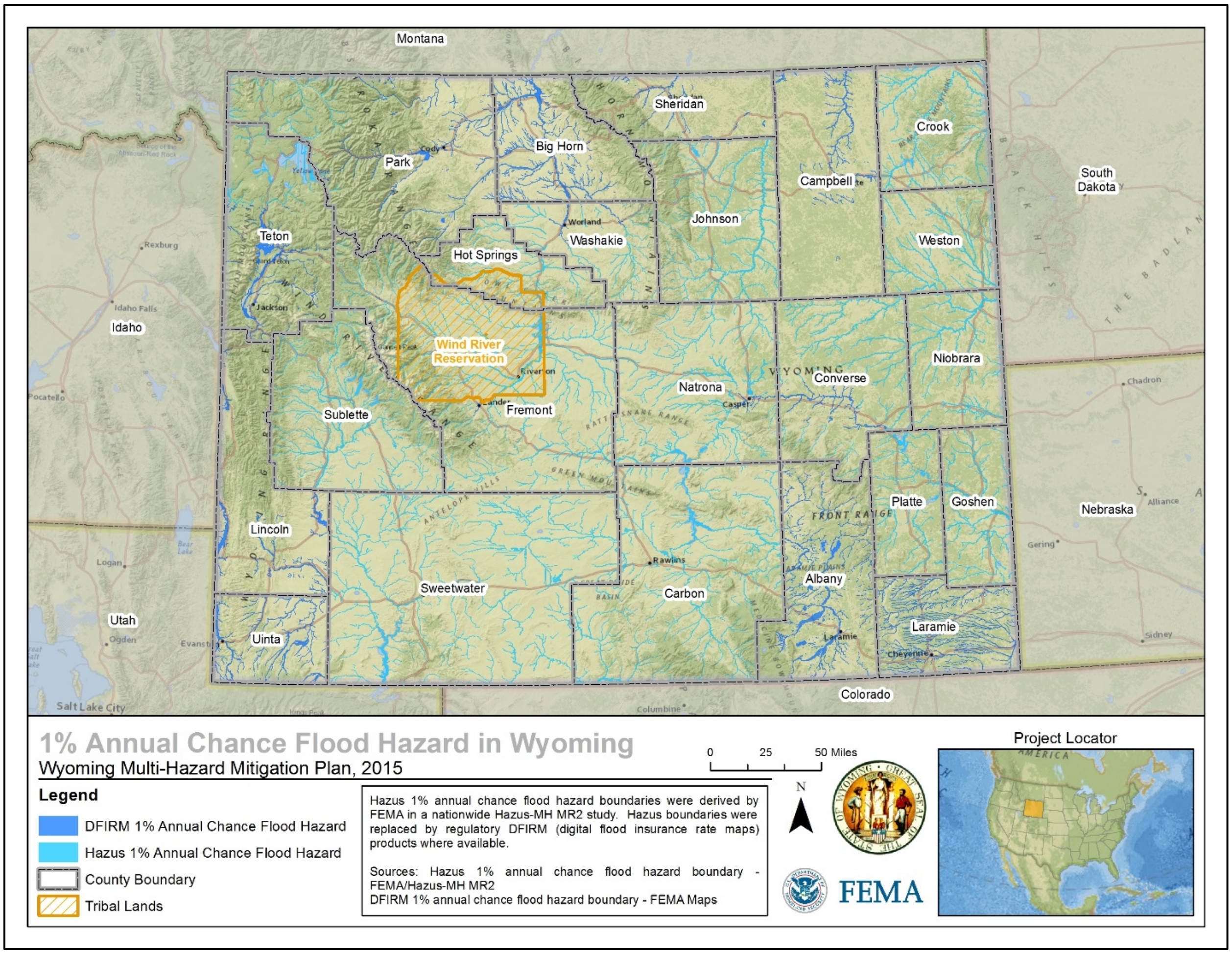


Figure 55. 1 Percent Annual Chance Flood Hazard

A series of maps and analysis were compiled for this update. FEMA Region VIII's Risk Analysis/GIS Division lent their skills to Wyoming.

History and Probability of Future Events

Below are two tables outlining Wyoming's presidentially-declared and state-declared emergencies resulting from flooding. **(Tables 38 and 39)**

Table 38. Presidential Disaster Declarations – Floods 1963-2015

Number	Declared	Description
4227	7/7/15	Severe Storms and Flooding
4007	7/22/11	Severe Storms, Flooding and Landslides
1923	07/14/2010	Flooding
740	08/07/1985	Severe Storms, Hail, Flooding
557	05/29/1978	Severe Storms, Flooding, Mudslides
155	07/04/1963	Heavy Rains, Flooding

Table 39. State-Level Emergencies – Flood 2005-2013

Date	Case #	# of Days	Location	Resource Used	Total Costs	Notes
5/3/2005	05-0002	1	Diamondville	CAP	$ 377.92	Photographic mission to assess the extent of flooding expected *(Gorny report)*
5/11/2005	05-0004	5	Sheridan County	Nat'l Guard	$ 333,881.58	WANG, Honor Farm, City of Sheridan, Sheridan County *(Gorny report)*
6/6/2005	05-0009	9	Albany County	Honor Farm & Guard	$ 2,850.00	Costs are pmt to Honor Farm only - no cost info avail for Guard. Incident participation was used to replace a drill previously scheduled for Laramie area *(Gorny report)*
8/15/2006	06-0019	2	Goshen County (LaGrange)	CAP	$ 122.72	Aerial recon
5/20/2008	08-0010	3	Baggs	Nat'l Guard	$ 30,705.72	Guard sandbagging, MSV#2
7/3/2009	0016IC-070609		Natrona County	WOHS	$ 21,147.41	State Disaster Declaration
3/8/2014		5	Big Horn & Washakie Counties	WOHS, Wranglers, Smoke Busters, Guard, VOAD		3/14/2014- State Disaster Declaration Executed- Ice Jam Flooding

The following table lists loss-causing flood events and associated damage by county, collected from SHELDUS and NCDC past events databases.

Table 40. Flood Events, Casualties, and Damage by County (1960-2015)

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Albany	7	-	-	$ 184,364	$ 125,000	$ 309,364
Big Horn	24	-	-	$ 3,155,239	$ 196,833	$ 3,352,072
Campbell	15	4	1	$ 1,585,406	$ 5	$ 1,585,411
Carbon	5	2	4	$ 47,739	$ -	$ 47,739
Converse	6	-	1	$ 458,072	$ 167	$ 458,239

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Crook	7	-	-	$ 708,406	$ -	$ 708,406
Fremont	22	-	1	$ 13,769,789	$ 790,000	$ 14,559,789
Goshen	9	-	-	$ 864,864	$ 210,000	$ 1,074,864
Hot Springs	7	-	-	$ 2,097,906	$ -	$ 2,097,906
Johnson	21	1	-	$ 2,762,472	$ 267,000	$ 3,029,472
Laramie	27	70	12	$ 65,389,431	$ 125,167	$ 65,514,597
Lincoln	9	-	-	$ 1,833,739	$ 175,000	$ 2,008,739
Natrona	22	1	-	$ 8,093,072	$ -	$ 8,093,072
Niobrara	4	-	-	$ 1,978,406	$ -	$ 1,978,406
Park	18	-	-	$ 1,980,572	$ 16,833	$ 1,997,406
Platte	12	-	-	$ 393,031	$ 225,167	$ 618,197
Sheridan	10	-	-	$ 1,151,739	$ -	$ 1,151,739
Sublette	3	-	-	$ 81,739	$ -	$ 81,739
Sweetwater	6	1	1	$ 797,789	$ -	$ 797,789
Teton	7	-	-	$ 118,406	$ 167	$ 118,572
Uinta	2	-	-	$ 31,739	$ -	$ 31,739
Washakie	14	-	-	$ 1,244,072	$ 31,667	$ 1,275,739
Weston	10	-	-	$ 921,406	$ -	$ 921,406
Statewide	**267**	**79**	**20**	**$ 109,649,400**	**$ 2,163,005**	**$ 111,812,405**

The following map shows losses by county for events recorded 1960-2012.

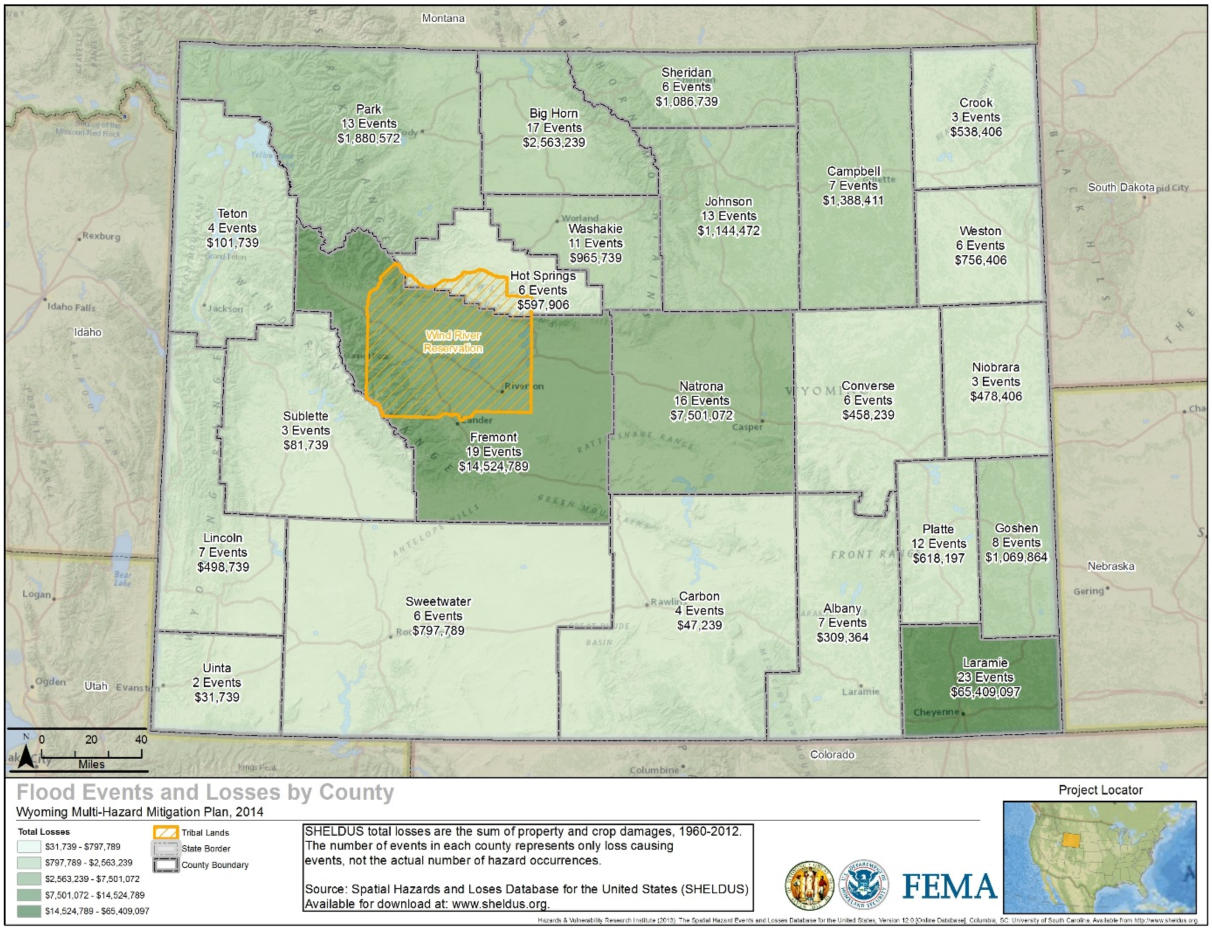


Figure 56. Flood Events and Losses by County, 1960-2012

The documented flood history for Wyoming extends back to July 1895 in Casper, Wyoming. The flood produced a 20-foot-high wall of water sweeping down Garden Creek, wiping out a camp of settlers at present-day Westwood School. Three people drowned.

Figure 57. Lincoln County Flood, 1983

Figure 58. Cheyenne, near Carlson St. August 2008, Curb and Gutter Flooding

The most damaging flood in Wyoming's history was the August 1, 1985 flood in Cheyenne. The dollar property loss was $65 million. In 2010 dollars the damage would be nearly $132.2 million. Twelve deaths and 70 injuries were associated with that event. The greatest loss of life associated with flooding, however, did not occur in 1985. In September 1923, five days of widespread rainfall caused a 60- to greater than 100-year flood resulting in a railroad bridge being washed out east of Casper. The event took 18 lives on September 27, 1923.

Figure 59. Encampment Flood, June 2008

Another significant flood occurred May 15, 1978. Heavy wet snow and record rains did extensive damage to property, crops, and livestock in 12 counties (Park, Big Horn, Campbell, Converse, Crook, Johnson, Natrona, Sheridan, Washakie, Weston, Hot Springs, and Niobrara). Hundreds of homes were damaged, and many totally destroyed. Numerous bridges and sections of roads were washed out power lines were downed, with much damage to cars and personal property. Total estimated damages came to $15.5 million.

August 27, 2002 the town of Kaycee in Johnson County was inundated by flash flooding from a storm that struck the southern part of the county. The flooding caused significant devastation, with the Wyoming Office of Homeland Security [then WEMA] reporting a final count on Wednesday, August 28, 2002 of $459,166 in damage, including 19 trailers, 22 houses, and 12 of Kaycee's 15 businesses.

Figure 60. Flash Flood in Middle Fork Powder River West of Kaycee

Wyoming experienced significant flooding in 2010 and again in 2011, each resulting in presidential declarations. The flooding in 2011 was more widespread than in 2010. The 2010 flood received a Presidential Declaration on July 14, 2010 and was the result of a sudden warm up creating mountain snow melt, further exacerbated by early spring rains. It impacted Fremont County and portions of the Wind River Indian Reservation which lies within Fremont County. The preliminary damage assessment totaled just over $7 million, reflecting a statewide per capita impact of $14.27.

Figure 61. June 2010 Fremont County Flood-Lander 'Sandbox'

Flooding in 2011, resulted in a presidential declaration on July 22, 2011 and impacted the Wind River Indian Reservation and 15 of Wyoming's 23 counties. The 2011 flooding was the result of significant mountain snowpack which melted over a two-month period. Preventative action taken by local counties, augmented by Wyoming National Guard Troop assistance and assistance from the Wyoming Office of Homeland Security, resulted in less flood damage than otherwise would have been experienced. Even though the flooding impact was felt throughout the state, the flooding in 2011 resulted in a preliminary damage assessment totaling $4.2 million (statewide per capita impact of $7.61), considerably less than the 2010 flood when only one county was impacted by flooding. The preventative action taken in advance of the spring snow-melt was viewed as a best practice to be re-implemented in future flooding events.

Figure 62. June 2011 Statewide Flooding – Berming and Sandbagging

Figure 63. Flood Waters on Capital Avenue, Cheyenne, July 15, 1896

The abbreviated flood history attached (**Appendix J**) was in large part derived from the monthly storm data reports generated and released by the National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center (NCDC). Other sources are unpublished reports from the Wyoming Office of Homeland Security, newspaper accounts, and periodicals from public libraries. The table is arranged by county in alphabetical order and represents those floods that have caused damage, injuries, or loss of life in addition to other flooding events.

Probability

Flood event frequency is calculated statewide and by county below and is based on loss-causing events, 1960-2015, collected from SHELDUS and NCDC databases.

Highly Likely = Value 4
267 loss-causing events ÷ 55.5 years = 4.8 flood events every year or a >100.0 % annual probability of a damaging flood event

Table 41. Flood Event Frequency by County

County	Total Events	Time Period	Frequency	Probability
Albany	7	55.5 yrs	13%	Likely
Big Horn	24		43%	Likely
Campbell	15		27%	Likely
Carbon	5		9%	Occasional
Converse	6		11%	Likely
Crook	7		13%	Likely
Fremont	22		40%	Likely
Goshen	9		16%	Likely
Hot Springs	7		13%	Likely
Johnson	21		38%	Likely
Laramie	27		49%	Likely
Lincoln	9		16%	Likely
Natrona	22		40%	Likely
Niobrara	4		7%	Occasional
Park	18		32%	Likely
Platte	12		22%	Likely
Sheridan	10		18%	Likely
Sublette	3		5%	Occasional
Sweetwater	6		11%	Likely
Teton	7		13%	Likely
Uinta	2		4%	Occasional
Washakie	14		25%	Likely
Weston	10		18%	Likely
Statewide	267	55.5 yrs	481%	Highly Likely

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. The map below shows these rankings by county to demonstrate local perception of risk across the state.

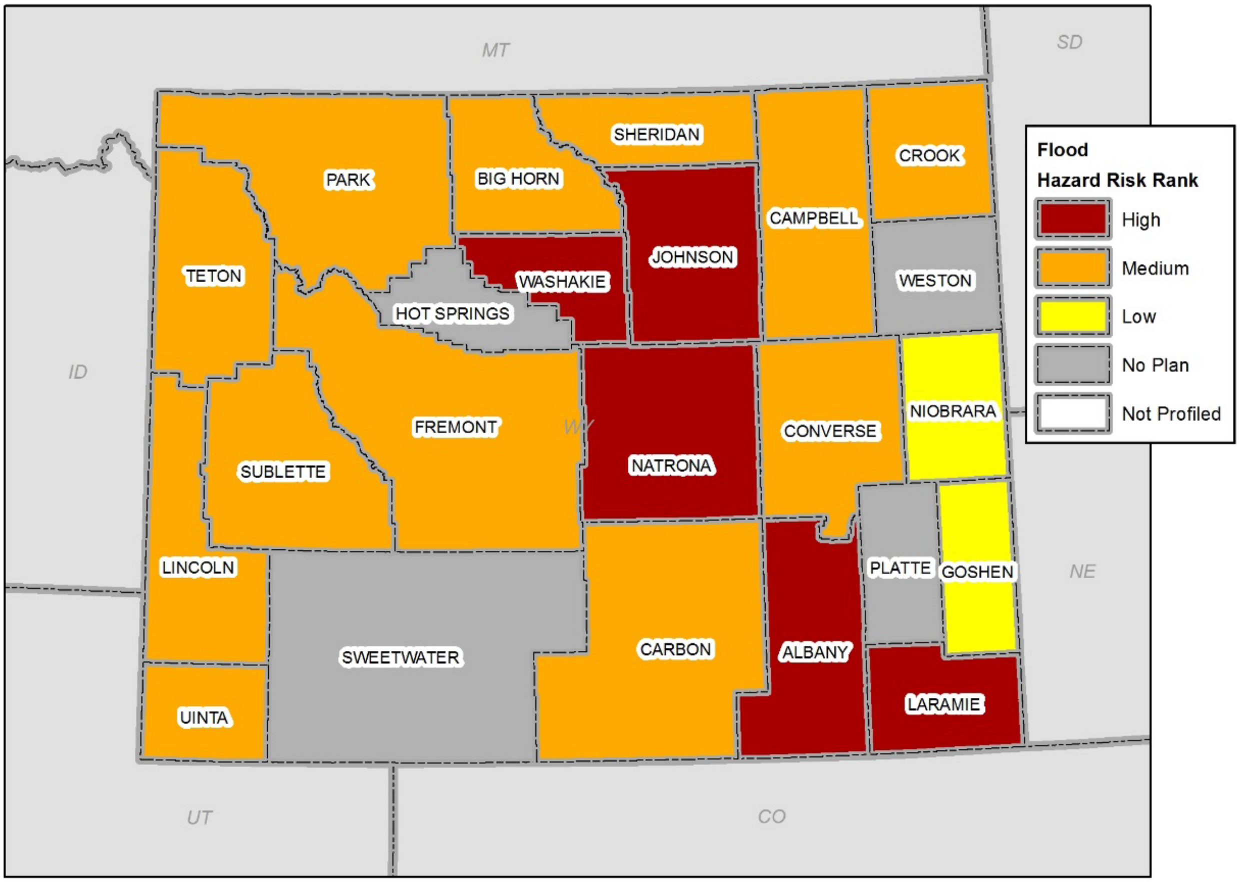


Figure 64. Flood Risk Rankings from Local Hazard Mitigation Plan Risk Assessments

Local plans incorporate risk assessments, GIS maps of 100 and 500 year floodplain maps, and tables related to the National Flood Insurance Program, all obtained from the Wyoming Office of Homeland Security. Because of a lack of resources, Wyoming counties rely heavily on the State Mitigation Plan for the majority of their risk assessments.

Sheridan, Big Horn, and Teton Counties have each received flood risk products (report, map, database) as part of a FEMA Risk MAP project. These products include flood risk assessments, depth and velocity grids, changes since last FIRM, and areas of mitigation interest datasets and should be incorporated into local planning efforts and statewide planning as appropriate.

State Risk Assessment

Planning level flood loss estimates were made available for every county in Wyoming with the 2010 update to the Wyoming Hazard Mitigation Plan. FEMA's HAZUS-MH MR2 GIS-based natural hazard loss estimation software was utilized to complete the county-level analysis. The HAZUS-MH flood model results included analysis for each of the 23 counties modeling streams draining a 10 square mile minimum drainage area, using 30 meter (1 arc second) Digital Elevation Models (DEM). Hydrology and hydraulic processes utilize the DEMs, along with flows from USGS regional regression equations and stream gauge data, to determine reach discharges and to model the floodplain. Losses are then calculated using HAZUS-MH national baseline inventories (buildings and population) at the census block level.

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

Potential losses derived from HAZUS-MH used default national databases and may contain inaccuracies; loss estimates should be used for planning level applications only. The damaged building counts generated are susceptible to rounding errors and are likely the weakest output of the model due to the use of census blocks for analysis. There could also be errors and inadequacies associated with the hydrologic and hydraulic modeling of the HAZUS-MH model. In rural Wyoming, census blocks are large and often sparsely populated or developed; this may create inaccurate loss estimates. HAZUS-MH assumes population and building inventory to be evenly distributed over a census block; flooding may occur in a small section of the census block where there are not actually any buildings or people, but the model assumes that there is damage to that block. In addition, excessive flood depths may occur due to problems with a digital elevation model (DEM) or with modeling lake flooding. Errors in the extent and depth of the floodplain may also be present from the use of 30 meter digital elevation models. HAZUS-MH Level II analyses based on local building inventory, higher resolution terrain models, and DFIRMs could be used in the future to refine and improve the accuracy of the results.

The HAZUS Flood Loss Estimates table **(Table 42)** includes building and contents value loss estimates, percent building damage, per capita loss, and displaced population and shelter needs estimates for each county.

Table 42. Hazus Flood Loss Estimates by County

County	Building Damage County	Building Loss	% Building Damage	Contents Loss*	% Contents Loss	Total Loss**	Per Capita Loss ($)*	Short Term Shelter	Displaced Population	% Short Term Shelter
Albany	132	$ 12,604,630	0.50%	$ 15,473,890	1.00%	$ 29,096,071	$ 769	985	1,528	64%
Big Horn	605	$ 69,163,956	8.30%	$ 73,670,765	13.80%	$ 146,514,473	$ 12,099	1,059	2,272	47%
Campbell	85	$ 15,896,292	0.70%	$ 24,334,874	1.50%	$ 42,347,911	$ 818	515	1,029	50%
Carbon	131	$ 21,063,326	1.60%	$ 26,766,350	3.20%	$ 49,306,310	$ 3,076	223	1,151	19%
Converse	50	$ 10,255,978	1.10%	$ 8,924,878	1.40%	$ 19,578,410	$ 1,301	219	590	37%
Crook	67	$ 8,513,124	1.80%	$ 8,119,118	2.70%	$ 16,984,836	$ 2,232	170	425	40%
Fremont	221	$ 31,030,603	1.30%	$ 35,426,191	2.20%	$ 68,889,454	$ 1,619	1,140	2,445	47%
Goshen	201	$ 17,953,877	2.00%	$ 18,915,818	3.10%	$ 38,480,030	$ 2,813	770	1,297	59%
Hot Springs	133	$ 18,305,287	4.80%	$ 34,407,456	13.50%	$ 54,417,734	$ 10,546	375	712	53%
Johnson	17	$ 6,554,928	1.10%	$ 7,419,847	2.00%	$ 14,386,529	$ 1,609	23	269	9%
Laramie	157	$ 30,105,341	0.50%	$ 58,988,436	1.40%	$ 91,647,122	$ 952	755	1,458	52%
Lincoln	8	$ 7,649,388	0.60%	$ 11,985,816	1.50%	$ 20,514,322	$ 1,119	92	603	15%
Natrona	1,866	$ 138,534,972	2.70%	$ 152,810,280	4.20%	$ 303,585,456	$ 3,842	5,740	7,049	81%
Niobrara	6	$ 2,149,874	1.20%	$ 2,314,339	1.80%	$ 4,552,954	$ 1,758	97	223	43%
Park	27	$ 11,145,744	0.50%	$ 9,837,125	0.70%	$ 21,482,179	$ 729	82	533	15%
Platte	16	$ 6,610,538	1.00%	$ 6,830,614	1.50%	$ 13,824,509	$ 1,578	92	455	20%
Sheridan	471	$ 48,545,513	1.70%	$ 61,520,484	3.00%	$ 114,006,053	$ 3,766	2,095	3,566	59%
Sublette	3	$ 4,655,892	0.70%	$ 5,006,119	1.20%	$ 10,012,238	$ 834	16	300	5%
Sweetwater	543	$ 77,001,473	2.60%	$ 114,576,355	5.90%	$ 202,592,237	$ 4,363	1,550	2,230	70%
Teton	334	$ 40,350,670	1.90%	$ 40,748,225	3.00%	$ 82,911,557	$ 3,703	1,965	2,869	68%
Uinta	155	$ 16,285,565	1.10%	$ 17,623,764	1.90%	$ 34,980,125	$ 1,595	922	1,439	64%
Washakie	195	$ 28,001,611	4.50%	$ 45,063,355	10.50%	$ 78,095,933	$ 8,775	730	1,278	57%

Weston	7	$ 2,569,910	0.50%	$ 2,513,117	0.80%	$ 5,220,278	$ 686	13	123	11%
Statewide	**5,430**	**$ 624,948,492**	**1.58%**	**$ 783,277,217**	**2.95%**	**$ 1,463,426,722**	**$ 2,461**	**19,628**	**33,844**	**58%**
*****2015 Dollars***										
*****Total loss is the sum of the building and content losses as well as indirect and business disruption losses***										

The Statewide Floodplain Boundary map (**Figure 56**) shows the statewide flood hazard. It was completed using the best available data, a combination of regulatory Digital Flood Insurance Rate Maps (DFIRM) and FEMA's HAZUS-MH MR2 study. Below is a map depicting the total loss estimates should the 100 year flood occur for each Wyoming County (**Figure 65**).

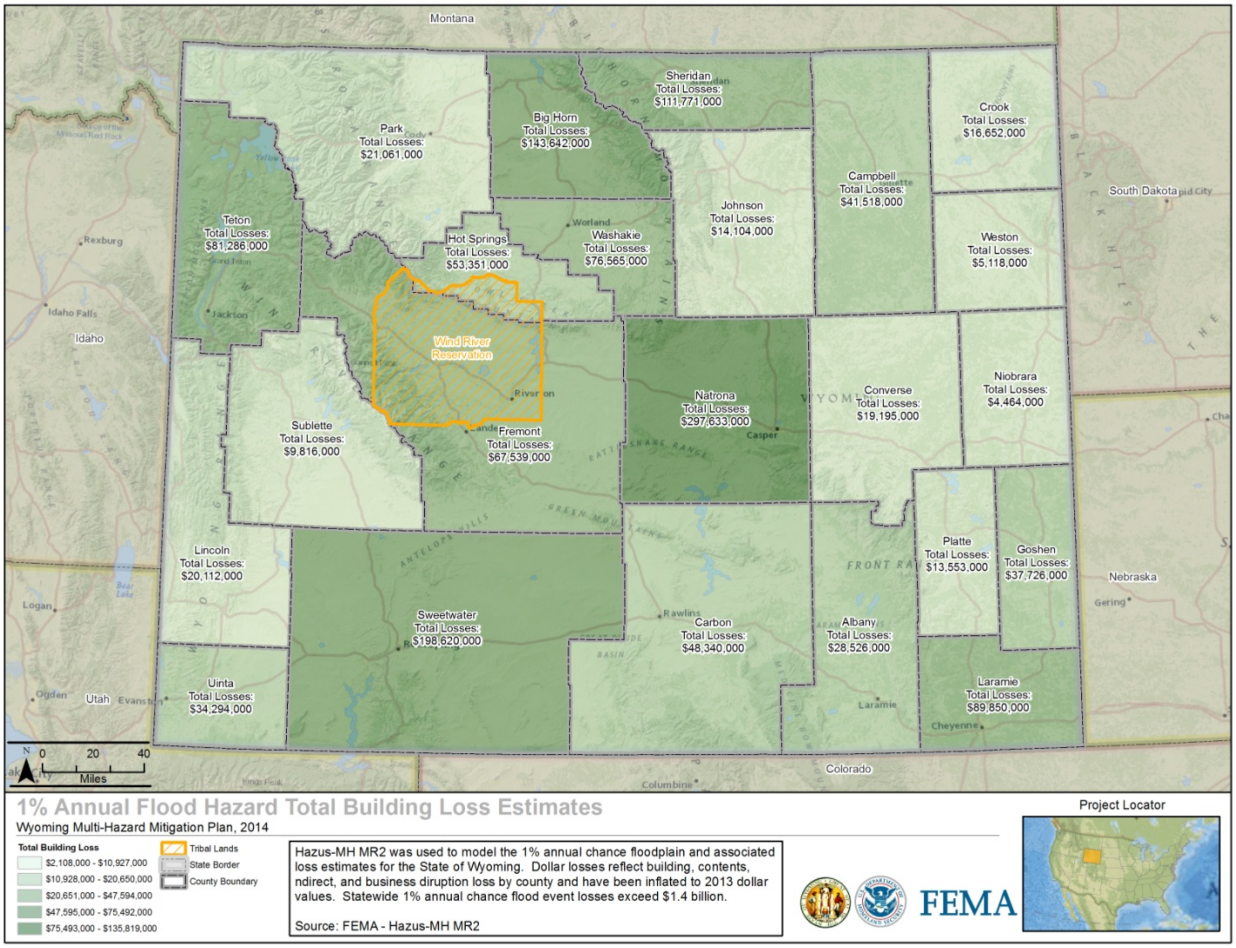


Figure 65. 1 Percent Annual Flood Hazard Total Building Loss Estimates

When summed together the total estimated statewide flood losses exceed $1.46 billion for Wyoming. Dollar loss estimates in Table 3.6.7 have been updated with an inflation factor of 1.02 percent between 2013 and 2015. Loss estimates in Map 3.6.8 reflect the 2013 values.

A map was also prepared for four of Wyoming's largest municipalities, depicting the area in each community which is susceptible to a 1 percent chance of flooding each year, sometimes referred to as the "100-year flood." (**Figure 66**). These four communities have experienced significant development over the past several years, making it important to appropriately regulate and monitor development in the flood hazard area.

Figure 66. 1 percent Annual Chance Flood Hazard Area, Casper, Cheyenne, Gillette, Laramie

Changes in Development

The percentage of developable lands within a county located in high hazard areas was calculated, a matrix was created and the hazard was mapped showing where growth rates intersect with a high percentage of developable lands. This was done using the population growth rates by county (**Appendix L**). With this matrix approach in the map below (**Figure 67**), Counties with darker blue shading represent those with higher population growth rates, while dark red shading represents those with a higher percentage of developable hazard area. The darker the purple shading represents the overlap of high population growth rates and developable hazard areas.

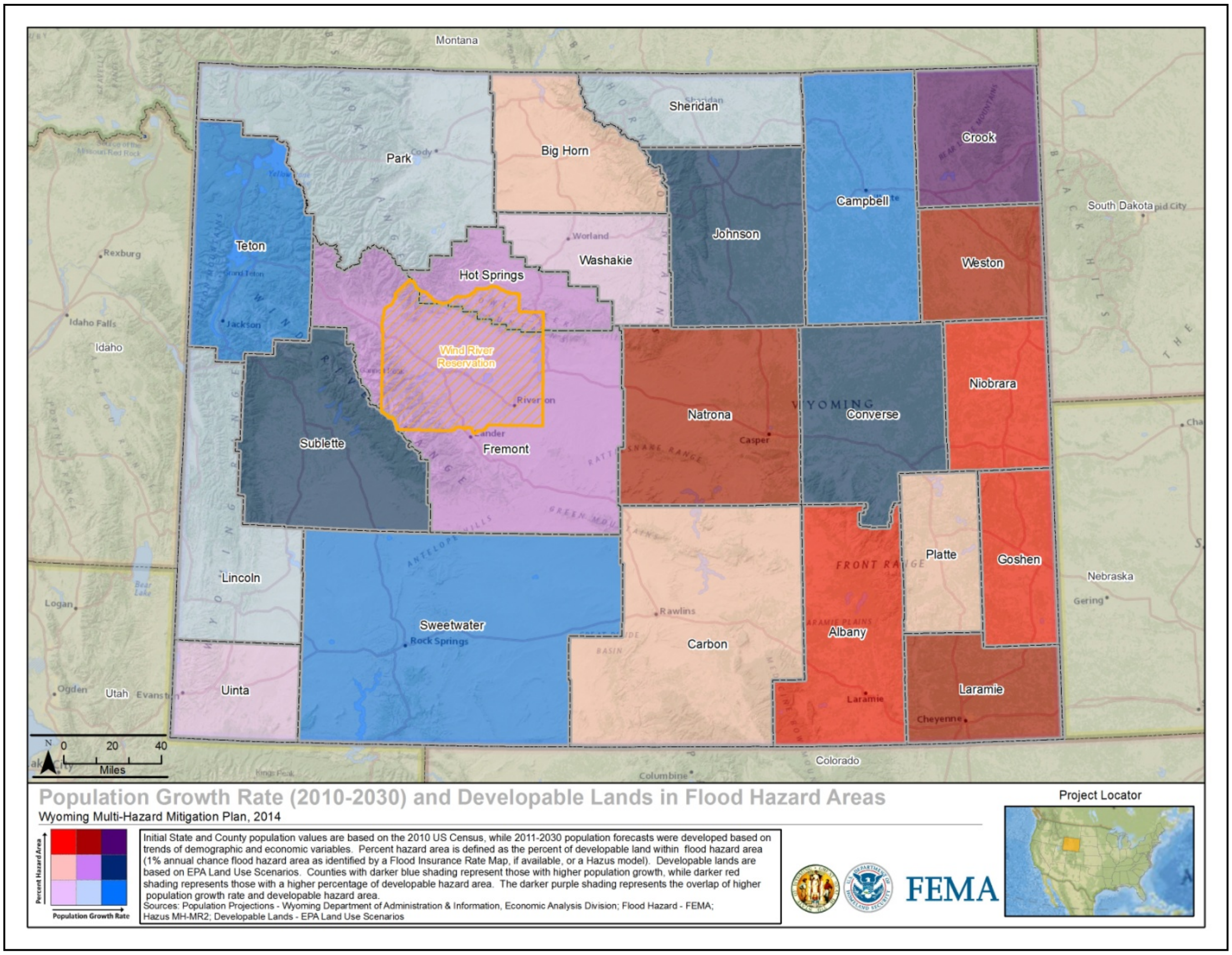


Figure 67. Intersection of Developable Lands in Flood Hazard Areas and Population Growth Rate 2010-2030

State Facilities at Risk

Losses to state facilities from flood events are listed in the table below; data includes number of events and associated damage and are sorted by state agency.

Table 43. State Building Losses – Flood (2/20/11-9/24/2015)

State Agency	Total Events	Loss ($)
Department of Corrections	8	$ 2,087
Department of State Parks and Cultural Resources	9	$ 464,280
Judicial District 8	1	$ -
Wyoming Department of Health	2	$ -
Wyoming Department of Transportation	4	$ -
Wyoming Fish and Game Department	9	$ 23,626

State Agency	Total Events	Loss ($)
Wyoming Office of Tourism Board	1	$ 1,633
Wyoming State Geological Survey	1	$ -
Total	**35**	**$ 491,627**

Some state structures are located within the 100-year flood plain. **Figure 68** below shows where state assets intersect with the boundary of the 1 percent annual chance of flood. The flood hazard boundaries were derived by FEMA in a nationwide HAZUS-MH MR2 study. The HAZUS boundaries were replaced by regulatory Wyoming Digital Flood Insurance Rate Maps (DFIRM) where available.

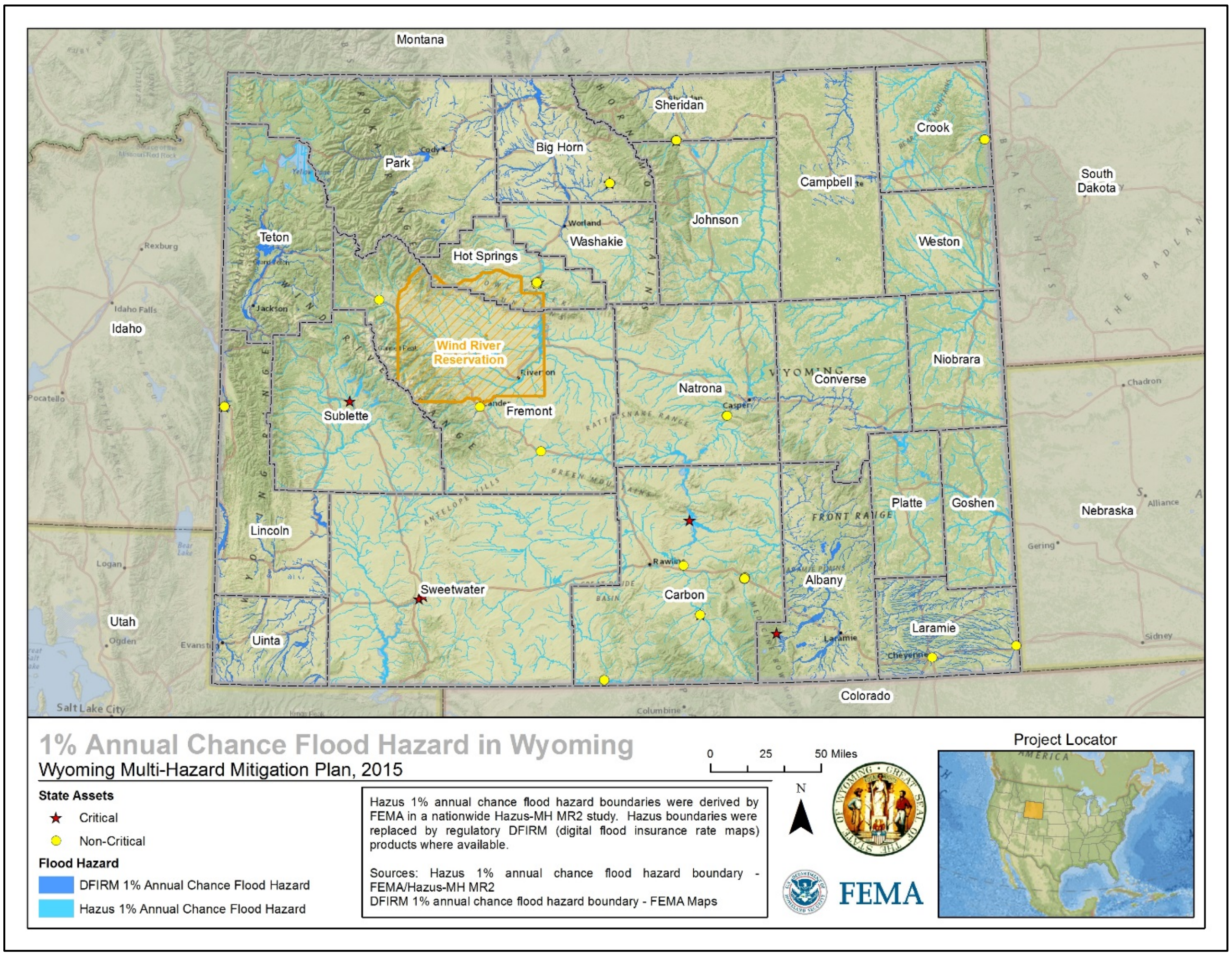


Figure 68. State Assets in the 1 Percent Annual Chance Flood Hazard

The table below summarize state facilities located within the 1 percent annual chance floodplain and the next table lists those facilities that are considered to be critical.

Table 44. State Facilities Exposed to the 1 Percent Annual Chance Flood Event

County	Buildings Exposed	Total Value*
Albany	3	$ 400,394
Big Horn	5	$ 659,292
Campbell	-	$ -
Carbon	15	$ 1,850,056
Converse	-	$ -
Crook	2	$ 758,738
Fremont	3	$ 3,222,019
Goshen	-	$ -
Hot Springs	14	$ 11,662,460
Johnson	-	$ -
Laramie	3	$ 3,135,092
Lincoln	11	$ 1,014,471
Natrona	3	$ 724,558
Niobrara	-	$ -
Park	-	$ -
Platte	-	$ -
Sheridan	8	$ 1,419,133
Sublette	1	$ 16,666
Sweetwater	2	$ 103,858
Teton	-	$ -
Uinta	-	$ -
Washakie	-	$ -
Weston	-	$ -
Statewide	**70**	**$ 24,966,737**

**2015 Dollars*

Table 45. Critical State Facilities Exposed to the 1 percent Annual Chance Flood Event

Agency	Location	Address	County
University of Wyoming	Horseshoe Haven Cabin	117 Rainbow Valley Road	Albany
University of Wyoming	Creekside Cabin	117 Rainbow Valley Road	Albany
University of Wyoming	Mountain View Cabin	117 Rainbow Valley Road	Albany
Game and Fish	Asst. Warden Residence I	2411 Fish Hatchery Road	Lincoln

Agency	Location	Address	County
State Parks and Cultural Resources	Medicine Lodge	4800 County Road 52	Big Horn
State Parks and Cultural Resources	Upper Area	4800 County Road 52	Big Horn
State Parks and Cultural Resources	Medicine Lodge River	4800 County Road 52	Big Horn
Department of Environmental Quality	BLM Building	1625 West Pine Street	Sublette
Department of Corrections	Probation & Parole	1750 Sunset Drive	Sweetwater
Public Defender's Office	Public Defenders Office	404 North Street	Sweetwater
State Engineers Office		215 North 1st Street	Carbon
State Engineers Office		215 North 1st Street	Carbon
State Parks and Cultural Resources	Sand Mountain		Carbon
Game and Fish	Story Hatchery	306 Fish Hatchery Road	Sheridan
Department of Health	Department of Health	117 North 4th Street	Hot Springs
Department of Health	Pioneer Home	141 Pioneer Drive	Hot Springs
Department of Health	Department of Health	328 Arapahoe Street	Hot Springs
Department of Family Services		403 Big Horn Street	Hot Springs
Department of Family Services	Enforcement/Clerk of District	415 Arapahoe Street	Hot Springs
Supreme Court	Hot Springs Circuit Court	415 Arapahoe Street	Hot Springs

Figure 69. 2011 Flooding in Carbon County

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 46. Flood Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	3.1	*High*
Flood	4.0	2.6	2.8	2.6	3.1		

HAIL

Description

Figure 70. Hail Damage in Ten Sleep, August 2010

Hail causes more than $1 billion of property damage nationally each year. The southeast corner of Wyoming lies within the nation's "Hail Alley." Together with adjacent portions of Colorado and Nebraska, this region of Wyoming is battered by more hailstorms than any other part of the United States. Climatological data shows this area of Wyoming averages five to nine days of hail annually.

Figures 9 and 10 show that though hail represents only nine percent of the number of hazard incidents recorded in SHELDUS, hail damage ranks #1 and has cost the residents of Wyoming in excess of $156 million, representing 39 percent of losses from natural hazards. This would indicate there is room for improvement in mitigation activity related to minimizing hail losses.

History and Probability of Future Events

The following table lists loss-causing hail events and associated damage by county, collected from SHELDUS and NCDC past events databases.

Table 47. Hail Events, Casualties, and Damage-County and Statewide (1960-2015)

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Albany	5	-	-	$ 70,083	$ -	$ 70,083

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Big Horn	12	1	-	$ 156,000	$ 875,500	$ 1,031,500
Campbell	34	2	-	$ 74,272,606	$ 5,550	$ 74,278,156
Carbon	3	-	-	$ 100,000	$ 500	$ 100,500
Converse	14	1	-	$ 122,633	$ 25,150	$ 147,783
Crook	37	4	-	$ 3,968,056	$ 30,500	$ 3,998,556
Fremont	17	-	-	$ 154,167	$ 174,167	$ 328,333
Goshen	32	-	-	$ 3,256,350	$ 1,351,550	$ 4,607,900
Hot Springs	5	1	-	$ 527,667	$ 4,167	$ 531,833
Johnson	19	-	-	$ 560,050	$ 280,050	$ 840,100
Laramie	95	3	-	$ 54,336,750	$ 5,733,350	$ 60,070,100
Lincoln	4	-	-	$ 110,000	$ 250,000	$ 360,000
Natrona	16	1	-	$ 1,237,700	$ 100	$ 1,237,800
Niobrara	16	-	-	$ 240,633	$ 5,600	$ 246,233
Park	16	-	-	$ 2,215,000	$ 1,115,000	$ 3,330,000
Platte	23	-	-	$ 511,050	$ 45,500	$ 556,550
Sheridan	11	-	-	$ 710,500	$ 5,600	$ 716,100
Sublette	-	-	-	$ -	$ -	$ -
Sweetwater	1	-	-	$ 700,000	$ -	$ 700,000
Teton	5	2	-	$ 35,000	$ 5,000	$ 40,000
Uinta	-	-	-	$ -	$ -	$ -
Washakie	8	-	-	$ 1,180,167	$ 176,667	$ 1,356,833
Weston	18	-	-	$ 1,650,606	$ -	$ 1,650,606
Statewide	**391**	**15**	**-**	**$ 146,115,017**	**$ 10,083,950**	**$ 156,198,967**

Table 48 shows that even though Laramie County experienced the greatest number of hail events, Campbell County reports the greatest monetary losses from hail.

The map below shows location of hail events and size of reported hail in Wyoming for recorded history from 1960-2012. There is a clear trend of hail events in the eastern portion of the state.

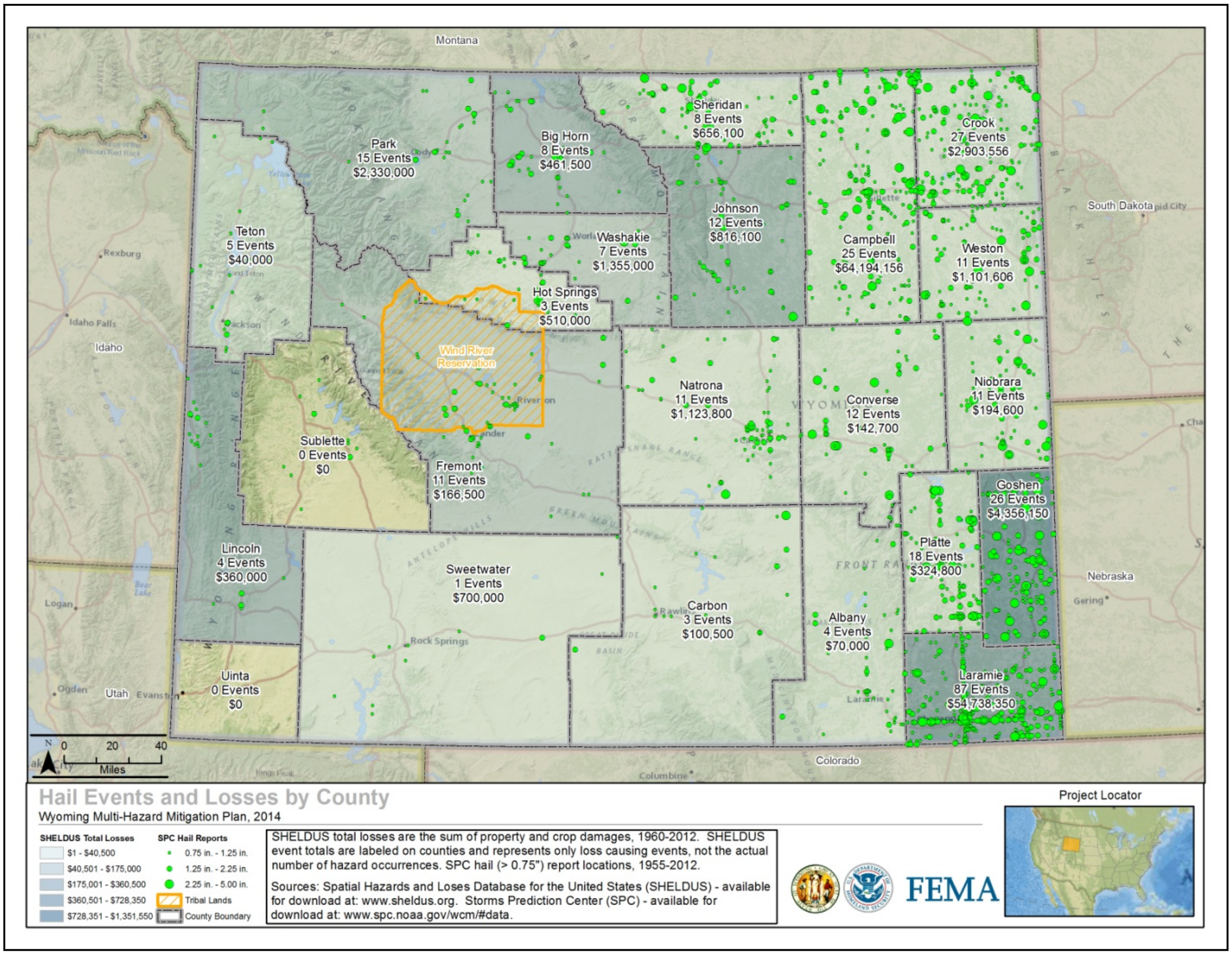


Figure 71. Hail Events and Losses by County, 1960-2012

There are significant gaps in the record prior to 1926. Continued research is required to complete the data gaps. One of the earliest years on record with significant hail damage was 1962. There was nearly $4 million (more than $28.75 million in 2010 USD) in recorded damages. The most damaging event that year occurred in Casper on July 31, 1962. Several inches of hail covered the southern half of Casper causing considerable damage to houses and cars.

Another year in which significant damage occurred across the state was 1977. There were 29 events with measurable damage of almost $15.1 million (nearly $54.5 million in 2010 USD). There were four separate events that each caused more than $2.75 million (almost $9.9 million in 2010 USD) in damage. On June 16, 1977, a storm with hail one inch to two inches in diameter cut across Cheyenne from the northwest to the southeast with considerable damage to houses, cars, trees, and gardens. On July 5, 1977, hail up to one inch fell over an area starting just south of Powell and extending eastward. Most damage was to buildings and cars. On July 11, 1977, hail up to one inch fell over an area between Heart Mountain and Powell. Most damage was to irrigated crops with some damage to buildings and cars. On July 26, 1977, hail up to 1.75

inches fell in a strip from five to six miles north of Powell to the southeast for 10 miles. Most damage was to irrigated crops with some damage to buildings and cars.

There was also heavy hail damage in 1978, with nearly $12.5 million ($45.3 million in 2014 USD) in reported damage. One storm accounted for much of the damage. On July 31, 1978, two thunderstorms did considerable damage to parts of Cheyenne. Hail up to 3 inches in diameter did estimated $9.0 million ($32.6 million in 2014 USD) damage to homes, property, and vehicles.

In 1979, there were also damages in excess of $9.1 million ($29.6 million in 2014 USD) reported across the state. Damages in excess of $2.75 million ($8.9 million in 2014 USD) occurred in both Sheridan and Fort Laramie.

On July 30, 1979, an extremely large and intense thunderstorm moving through the Cheyenne area caused extensive hail damage to cars, homes, and city buildings. Hail up to two inches in diameter was verified in town with reports of baseball-sized hail south of the city. Damage was in excess of $2.5 million ($8.3 million in 2014 USD) as reported by the Wyoming Tribune Eagle. State Farm Insurance reported more than $3.2 million in claims for the event, and the State of Wyoming All-Hazard Mitigation Plan from December 1999, reported that $16.5 million in damage may have occurred during the storm. The $16.5 million figure was obtained from the Western Insurance Information Service, and may have included damage from Fort Collins, Colorado.

On August 1, 1985, a nearly stationary severe thunderstorm produced the most damaging flash flood on record for Cheyenne and the state. Twelve people lost their lives, 70 were injured, and damage to homes, cars, and businesses was estimated at $65 million ($142.7 million in 2014 USD). At the National Weather Service Forecast Office near the airport, 6.06 inches of rain fell in just over 3 hours. By 7:30 p.m., in addition to blinding rain, hail up to two inches in diameter and winds to 70 mph were occurring in the Cheyenne area. Many streets turned into 2- to 4-inch deep rivers with large amounts of hail floating on top. Basements of homes and businesses quickly filled up with water and hail as flood waters crashed through doors and windows. Some basements equipped with drains were flooded with two to five feet of hail after the water drained away. In some areas of Cheyenne the hail had piled up into 4- to 8-foot drifts (**Figure 72**).

Figure 72. 1985 Hailstorm in Cheyenne

On September 2, 1986, thunderstorm winds damaged the roof of a house, toppled power poles, and uprooted pine trees on Casper Mountain. Hail up to two inches in diameter moved through Casper, causing extensive damage to vehicles, buildings, and vegetation. Damage was estimated at $29 million ($62.5 million in 2014 USD).

On August 3, 1987, a hailstorm hit Cheyenne with 0.5- to 2-inch-diameter hail. This storm heavily damaged cars at three major car dealerships west of downtown. Many of the cars were severely dented, with numerous broken or cracked windshields. Another hard hit area was F.E. Warren Air Force Base, where numerous vehicles were dented and windows shattered or broken. Three people were slightly injured during the hailstorm. The damage was estimated at $37 million ($76.9 million in 2014 USD).

On July 30, 1993, a number of thunderstorms worked their way through northeast Wyoming. The Gillette area was hit hard, with one report of 4-inch-diameter hail from the central tower at the Gillette airport. There was significant roof and window damage to homes and businesses. No injuries were noted. The damage was reported to be $17 million ($27.8 million in 2014 USD). The Gillette area again experienced $17 million ($27.8 million in 2014 USD) in hail damage on June 21, 2003. Extensive hail damage occurred to roofs and automobiles.

On August 26, 2002, $30 million ($39.4 million in 2014 USD) in hail damage occurred in Cheyenne. Hail from one inch up to 2.75 inches in diameter fell over the central and western parts of Cheyenne. Significant damage was reported to automobiles and roofs.

An abbreviated hail history is presented in **(Appendix K)**. The data were derived from the monthly Storm Data reports generated by the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC). Other sources are unpublished reports from the Wyoming Office of

Homeland Security, newspaper accounts, and periodicals from public libraries. The table represents hailstorms that have caused damage, injuries, or loss of life.

Figure 73. Hail on June 16, 2008[35]

Probability

Hail event frequency is calculated statewide and by county below and is based on loss-causing events, 1960-2015, collected from SHELDUS and NCDC databases.

Highly Likely = Value 4 391 Hail Events Reported ÷ 55.5 years = 7 flood events every year or a >100.0 % annual probability of a damaging flood event

[35] http://commons.wikimedia.org/wiki/File:Hail_RichmondHill.jpg (Accessed 2/19/14)

Laramie County's probability of experiencing a hail event far surpasses those of the other 22 counties.

Table 48. Hail Event Frequency

County	Total Events	Time Period	Frequency	Probability
Albany	5	55.5 Years	9%	Occasional
Big Horn	12		22%	Likely
Campbell	34		61%	Likely
Carbon	3		5%	Occasional
Converse	14		25%	Likely
Crook	37		67%	Likely
Fremont	17		31%	Likely
Goshen	32		58%	Likely
Hot Springs	5		9%	Occasional
Johnson	19		34%	Likely
Laramie	95		171%	Highly Likely
Lincoln	4		7%	Occasional
Natrona	16		29%	Likely
Niobrara	16		29%	Likely
Park	16		29%	Likely
Platte	23		41%	Likely
Sheridan	11		20%	Likely
Sublette	-		0%	Unlikely
Sweetwater	1		2%	Occasional
Teton	5		9%	Occasional
Uinta	-		0%	Unlikely
Washakie	8		14%	Likely
Weston	18		32%	Likely
Statewide	**391**	**55.5 Years**	**705%**	**Highly Likely**

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. The map below shows these rankings by county to demonstrate local perception of risk across the state.

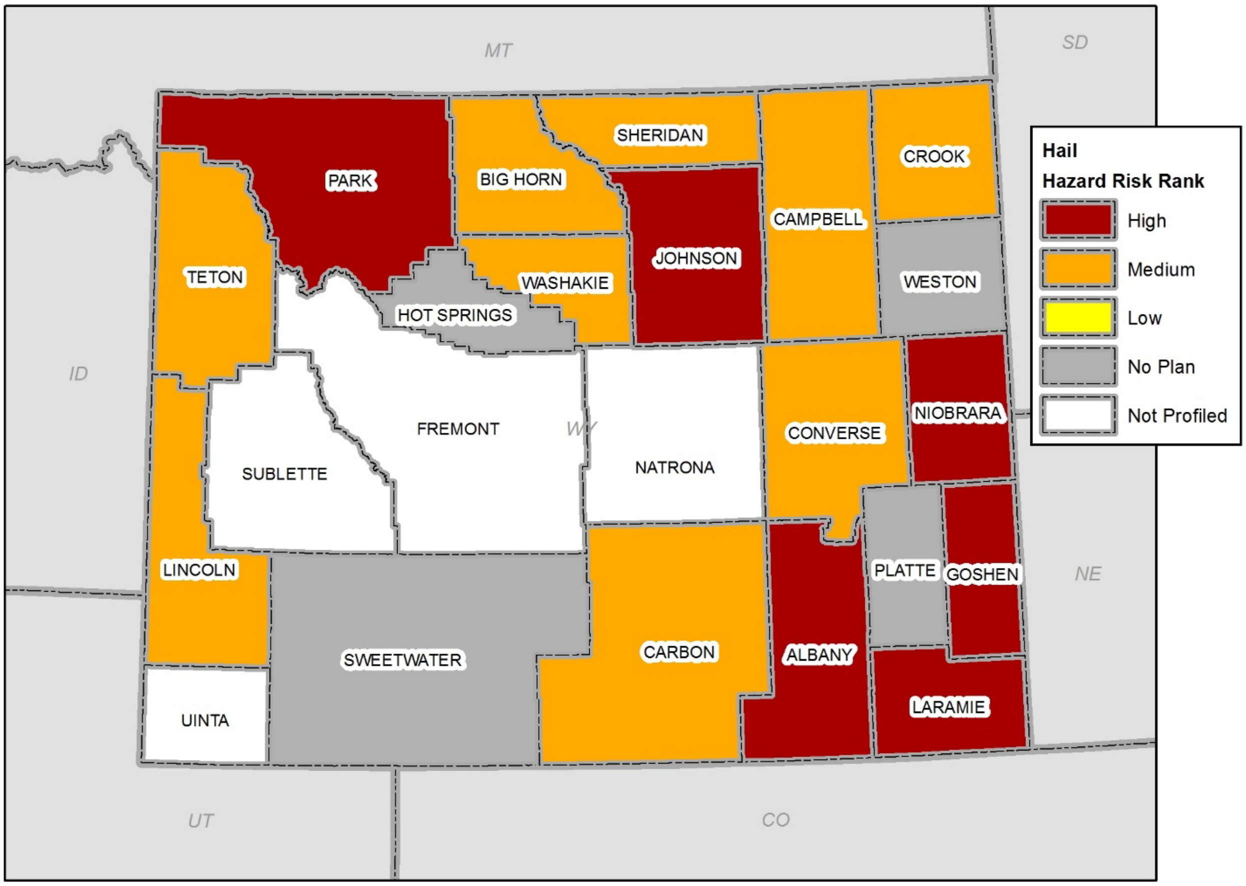


Figure 74. Hail Risk Rankings from Local Hazard Mitigation Plan Risk Assessments

A review of the local mitigation plans reflects hail as a common hazard among Wyoming counties. Each county has ranked hail risk within their borders based on the population impacted, probability of occurrence within their borders and the property impacted.

Statewide Risk Assessment

Based on past event locations and summary of hail risk assessments, there is a clear trend of hail events and risk in the eastern portion of the state. Campbell County has experienced highest dollar loss and Laramie County second highest.

Changes in Development

Campbell County has the 2^{nd} highest projected growth rate in the state (highest growth rate in eastern Wyoming) of 43 percent and Laramie County has the 10 highest growth rate of 16 percent.

State Facilities at Risk

There are 35 state facilities with a value of more than $12 million in Campbell County; 29 of those facilities are in the City of Gillette. There are 326 state facilities with a value greater than $1 billion in Laramie

County; 224 of those facilities are in the City of Cheyenne. These clusters of state facilities may be at high risk to hail damage.

Losses to state facilities from hail events are listed in the table below; data includes number of events and associated damage and are sorted by state agency.

Table 49. State Building Losses – Hail (2/20/2011-9/24/2015)

State Agency	Total Events	Loss ($)
Department of Administration and Information	15	$ 1,286,975
Department of Corrections	1	$ 1,052
Department of State Parks and Cultural Resources	4	$ -
Wyoming Fish and Game Department	6	$ 8,184
Wyoming Military Department (Adjutant General)	1	$ -
Total	**27**	**$ 1,296,211**

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 50. Hail Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	2.7	*Moderate*
Hail	4.0	1.8	2.4	3.3	1.4		

Landslide

Description

Figure 75. Landslide Between Alpine and Jackson (Spring 2011)

Landslides are one of the most common geologic hazards in Wyoming. Some of the highest landslide densities in the country are found within Wyoming. According to the Wyoming Department of Transportation Geology Program, there are 248 landslide sites around the state impacting Wyoming's roads documented in their database. This includes areas repaired, landslide mitigation projects in process, and locations being monitored. Given the number of landslide sites impacting highways around the state, the probability is high that landslide activity will continue to impact the traveling public using Wyoming's highway system. Landslides also impact residents and businesses who construct structures in areas subject to landslides.

Wyoming landslide areas continue to be monitored and mitigated for landslide activity. In the three years since the last mitigation plan was published WyDOT has expended 17,500 man hours at a cost of nearly $950,000 to remove landslide debris from Wyoming's highway system. Investments of more than $43 million have mitigated 47 landslide areas over the past three years.

One of the largest landslide complexes in the country is located southwest of Cody in northwestern Wyoming. The Carter Mountain landslide was more than 5 miles wide and 20 miles long. Landslides cause damage every year in Wyoming, but because many occur in remote areas, public awareness of their dangers is low.

Early in April 2014 Jackson reported a water main break which resulted in a loss of water to a neighborhood. Shortly thereafter, the break was determined to be the result of a slow-moving landslide in the vicinity of Budge Road in Jackson. Homes and businesses in the vicinity have been impacted, with one home being condemned by the city at the time of this mitigation plan update.

A geologist was hired to assist and evacuation orders were issued for households in the high-risk area to protect life and prevent injury. Businesses in the high-risk area were impacted, with businesses forced to close. The business closings, in turn, impacted the livelihood of more than 100 employees.

Employee housing, located at the business sites were also ordered to be evacuated. Employees were not only out of work, they were also unable to stay in their homes. Many of the employees found friends or family to stay with. Some utilized shelters established by the Red Cross.

The landslide continues to be a slowly-developing situation which could continue for months or even years. Ways to mitigate property damage and impacts to the community are being actively pursued at this time. This may be an isolated incident in the community. Given the topography of the area, however, Jackson may be susceptible to future landslides.

There are many types of landslides present in Wyoming. In order to properly describe landslide type, the Geologic Hazards Section of the Wyoming State Geological Survey (WSGS) developed a landslide classification modified from Varnes (1978) and Campbell (1985). As can be seen in **Figure 76** there are five basic types of landslides that occur in three types of material. Falls, topples, slides, lateral spreads, and flows can occur in bedrock, debris, or earth. While individual landslide types can occur in nature, most landslides are complex, or composed of combinations of basic types of landslides.

Falls and topples are easy to visualize. In a fall, material detached from a steep slope or cliff descends through the air, and may bounce and roll. In a topple, a mass rotates forward on a pivot point. If a toppling mass pivots far enough, a fall may result.

Slides are characterized by shear displacement along one or several surfaces. Two general types of slides are recognized, rotational and translational. In a rotational slide, the surface of rupture is concave upward, and the mass rotates along the concave shear surface. Rotational slides are usually called slumps, and they can occur in bedrock, debris, or earth. In a translational slide, the surface of rupture is a planar or gently undulatory surface. In bedrock and earth, translational slides are usually called block slides if an intact mass slides down the slope. If rock fragments or debris slide down a slope on a distinct shear plane, the movements are called rock slides or debris slides. It is easy to see that confusion can result by applying the term “slide” to all types of landslides.

Lateral spreads are characterized by lateral extension movements in a fractured mass. Lateral spread movements may occur in bedrock and soil as a result of liquefaction or plastic flow of subjacent materials, or in bedrock without a well-defined basal shear surface or zone of plastic flow. Lateral spreads in bedrock without a well-defined zone of shearing or flow, usually occur on ridge crests.

In general, a flow is a moving mass that has differential internal movements that are distributed throughout the mass. While most flows occur in debris and earth, one type of flow, gravitational sagging, does occur in bedrock. Flows in debris and earth can be cohesive or non-cohesive. Both cohesive and non-cohesive flows are further subdivided by water content and material properties.

Cohesive flows in debris include soil creep, solifluction, block streams, talus flows, and rock glaciers. Soil creep is an imperceptibly slow deformation that continues under constant stress. Solifluction is a slow flow in soil that is often observed in areas with perennially or permanently frozen ground. Block streams are slow moving tongues of rocky debris on steep slopes, and are often fed by talus cones. Talus flows are slow flows that occur in the basal portions of talus slopes. Rock glaciers are not true landslides, but have been included in the classification scheme because they are mass movements composed of coarse debris.

Interstitial ice between debris fragments plays a role in the movement of rock glaciers, which are similar in form to a true glacier.

Cohesive flows in earth include soil creep, solifluction, earth flows, and debris laden earth flows. Soil creep and solifluction in earth are similar to those in debris. Earth flows are very slow to rapid flows that have a distinct source area, a main flow track, and a lobate depositional area. Debris laden earth flows are flows that appear to be earth flows but are composed of debris. Standard classifications do not recognize debris laden earth flows, but many have been observed in Wyoming. Many of the landslides present in Wyoming have an earth flow component.

Non-cohesive flows in debris include rock fragment flows and debris flows. Rock fragment flows are extremely rapid flows composed of dry to moist rock debris. This type of flow can be initiated by a rock fall, by seismic activity, or by other processes. In some cases, it appears that rock debris has moved on a cushion of air, although other mechanisms may have dominated the process. Rock fragment flows can cause significant destruction in a short period of time. Debris flows are a slurry flow composed of debris and a significant amount of water. They are usually associated with unusually heavy precipitation or with rapid snowmelt. Debris flows commonly follow preexisting drainage ways, and commonly form debris levees along their main flow track. Debris flows are a significant component of alluvial fans in mountainous areas with the main debris flow deposit having a broad, fairly flat, fan shape. Debris flows are very common in the mountainous areas of Wyoming.

Non-cohesive flows in earth include loess flows, dry sand flows, wet sand flows, rapid earth flows, and mud flows. Loess flows and dry sand flows are rapid to very rapid flows of dry material. Loess flows are usually initiated by seismic activity, and are a fluid suspension of silt in air. Fortunately, none have yet been identified in Wyoming. Dry sand flows usually occur along shorelines or in Aeolian deposits. In Wyoming, most dry sand flows are very small. Wet sand flows occur along river banks or shorelines composed of saturated clean sand. The destabilized sand usually flows into an adjacent body of water. Wet sand flows are not common in Wyoming. Rapid earth flows, also called quick clay flows, are very rapid flows that involve the liquefaction of subjacent material and the entire slide mass. They usually initiate in sensitive materials, such as quick clay, and are not common in Wyoming. Mud flows are slurry flows composed of earth and a significant amount of water. They differ from debris flows only in the size of their component materials.

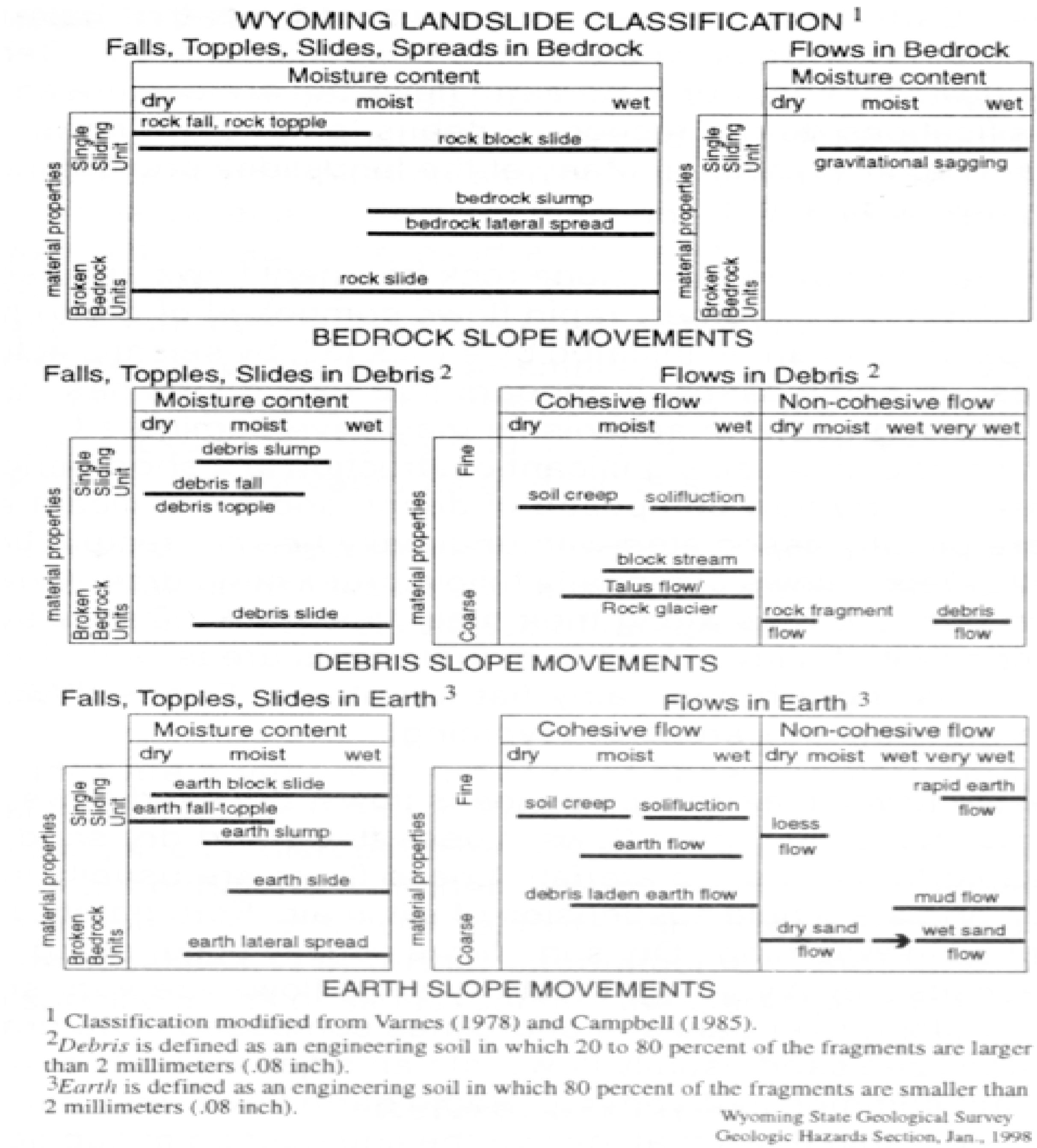


Figure 76. Wyoming Landslide Classifications

Most landslides mapped in Wyoming are classified as being complex. For example, many landslides in the state are slump/earth flow complexes. That type of landslide is composed of a slump at its head, with the main body and deposit being an earth flow. Block slides often grade into rock slides, which can further grade into earth flows or debris laden earth flows. Such a movement would be classified as a block slide/rock slide/flow complex.

Figure 77. Clearing Landslide between Alpine and Jackson, February 2011

History and Probability of Future Events

The following tables list loss-causing landslide events and associated damage by county, collected from SHELDUS and NCDC past events databases.

Table 51. Landslide Events, Casualties, and Damage by County and Statewide (1960-2015)

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Albany	-	-	-	$ -	$ -	$ -
Big Horn	2	-	-	$ 100,500	$ -	$ 100,500
Campbell	-	-	-	$ -	$ -	$ -
Carbon	-	-	-	$ -	$ -	$ -

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Converse	-	-	-	$ -	$ -	$ -
Crook	-	-	-	$ -	$ -	$ -
Fremont	-	-	-	$ -	$ -	$ -
Goshen	-	-	-	$ -	$ -	$ -
Hot Springs	-	-	-	$ -	$ -	$ -
Johnson	2	-	-	$ 100,500	$ -	$ 100,500
Laramie	-	-	-	$ -	$ -	$ -
Lincoln	2	-	-	$ 275,000	$ -	$ 275,000
Natrona	2	-	-	$ 100,500	$ -	$ 100,500
Niobrara	-	-	-	$ -	$ -	$ -
Park	3	-	-	$ 143,000	$ -	$ 143,000
Platte	-	-	-	$ -	$ -	$ -
Sheridan	-	-	-	$ -	$ -	$ -
Sublette	1	-	-	$ 25,000	$ -	$ 25,000
Sweetwater	-	-	-	$ -	$ -	$ -
Teton	4	-	-	$ 393,000	$ -	$ 393,000
Uinta	-	-	-	$ -	$ -	$ -
Washakie	2	-	-	$ 100,500	$ -	$ 100,500
Weston	-	-	-	$ -	$ -	$ -
Statewide	**18**	-	-	**$ 1,238,000**	$ -	**$ 1,238,000**

The generalized landslide distribution in Wyoming is shown in **Figure 78**. Most of the mapped landslides occur in mountainous areas with levels of precipitation significantly greater than in the state's basins, as would be expected. Some of the highest landslide densities also occur in areas with active faults exposed at the surface, and in areas with higher levels of seismic activity than the rest of the state. To date few studies have been done on the relationship between landslides and seismic activity.

Wyoming roads and highways are where the most significant impact is felt from landslide hazards in Wyoming. Residents and visitors alike are impacted by landslides when roads are damaged by landslides. Landslides cause road closures and can result in significant resource allocation to landslide sites. The state agency most significantly impacted when roads are blocked is the Wyoming Department of Transportation (WyDOT). WyDOT reports 248 locations have active landslide areas impacting roadways. These areas continue to be monitored and mitigated for landslide activity. In the three years since the last mitigation plan was published WyDOT has expended 17,500 man hours at a cost of nearly $950,000 to remove landslide debris from Wyoming's highway system. Mitigation investments of more than $43 million have mitigated 47 landslide areas over the past three years.

Historical landslides outside the highways in Wyoming are not well defined. There are some notable landslides that have been documented, however.

On June 23, 1925, the lower Gros Ventre landslide north of Jackson activated, damming the Gros Ventre River. The landslide mass was a block slide/rock slide/rock fragment/flow complex. Bedrock is dipping towards the Gros Ventre River, with Tensleep Formation sandstones on top of Amsden Formation shales. The sandstones were fairly saturated with water, and the interface between the sandstones and relatively slippery shales was well lubricated. Small earthquakes may have caused the slope to destabilize, and a large mass of sandstone detached. It moved rapidly downslope, breaking up as it moved. The rapidly moving mass shot across the Gros Ventre River, moved partly up the slope on the opposite valley wall, and settled back into the river, forming a landslide dam and lake. Two years later, on May 18, 1927, the landslide dam partially failed, resulting in flooding and the loss of six lives in Kelly, Wyoming.

In July, 1937, landslides in the Big Horn Basin destroyed large sections of railroad tracks and washouts swept away a large number of highway bridges. Railroads and highways were washed out and mining property damaged. Heavy flood damage also occurred in the Big Horn Basin, particularly in the Wind River Canyon and in the vicinity of Shoshoni. The damage in the Wind River Canyon resulted from land slides, which took out several sections of highway and railroad. In all, highways suffered damage in 12 counties. Severe damage occurred in the Upper Big Horn Basin. There were more than 3,000 feet of railway washed out and much covered by landslides. The highway was badly damaged from Riverton to Thermopolis and traffic was suspended temporarily. Near Shoshoni traffic was possible only by long detours. Highways were considerably damaged in ten other counties in the eastern half of the state.

In the mid-1980s, a slump/flow complex destabilized at Fossil Butte National Monument in Lincoln County. The landslide moved downslope and destroyed the main rail line of the Union Pacific Railroad over a few hundred feet. The line was closed for a number of days, and all rail traffic that would normally be routed through the area had to be diverted through Colorado.

On May 18, 1997, a slump/debris flow complex formed south of Jackson. The debris flow covered and closed U.S. Highway 26/89 through the Snake River Canyon in Teton County. Approximately 300 feet of the highway was covered with up to 15 feet of landslide material. Because of the negative economic impact on the area, the Wyoming Governor declared the area a disaster, and the National Guard was mobilized to help clear the roadway. The road was opened to twice-a-day commuter traffic in three weeks and to full-time traffic in six weeks.

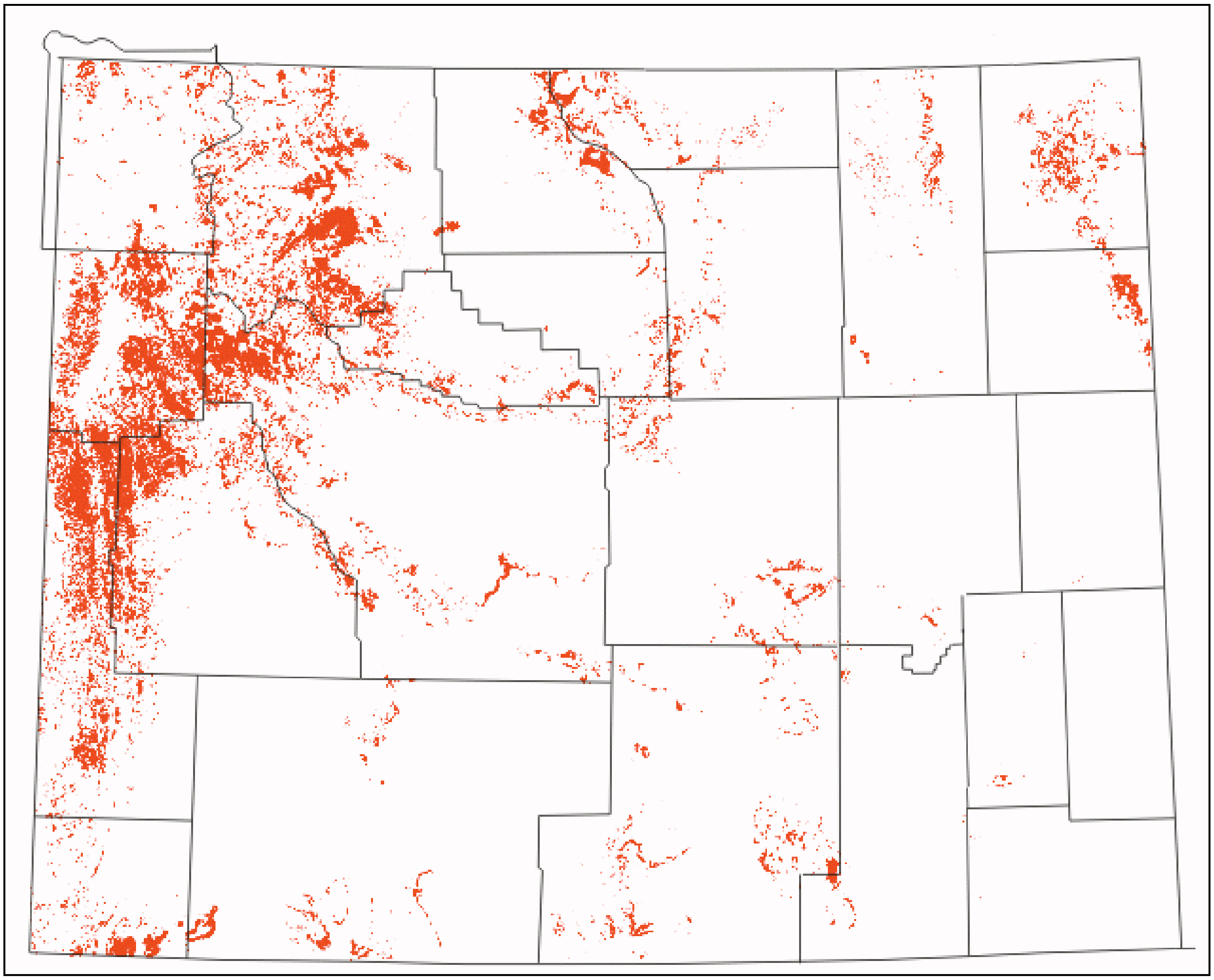


Figure 78. Wyoming Landslide Area Shown in Red[36]

On July 18, 2004, a rockslide/debris flow complex closed the east entrance to Yellowstone National Park on U.S. Highway 14/16/20. The landslide, which was within the park boundaries, closed the road through traffic until July 24, 2004. Three vehicles were trapped within the landslide mass, and a fourth was stranded. There was an economic impact on Park County because of the reduction in tourist traffic. There have been a number of other debris flow complexes that have closed U.S. Highway 14/16/20 historically, usually east of Yellowstone National Park.

In May 2011 a landslide occurred on Highway 89 between Afton and Jackson. As in the 1997 landslide described above, the May 2011 landslide represented an economic hardship for local residents. Residents living in Afton and working in Jackson were forced to take a 75 mile detour around the landslide into Idaho and over two mountain passes to get to work as Highway 89 is the only direct route between the two towns.

[36] http://www.wrds.uwyo.edu/wrds/wsgs/hazards/landslides/lshome.html (Accessed 2/19/2014)

Damage caused by landslide activity is typically to highways within the state and is addressed by the Wyoming Department of Transportation (WyDOT). WyDOT has had recurring problems with landslides in the Bondurant, Hoback Junction, Snake River Highway, Atlantic City, Miller Mountain, Sheridan, Buffalo, Thayne, and Togwotee Pass areas.

Local geology, geologic structure, hydrology, and precipitation are the primary reasons that landslides occur in specific areas. Human activities such as road and highway construction can also have an effect on the occurrence of landslides.

Figure 79. 600-ft Long Landslide on Highway 70 near Braggs (May 2011)[37]

WyDOT estimates that the approximate yearly cost to remove landslides from roads, maintain landslide-damaged roads, and to study or stabilize landslides averages nearly $800,000 (when the outlier costs from 1998 are included in the calculation). The average year results in nearly $300,000 expended on landslide debris removal costs when the costs are averaged from 1999 forward. **Table 52** below shows the past fifteen years of road repair expenditures by WyDOT resulting from landslides.

[37] Photo courtesy of Wyoming Department of Transportation

Table 52. Yearly Cost of Landslide Related Activities – Wyoming Department of Transportation

Yearly Costs of Landslide-Related Activities	
Fiscal year	**Cost**
1998	$ 8,000,000
1999	$ 396,500
2000	$ 288,900
2001	$ 194,300
2002	$ 157,200
2003	$ 184,300
2004	$ 154,700
2005	$ 237,700
2006	Not available
2007	$ 216,400
2008	$ 347,200
2009	$ 377,100
2010	$ 461,000
2011	$ 356,688
2012	$ 268,149
2013	$ 322,987

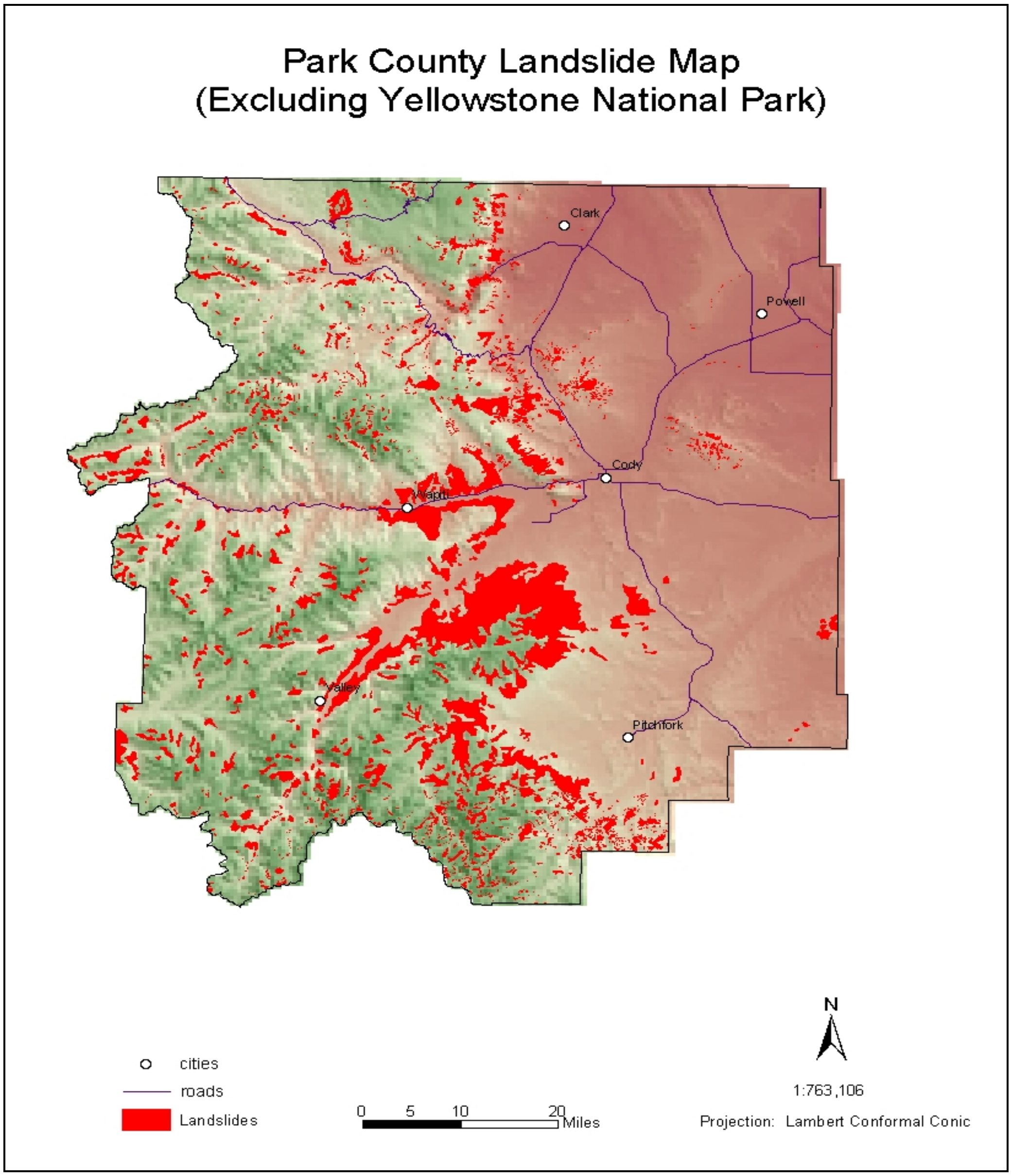


Figure 80. Park County Landslide Map

Counties in eastern plains regions of the state reflect little-to-no risk associated with landslides and do not analyze the risk. Others, like Park and Albany County, do expect landslides to occur within their borders. Most county plans reflect landslide areas are outside heavily populated areas. Risk is still associated with those areas, as landslide areas tend to be picturesque, mountainous locations and therefore attract development. Development in landslide areas frequently consists of vacation homes and represents a potential risk for injury, loss of life and property.

Probability

Landslide event frequency is calculated statewide and by county below and are based on loss-causing events, 1960-2015, collected from the SHELDUS and NCDC databases.

Likely = Value 3
18 events / 55.5 years = 32 % annual probability of a Landslide event

Table 53. **Landslide Event Frequency**

County	Total Events	Time Period	Frequency	Probability
Albany	-	55.5yrs	0%	Unlikely
Big Horn	2		4%	Occasional
Campbell	-		0%	Unlikely
Carbon	-		0%	Unlikely
Converse	-		0%	Unlikely
Crook	-		0%	Unlikely
Fremont	-		0%	Unlikely
Goshen	-		0%	Unlikely
Hot Springs	-		0%	Unlikely
Johnson	2		4%	Occasional
Laramie	-		0%	Unlikely
Lincoln	2		4%	Occasional
Natrona	2		4%	Occasional
Niobrara	-		0%	Unlikely
Park	3		5%	Occasional
Platte	-		0%	Unlikely
Sheridan	-		0%	Unlikely
Sublette	1		2%	Occasional
Sweetwater	-		0%	Unlikely
Teton	4		7%	Occasional
Uinta	-		0%	Unlikely
Washakie	2		4%	Occasional
Weston	-		0%	Unlikely
Statewide	**18**	**55.5yrs**	**32%**	**Likely**

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. The map below shows these rankings by county to demonstrate local perception of risk across the state.

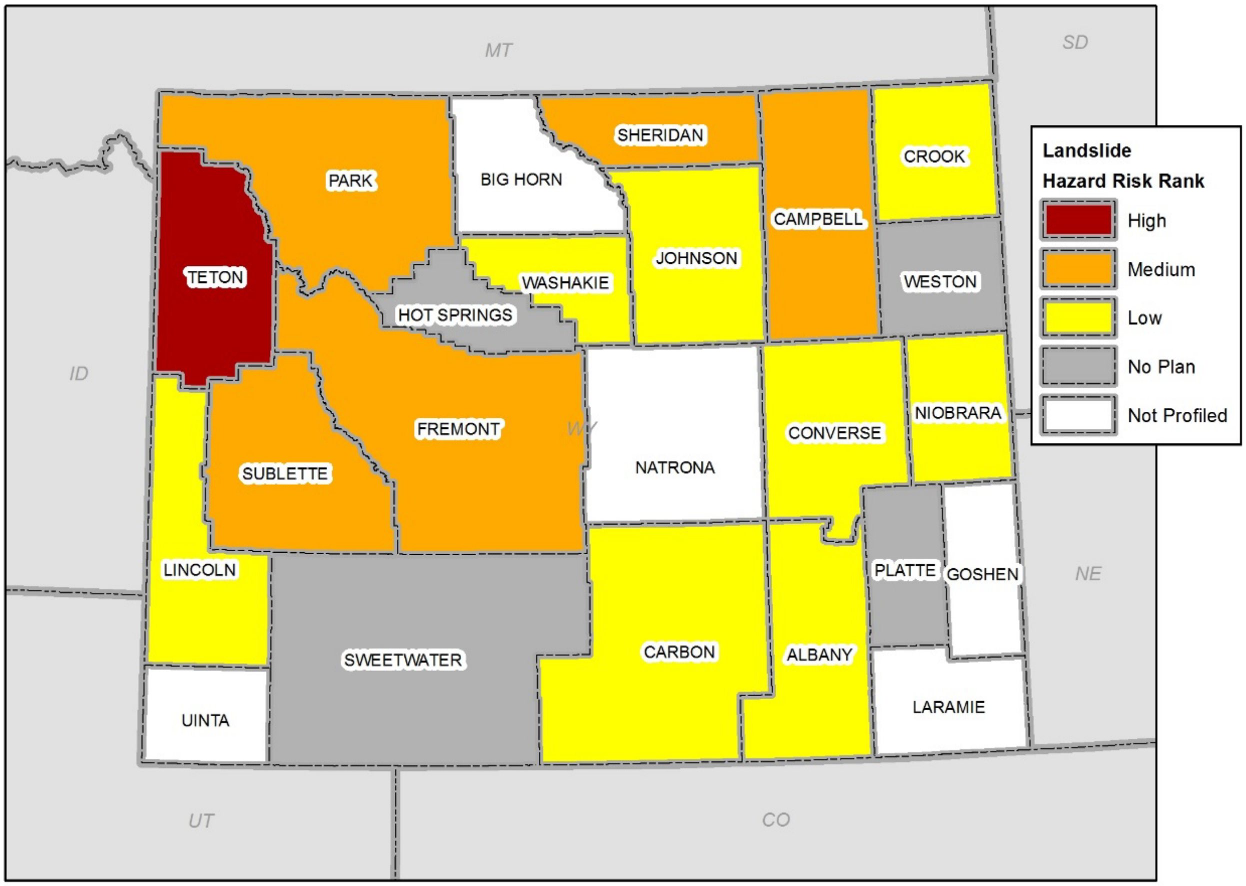


Figure 81. Landslide Risk Rankings from Local Hazard Mitigation Plan Risk Assessments

Probably due to the relative slow movement inherent to Wyoming's landslide hazard which makes loss of life less likely, Wyoming counties consider landslides to be a medium or low-risk hazard from a local perspective. Landslides in Wyoming typically occur in less populated areas, with most significant losses to transportation nodes, namely roads and highways, rather than personal property. The most significant impact tends to be when no alternative route exists between populated areas and access is blocked by the presence of a landslide.

Statewide Risk Assessment

Landslide risk is highest in Teton County and northwest Wyoming according to local risk assessments and previous event losses.

The landslide hazard is also very prevalent in Lincoln, Sublette, Fremont, and Park Counties.

Changes in Development

Teton County is the fourth fastest growing county in the state with a projected growth rate of 24 percent between 2010 and 2030.

State Facilities at Risk

There are 88 state facilities in Teton County; 32 of those are in the Town of Jackson. Critical facilities include Attorney General's Office, Departments of Corrections, Family Services, Health, Revenue, Transportation, Game and Fish, Judicial District 9B, Public Defender's Office, State Engineers Office, and Supreme Court. Proximity of state facilities and the landslide hazard should be studied for a more accurate assessment of risk.

Transportation corridors are particularly at risk to landslides in northwestern Wyoming.

There were no recorded losses to state facilities from landslides.

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 54. Landslde Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	2.3	*Moderate*
Landslide	3.0	1.7	1.4	3.4	2.1		

Lightning

Description

Lightning remains a certain danger in Wyoming. Lightning is a sudden electrical discharge released from the atmosphere that follows a course from cloud to ground, cloud to cloud, or cloud to surrounding air, with light illuminating its path (**Figure 82**). Lightning's unpredictable nature causes it to be one of the most feared weather elements.

Figure 82. Lightning Over Devils Tower[38]

In Wyoming, outdoor enthusiasts venturing to high and exposed areas should be especially cautious because rapid thunderstorm development with associated lightning can place even the most experienced climbers in jeopardy without warning. Hikers and climbers above the timberline should plan to be off exposed mountain tops and ridges by 2 p.m. during the summer months to avoid being struck by lightning unless proper shelter is available (Wyoming Climate Atlas).

A history of recorded lightning events in Wyoming can be found in Appendix M. Nationwide lightning strikes are routinely monitored by Vaisala, Inc. with accuracies to within a 1 kilometer resolution. For the period of 1998 through 2000, the Wyoming annual lightning strike frequency is depicted in **Figure 83**. Clearly the eastern plains have more than three times the cloud to ground lightning strikes as does the western half of the state. Platte, Weston, Crook, and parts of Campbell, Niobrara, and Laramie counties are the most active in the state. These values probably vary by 50 percent in a year depending on whether there is a drought or enhanced monsoonal flow. However, the locations of maximum and minimum strikes do not change much from year to year.

[38] Photograph courtesy of Christopher McLeod

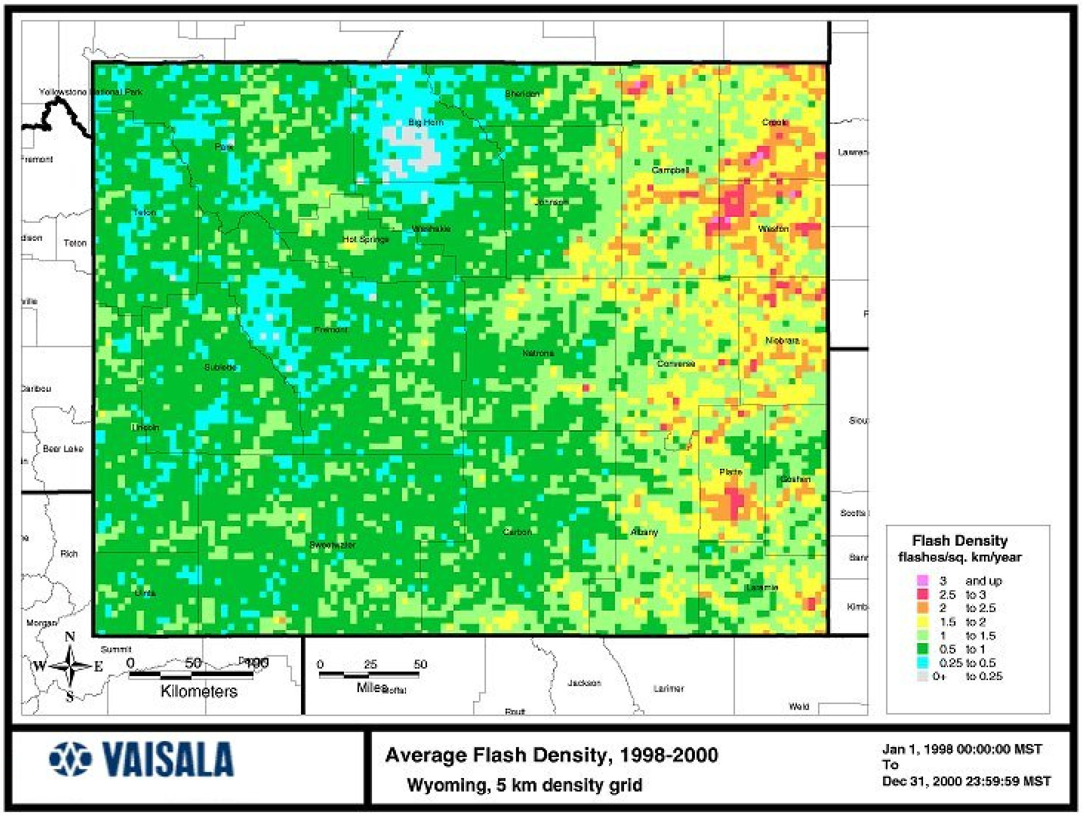


Figure 83. Average Annual Lightning Flash Density 1998-2000

Lightning is the leading cause of wildland fires in Wyoming (**Figure 84**), and is indirectly responsible for millions of dollars’ worth of fire damage. Whether in a drought or wet period, Wyoming's hot and windy summers can cause rapid changes to the fire risk over grasslands and forests.

In **Figure 84** a 31-year record of lightning-caused wildfires as well as the percent of lightning-induced wildfires is shown. The worst events occurred in July and August 1988, when, according to the U.S. Bureau of Land Management, lightning ignited 29 fires, setting 4,159 acres ablaze, resulting in a total of $780,330 in damage.

Historical trends demonstrate that lightning will continue to be the leading cause of wildland fires in the state, and it will maintain dominance in the eastern plains of Wyoming. Given the greater likelihood of lightning in the eastern plans of Wyoming, counties most likely to be impacted by lightning and the potentially resulting wildland fire are Crook, Weston, Niobrara, Goshen, Laramie, Platte, Converse and Campbell Counties. However, as documented by the Average Flash Density Map above (**Figure 83**), all counties are subject to lightning.

Due to the nature of lightning, those at greatest risk for life-threatening lightning hazard impacts fall within two categories: those enjoying outdoor activities and those in poor health who rely on electricity. Outdoorsmen are susceptible to direct lightning strikes and/or to wildfire started by lightning. Individuals reliant on electricity to meet day-to-day health needs, those reliant on oxygen machines for example, may be impacted by lightning because of lightning-caused power outages. Both of these groups are susceptible to serious injury or death.

History and Probability of Future Events

The following table lists loss-causing lightning events and associated damage by county, collected from SHELDUS and NCDC past events databases.

Table 55. Lightning Events, Casualties and Damage by County and Statewide (1960-2015)

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Albany	14	2	3	$ 347,339	$ 5,000	$ 352,339
Big Horn	5	3	1	$ 27,339	$ -	$ 27,339
Campbell	10	4	-	$ 89,432	$ -	$ 89,432
Carbon	12	5	4	$ 40,222	$ 6,000	$ 46,222
Converse	9	-	3	$ 41,228	$ 5,000	$ 46,228
Crook	10	2	-	$ 293,382	$ 500	$ 293,882
Fremont	20	7	3	$ 294,821	$ 40,000	$ 334,821
Goshen	5	0	2	$ 23,239	$ -	$ 23,239
Hot Springs	3	-	-	$ 108,882	$ -	$ 108,882
Johnson	10	14	1	$ 42,795	$ -	$ 42,795
Laramie	12	7	1	$ 37,795	$ -	$ 37,795
Lincoln	9	6	1	$ 37,265	$ 500	$ 37,765
Natrona	13	3	-	$ 362,771	$ -	$ 362,771
Niobrara	4	0	-	$ 30,739	$ 3,000	$ 33,739
Park	24	12	6	$ 168,464	$ -	$ 168,464
Platte	6	7	-	$ 31,839	$ 1,000	$ 32,839
Sheridan	5	2	1	$ 31,739	$ -	$ 31,739
Sublette	7	5	2	$ 34,789	$ 42,000	$ 76,789
Sweetwater	16	9	2	$ 92,914	$ -	$ 92,914
Teton	25	51	2	$ 616,414	$ -	$ 616,414
Uinta	3	-	-	$ 36,739	$ -	$ 36,739
Washakie	6	1	1	$ 43,321	$ -	$ 43,321
Weston	4	0	-	$ 33,882	$ -	$ 33,882
Statewide	**232**	**141**	**33**	**$ 2,867,350**	**$ 103,000**	**$ 2,970,350**

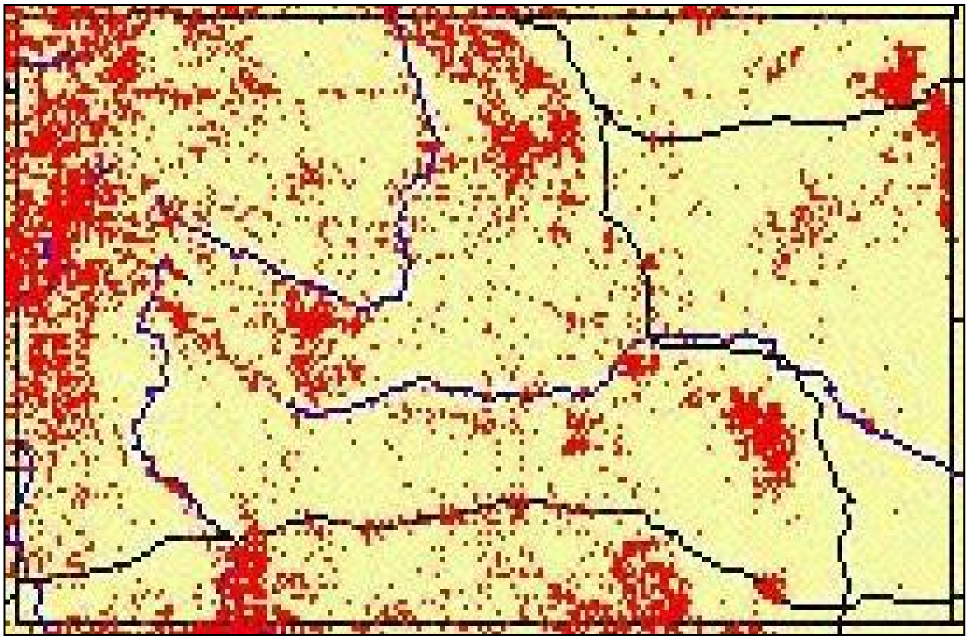


Figure 84. Lightning-induced Fire Source Points 1970-2000[39]

Historical losses experienced as a result of lightning events are highlighted on a county-by-county basis in the map below (**Figure 85**).

There have been 232 lightning events in Wyoming over the past 55 years resulting in 33 deaths and 141 injuries. Lightning events in Wyoming result in more than one injury for every two events and more than one death for every ten events, or one death every two years and an injury every 1 ½ years. (**Table 56**) While the monetary losses are also significant over the past 55 years ($2.9 million), the loss of life and injuries resulting from lightning are particularly concerning. Educating the public on the dangers represented by lightning should be considered as a high-priority mitigation activity. Further, educating the public on actions to take to minimize lightning risk should be included in the messaging.

[39] Source: Wyoming Climate Atlas

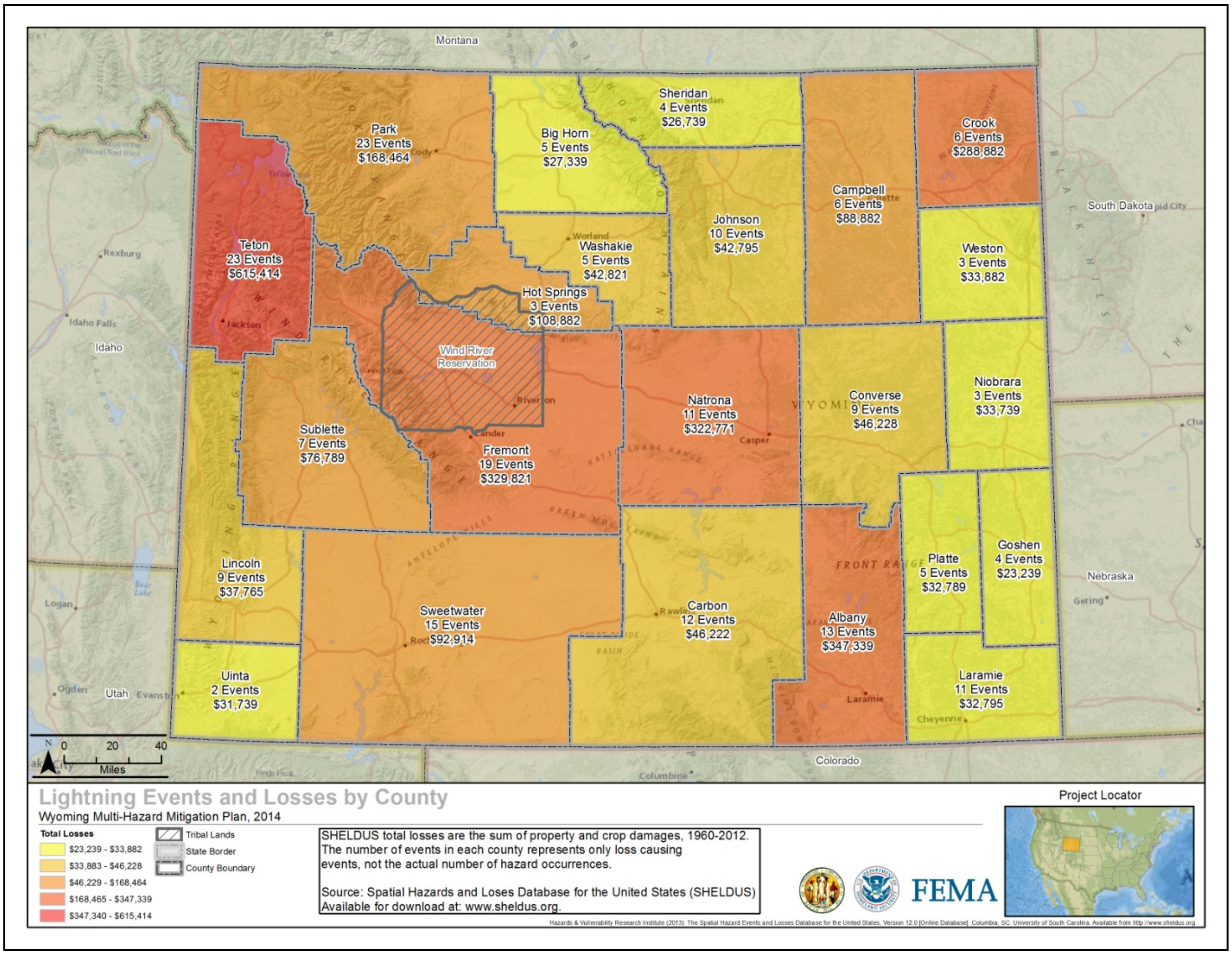


Figure 85. Lightning Events and Losses by County

Probability

Lightning event frequency is calculated statewide and by county below and is based on loss-causing events, 1960-2015, collected from SHELDUS and NCDC databases.

Highly Likely = Value 4
232 Reported ÷ 55.5 years = 4.2 Lightning events every year or a >100 % annual probability of a Lightning event

Table 56. Lightning Event Frequency

County	Total Events	Time Period	Frequency	Probability
Albany	14	55.5yrs	25%	Likely
Big Horn	5		9%	Occasional
Campbell	10		18%	Likely
Carbon	12		22%	Likely
Converse	9		16%	Likely
Crook	10		18%	Likely
Fremont	20		36%	Likely
Goshen	5		9%	Occasional
Hot Springs	3		5%	Occasional
Johnson	10		18%	Likely
Laramie	12		22%	Likely
Lincoln	9		16%	Likely
Natrona	13		23%	Likely
Niobrara	4		7%	Occasional
Park	24		43%	Likely
Platte	6		11%	Likely
Sheridan	5		9%	Occasional
Sublette	7		13%	Likely
Sweetwater	16		29%	Likely
Teton	25		45%	Likely
Uinta	3		5%	Occasional
Washakie	6		11%	Likely
Weston	4		7%	Occasional
Statewide	**232**	**55.5yrs**	**418%**	**Highly Likely**

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. The map below shows these rankings by county to demonstrate local perception of risk across the state.

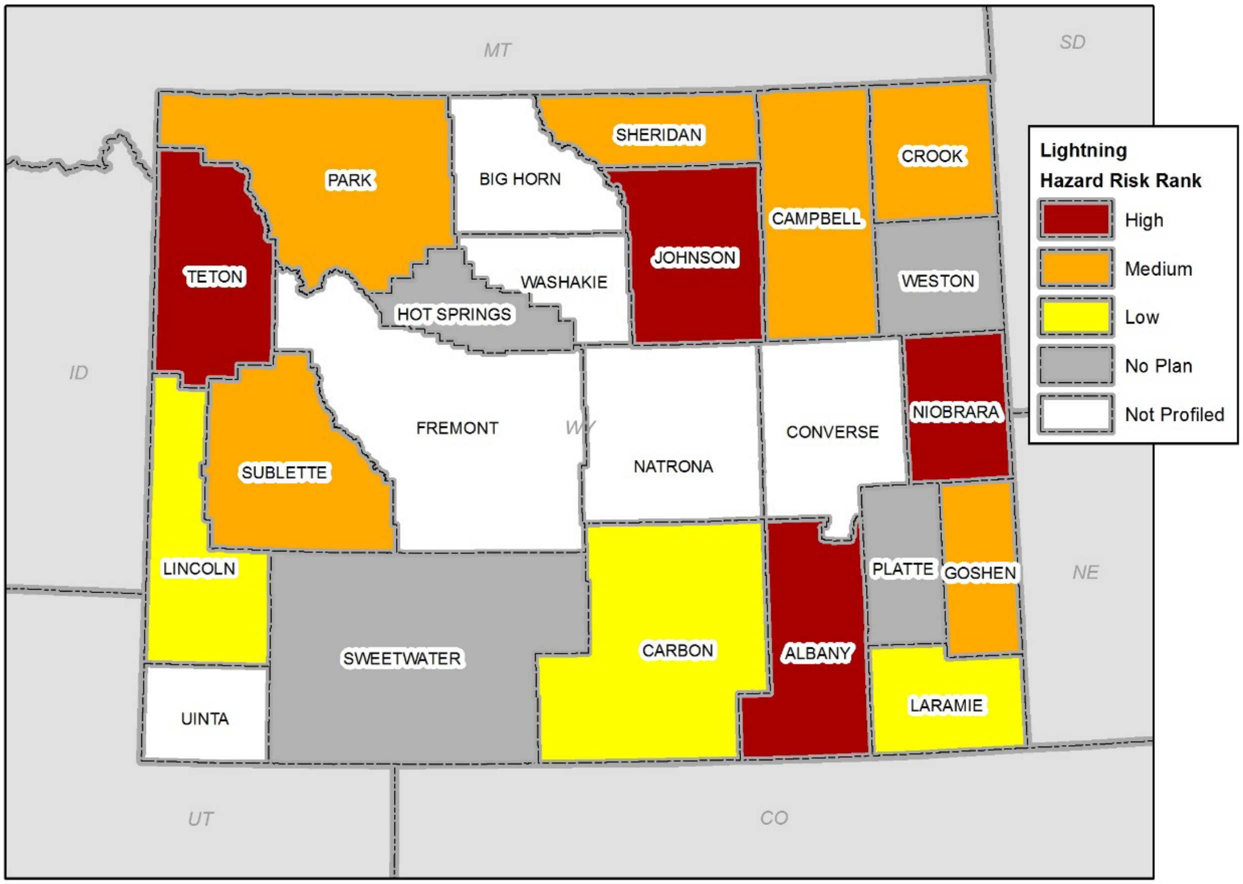


Figure 86. Lightning Risk Rankings from Local Hazard Mitigation Plan Risk Assessments

Statewide Risk Assessment

Highest average annual lightning flash density, according to the map above, is in Crook and Weston Counties. Most loss causing events are in Park and Teton Counties and most deaths happened in Park County.

Changes in Development

Among the counties mentioned at highest risk to lightning events, Teton and Crook have the highest projected growth rates. Teton is fourth highest in the county with a 24 percent projected growth rate and Crook is fifth in the county with a projected growth rate of 23 percent.

State Facilities at Risk

There are 117 state facilities in Crook County, 66 in Weston, 140 in Park, and 88 in Teton that are potentially at highest risk to the lightning hazard in the state.

Losses to state facilities from lightning events are listed in the table below; data includes number of events and associated damage and are sorted by state agency.

Table 57. State Building Losses – Lightning (2/20/11-9/24/15)

State Agency	Total Events	Loss ($)
Department of Corrections	8	$ -
Department of State Parks and Cultural Resources	2	$ 3,815
Wyoming Department of Agriculture	1	$ -
Wyoming Department of Health	1	$ 3,167
Wyoming Fish and Game Department	1	$ 669
Total	13	$ 7,651

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 58. Lightning Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	2.4	*Moderate*
Lightning	4.0	1.5	1.5	3.4	1.3		

Mine Subsidence

Description

Underground coal mining began in Wyoming during the 1860s. Many of the early coal mines were not designed and constructed well. Many were also shallow, and often had minimal ground support in the form of mine timbers. As a result their underground pillars failed. If enough pillars fail, the caprock in the mine will collapse. The effect of the collapse reaches the surface in some cases. If the effect of the collapse reaches the surface, a subsidence pit or trough forms. Not all subsidence from mining is due to poor design. Most underground mines eventually have roof failures due to lack of maintenance, and continuous loading of the unsupported rock layers overhead. In some cases the pillars were pulled as mining retreated from an area. In other cases fires occurred in the mines, resulting in a loss of strength in pillars and caprock.

Figure 87. Subsidence above Old Monarch Coal Mine North of Sheridan[40]

Significant areas of Wyoming have abandoned underground mines present. Mining subsidence has been threatening those areas since the onset of mining in the 1860s. Due to the long history of underground mining in the state, many more undermined areas have subsided than most people imagine. A written history of mine subsidence in or near urban areas was published in the *Governor's Workshop on Mine*

[40] U.S. Geological Survey Photo

Subsidence proceedings held on October 31, 1986 at the University of Wyoming. The WSGS generated a report for each county in Wyoming on abandoned underground coal mines and hard rock mines which have been identified. Mining sites and subsidence have been reported through multiple avenues including the US Geological Survey, Wyoming Geological Survey, US Forest Service personnel, BLM personnel, hunters, and other private individuals. The Abandoned Mine Lands Division (AML) of the Wyoming Department of Environmental Quality (DEQ) have recorded and actively pursued mitigation of mined out areas throughout the state. One mitigation activity includes generating GIS layers of mined out sites. Two mining GIS inventory projects have been completed, one in 2001 and the other in 2004, wherein staff physically visited and geolocated mined out areas. The AML has accurately mapped approximately 3,000 of the nearly 4,000 reported abandoned mining sites. A high-level map showing numbers of abandoned mines in areas around the state follows (**Figure 88**). More detailed, local information is available through the AML upon request.

History and Probability of Future Events

Subsidence problems have occurred in Rock Springs, Hanna, Glenrock, Superior, Reliance, Evanston, Kemmerer, Sheridan, and Gillette. A map showing documented mined-out areas in Wyoming is shown in **Figure 88**. Many of the areas shown are susceptible to subsidence. **Figure 89** shows mine sites with underground workings that are susceptible to subsidence. Property and infrastructure damage associated with mine subsidence in Wyoming communities is on-going.

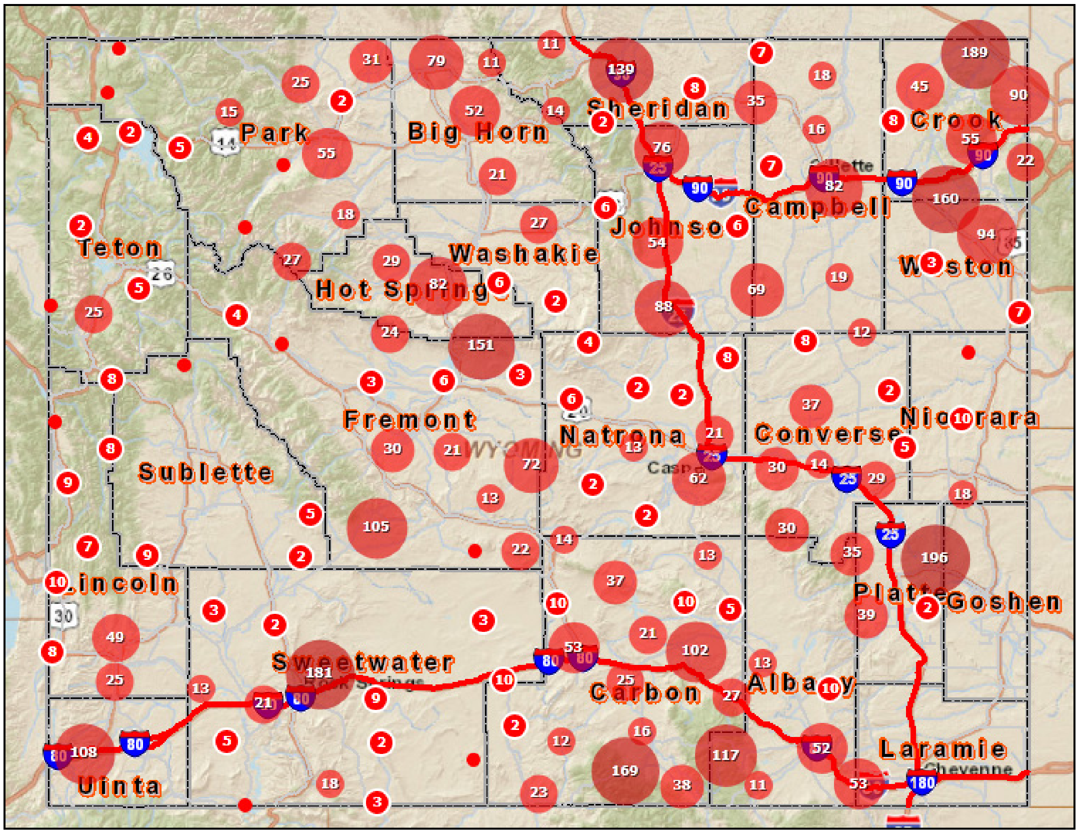


Figure 88. Mined-out Areas and Mine Subsidence in Wyoming

Many of Wyoming's coal mines are along and near Railroad routes through Wyoming. Mapping of Wyoming's mined out areas is considered virtually complete, though occasionally a previously unmapped area is discovered and mapped. Historically, much mitigation of Wyoming's mined out areas has been funded through fees charged on coal extracted from the state. The program is funded through the Office of Surface Mining from funds collected through a mine reclamation fee assessed on each ton of coal produced. The Surface Mining Control and Reclamation Act (SMCRA) includes a provision that each state, including Wyoming, would receive an amount equal to 50 percent of the mine reclamation fee collected in that state. Historically, Congress did not appropriate the full 50 percent funding resulting in reduced reclamation resources for Wyoming. In 2007, SMCRA was amended to return the funding to the full 50 percent state share resulting in a significant increase in funding for Wyoming. In 2012, Congress limited AML reclamation funding for Wyoming to a maximum of $15 million per year. This significantly reduced the funding available for reclamation in Wyoming.

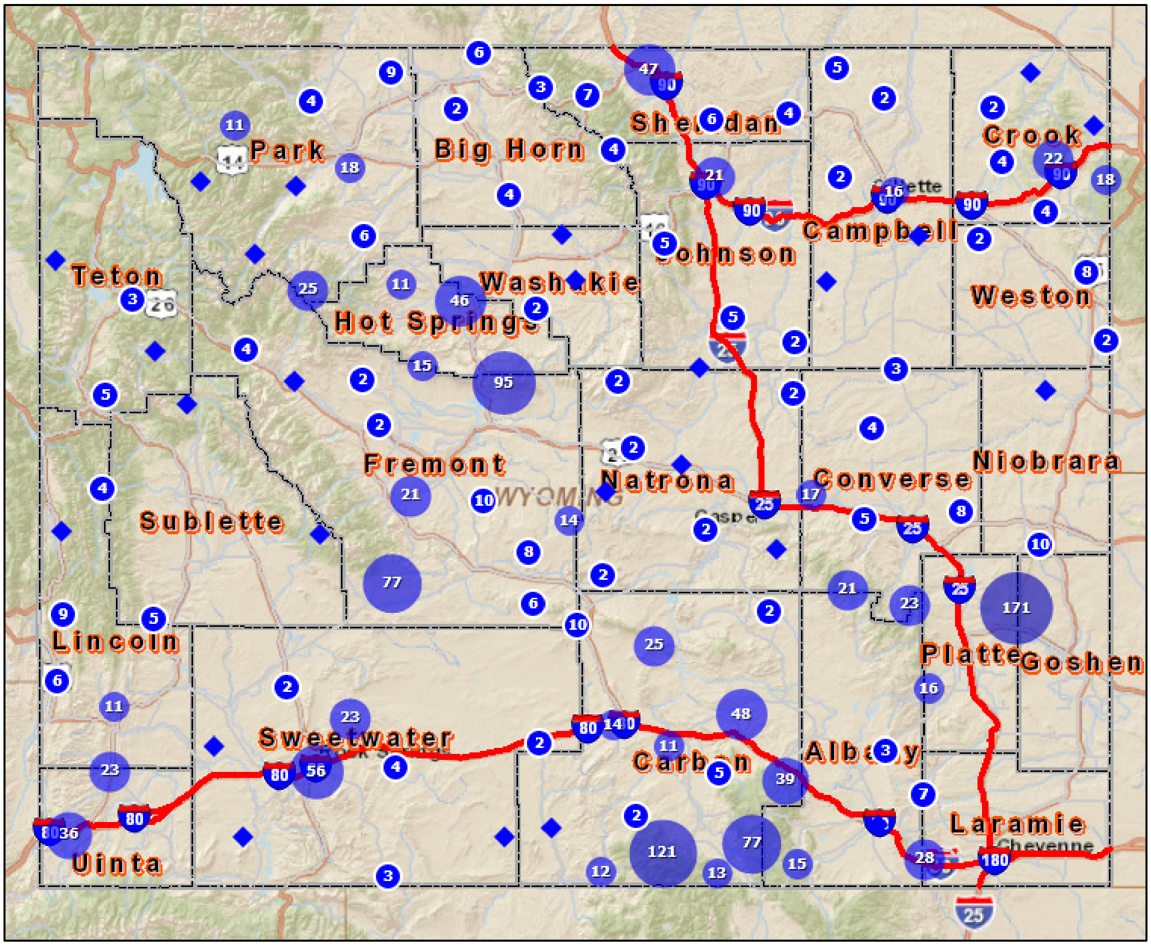


Figure 89. Abandoned Mine Sites with Subsidence-Prone Underground Workings

Over the past several years, in addition to a large number of traditional mine reclamation projects on both coal and non-coal mine sites, the AML has funded two or three large subsidence mitigation projects annually, along with smaller projects to protect individual homeowners, done at the request of individual homeowners. Recent subsidence mitigation projects have focused on protecting critical infrastructure. In the Rock Springs area, the community's water tank, and water supply lines have been protected and Interstate 80 north of Rock Springs has also been protected.

These recent subsidence mitigation projects involve 'grouting' mined out areas. 'Grouting' involves a process of filling the underground mine cavity created by previous mining activity with light cement. This supports the cavity's ceiling, minimizing the likelihood of collapse and impacts to the surface topography. Depending on the situation, another mitigation option can be pursued which involves creating cement support pillars in the cavity to support the cavity's ceiling. Other methods use conventional construction equipment to dig out the collapsed area and install an earthen backfill to stabilize the subsidence feature.

An indirect measure of subsidence impact is the cost of mitigating the hazard. The AML Program at DEQ has spent $303.4 million through 2013 mitigating the effects of mine subsidence alone, as part of the abandoned mine reclamation program.

Another mitigation effort available to property owners, the AML makes subsidence insurance available to property owners in affected communities. Homeowners who elect to have their property mitigated for subsidence receive an additional benefit as the cost of subsidence insurance is covered for one year by the AML program at DEQ. The cost of insurance is affordable for property owners, and is based on the county's tax valuation of the property, with a maximum of $250,000 insurance available. Given the known risk, insurance is particularly valuable for homeowners in subsidence-prone areas.

The AML monitors underground coal fires burning in mined out areas around the state. Underground fires also make the surface above the fire more susceptible to subsidence. It doesn't make sense to open a coal seam at the site of a fire, exposing the flame to greater oxygen supply and further endangering people. Mitigation efforts can be undertaken to interrupt underground coal fires, however. The most cost effective and safest methods involve measures to deny oxygen to the fires. This may take the form of backfilling cracks and fire vents such as the pictures following (**Figures 90 and 91**), installing massive earthen caps over the active fire zone to seal cracks and vents and other ways air can circulate within the fire zone. Methods may involve sealing openings and large cracks with cement. In places where a seam is burning, the fire may be interrupted by trenching across the seam in uninvolved coal, then isolating the unburned area from the advancing fire by filling the trench with inert, noncombustible earthen material.

Businesses seeking to lay pipelines, electrical transmission lines, develop a well site, or build another type of business structure in an area subject to subsidence hazards are typically referred to the AML during the environmental review process. This contact helps ensure new, developing infrastructure can be routed around problem areas, or if more efficient and possible, the area can be mitigated for subsidence hazards before structures or individuals are exposed to the hazard.

Figure 90. Smoke from Underground Coal Fire in the Powder River Basin North of Sheridan[41]

Figure 91. Smoke from Underground Coal Fire at the Powder River Basin North of Sheridan

[41] Courtesy of Ed Heffern (BLM Wyoming)

Locations where mine subsidence may occur are located throughout the state in both populated and unpopulated areas. Development in locations where mine subsidence occurs certainly has the potential to impact individual homes or neighborhoods. While it is believed all mined out areas in Wyoming have been mapped, it is unknown if all locations of potential subsidence have been located. The uncertainty regarding the locations of more potential subsidence areas means there is the possibility development may occur in a subsidence-prone location without the knowledge of contractors or developers prior to development. Given this fact, there is no way to determine with certainty the likelihood development will occur in a subsidence-prone location and therefore it's difficult to put a risk factor to this hazard as it relates to development within Wyoming's borders.

Probability

Likely = Value 2
Mine Subsidence events have between 1 & 10% Annual Probability

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. Nine counties profiled subsidence in local plan risk assessments; Crook County and the City of Rock Springs ranked the risk and medium and the rest ranked the risk as low.

You will note all counties recognizing subsidence as a hazard within their county's borders consider the hazard to rank low. Most are unable to state the number of incident occurrences and also reflect minor, if any damage.

Statewide Risk Assessment

Crook County and the City of Rock Springs in Sweetwater County rated the subsidence hazard as medium in local risk assessments. According to the maps above, Carbon County has the highest prevalence of the subsidence hazard.

Changes in Development

Crook County has the fifth highest projected rate of population growth from 2010 to 2030 in Wyoming at 23 percent. Sweetwater has a projected rate of 19 percent and Carbon a rate of 2 percent.

State Facilities at Risk

There are 117 state facilities in Crook County, most of which are in the Town of Sundance, 99 in Sweetwater, most of which are in the City of Rock Springs, and 218 in Carbon, most of which are in the City of Rawlins, that are potentially at risk to the mine subsidence hazard.

There were no recorded losses to state facilities from mine subsidence.

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 59. Subsidence Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	1.2	*Low*
Subsidence	2	1.5	1.3	2.7	2.2		

TORNADO

Description

Wyoming, lying just west of “tornado alley”, is fortunate to experience fewer intense tornadoes than its neighboring states to the east. However, tornadoes remain a significant hazard in the state. Tornadoes are the most intense storm on earth, having been recorded at velocities exceeding 315 miles per hour (mph). The phenomena results in a destructive rotating column of air ranging in diameter from a few yards to greater than a mile, usually associated with a downward extension of cumulonimbus cloud. Tornadoes are classified by their intensity using the Fujita (F) Scale, with F0 being the least intense and F6 being the most intense. **(Table 60)**

Table 60. Fujita Scale of Tornado Intensity

Fujita Scale	Wind Speed	Damage
F0	40-72	Light
F1	73-112	Moderate
F2	113-157	Considerable
F3	158-206	Severe
F4	207-260	Devastating
F5	261-318	Incredible
F6	319-379	Inconceivable

The weakest intensity, F0, tornadoes describe more than half of Wyoming’s past tornadoes. The strongest tornado in Wyoming was an F4 with winds between 207 and 260 mph. The tornado was the highest elevation F4 tornado ever documented. This tornado occurred in Teton County on July 21, 1987 and resulted in $500,000 in damages.

According to the Wyoming Climate Atlas, Wyoming ranks 25th in the number of annual tornadoes (10), 33rd in fatalities (six deaths per one million people), 36th in property damage ($49,339,505) (figure from WSGS), and 37th in injuries, in the U.S. from 1950 to 1994. (Excerpted from the Wyoming Climate Atlas) A record of Wyoming’s tornadoes can be found in **Appendix P**.

Tornado statistics, especially prior to the 1970s, must be viewed as incomplete since many twisters must have occurred without being witnessed. Wyoming’s open rangelands experience little, if any, damage from these storms, so many go unreported. In the 1990s, the Internet and Doppler radar increased the public’s awareness of tornadoes increasing the potential of more being observed and reported. However, the trend in annual tornadoes has decreased by one-third since 1976 and appears to have coincided with a major hemispheric weather pattern shift, despite the increased reporting based on Doppler radar vortex (circulation) signatures. (Wyoming Climate Atlas).

Figure 92. F2 Tornado in Wright, August 2005

History and Probability of Future Events

By a large margin, 1979 was the year with the greatest damage, estimated at $42.8 million, with the influential factor being the Cheyenne-area tornado on July 16. The second worst year was 2005 with a total estimated damage of $5 million. This is a significant difference of $37.8 million. The damage in 1979 is not likely to reoccur, but nevertheless is possible and should be considered in this mitigation plan and in the State's Threat Identification and Risk Assessment (THIRA) and the State's Preparedness Report (SPR). The 1979 tornado damage was concentrated on property, rather than crops. Such an incident could occur again in the future. **Figure 93** shows the number of recorded tornados and the estimated losses for each county for events 1960-2013.

The following table lists loss-causing tornado events and associated damage by county, collected from SHELDUS and NCDC past events databases.

Table 61. Tornado Events, Causalities, and Damage by County and Statewide (1960-2015)

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Albany	3	1	-	$ 355,000	$ -	$ 355,000
Big Horn	10	1	-	$ 63,500	$ 500	$ 64,000
Campbell	16	5	2	$ 6,230,550	$ 350	$ 6,230,900
Carbon	2	-	-	$ -	$ 55,000	$ 55,000
Converse	6	4	-	$ 15,500	$ 550	$ 16,050
Crook	15	2	1	$ 516,050	$ 1,000	$ 517,050
Fremont	12	4	-	$ 143,000	$ 100	$ 143,100
Goshen	18	-	-	$ 717,100	$ 5,050	$ 722,150
Hot Springs	1	-	-	$ 5,000	$ -	$ 5,000
Johnson	4	-	-	$ 8,550	$ 50	$ 8,600
Laramie	24	43	1	$ 5,171,200	$ 50,700	$ 5,221,900
Lincoln	1	-	-	$ 5,000	$ -	$ 5,000
Natrona	14	9	-	$ 76,100	$ 250	$ 76,350
Niobrara	11	5	-	$ 181,000	$ 50	$ 181,050
Park	6	-	-	$ 15,550	$ 50,050	$ 65,600
Platte	8	2	-	$ 110,500	$ 5,050	$ 115,550
Sheridan	5	-	-	$ 6,500	$ 500	$ 7,000
Sublette	1	-	-	$ 50	$ -	$ 50
Sweetwater	3	-	-	$ 40,000	$ -	$ 40,000
Teton	1	-	-	$ 500,000	$ -	$ 500,000
Uinta	2	-	-	$ 1,000	$ -	$ 1,000
Washakie	3	-	-	$ 75,500	$ -	$ 75,500
Weston	6	2	-	$ 58,000	$ 300	$ 58,300
Statewide	**172**	**78**	**4**	**$ 14,294,650**	**$ 169,500**	**$ 14,464,150**

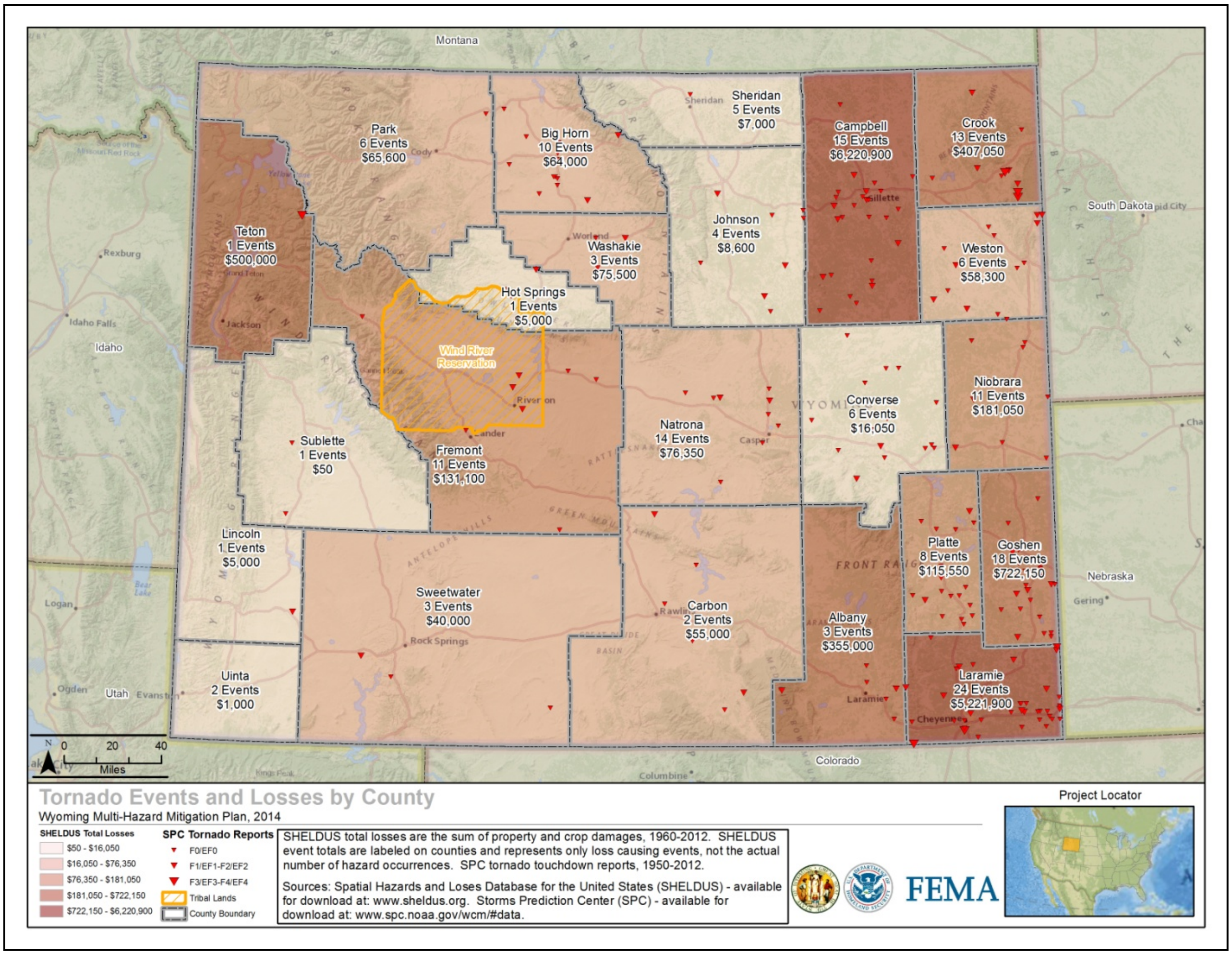


Figure 93. Tornado Events and Losses by County

Property versus crop damage should be considered because property tends to be more critical to restore and time sensitive than crops. However, long-term effects of crop damage have potential to affect the public, but restoration is not as time sensitive as property damage.

Figure 94. Damage from F2 Tornado in Wright (August 2005)

On the Tornado History Projects website there are 623 recorded tornado events in Wyoming from 1950 through 2012. According to the Tornado History Project, Wyoming tornados have killed four people and injured 102 in the same time period. The greatest distance traveled by a tornado in Wyoming is 52 miles.[42] As one would expect, the concentration of recorded tornados occurred in the eastern portion of the state, where the plains are located.

Annual tornado statistics show a wide variation across the state. For example, 42 tornadoes were counted in 1979 while no tornadoes were reported in 1951 and 1970 (**Figure 95**). SHELDUS reports all Wyoming counties have experienced a tornado. Laramie County had the greatest number of tornadoes in the state (24) while Teton, Lincoln, Sublette and Hot Springs Counties recorded only one (**Figure 93).** Laramie County has the largest population and, thus, tornadoes could be expected to cause greater damage to structures. The fact that extreme southeast Wyoming is closest to "tornado alley" explains the higher number of tornadoes. The average length of a tornado in Wyoming is 3.05 miles with an average width of 79 yards. On average there are six tornado days per year (Excerpted from the Wyoming Climate Atlas).

[42] http://www.tornadohistoryproject.com/tornado/Wyoming (Accessed 3/2//2014)

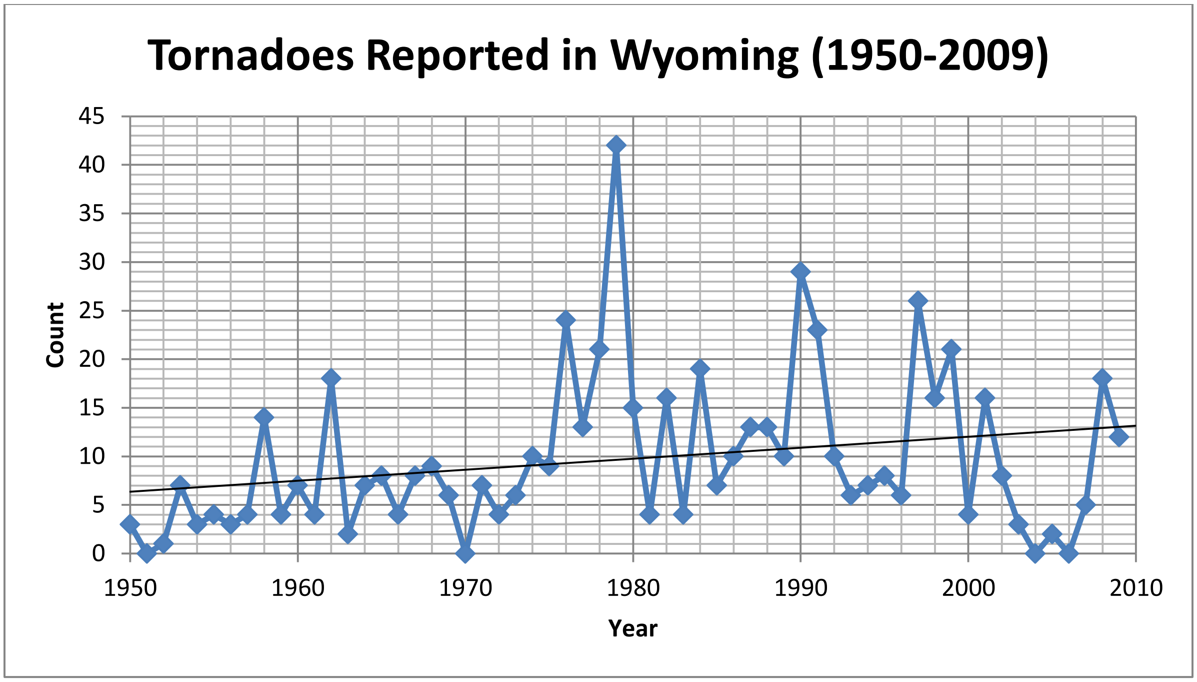


Figure 95. Tornadoes Reported in Wyoming 1950-2009

Statistically, Wyoming residents can expect tornadoes to occur between April to October, with the highest concentration of tornadoes in June (**Figure 96**). Tornadoes are more likely to occur between 3 p.m. and 4 p.m. (**Figure 97**).

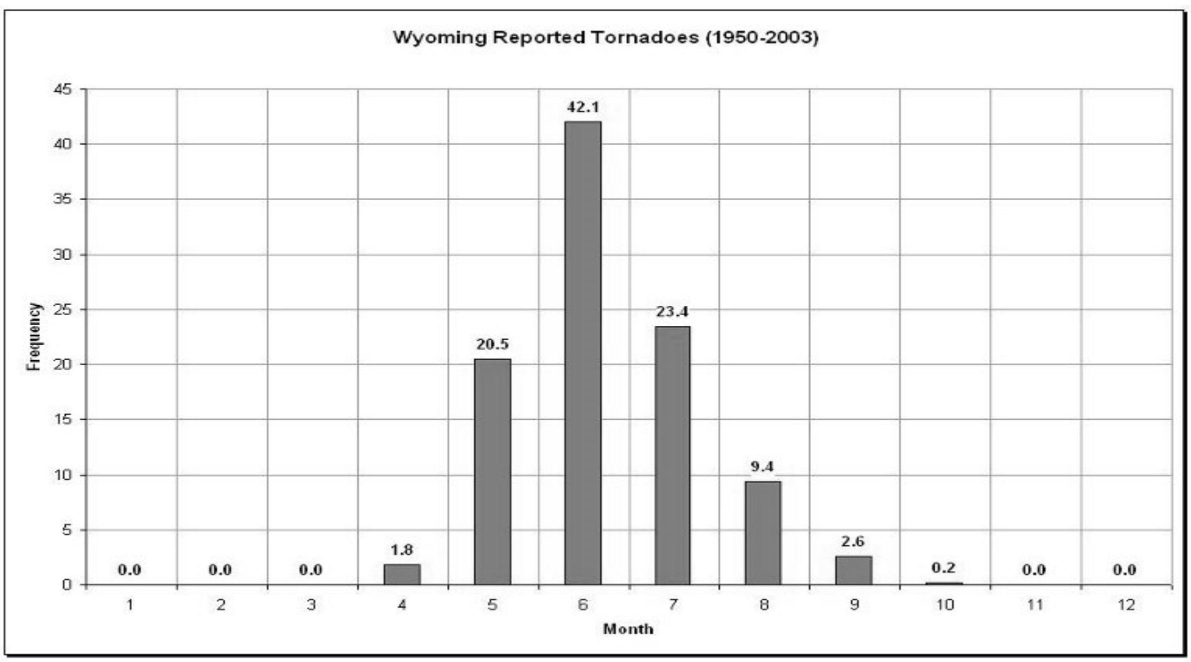


Figure 96. Monthly Tornado Statistics 1950-2003[43]

[43] Wyoming Climate Atlas

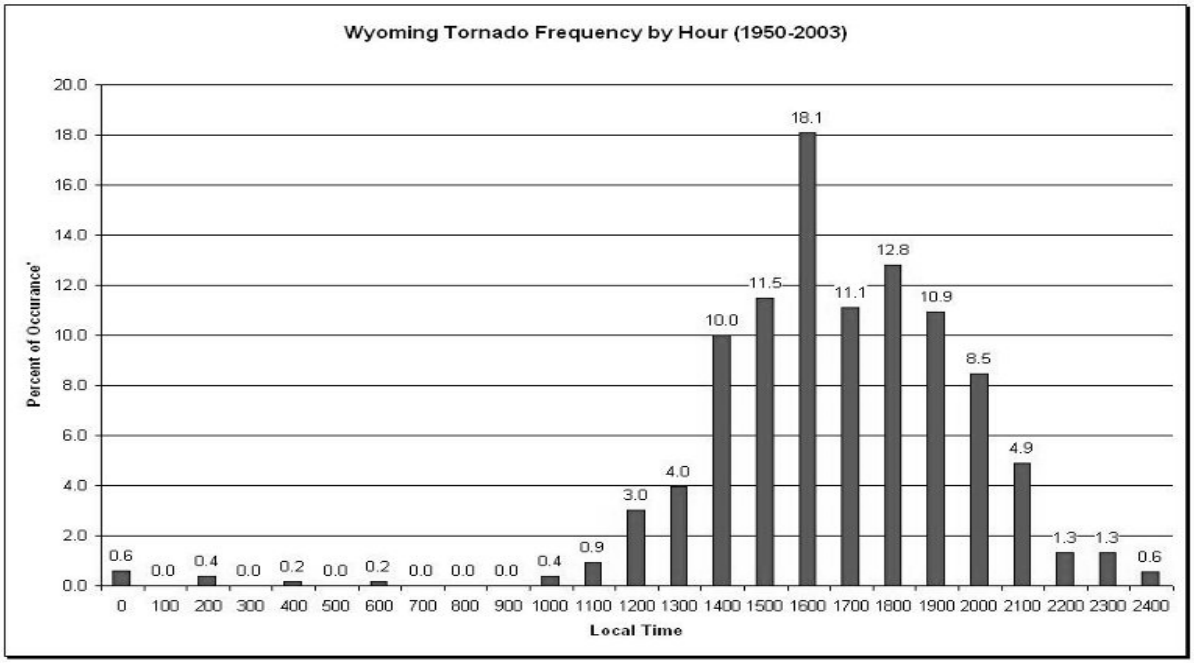


Figure 97. Tornado Frequency by Hour 1950-2003[44]

Presidential Declaration

There has been one Presidential Disaster Declaration related to tornadoes in Wyoming. FEMA DR-WY-1599 was associated with the August 12, 2005, tornado in Wright, Wyoming located in Campbell County.

Although counties have been affected to lesser and greater extents by tornado intensity, frequency, and damage, they nevertheless have struck every county in Wyoming, thus proving to be a considerable danger. Historically, the most devastating tornado event in Wyoming was July 16, 1979 when the Cheyenne area received between $5 and $50 million worth of damage.[45] This is significant because Laramie County, the location of the state's capitol, has Wyoming's greatest population and is also the most likely to have the highest frequency and intensity of tornadoes.

Historical data demonstrates the most critical area of the state for tornado hazard is the eastern one third, with the five most threatened areas being Laramie, Campbell, Goshen, Crook, and Niobrara Counties. The four least threatened areas include Teton, Sublette, Hot Springs and Lincoln Counties (**Figure 93**).

Laramie, Goshen, and Campbell Counties should be viewed as most critical. The July 1979 tornado in the Cheyenne area, resulting in millions of dollars' worth of damage, should be considered a worst-case scenario. The data suggests that Cheyenne's size and location places it at the highest risk for economic damage from tornado hazards.

[44] Wyoming Climate Atlas
[45] http://www.tornadohistoryproject.com/tornado/Wyoming/1979/July/table (Accessed 3/28/2014)

The most recent tornadoes causing loss of life occurred in Big Horn County on June 26, 1959, in Cheyenne on July 16, 1979, and in Wright on August 12, 2005. One life was lost in the Big Horn and Cheyenne events, and two lives were lost in the Wright event. The Cheyenne event also resulted in 40 injuries.

Probability

Tornado event frequency is calculated statewide and by county below and is based on loss-causing events, 1960-2015, collected from SHELDUS and NCDC databases.

Highly Likely = Value 4
172 Reported ÷ 55.5 years = 3.1 Tornado events every year or a >100.0 % annual probability of a Tornado event

Table 62. Tornado Event Frequency

County	Total Events	Time Period	Frequency	Probability
Albany	3	55.5 Years	5%	Occasional
Big Horn	10		18%	Likely
Campbell	16		29%	Likely
Carbon	2		4%	Occasional
Converse	6		11%	Likely
Crook	15		27%	Likely
Fremont	12		22%	Likely
Goshen	18		32%	Likely
Hot Springs	1		2%	Occasional
Johnson	4		7%	Occasional
Laramie	24		43%	Likely
Lincoln	1		2%	Occasional
Natrona	14		25%	Likely
Niobrara	11		20%	Likely
Park	6		11%	Likely
Platte	8		14%	Likely
Sheridan	5		9%	Occasional
Sublette	1		2%	Occasional
Sweetwater	3		5%	Occasional
Teton	1		2%	Occasional
Uinta	2		4%	Occasional
Washakie	3		5%	Occasional
Weston	6		11%	Likely

County	Total Events	Time Period	Frequency	Probability
Statewide	**172**	**55.5 Years**	**310%**	**Highly Likely**

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. The map below shows these rankings by county to demonstrate local perception of risk across the state.

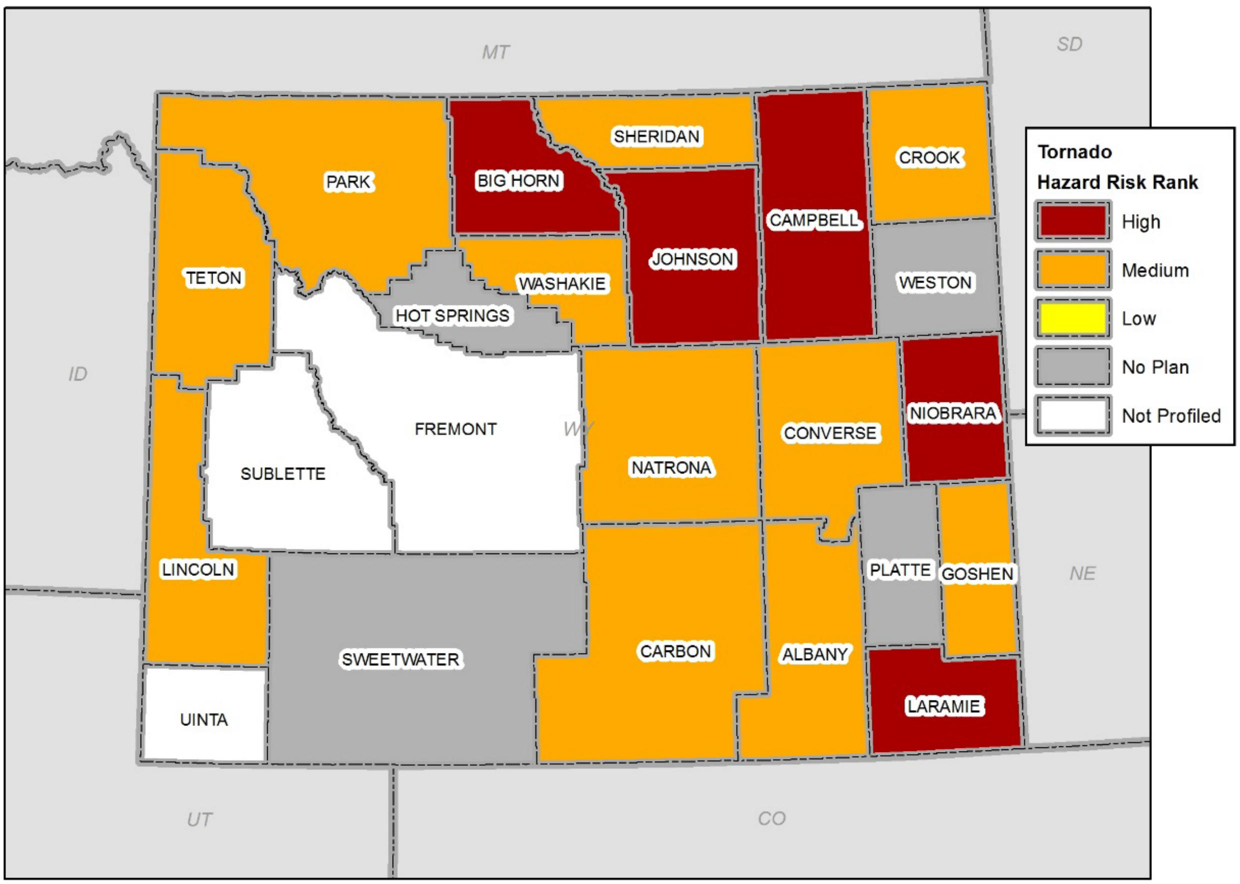


Figure 98. Tornado Risk Rankings from Local Hazard Mitigation Plan Risk Assessments

You will note all counties rank tornadoes risk between a medium and high hazard within their borders. Potential losses quoted within the local plans vary widely, based on their past experience, population density and development within the county and its jurisdictions.

Statewide Risk Assessment

According to tornado events and losses in the last 55 years, Campbell and Laramie Counties have the greatest risk to tornadoes. Highest population clusters in these counties are in the City of Gillette and City of Cheyenne.

Campbell and Laramie, along with Big Horn, Johnson, and Niobrara Counties have each rated tornado as a high risk hazard in their local risk assessments.

Changes in Development

Campbell County a 43 percent projected population growth between, second highest in the state. Laramie County has the tenth fastest growing population at 16 percent.

Development can impact the risk presented by tornadic activity. Increased population can mean greater damage in the event a tornado strikes. Tornado shelters and basements become more important the greater the population in order to help prevent loss of life in the event of a tornado. Additionally, those unfamiliar with the hazard may be drawn to watch events as they unfold rather than take shelter, putting them at greater risk of injury or death. They Wyoming Profile section documents those counties with higher population increases and populations with greater vulnerability based on income levels, age, and other social vulnerability criteria.

State Facilities at Risk

Historically Wyoming's government property has experienced one damaging tornado event totaling $4,251 from 1985 to 2015.

There are 35 state facilities with a value of more than $12 million in Campbell County (29 of those in Gillette) and 326 state facilities with a value of $1 billion in Laramie (244 of those in Cheyenne) that may be at highest risk to tornado damage.

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 63. Tornado Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	3.0	*High*
Tornado	4.0	2.7	2.3	3.5	1.9		

Wildfire

Description

Wyoming's semi-arid climate and rural character make the state vulnerable to catastrophic wildland fires, which comprise more than 50 percent of all fires in Wyoming. As defined by the National Interagency Fire Center (NIFC), a "wildland fire" is any non-prescribed, non-structure fire that occurs in the wildland.

Figure 99. Sawmill Canyon Fire-Platte County, 2012[46]

Wyoming's Forest Action Plan identifies fire in the wildland-urban interface (WUI) as threat that is significant and expanding. Fire in the WUI impacts suppression strategies, tactics, costs, and also potentially firefighter and public safety. Lands in the WUI are often desirable for housing development due to amenities such as forests or other vegetation which in turn present a hazard to the development. The Forest Action Plan also identifies strategies and tactics to help reduce the risk of wildfire in the WUI. Increased areas of WUI are prompting policy makers and fire management organizations to respond to the need to mitigate wildfire risk.

Conditions on some landscapes are no longer within normal fire regimes or fire return intervals, the result of effective fire suppression, limited forest management, and climatic factors. For example, ponderosa pine stands often burn in an intense, stand replacing manner, rather than the lower intensity fires of the past. With more intense fires there is the risk of the loss of ecosystem components, such as large trees, plus risk of damage to other resources, such as water quality. For some landscapes, before fire can safely

[46] Photo courtesy of Wyoming State Forestry Division

be returned, if desired, mechanical treatment would be necessary to reduce fuels to help control fire intensity.

According to the Wyoming State Forestry Division, the majority of wildfires in the state are started naturally by lightning. This makes Wyoming dissimilar to more heavily populated states, as those states with higher populations find their wildfires are more likely to be human-caused. As the population in Wyoming slowly increases, the number of human caused fires also slowly increases. Ninety-eight percent of all wildfires—both human and those caused naturally —in Wyoming are extinguished by firefighters within 10-acres of ignition.

Although different reports, assessments, plans, and programs have been developed by organizations at all levels of government, interagency coordination has proven to be extremely effective. Today Wyoming wildland fires are managed and supported to varying extents through a cooperative effort by the:

- U.S. Bureau of Land Management (BLM) Wyoming Fire Program
- Geospatial Multi-Agency Coordination (GeoMAC) Wildland Fire Support Maps
- Wyoming Fire Academy
- National Park Service (NPS) Fire Management Program
- U.S. Fish and Wildlife Service (FWS) Fire Management Branch
- National Interagency Fire Center (NIFC)
- U.S. Bureau of Indian Affairs (BIA) Fire and Aviation Management – NIFC
- USDA Forest Service (USFS) Fire and Aviation Management
- Wyoming State Fire Marshalls Office
- Wyoming Office of Homeland Security (WOHS)
- Wyoming State Forestry Division
- County and Local Fire Departments/Districts

Before discussing wildland fire hazard in Wyoming some key terms should be identified. The term "wildland/urban interface" or WUI is widely used within the wildland fire management community to describe any area where man-made structures are constructed close to or within a boundary of natural terrain and fuel, where high potential for wildland fires exists. "Aspect" refers to the direction in which a slope faces. "Fuel" consists of combustible material, including vegetation, such as grass, leaves, ground litter, plants, shrubs, and trees that feed a fire.

In the past, the principle wildland fire response plan for the state was the Wyoming Wildland Urban Interface Hazard Assessment produced by a joint venture of the Wyoming State Forestry Division, USFS, BLM, NPS, and other interested parties, with the BLM hosting the data. This is a geographic information system (GIS)-based mapping mission building on The Front Range Redzone Project in Colorado—the first fire-hazard mapping program of its kind. The assessment maps fire hazard incorporating population density against slope, aspect, and fuels. With the mapping analysis evaluating areas of varying wildfire vulnerability, the final output will result in a Risk, Hazard, and Value (RHV) map displaying areas of concern (red zones) for catastrophic wildland fires (**Figure 102**). The Wyoming Wildland Urban Interface Hazard

Assessment builds on the work of earlier hazard methodologies and provides new and updated data to further enhance accuracy and scale.

Figure 100. Fontenelle Fire-Sublette County 2012[47]

Currently, the Wyoming Forest Action Plan and the Western Wildfire Risk Assessment are considered the primary strategic plans that address wildland fire management in the state. Additionally, the Wyoming Interagency Cooperative Fire Management and Stafford Act Response Agreement outline areas of cooperation and coordination with respect to fire prevention, readiness, detection, fuels management, suppression, information sharing, communications, and reimbursement for shared resources. The agreement is produced through a joint venture of the U.S. Bureau of Land Management (BLM); National Park Service, Intermountain Region; Bureau of Indian Affairs, Rocky Mountain Region (BIA); Fish and Wildlife Service, Mountain Prairie Region; U.S. Department of Agriculture, Forest Service Rocky Mountain and Intermountain Regions; and the Wyoming State Board of Land Commissioners, Office of State Lands and Investments, Wyoming State Forestry Division. The agreement is implemented at the county and local level through Annual Operating Plans (AOPs). Community Wildfire Protection Plans (CWPPs) are also utilized, as well as other federal agency wildfire management plans.

Research following wildland fires has provided some lessons learned:

- Fertile soil with good-water holding capacity and dense, diverse vegetation before the fire recovered quickly.

[47] Photo courtesy of Wyoming State Forestry Division

- Grasslands returned to pre-fire appearance within a few years.
- Many of the burned forests were mature lodgepole; this species is re-colonizing most of the burned areas.
- The first seedlings of Engelmann spruce, subalpine fir, Douglas-fir, and whitebark pine have emerged.
- Aspen reproduction has increased because fire stimulated the growth of suckers from the aspen's underground root system and left behind bare mineral soil that provides good conditions for aspen seedlings.
- Some of the grasses that elk eat were more nutritious after the fire.
- Bears graze more frequently at burned than unburned sites.
- Cavity-nesting birds, such as bluebirds, had more dead trees for their nests; birds dependent on mature forests, such as boreal owls, lost habitat.

Fuel types in Wyoming's WUI include many grasses, forbs, shrubs, trees, and forest residues. All of these types of vegetation can provide increased fire hazard near structures. Mitigating the risk of fire in the WUI can involve different practices depending on the fuels in the vicinity. It is also important to be aware that other fuels, such as firewood piles or other items in close proximity to a structure, can contribute to the risk that fire poses to a structure. Similarly, certain construction materials such as wood shingles can make a home more vulnerable to fire in the vicinity.

History and Probability of Future Events

The following table lists loss-causing wildfire events and associated damage by county, collected from SHELDUS and NCDC past events databases.

Table 64. Wildfire Events, Casualties, and Damage by County and Statewide (1960-2015)

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Albany	-	-	-	$ -	$ -	$ -
Big Horn	3	-	1	$ 38,750	$ -	$ 38,750
Campbell	-	-	-	$ -	$ -	$ -
Carbon	-	-	-	$ -	$ -	$ -
Converse	-	-	-	$ -	$ -	$ -
Crook	-	-	-	$ -	$ -	$ -
Fremont	8	10	-	$ 2,677,500	$ -	$ 2,677,500
Goshen	-	-	-	$ -	$ -	-
Hot Springs	1	1	1	$ -	$ -	-
Johnson	2	-	-	$ 36,250	$ -	$ 36,250
Laramie	-	-	-	$ -	$ -	$ -
Lincoln	2	-	-	$ 22,500	$ -	$ 22,500

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Natrona	5	-	-	$ 4,336,250	$ -	$ 4,336,250
Niobrara	-	-	-	$ -	$ -	$ -
Park	2	-	1	$ 302,500	$ -	$ 302,500
Platte	-	-	-	$ -	$ -	$ -
Sheridan	-	-	-	$ -	$ -	$ -
Sublette	2	-	-	$ 22,500	$ -	$ 22,500
Sweetwater	2	-	-	$ 561,000	$ -	$ 561,000
Teton	3	-	-	$ 322,500	$ -	$ 322,500
Uinta	-	-	-	$ -	$ -	$ -
Washakie	2	-	-	$ 36,250	$ -	$ 36,250
Weston	-	-	-	$ -	$ -	$ -
Statewide	**32**	**11**	**3**	**$ 8,356,000**	**$ -**	**$ 8,356,000**

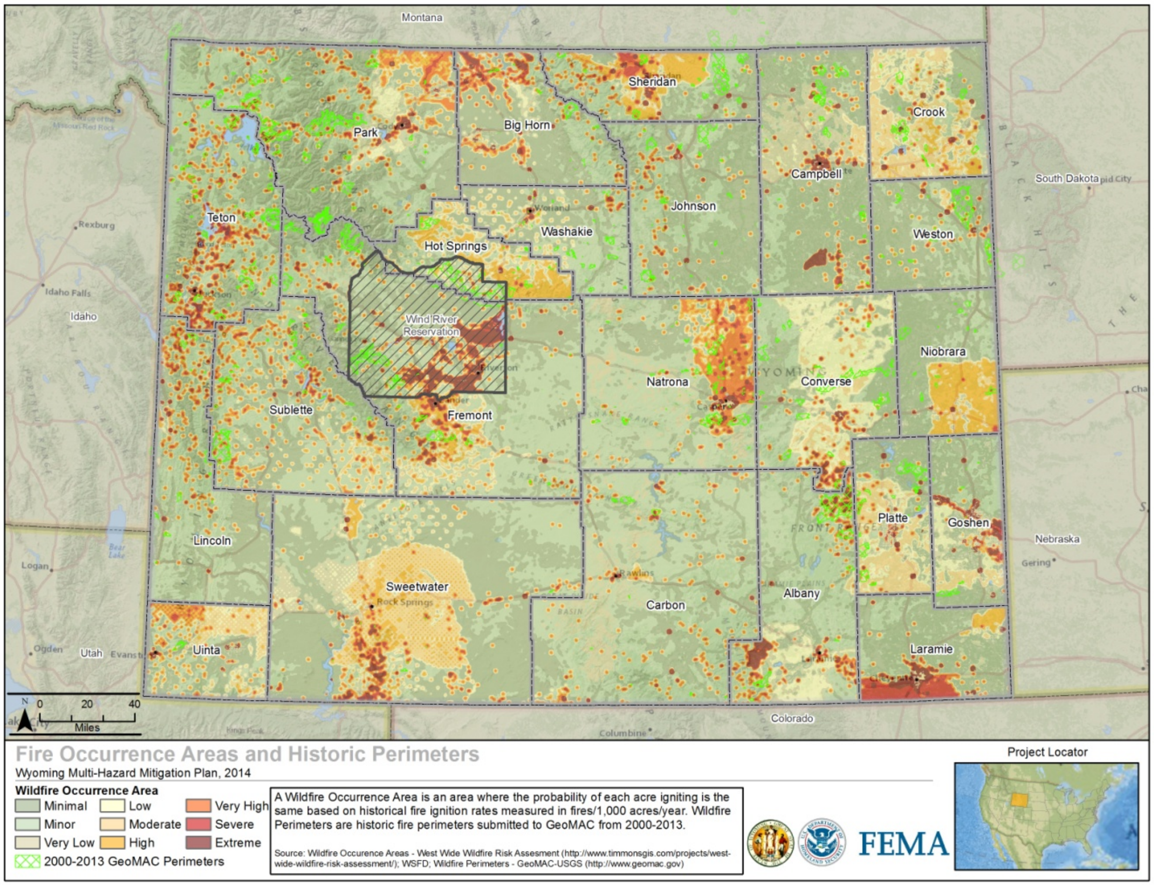


Figure 101. Fire Occurrence Areas and Historic Perimeters

As one of the most arid states in the U.S., Wyoming has experienced large fires historically. One of the earliest recorded large fires was in the summer of 1876 when the Sioux Indians retreated into the Big Horn Mountains, setting fire to the land, burning an estimated 500,000 acres to keep the United States Army, under the command of General Crook, from pursuing them. Today, fires of equivalent magnitude can and have occurred.

2012 Fire Season

The 2012 fire season was in many ways the most severe fire season in Wyoming since 1988. An estimated 1,000 wildland fires burned over 600,000 acres of state, private, and federal lands. The fire season started early following a dry winter and spring, with drought intensifying since the late summer of 2011. The first large fire in the state requiring a Type II Incident Management Team was the Cow Camp Fire in Albany County that started on June 5th. The Cow Camp Fire consumed over 8,400 acres. There were 31 qualifying Emergency Fire Suppression Account (EFSA) fires in 13 different counties and four FEMA Fire Management Assistance Grant (FMAG) fires. In an average season, there are less than six EFSA qualifying fires and, at the most, one FEMA FMAG Fire. Initial attack and large fires subsided with the Sheepherder Hill Complex in Natrona County and the Horsethief Canyon Fire in Teton County in September. Initial attack continued through the month of November, with some counties, such as Crook County reporting wildfires in every month of 2012.

In the 2012 season, Wyoming firefighters witnessed unprecedented fire behavior and rates of spread. The results were 80 homes/cabins destroyed, 50 outbuildings destroyed, with costs to local and state government exceeding 40 million dollars. Eventually, all 23 counties in the state had fire restrictions in place, as well as most public federal lands. Despite the loss of values, improvements, range land, and timber, the safety record during the 2012 season was second to none. Early on in the season, heat related illnesses were experienced on some incidents. As the season progressed there were very few minor or major injuries. The commitment to training and firefighter and public safety was demonstrated on every incident. Over the course of the fire season, thousands of wildland firefighters from thirty one different states assisted in suppressing the fires. Lessons learned from the 2012 fire season include:

- Firefighting: Continue to fight fires and be adequately prepared for the next year.
- Rehabilitation and Restoration: Restore landscapes and rebuild communities damaged by the wildfires of 2012.
- Hazardous Fuel Reduction: Invest in projects to reduce wildfire risk.
- Community Assistance: Work directly with communities to ensure adequate community planning and protection.

Table 65 is a chronological history of fires and the number of acres burned, highlighting both the figures for federal land, state and private lands, and their totals between 1960 and 2013.

Table 65. History of Numbers of Fires and Acres Burned

Year	Intensity type	Amount		
		Federal land	State & private land	Total
1960[1]	Number of fires	159	39	198
	Number of acres burned	2,533	840	3,373
1961[1]	Number of fires	147	57	204
	Number of acres burned	1,193	16	1,209
1962[1]	Number of fires	116	20	136
	Number of acres burned	241	44	285
1963[1]	Number of fires	141	31	172
	Number of acres burned	1,367	764	2,131
1964[1]	Number of fires	143	24	167
	Number of acres burned	3,650	393	4,043
1965[1]	Number of fires	68	15	83
	Number of acres burned	228	94	322
1966[2]	Number of fires	261	243	504
	Number of acres burned	2,391	4,908	7,299
1967[2]	Number of fires	35	156	291
	Number of acres burned	325	4,490	4,815

Year	Intensity type	Amount		
		Federal land	State & private land	Total
1968[3]	Number of fires	163	132	295
	Number of acres burned	2,551	12,122	14,673
1969[3]	Number of fires	231	396	627
	Number of acres burned	2,980	25,981	28,961
1970[3]	Number of fires	241	413	654
	Number of acres burned	7,984	11,378	19,362
1971[3]	Number of fires	209	433	642
	Number of acres burned	3,406	67,567	70,973
1972[3]	Number of fires	183	438	621
	Number of acres burned	1,362	24,078	25,440
1973[3]	Number of fires	200	444	644
	Number of acres burned	2,911	10,047	12,958
1974[3]	Number of fires	301	772	1,073
	Number of acres burned	5,000	27,847	32,847
1975[3]	Number of fires	205	513	718
	Number of acres burned	6,101	15,177	21,278
1976[3]	Number of fires	349	589	938
	Number of acres burned	7,019	14,795	21,814
1977[3]	Number of fires	369	612	981
	Number of acres burned	6,045	16,885	22,930
1978[3]	Number of fires	301	559	860
	Number of acres burned	3,392	5,220	9,152
1979[3]	Number of fires	366	598	964
	Number of acres burned	12,100	16,294	28,394
1980[3]	Number of fires	333	603	936
	Number of acres burned	2,426	15,665	18,091
1981[3]	Number of fires	406	677	1,083
	Number of acres burned	30,326	6,757	37,083
1982[3]	Number of fires	205	555	760
	Number of acres burned	1,779	16,026	17,805
1983[3]	Number of fires	177	734	911
	Number of acres burned	2,294	25,136	27,430
1984[2]	Number of fires	169	607	776
	Number of acres burned	658	13,305	13,963
1985[2]	Number of fires	352	1,252	1,604
	Number of acres burned	11,227	56,185	67,412
1986[2]	Number of fires	202	546	748
	Number of acres burned	6,385	15,325	21,710
1987[2]	Number of fires	201	816	1,017
	Number of acres burned	7,872	21,123	28,995
1988[2]	Number of fires	504	1,456	1,960
	Number of acres burned	1,413,175	124,127	1,537,302

Year	Intensity type	Amount		
		Federal land	State & private land	Total
1989[2]	Number of fires	278	738	1,016
	Number of acres burned	4,331	25,088	29,419
1990[2]	Number of fires	353	492	845
	Number of acres burned	2,221	31,499	33,720
1991[4]	Number of fires	379	836	1,215
	Number of acres burned	16,106	61,944	78,050
1992[4]	Number of fires	407	872	1,279
	Number of acres burned	6,750	33,727	40,477
1993[4]	Number of fires	163	303	466
	Number of acres burned	4,283	4,628	8,911
1994[4]	Number of fires	584	1,027	1,611
	Number of acres burned	44,207	58,480	102,687
1995[4]	Number of fires	250	597	847
	Number of acres burned	2,846	12,697	15,525
1996[4]	Number of fires	516	1,506	2,022
	Number of acres burned	105,687	417,310	522,997
1997[4]	Number of fires	171	738	909
	Number of acres burned	8,420	20,016	28,436
1998	Number of fires	112[7]	446[6]	558[5]
	Number of acres burned	17,569[7]	5,373[6]	22,942[5]
1999	Number of fires	158[7]	574[6]	732[5]
	Number of acres burned	37,204[7]	47,097[6]	84,301[5]
2000[6]	Number of fires	339	909	1,248
	Number of acres burned	261,967	358,697	620,664
2001	Number of fires	486[7]	219[6]	705[8]
	Number of acres burned	138,696[7]	18,414[6]	157,110[8]
2002[6]	Number of fires	303	815	1,118
	Number of acres burned	60,007	163,227	223,234
2003[6]	Number of fires	283	727	1,010
	Number of acres burned	44,797	22,888	67,685
2004	Number of fires	185	655	850
	Number of acres burned	2,665	23,909	26,574
2005	Number of fires	190	697	887
	Number of acres burned	8,695	17,104	25,779
2006	Number of fires	289	1,008	1,297
	Number of acres burned	57,893	262,151	320,044
2007	Number of fires	254	816	1070
	Number of acres burned	50,878	52,304	107,505
2008	Number of fires	211	533	744
	Number of acres burned	88,908	51,456	140,364
2009	Number of fires	248	422	670

Year	Intensity type	Amount		
		Federal land	State & private land	Total
	Number of acres burned	939	5,778	6,717
2010 (Estimate)	Number of fires	321	541	562
	Number of acres burned	23,926	67,062	90,988
2011	Number of fires	643	355	998
	Number of acres burned	130,129	92,948	223,077
2012	Number of fires	802	547	1.349
	Number of acres burned	334,948	427,559	762,507
2013	Number of fires	448	281(Partial reporting, all fires not reported at this time	729 (Partial)
	Number of acres burned	43,844	1,511 (Partial reporting, all fires not reported at this time	45,355 (Partial)

[1] USDA Forest Service, Annual Fire Report for the National Forests
[2] USDA Forest Service, Summary of Forest Fire Statistics for the US (CD from USDA FS, Washington, DC)
[3] USDA Forest Service, Wildfire Statistics
[4] USDA Forest Service, Wildland Fire Statistics
[5] Wyoming State Forestry Division
[6] USDA Forest Service, Rocky Mountain Area and Coordination Center 1998-2003 Annual Report Figures
[7] Subtracted "State and Private" from "Total"
[8] Wyoming State Fire Marshal

Probability

Wildfire event frequency is calculated statewide and by county below and is based on loss-causing events, 1960-2015, collected from SHELDUS and NCDC databases.

Likely = Value 3
32 Reported ÷ 55.5 years = 58% annual probability of a Wildland Fire event

Table 66. Wildfire Event Frequency

County	Total Events	Time Period	Frequency	Probability
Albany	-	55.5 yrs	0%	Unlikely
Big Horn	**3**		5%	Occasional
Campbell	**-**		0%	Unlikely

County	Total Events	Time Period	Frequency	Probability
Carbon	-		0%	Unlikely
Converse	-		0%	Unlikely
Crook	-		0%	Unlikely
Fremont	8		14%	Likely
Goshen	-		0%	Unlikely
Hot Springs	1		2%	Occasional
Johnson	**2**		4%	Occasional
Laramie	-		0%	Unlikely
Lincoln	2		4%	Occasional
Natrona	5		9%	Occasional
Niobrara	-		0%	Unlikely
Park	2		4%	Unlikely
Platte	-		0%	Unlikely
Sheridan	-		0%	Unlikely
Sublette	2		4%	Occasional
Sweetwater	**2**		4%	Occasional
Teton	3		5%	Occasional
Uinta	-		0%	Unlikely
Washakie	2		4%	Occasional
Weston	-		0%	Unlikely
Statewide	**32**	**55.5 yrs**	**58%**	**Likely**

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. The map below shows these rankings by county to demonstrate local perception of risk across the state.

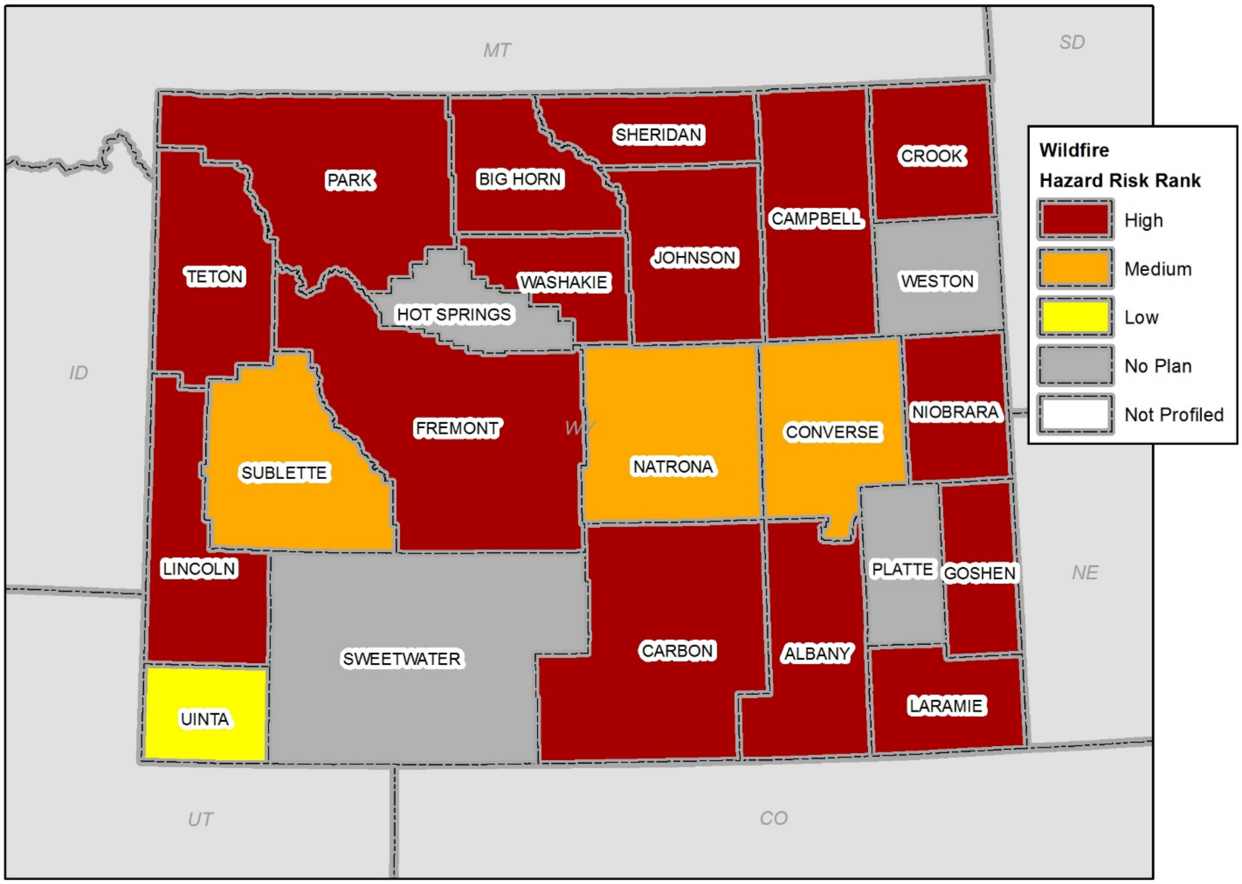


Figure 102. Wildfire Risk Rankings from Local Hazard Mitigation Plan Risk Assessments

Several counties have developed firewise communities within their borders, making mitigation efforts and fire prevention education a priority. This is particularly true of those counties within the mountain ranges of Wyoming.

Fourteen of the nineteen local county hazard mitigation plans in the state rate the wildfire hazard as high risk.

Statewide Risk Assessment

Research completed by Headwaters Economics, dated 2010, found that:

- Of the 11 western states, Wyoming has the ninth largest area of undeveloped, forested private land bordering fire-prone public lands, and ranks last (11th) among western states in the amount of forested land where homes have already been built next to public lands.
- Wyoming has more than 400 square miles of forested private land that borders public lands, of which 96 percent has not yet been developed.
- Housing in Wyoming's wildland urban interface consumes a whopping 7.6 acres per person, compared to the 0.5 acres per person average on other western private lands. These are larger residential lots than in any other western state's wildland urban interface.

- Wyoming has 4,604 residences in its wildland urban interface, of which 44 percent are seasonal homes or cabins.

Wyoming ranks eleventh (last) among western states in the number of homes built in forested areas next to public wildlands, and first in the percentage of those homes that are only seasonally occupied.

Overall, Wyoming has less developed wildland urban interface than most western states. The areas of highest existing risk from wildfire (number of square miles of the wildland urban interface with homes now) mainly occur within Park, Teton and northern Lincoln Counties. Combined, these three counties have more than 3,000 homes spread across 10 miles of wildland urban interface. Throughout Wyoming there remains potential for future home construction in more than 400 square miles of undeveloped, forested private lands adjacent to fire-prone public lands. Building homes in these high-risk areas would put lives and property in the path of wildfires.[48]

Table 67. Top 10 Counties Ranked by Existing and Potential Risk[49]

County	State	Developed Sq. Mi.	Undeveloped Sq. Mi.	Percent Developed	Homes	% Second Homes
Lincoln County	Wyoming	2.9	13.5	18.00%	684	21.00%
Albany County	Wyoming	1.8	30.3	6.00%	362	88.00%
Sheridan County	Wyoming	1.7	13.9	11.00%	336	70.00%
Carbon County	Wyoming	1.5	52.2	3.00%	164	95.00%
Park County	Wyoming	1.5	28.7	5.00%	385	58.00%
Natrona County	Wyoming	0.9	8.7	9.00%	230	76.00%
Sublette County	Wyoming	0.5	16.9	3.00%	71	76.00%
Fremont County	Wyoming	0.4	23.8	1.00%	69	81.00%
Crook County	Wyoming	0.3	59.6	1.00%	54	22.00%
Lincoln County	Wyoming	2.9	13.5	18.00%	684	21.00%

[48] http://headwaterseconomics.org/pubs/wildfire/wy.php (Accessed 6/4/2011)

[49] Counties are ranked by the number of square miles of developed land in the wildland interface

Table 68. Top 10 Counties in Wyoming Ranked by Potential Risk[50]

County	State	Developed Sq. Mi.	Undeveloped Sq. Mi.	Percent Developed	Homes	% Second Homes
Carbon County	Wyoming	1.5	52.2	3.00%	164	95.00%
Converse County	Wyoming	0.3	34.9	1.00%	66	79.00%
Albany County	Wyoming	1.8	30.3	6.00%	362	88.00%
Teton County	Wyoming	5.6	29.9	16.00%	2060	23.00%
Johnson County	Wyoming	0.3	28.7	1.00%	88	99.00%
Park County	Wyoming	1.5	28.7	5.00%	385	58.00%
Fremont County	Wyoming	0.4	23.8	1.00%	69	81.00%
Uinta County	Wyoming	0	23.8	0.00%	14	71.00%
Sublette County	Wyoming	0.5	16.9	3.00%	71	76.00%

[50] Counties are ranked by the number of square miles of undeveloped land in the wildland interface.

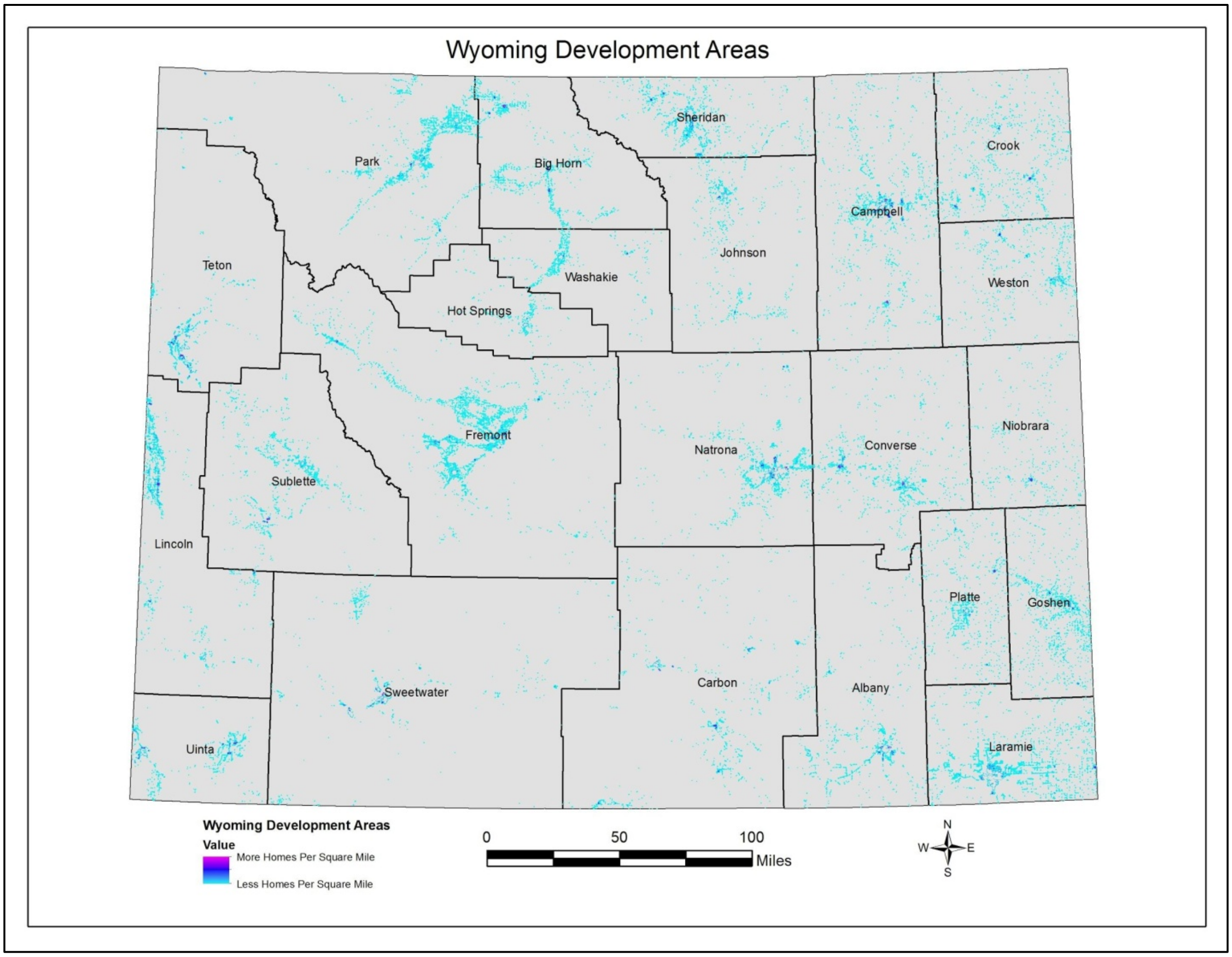


Figure 103. Homes in the Wildland Interface

The Wildland Development Areas (WDA) data layer was developed to identify "where people live" in wildland areas that are threatened by fire from wildland fuels. Wildland Development Areas were compiled from the Where People Live (WPL) dataset which was developed using advanced modeling techniques based on the LandScan population count data available from the Department of Homeland Security, HSIP Freedom Dataset. The HSIP Freedom dataset is available at no cost to U.S. local, state, territorial, tribal and Federal government agencies.

The process excluded the core urban areas that are not in a neighborhood or area threatened by fire burning in wildland fuels. In the process, care was taken to leave relatively small, high-density structure areas, one housing unit on 1/3rd of an acre or more, in the Wildland Development Areas data layer when the area was small enough to be threatened by fire from wildland fuels.

The WPL and WDA datasets have been derived to represent the number of houses per square kilometer, consistent with Federal Register and USFS Silvis datasets. However, to aid in the interpretation and use of this data, the legends are presented in "houses per acre".

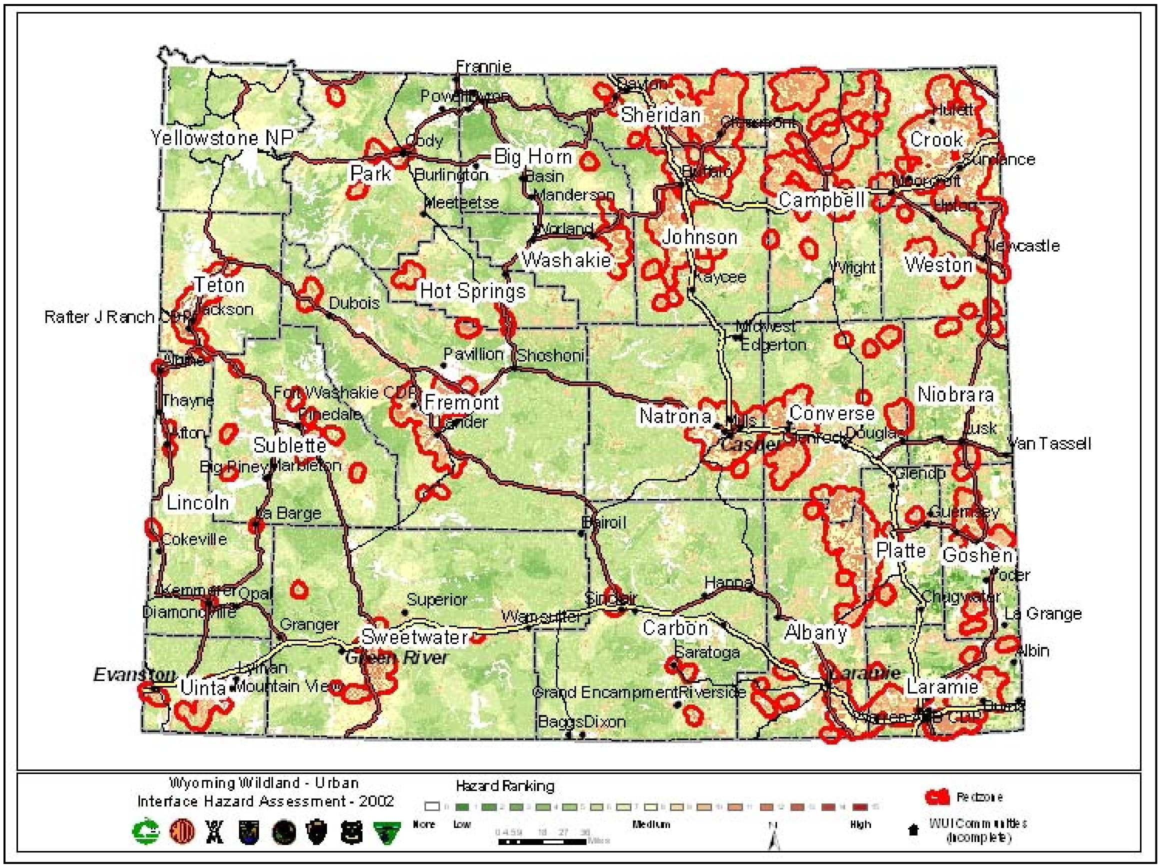


Figure 104. Wyoming Wildland Urban Interface Hazard Assessment Red Zones (2002)

The Wildland Urban Interface Hazard Assessment uses three main layers to determine fire danger: Risk, Hazard, and Values. The following lists include the data used to create each of the three layers.

1. Risk – Probability of Ignition
   a. Lightning Strike density
   b. Road density
   c. Historic fire density

2. Hazard – Vegetative and topological features affecting intensity and rate of spread
   a. Slope
   b. Aspect
   c. Fuels – Interpreted from GAP Vegetation information.

3. Values – Natural or man-made components of the ecosystem on which a value can be placed.
   a. Housing Density – Life and property

4. Non-flammable areas mask – a mask was created to aid in the analysis for areas that will not carry fire such as water and rock areas. These areas show in the final assessment as a zero value for hazard.

Risk, hazard, and value are combined to produce the final output for the Hazard Assessment as depicted in the map above. Areas of highest hazard are buffered to establish the Red Zone layer and are mostly in the eastern portion of Wyoming.

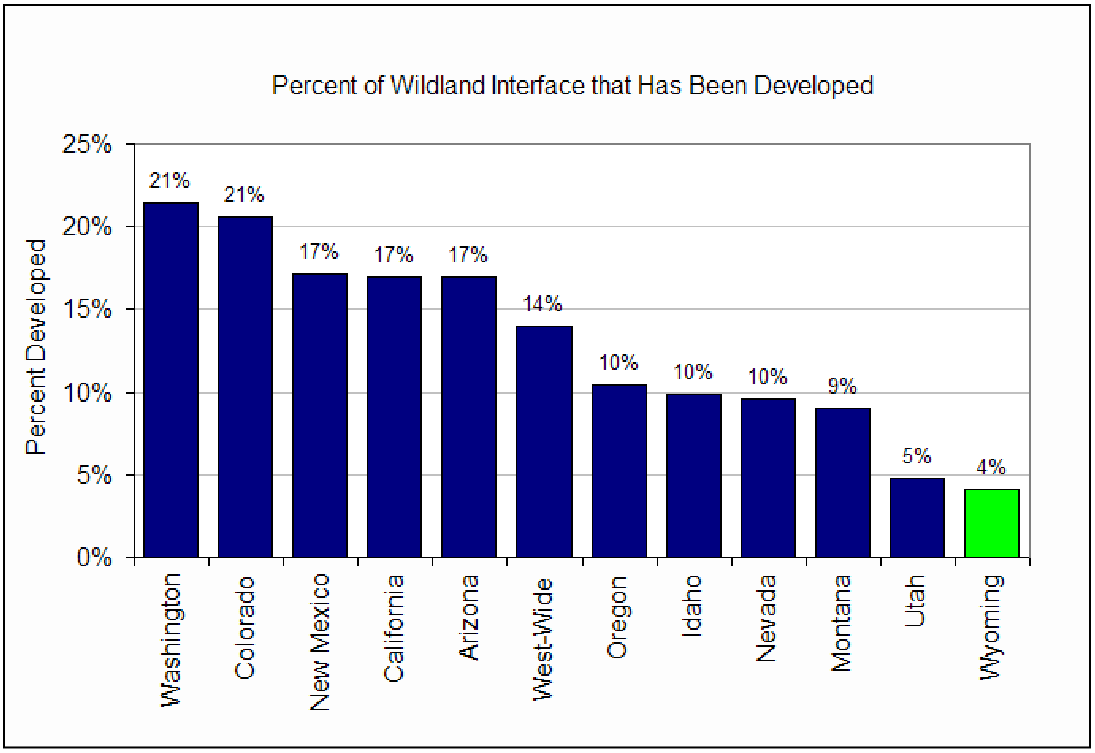


Figure 105. Percent of Wildland Interface

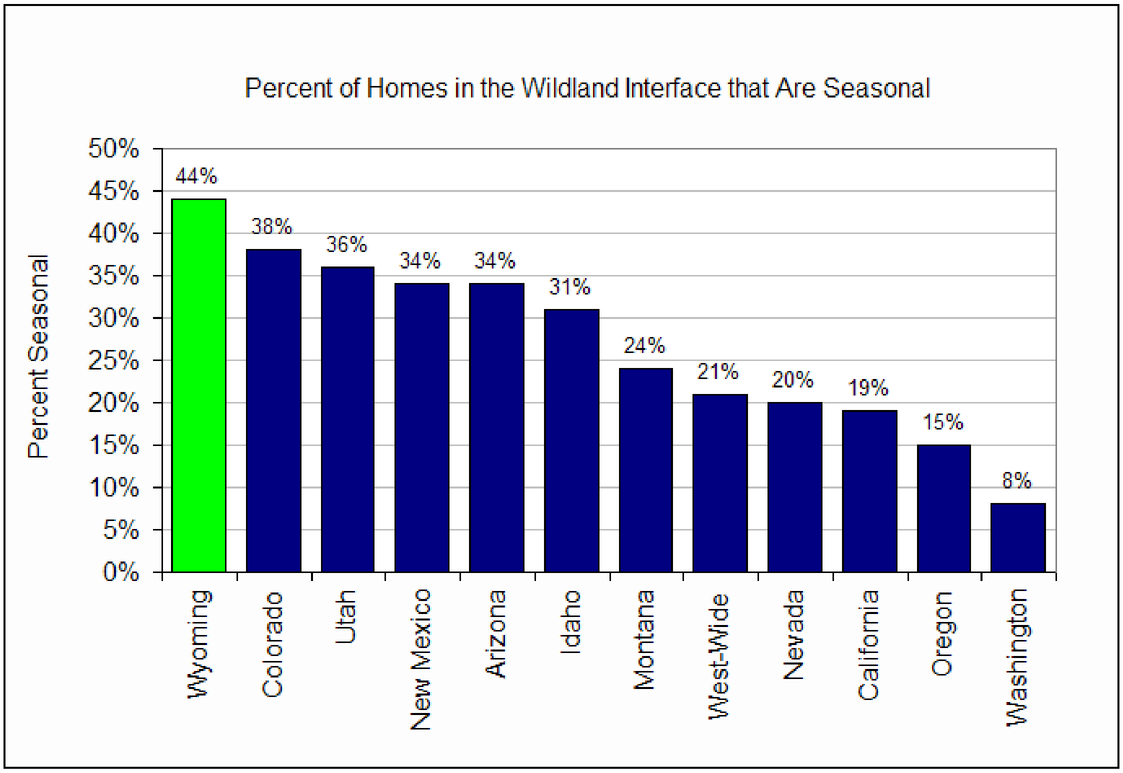


Figure 106. Percent of Seasonal Homes in Wildland Interface

When an analysis between annual precipitation rates and acreage burned is conducted, it reveals that there is a relationship between the variables. The average annual acres burned from 1960 to 2007 are 147,787.19, with a maximum acreage of 1,537,302 in 1988 and a minimum of 285 in 1962. Since 1999 Wyoming has been experiencing a significant drought yielding an average of 230,599 acres burned between 1999 and 2003—a considerable difference of 156,549 average acres from the 43-year span, 1960 to 2003—providing evidence for the precipitation/acreage burned relationship.

Figure 107 displays a relationship between annual precipitation and the number of acres burned from wildland fires from 1960 to 2006. It is apparent that a precipitation decrease yields an increase in acreage burned. The most dramatic example is in 1988 where a total of 1,537,302 acres were burned and 8.55 inches of precipitation fell that year. Both figures are a record high and low, respectively, between the years 1960 and 2006.

Future impacts can be determined by weather analysis and prediction with drought and precipitation, and continuing studies with this relationship can be pursued further.

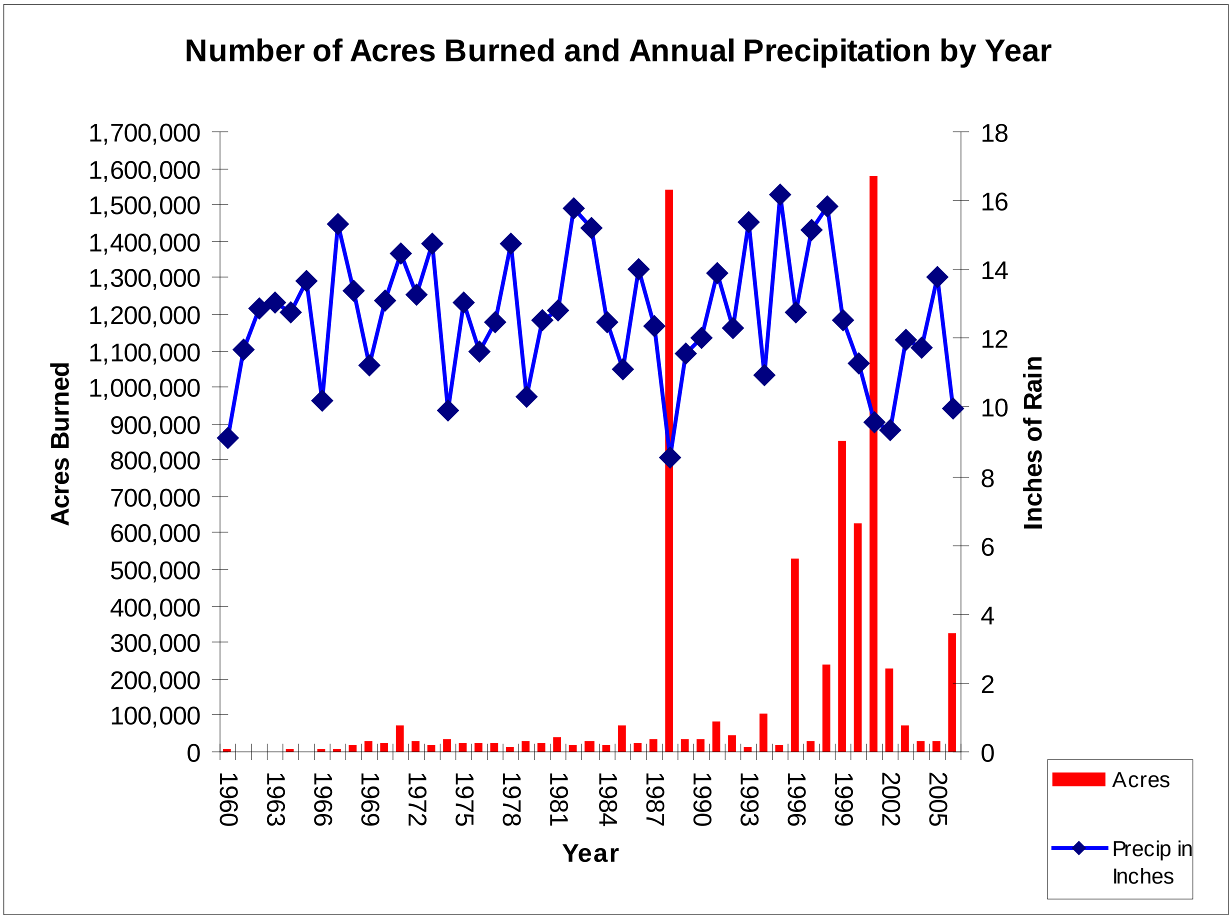


Figure 107. Annual Precipitation and Acres Burned Relationship

Wyoming Government Property

Historically, from August 1985 forward, there has been one wildland fire resulting in damage to state-owned property. The single event resulted in one monitoring station being burned and represents a loss of $1,687. If the past 25 years represents a loss record which can be expected to continue into the future, wildland fires are a minimal risk to state properties with an estimated annual loss of $67. Given the value of properties in locations identified as subject to wildland fires, past history may represent an accurate loss estimate given established mitigation efforts or it may merely reflect historical good fortune.

Changes in Development

Fremont and Natrona Counties have had the most loss-causing wildfire events and have the highest dollar losses from that hazard. Fremont is the eighth fastest growing county and Natrona is the ninth fastest in the state with projected population growth of 17.4 percent and 17.1 percent respectively.

State Facilities at Risk

WUI red zone boundaries shown in the map above were digitized in GIS; state facility and critical facilities within those boundaries are summarized by county in the table below.

Table 69. State Facilities Exposed to Wildland Urban Interface Red Zones

County	State Facilities	Value*	Critical State Facilities	Value*
Albany	357	$ 3,929,112,248	148	$ 1,077,638,903
Big Horn	-	$ -	-	$ -
Campbell	30	$ 10,068,216	18	$ 9,553,701
Carbon	23	$ 33,278,275	16	$ 22,794,003
Converse	27	$ 2,921,875	5	$ 731,563
Crook	114	$ 30,708,365	55	$ 5,242,418
Fremont	57	$ 15,317,751	24	$ 9,151,777
Goshen	4	$ 169,640	3	$ 155,549
Hot Springs	2	$ 8,012,373	1	$ 7,808,373
Johnson	47	$ 19,296,549	16	$ 14,608,093
Laramie	263	$ 917,584,913	141	$ 666,968,606
Lincoln	46	$ 8,320,404	21	$ 5,959,255
Natrona	120	$ 90,996,745	48	$ 27,877,408
Niobrara	-	$ -	-	$ -
Park	23	$ 5,085,268	14	$ 4,121,964
Platte	-	$ -	-	$ -
Sheridan	133	$ 69,329,684	43	$ 42,488,074
Sublette	4	$ 848,388	-	$ -
Sweetwater	29	$ 16,143,075	12	$ 15,052,079
Teton	37	$ 22,315,803	17	$ 13,985,131
Uinta	7	$ 2,056,430	5	$ 1,983,440
Washakie	95	$ 32,082,653	-	$ -
Weston	63	$ 21,145,734	26	$ 9,615,457
Statewide	**1,481**	**$ 5,202,711,736**	**613**	**$ 1,935,735,794**

2015 Dollars

Losses to state facilities from wildfire events are listed in the table below; data includes number of events and associated damage and are sorted by state agency.

Table 70. State Building Losses – Wildfire (2/20/2011-9/24/2015)

State Agency	Total Events	Loss ($)
Attorney General	1	$ -
Department of State Parks and Cultural Resources	3	$ -

State Engineer	1	$ -
Wyoming Fish and Game Department	2	$ 40,591
Wyoming Military Department (Adjutant General)	1	$ -
Total	**8**	**$ 40,591**

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 71. Wildfire Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	2.8	*Moderate*
Wildfire	3.0	2.5	2.8	2.9	3.3		

WIND

Description

This plan update includes wind as a state-wide natural hazard for the first time. The 2011 Wyoming Mitigation Plan stated a goal for the 2014 update was to incorporate analysis of wind hazards in the state. During the 2011 mitigation plan update, damage from wind was prevalent in the insurance claims filed on state property. Therefore the question was asked if the inclusion of wind as a natural hazard would be appropriate to incorporate into the mitigation plan.

This section includes thunderstorm, non-convective wind categories, and windblown deposits. Wyoming has some of the most significant windblown deposits in the U.S. Strong winds can mobilize and significantly move sand or silt grains in much of Wyoming. Many of the mapped deposits in Wyoming are somewhat stabilized, but a significant number are still active.

Figure 108. Killpecker Sand Dunes near Rock Spring, Wyoming[51]

The Killpecker Dune Field, in northern Sweetwater County, is more than 50 miles long and 10 miles wide at its widest point. The Seminoe Dune Field, extends from the Seminoe Reservoir to the west for approximately 30 miles, and is approximately 15 miles wide at its widest point. The Casper Dune Field is a part of a much larger series of dune fields that extend from eastern Fremont County to the Casper area (**Figure 109**).

[51] http://www.wyomingtourism.org/thingstodo/detail/Killpecker-Sand-Dunes/31316 (Accessed 4/1/2014)

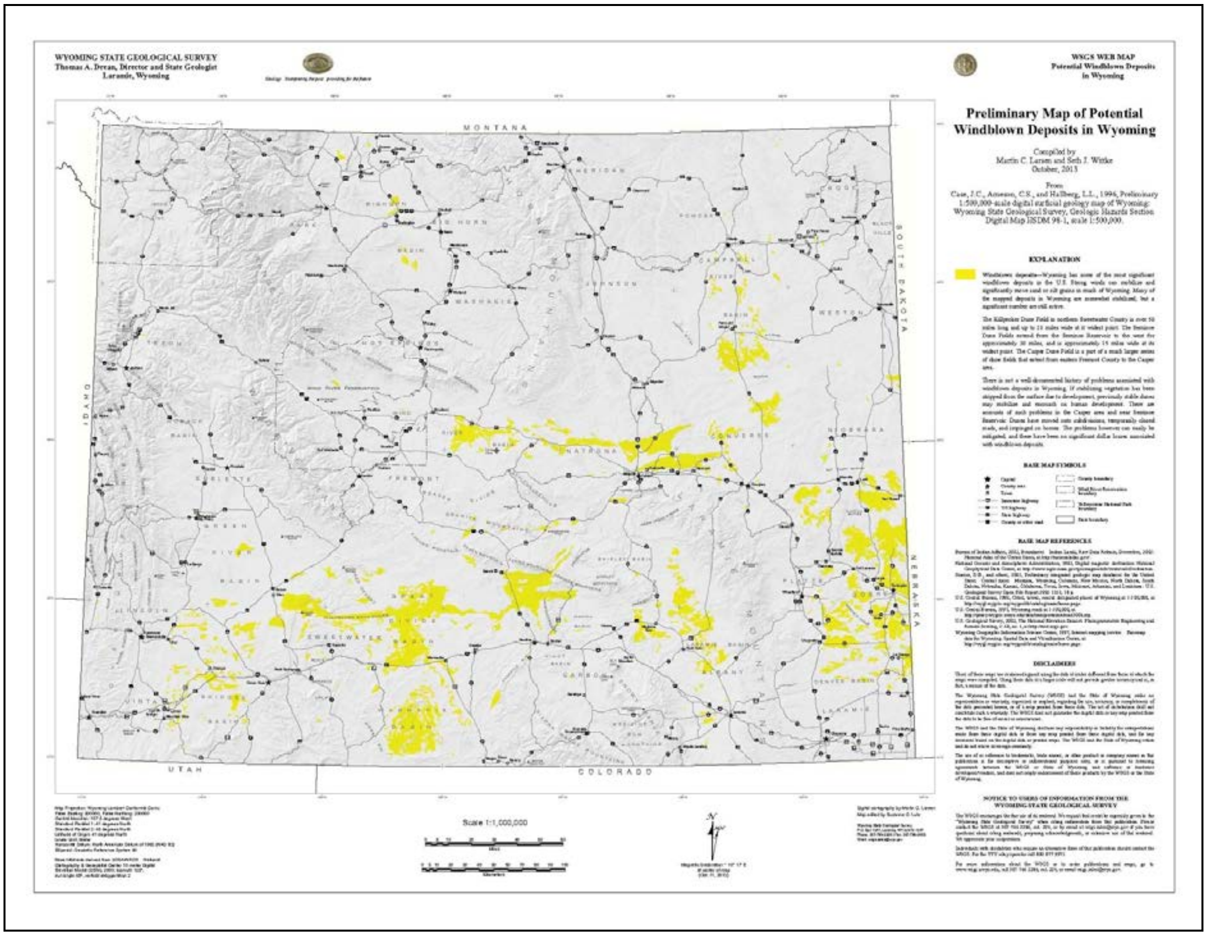


Figure 109. Preliminary Map of Potential Windblown Deposits[52]

In Carbon County's mitigation plan their windblown deposit hazard is pictured near the Semino Reservoir (**Figure 110**). Carbon County's location in the 'wind zone,' where a gap in the Rocky Mountains funnel and concentrate westerly winds, makes windblown deposits more likely to cause damage because of the force of the wind carrying the deposits. However, in Carbon County as in the rest of the state, there is no well-documented history of problems associated with windblown deposits.

As development continues in Wyoming, more land is disturbed. Currently stabilized dunes may be disrupted, leading to nuisance problems with windblown deposits.

[52] Map Courtesy of Wyoming Geological Survey

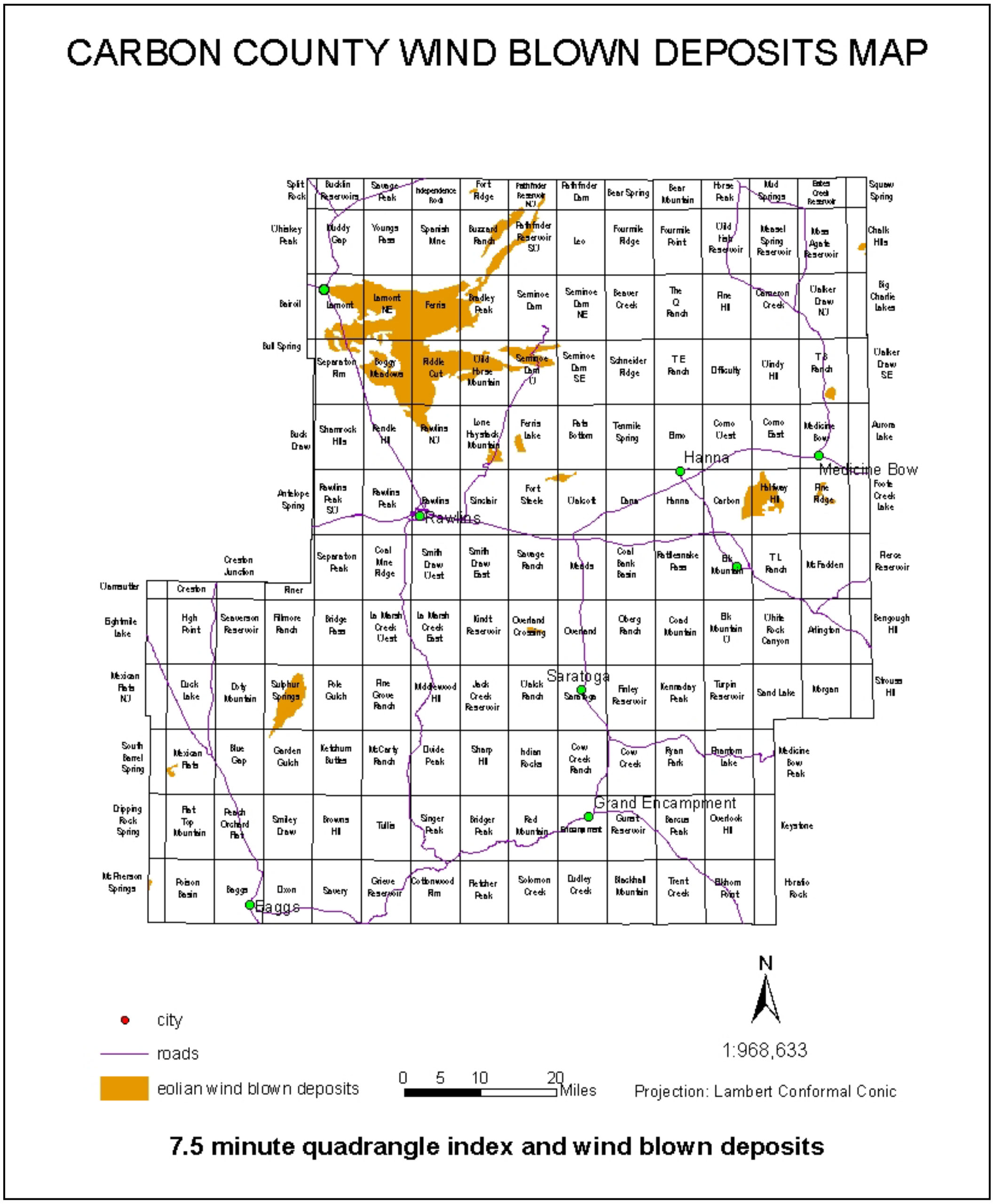


Figure 110. Carbon County Windblown Deposits (Seminoe Dune Field)

History and Probability of Future Events

The following table lists loss-causing wind events and associated damage by county, collected from SHELDUS and NCDC past events databases.

Table 72. Wind Events, Causalities, and Damage by County and Statewide (1960-2015)

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Albany	72	3	0	$ 1,629,865	$ 11,914	$ 1,641,780
Big Horn	51	0	-	$ 620,768	$ 1,625	$ 622,393
Campbell	84	11	-	$ 1,783,290	$ 9,792	$ 1,793,081
Carbon	64	16	-	$ 436,219	$ 11,831	$ 448,050
Converse	58	2	-	$ 265,417	$ 7,748	$ 273,165
Crook	60	1	-	$ 672,540	$ 4,792	$ 677,331
Fremont	101	52	1	$ 1,230,183	$ 4,250	$ 1,234,433
Goshen	65	3	-	$ 2,077,051	$ 22,164	$ 2,099,215
Hot Springs	37	0	-	$ 133,421	$ 875	$ 134,296
Johnson	42	2	-	$ 172,647	$ 8,792	$ 181,439
Laramie	110	20	1	$ 3,095,224	$ 516,914	$ 3,612,138
Lincoln	29	1	-	$ 556,263	$ -	$ 556,263
Natrona	84	14	1	$ 692,000	$ 11,250	$ 703,250
Niobrara	57	5	-	$ 254,411	$ 11,914	$ 266,326
Park	73	5	2	$ 798,838	$ 54,167	$ 853,005
Platte	88	8	0	$ 1,978,340	$ 12,164	$ 1,990,505
Sheridan	39	0	-	$ 227,472	$ 504,792	$ 732,264
Sublette	25	0	-	$ 637,172	$ -	$ 637,172
Sweetwater	57	17	-	$ 272,523	$ 14,050	$ 286,573
Teton	42	8	6	$ 632,482	$ 500	$ 632,982
Uinta	23	0	1	$ 120,847	$ -	$ 120,847
Washakie	34	1	-	$ 205,652	$ 1,000,625	$ 1,206,277

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Weston	62	1	-	$ 873,090	$ 4,792	$ 877,881
Statewide	**1357**	**174**	**13**	**$ 19,365,716**	**$ 2,214,951**	**$ 21,580,666**

Data from the Wyoming State Property Risk Division revealed significant damage to state government property as a result of wind. In fact, wind ranks third in hazards generating damage to state property. Wind, because of its constant presence in Wyoming, is just dealt with by the population and often overlooked as a hazard. In retrospect, wind is a damage-inducing hazard. Wyoming's wind is also becoming a positive economic factor as renewable wind energy is being developed around the state. Given the damage it causes and the economic impact, wind warrants a review.

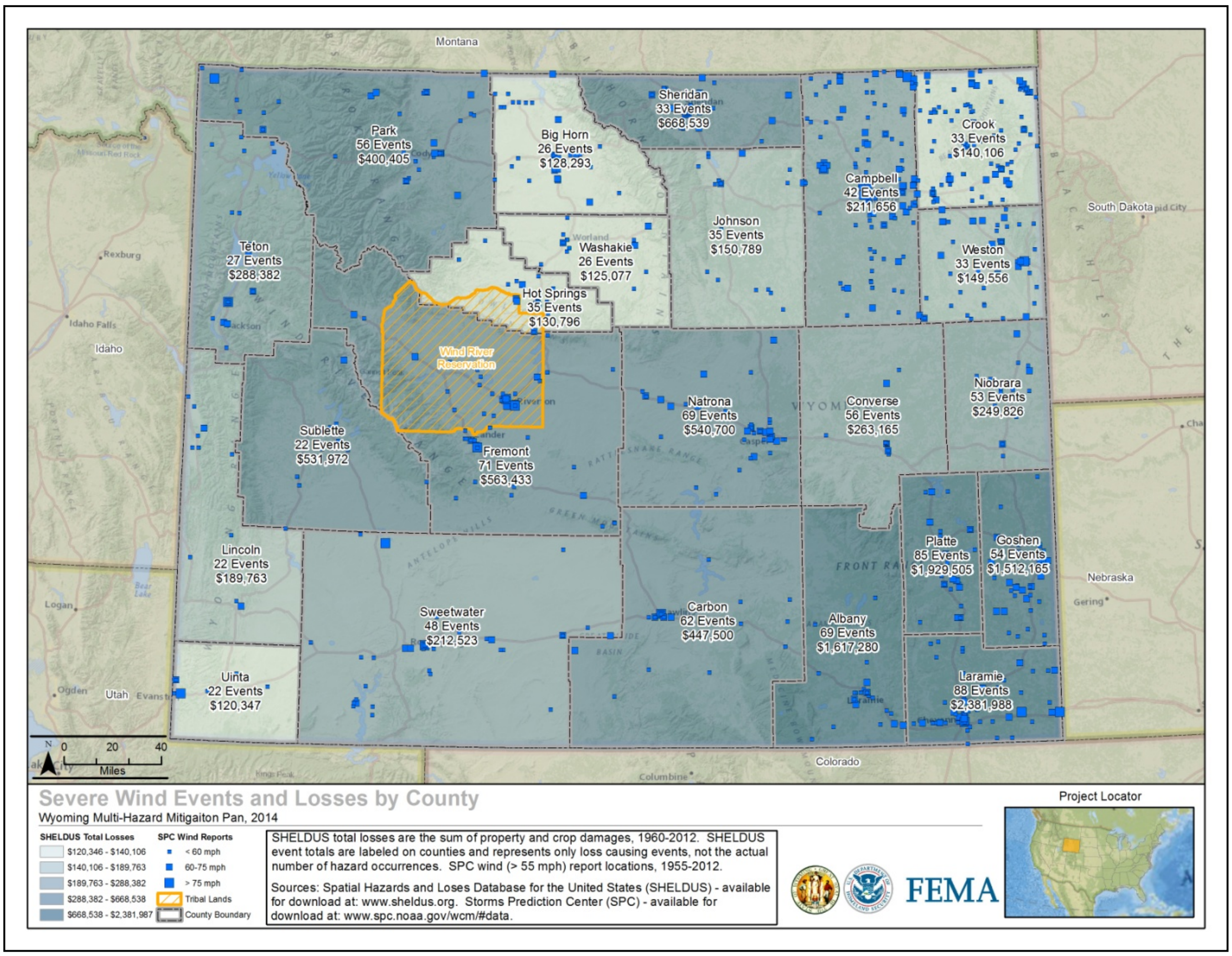


Figure 111. Wind Events and Losses by County

SHELDUS reports only those high wind incidents causing losses. Incidents between 1960 and 2012 are reflected in the map above (**Figure 111**). Wind events reported in SHELDUS number 1,067 events, or one third (33 percent) of the loss causing events in Wyoming. Though high in number of events, losses from wind events represent only 3 percent of costs to Wyoming residents from hazards, or just under $13 million.

The National Oceanic and Atmospheric Administration (NOAA) is another source reflecting number of high wind incidents and reported losses. From January 2011 through December 2013, there have been 989 high wind incidents, resulting in $247K reported losses, one death, and one injury. High wind event information obtained from the NOAA National Climatic Data Center Storm Events Database is summarized in three tables below. Further event details can be found in **Appendix F**.

Table 73. High Wind Events 2011 through 2013

2011 - High Wind Events	
Summary Info:	**317 Events**
Number of County/Zone areas affected:	35
Number of Days with Event:	70
Number of Days with Event and Death:	1
Number of Days with Event and Death or Injury:	1
Number of Days with Event and Property Damage:	8
Number of Days with Event and Crop Damage:	0

2012 - High wind Events	
Summary Info:	**417 Events**
Number of County/Zone areas affected:	45
Number of Days with Event:	60
Number of Days with Event and Death:	0
Number of Days with Event and Death or Injury:	0
Number of Days with Event and Property Damage:	2
Number of Days with Event and Crop Damage:	0

2013 - High wind Events	
Summary Info:	**255 Events**
Number of County/Zone areas affected:	36
Number of Days with Event:	37
Number of Days with Event and Death:	0

Number of Days with Event and Death or Injury:	1
Number of Days with Event and Property Damage:	3
Number of Days with Event and Crop Damage:	0

In the period between March 1, 1994 and November 30, 2011 there were 281 high wind events in Wyoming with wind speeds reaching 63 knots (F1 Tornado Equivalent). Between January 1, 1996 and November 30, 2011 there were five high wind events with wind speeds reaching 98 knots (F2 Tornado Equivalent).[53] High wind events reaching 63 knots or greater resulted in property damage of more than $2.3 million. Details on these events can be found in **Appendix G**. It can be expected that not all damage was reported and rather was repaired by individuals with no report filed.

Windblown Deposits

There is no well-documented history of problems associated with windblown deposits in Wyoming. If stabilizing vegetation is stripped from the surface because of some form of development, previously stable dunes may mobilize and encroach on human development. There are accounts of such problems in the Casper area. Dunes have moved onto subdivision properties, temporarily closed roads, and impinged on homes. The problems were easily fixed, and no significant dollar losses have been associated with windblown deposits. Further, there is no recent history of the recreating public requiring search and rescue in Wyoming dune areas utilizing public assets.

Probability

Wind event probability is calculated statewide and by county below and is based on loss-causing events, 1960-2015, collected from SHELDUS and NCDC databases.

Highly Likely = Value 4
1,357 Reported ÷ 55.5 years = 24.5 Wind events every year or a >100.0 % annual probability of a Wind event

Table 74. Wind Event Frequency

County	Total Events	Time Period	Frequency	Probability
Albany	72	55.5 yrs	130%	Highly Likely
Big Horn	51		92%	Highly Likely
Campbell	84		151%	Highly Likely
Carbon	64		115%	Highly Likely
Converse	58		105%	Highly Likely
Crook	60		108%	Highly Likely
Fremont	101		182%	Highly Likely

53 http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms (Accessed 3/2/2012)

County	Total Events	Time Period	Frequency	Probability
Goshen	65		117%	Highly Likely
Hot Springs	37		67%	Likely
Johnson	42		76%	Likely
Laramie	110		198%	Highly Likely
Lincoln	29		52%	Likely
Natrona	84		151%	Highly Likely
Niobrara	57		103%	Highly Likely
Park	73		132%	Highly Likely
Platte	88		159%	Highly Likely
Sheridan	39		70%	Likely
Sublette	25		45%	Likely
Sweetwater	57		103%	Highly Likely
Teton	42		76%	Likely
Uinta	23		41%	Likely
Washakie	34		61%	Likely
Weston	62		112%	Highly Likely
Statewide	**1357**	**55.5 yrs**	**2445%**	**Highly Likely**

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. Eight counties profiled wind in local plan risk assessments; Big Horn and Laramie Counties ranked the risk as high, Albany and Lincoln as medium, and the remaining as low.

Those who do not address the hazard may be taking the lead of the state's previous years' mitigation plan or they may not view wind as a hazard in their county. The conclusion may be drawn that individual mitigation efforts are relatively effective, making wind of limited impact. Another conclusion may be that familiarity has developed complacency, as wind is frequently experienced throughout the state and Wyoming residents have grown 'comfortable' with wind as 'the norm.'

Statewide Risk Assessment

Laramie and Goshen Counties have had the highest dollar losses to severe wind events. Laramie and Fremont Counties have had the most loss causing events of all the counties in the state.

Changes in Development

Fremont has the eight highest projected population growth rate in the state at 17 percent, Laramie has a projected rate of 16 percent, and Goshen 7 percent. The growing population center at the City of Cheyenne is particularly vulnerable to damage from wind events.

State Facilities at Risk

Fremont County has 626 state facilities, with a value of $178 million, Laramie has 326 facilities, with a value of $1 billion, and Goshen has 103 facilities, with a value more than $153 million that are likely to be at higher risk to wind damage than others in the state.

Losses to state facilities from wind events are listed in the table below; data includes number of events and associated damage and are sorted by state agency.

Table 75. State Building Losses – Wind (2/20/2011-9/24/2015)

State Agency	Total Events	Loss ($)
Department of Administration and Information	3	$ 78,886
Department of Corrections	1	$ 20,750
Department of State Parks and Cultural Resources	8	$ 7,625
Secretary of State	1	$ 5,900
University of Wyoming	1	$ 34,994
Wyoming Department of Agriculture	2	$ -
Wyoming Department of Health	4	$ 24,795
Wyoming Department of Transportation	3	$ 3,113
Wyoming Fish and Game Department	6	$ 14,714
Wyoming Military Department (Adjutant General)	1	$ 8,199
Total	**30**	**$ 198,976**

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 76. Wind Event Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	2.8	*Moderate*
Wind	4.0	1.7	3.1	2.4	2.3		

Winter Storm

Description

Severe winter storms affect far more people in Wyoming than their summer counterparts, even though they are inherently less violent. Severe snowstorms are so extensive that they usually require a day or two to cross and completely exit the state. Blizzard conditions bring the triple threat of heavy snowfall, strong winds, and low temperatures. Poor visibility and huge snowdrifts are major hazards caused by blowing snow. These storms disrupt work, make travel difficult or impossible, isolate communities, kill livestock by

Figure 112. Hay Trucks Bringing Aid to Marooned Ranches, Blizzard of 1949

the hundreds or thousands, and sometimes leave human fatalities in their wake. [54]

Fortunately, the simultaneous combination of heavy snowfall, strong winds, and low temperatures are fairly rare, even in Wyoming. In some places, however, such as southeastern Wyoming, strong winds often lift snow crystals from the ground in quantities large enough to produce hazardous ground blizzards without accompanying snowfall.

Because winter storms are so prevalent in Wyoming, vulnerable populations can be significantly impacted. Impacts include inability to get from one location to another because of closed roads, making pharmacies

[54] Photo courtesy of Wyoming State Archives

and grocery stores inaccessible. Electrical outages are also prevalent during winter snow storms and blizzards, limiting or eliminating household heating and cooking capability. Preparation for winter storms is needed to ensure successful weathering of the situation. Some winter storm preparations to be considered by residents include the creation and maintenance of adequate water and food within a 3-day kit both in vehicles and at home, backup power generation capabilities, and backup household heating options. Winter storms are best weathered by sheltering in place during the storm, and attempting to go out only after the storm has ended.

Rural areas tend to be more susceptible to power outages in winter storms and power outages in rural areas tend to be of greater duration than those in more populated areas. Rural locations are more likely to have livestock and farming economic factors, which can be significantly impacted by winter weather. Blizzards and winter storms have resulted in livestock deaths and livestock rescue efforts including hay drops by helicopter and snow removal efforts to give ranchers access to their livestock to minimize losses.

Winter storms and blizzards are particularly impactful on people unfamiliar with the hazard. This makes those areas of increased development more vulnerable and subject to risk from the hazard, assuming a percentage of those moving to developing areas are unfamiliar with winter storms, specifically the need to make preparations ahead of the storm and the need to shelter-in-place through a blizzard or winter storm. The 2010 census documents those counties with the greatest increase in population. In areas of high development with an influx of families, education is critical to help prepare the community for the hazard. Other important mitigation efforts include advance warning through media and all-hazard radios.

History and Probability of Future Events

The following table lists loss-causing winter storm events and associated damage by county.

Table 77. Winter Storm Events, Causalities, and Damage by County and Statewide (1960-2015)

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Albany	48	39	4	$ 1,160,187	$ 252,067	$ 1,412,255
Big Horn	24	1	0	$ 3,954,911	$ 62,813	$ 4,017,723
Campbell	38	3	2	$ 6,231,124	$ 868	$ 6,231,992
Carbon	42	22	6	$ 1,076,266	$ 1,429	$ 1,077,694
Converse	44	17	2	$ 4,685,149	$ 2,380	$ 4,687,529
Crook	37	1	1	$ 7,050,715	$ 868	$ 7,051,583
Fremont	43	27	2	$ 4,275,486	$ 62,813	$ 4,338,298
Goshen	41	5	1	$ 960,104	$ 152,067	$ 1,112,171
Hot Springs	25	14	1	$ 3,805,109	$ 62,813	$ 3,867,922
Johnson	29	28	1	$ 4,086,960	$ 62,813	$ 4,149,772
Laramie	50	36	3	$ 1,347,945	$ 252,067	$ 1,600,012

County	Total Events	Total Injuries	Total Fatalities	Total Property Damage	Total Crop Damage	Total Damage
Lincoln	29	26	1	$ 3,323,615	$ 313	$ 3,323,928
Natrona	43	32	1	$ 7,031,284	$ 62,813	$ 7,094,097
Niobrara	43	15	1	$ 4,833,066	$ 2,380	$ 4,835,446
Park	30	29	4	$ 3,501,463	$ 62,813	$ 3,564,275
Platte	43	8	1	$ 1,176,770	$ 2,067	$ 1,178,838
Sheridan	23	1	0	$ 3,799,465	$ 62,813	$ 3,862,277
Sublette	29	26	1	$ 3,295,827	$ 313	$ 3,296,139
Sweetwater	34	16	3	$ 182,080	$ -	$ 182,080
Teton	28	28	3	$ 3,450,804	$ 313	$ 3,451,117
Uinta	24	1	0	$ 159,443	$ -	$ 159,443
Washakie	23	0	0	$ 3,890,036	$ 313	$ 3,890,348
Weston	38	2	0	$ 7,134,224	$ 868	$ 7,135,092
Statewide	**808**	**374**	**36**	**$ 80,412,033**	**$ 1,108,000**	**$ 81,520,033**

Presidential and State Emergency/Disaster Declarations

There have been two Presidential Disaster Declarations related to winter storms in Wyoming. FEMA DR-WY-1268 was associated with the October 4-5, 1998, storm in Niobrara and Converse Counties. FEMA DR-WY-1399 was associated with the November 1, 2000 storm in Crook and Weston Counties.

Table 78. State-Level Emergencies

State-Level Emergencies (Winter Storm)									
Date	Case #	Duration (Days)	Locatio n	Event Type	Resource Used	Cost to WOHS (supported by docs)	Cost to WOHS - Est. (personnel, vehicle etc.)	Total Costs	Notes
2/7/2007	07-0002	1	Albany County	Snow Removal	Nat'l Guard	$ 11,233.36	$ 200.00	$ 11,433.36	
2/4/2008	08-0003	4	Niobra ra County	Snow Removal	Nat'l Guard	$ 13,510.09	$ -	$ 13,510.09	Guard front-end loaders & dump trucks

Figure 113. Clearing Snow from Wyoming Highway 130 on June 10, 2011

Winter storms usually cover a significant part of the state, and as such are difficult to describe regionally. Data show that Lake Yellowstone and Lander lead the state in frequency of major snowstorms with an average of about five such days per year. The time of year when they receive these storms, however is quite different. At Lake Yellowstone and throughout most of western Wyoming, major snowstorms strike—most often in the mid-winter months. In Lander and most other parts of the state (excluding the high mountains), major snowstorms hit with greatest frequency in March and April. The springtime snowstorm peak is particularly destructive for ranchers because it coincides with calving and lambing seasons.

Winter storm history in Wyoming extends from 1871 to present. There have been several winter storms in Wyoming which caused great damage, loss of life, significant economic impact, and brought about change in livestock practices. A few of the most significant storms are described below.

The winter of 1886-1887 brought one of the most significant early storms recorded. The snow came early and grew very deep. Then, a freak thaw turned much of this to water. Cold weather moved back in, freezing the thawed liquid into a crust of ice, which prevented cattle from getting through to the forage underneath. These conditions, accompanied by a blizzard of unusual severity, caused a loss of more than 50 percent of the state's livestock. The snow was 6 feet deep on the level between Mountain Home and Woods Landing. On February 12, 1887 the storms were still raging over the state, and the snow was packed so hard that stages could drive over it. Trains were stalled on their tracks.

The most significant blizzard in Wyoming's history in human impact occurred from January 2, 1949 to February 20, 1949. Snowfall in parts of eastern and southeastern Wyoming measured up to 30 inches, with drifts 20 to 30 feet high. Within 24 hours of the storm initiation, all bus, rail, and air traffic was halted. There were thousands of stranded motorists and rail passengers. Three thousand three hundred (3,300) miles of state highway lay in the storm area. Seventeen people perished, along with 55,000 head of cattle (approximately 15 percent of the state's cattle) and more than 105,000 sheep. As the storm continued, Wyoming cities began to run out of food in the stores. Several other blizzards followed the first. It is estimated from field men's reports that 4,194 people received aid through the U.S. Department of the Interior operations, and help was given to 994 ranches (**Figure 114**). Seventeen people lost their lives during the storm, the greatest loss of life documented for a Wyoming winter storm. Total economic loss is estimated at more than $9 million (more than $88 million in 2013 dollars).

From April 25-27, 1984, the worst late spring blizzard ever to hit Wyoming battered the northern part of the state for three days. The northeast section was the hardest hit as snowfalls of 2 to 3 feet were whipped into 15 to 20 foot drifts by 65 mph winds. A rancher near Wright and one near Sundance died of exposure as they were stranded while hauling hay to their livestock. All of northeast Wyoming was effectively shut down for two days. Major damage occurred to the livestock industry as more than 200,000 sheep and cattle perished in the storm. Some ranchers lost up to 95 percent of their sheep, and up to 50 percent of their cattle. Contributing factors to the very high losses were: a large number of the sheep had recently been shorn; the livestock were well into the spring lambing and calving season; and finally, the storm started as cold rain that changed to wet snow which stuck to everything. In addition, the weight of the record-breaking snow damaged many roofs, and high winds of 50 to 65 mph blew down quite a few structures. Total economic loss was estimated at more than $100 million. The storm is the most costly in Wyoming's history.

On October 4-5, 1998, 8 to 12 inches of heavy, wet snow fell across eastern Converse County and Niobrara County. The heavy snow downed trees and power lines. Ice buildup was up to 6 inches around many power lines. The build-up of ice around the power lines, along with 40 mph winds, caused 200 power poles to snap. Four thousand people were without power for up to five days in the Lusk, Manville, Van Tassell, and Lance Creek areas. Interstate 80 between Cheyenne and Laramie was closed due to near zero visibilities.

On November 1, 2000, an intense winter storm brought high winds and heavy, wet snowfall to portions of northeastern Wyoming. In Crook and Weston counties, snowfall rates were one to two inches an hour. Snowfall totals in the plains were from 4 to 8 inches, while in the Bear Lodge Mountains, totals were from 8 to 24 inches. The Four Corners area in northeastern Weston County reported the most snowfall at 24 inches. High, sustained winds up to 40 mph with gusts to 60 mph caused blizzard conditions and toppled 600 power poles. Seven thousand people were without power; almost 15 miles of lines had to be replaced. The city of Moorcroft had more than 150 stranded semi-trucks after the interstate was shut down. In Campbell County, the temperatures were too warm for snow and rain fell throughout the day, but high winds were reported with gusts more than 50 mph at times. The highest gust in Campbell County was 64 mph at Echeta.

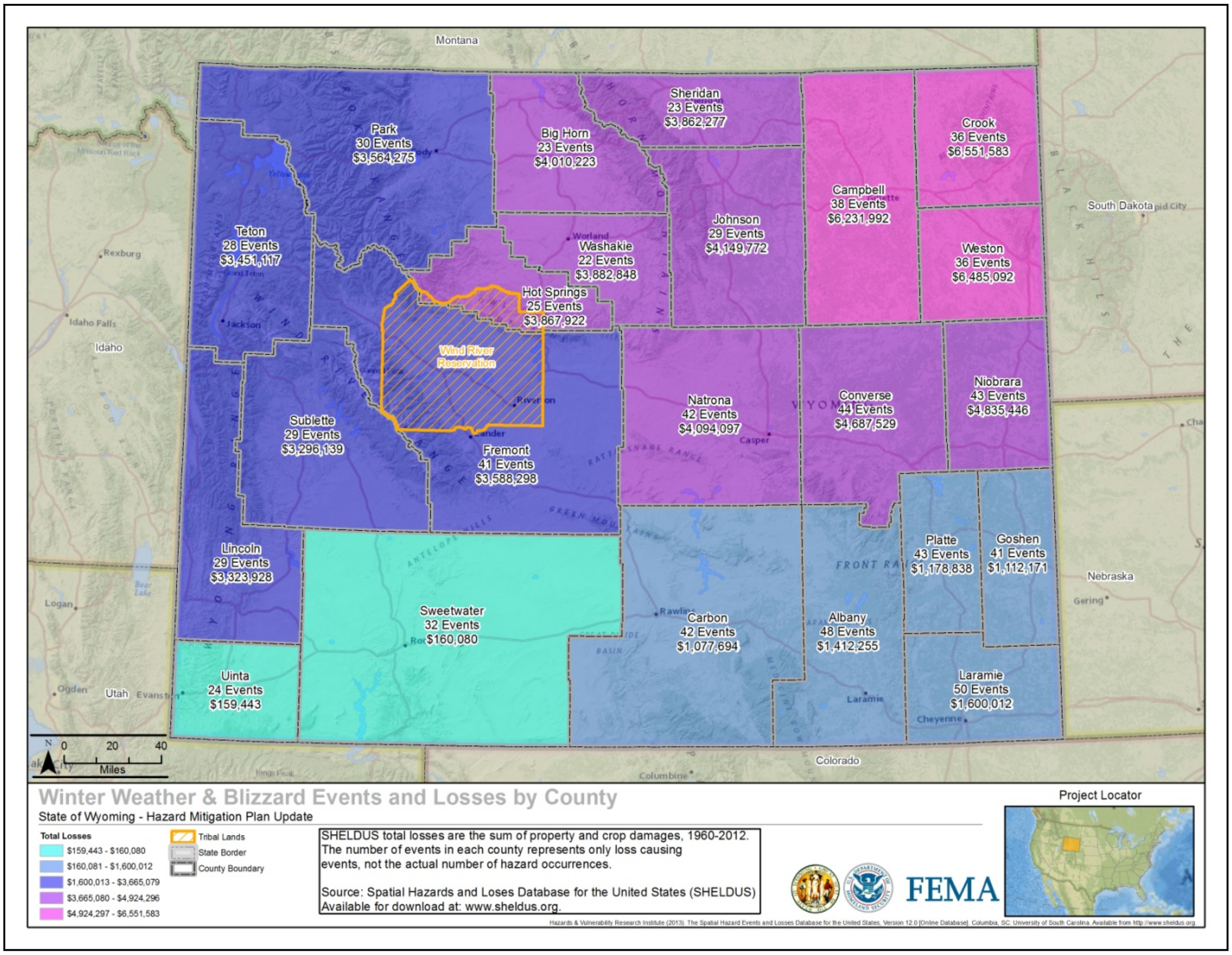


Figure 114. Winter Weather and Blizzard Events and Losses by County

A complete history of blizzards and winter storms that caused damage, loss of life, significant closure of highways, and/or impacts to the livestock industry can be found in **Appendix Q**. The data were derived from the monthly Storm Data and Climatological Data reports from National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC). Other sources are unpublished reports from WOHS, newspaper accounts, and periodicals from public libraries.

Probability

Winter storm event frequency is calculated statewide and by county below and is based on loss-causing events, 1960-2015, collected from SHELDUS and NCDC databases.

Highly Likely = Value 4
808 Reported ÷ 55.5 years = 14.6 Winter Storm and Blizzard events every year or a >100.0 % annual probability of a Winter Storm and Blizzard event

Table 79. Winter Storm Event Frequency

County	Total Events	Time Period	Frequency	Probability
Albany	48		86%	Likely
Big Horn	24		43%	Likely
Campbell	38		68%	Likely
Carbon	42		76%	Likely
Converse	44		79%	Likely
Crook	37		67%	Likely
Fremont	43		77%	Likely
Goshen	41		74%	Likely
Hot Springs	25		45%	Likely
Johnson	29		52%	Likely
Laramie	50		90%	Highly Likely
Lincoln	29	55.5 yrs	52%	Likely
Natrona	43		77%	Likely
Niobrara	43		77%	Likely
Park	30		54%	Likely
Platte	43		77%	Likely
Sheridan	23		41%	Likely
Sublette	29		52%	Likely
Sweetwater	34		61%	Likely
Teton	28		50%	Likely
Uinta	24		43%	Likely
Washakie	23		41%	Likely
Weston	38		68%	Likely
Statewide	**808**	**55.5 yrs**	**1456%**	**Highly Likely**

Vulnerability and Loss Estimates

Local Risk Assessments

Figure 12 in the Local Risk Assessment Summary section of this plan lists risk rankings by hazard taken from local mitigation plan risk assessments. Rankings are all calculated slightly differently; each considers probability and potential impact to people and property. Some also consider interruption of services, spatial extent, warning time, and duration. The map below shows these rankings by county to demonstrate local perception of risk across the state.

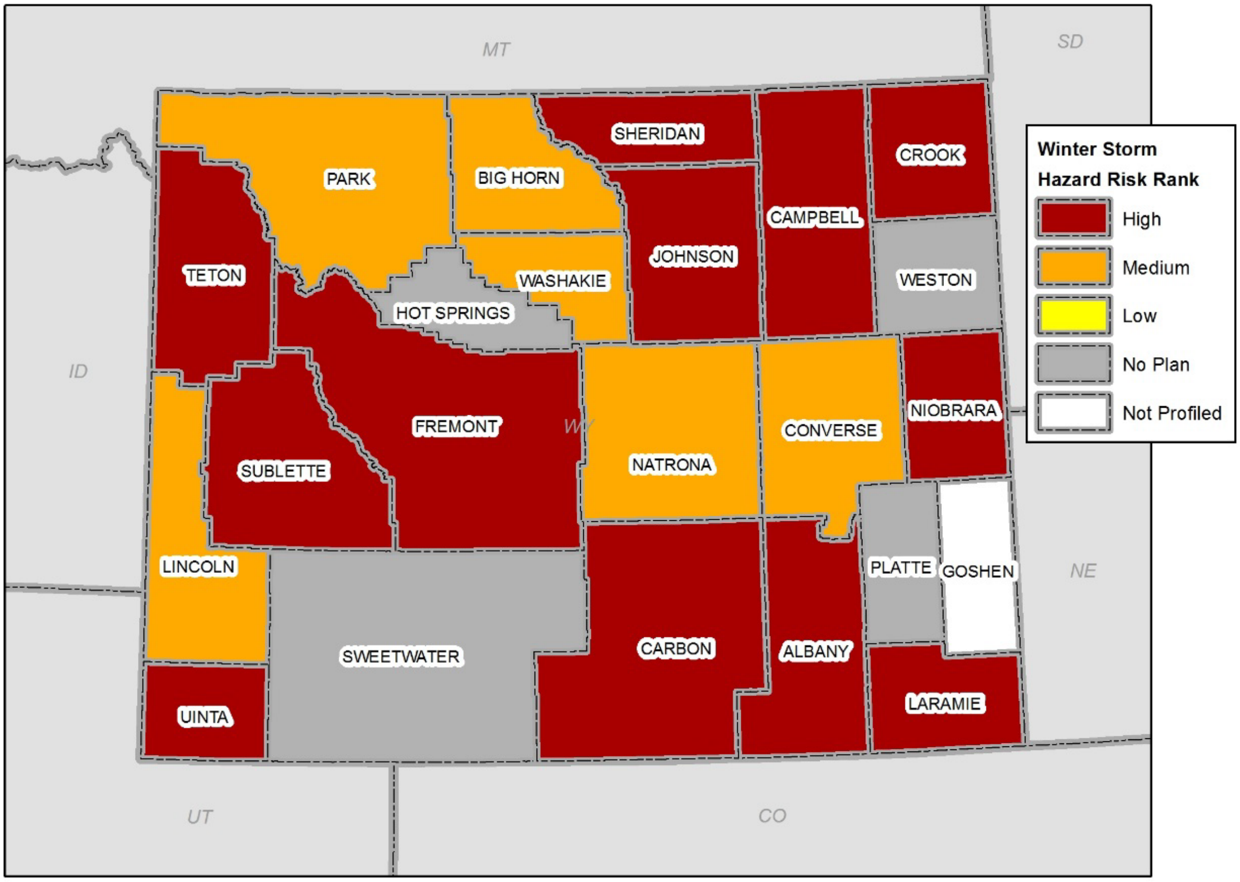


Figure 115. Winter Storm Risk Rankings from Local Hazard Mitigation Plan Risk Assessments

You will note all counties with mitigation plans consider the hazard to rank from medium-high to high within their borders. Most do not state a specific number of incident occurrences but recognize there are multiple storms each year, and reflect significant potential damage as a result of winter storms.

Statewide Risk Assessment

Carbon County has had the most fatalities and Crook, Natrona, and Weston have had the highest dollar losses from previous winterstorm events. Generally, risk is higher in northeastern counties in the state based on previous losses.

Changes in Development

Of the counties mentioned above, Crook County has the highest projected population growth at 23 percent. Moorcroft and Sundance are the larger towns in the county and each have a projected growth of 22 percent.

State Facilities at Risk

There are 23 state facilities in the Towns of Moorcroft and Sundance in Crook County with a total value of $4.7 million. Of these, there are 11 critical facilities including Department of Corrections, Department of

Family Services, Department of Health, Department of Transportation, Game and Fish, State Engineers Office, and Supreme Court facilities.

Historically Wyoming State Government property experienced 28 damaging winter storm events totaling $220,000 in the 307-month period from August, 1985 through February, 2011.

State facility losses from events Feb 2011 to present are listed in the table below; data includes number of events and associated damage and are sorted by state agency.

Table 80. State Building Losses – Winter Storms (2/20/2011-9/24/2015)

State Agency	Total Events	Loss ($)
Department of Administration and Information	2	$ 5,500
Department of Corrections	3	$ 3,010
Department of Environmental Quality	1	$ -
Department of State Parks and Cultural Resources	2	$ -
University of Wyoming	2	$ 517,940
Wyoming Department of Agriculture	1	$ -
Wyoming Department of Health	3	$ 1,500
Wyoming Department of Transportation	1	$ -
Wyoming Fish and Game Department	6	$ 40,349
Total	21	$ 568,299

Risk Factor

The following table shows scores for each of the risk factor criteria, as determined by risk assessment data and by members of the State Plan stakeholder group, as well as the final risk factor and overall risk rating.

Table 81. Winter Storm Risk Factor and Risk Rating

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor	Risk Rating
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	3.1	*High*
Winter storm	4.0	2.3	3.5	2.0	2.9		

Additional Hazards of State Concern

Space Weather

According to Wikipedia, "*Space Weather is the concept of changing environmental conditions in near-Earth space or the space from the Sun's atmosphere to the Earth's atmosphere… Space weather is the description of changes in the ambient plasma, magnetic fields, radiation, and other matter in space. Much of space weather is driven by energy carried through interplanetary space by the solar wind from regions near the surface of the Sun and the Sun's atmosphere.*"[55]

Space weather is a vast field of scientific research and application. For the purpose of this plan, this chapter will briefly review the impacts of solar weather from a layman's perspective rather than pursue an exhaustive study of the field. The focus will be on solar weather impacts to critical infrastructure. We will also briefly list the impact of historical solar weather events at the time they occurred and extrapolate potential impacts on electronics and other systems used throughout Wyoming. Lastly, potential mitigation actions will be discussed.

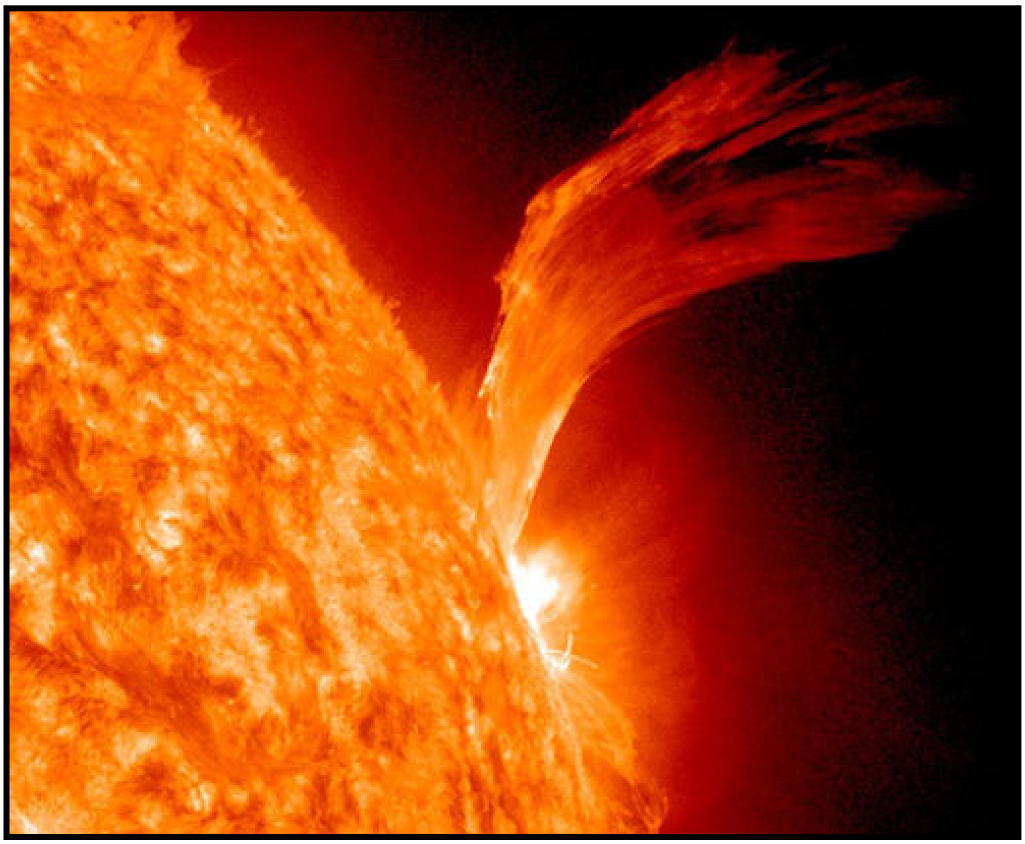


Figure 116. September 2010 Solar Flare – NASA/SDO Photo[56]

[55] http://en.wikipedia.org/wiki/Space_weather (Accessed 3/27/2014)

[56] http://www.space.com/11506-space-weather-sunspots-solar-flares-coronal-mass-ejections.html (Accessed 4/17/2014)

Electrical Grid

The electrical grid is composed of many elements. Electrical network systems are known to be sensitive to space weather disturbances. Three cables, two hot and one ground, carry high voltage electricity while suspended on 100-foot towers. Those lines terminate at regional substations where the high voltages are converted to lower voltages. These lines then go to neighborhoods where the neighborhood transformer further reduces the voltage to the 220 or 110 volts which then supplies electricity to about a dozen homes.

When space weather disturbances cause Geomagnetically Induced Currents (GICs), the GICs can enter a transformer through the earth 'ground' connection. The additional current ultimately generates hot spots inside the transformer, where temperatures can increase very rapidly to hundreds of degrees in only a few minutes. These high temperatures can continue for the duration of a magnetic storm which can last for hours. High temperatures impact the insulation in the transformer, causing damage that is cumulative in nature, shortening the life of the transformer. GICs impact the larger, high voltage transmission network lines' substations in a similar manner, making the electrical grid subject to a widespread cascading failure in extreme disturbance events impacting multiple substations. An example of this type of failure is the collapse of the Hydro-Quebec Power Network on March 13, 1989 when GICs overloaded a transformer. The transformer failed, leading to a blackout impacting 6 million people for more than 9 hours.

Global Positioning System (GPS)

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on the earth where there is an unobstructed line of sight to four or more GPS satellites.

GPS satellites use radio signals to communicate from space. Those radio signals can be distorted by a disturbed ionosphere, causing a receiver to compute an inaccurate position or fail to compute any position at all. Space weather events can make GPS signals unreliable and impact society significantly. Commercial aviation uses a precise GPS navigation too called the Wide Area Augmentation System (WAAS). Every major space weather event impacts the WAAS, sometimes for only minutes. In some cases it has been disabled for days. Society has become more and more reliant on GPS tools to navigate stage locations. These tools can be made unreliable in a space weather event.

Long Distance Radio Signals

The ionosphere bends radio waves in a manner similar to water in a swimming pool bending visible light. Radio waves in the 'shortwave band' are bent so much by the ionosphere that they are reflected back like a mirror reflects light. This bending and reflection of radio waves makes it possible for a shortwave radio signal to be transmitted around the curvature of the earth to a distant location. Shortwave radio is considered a critical backup communication system when newer satellite voice and data equipment is not available or is not functional. Space weather events can create irregularities in the ionosphere which scatter the signals instead of reflecting them, making shortwave communication over long distances poor or impossible.

Electronics

Wyoming is similar to the rest of the United States, in that much of the economy is tied in some way to electronic equipment like computers, phones, vehicle operation systems, etc. Electronic equipment will be impacted by heat generated by GICs and interrupted electrical supply.

Notable Space Weather Events

- On the night of December 21, 1806, Alexander von Humboldt observed that his compass had become erratic during a bright auroral event.
- The Solar storm of 1859 caused widespread disruption of telegraph service.
- The Aurora of November 17, 1882 disrupts telegraph service.
- The May 1921 geomagnetic storm, one of the largest geomagnetic storms causes worldwide disruption of telegraph service and damage to electrical equipment.
- August 7, 1972 a large Solar Energetic Particles event occurred. If astronauts had been in space at the time, the dose would have been deadly or at least life-threatening. Fortunately, this large event happened between the Apollo 16 and Apollo 17 lunar missions.
- The March 1989 geomagnetic storm included the full array of space weather effects: Solar Energetic Particles, Coronal Mass Ejection, Forbush decrease, ground level enhancement, geomagnetic storm, etc..
- The 2000 Bastille Day event produces exceptionally bright aurora.
- April 21, 2002, the Nozomi Mars Probe was hit by a large Solar Energetic Particles event which caused large-scale failure. The mission, which was already about 3 years behind schedule, was eventually abandoned in December 2003.[57]

Table 82. Earth-Space Activities Disrupted by Solar Events[58]

Solar-Geophysical Phenomena monitored by SWPC	Solar Phenomena	Solar Radiation Hazards	Geomagnetic Activity	Solar Radio Interference
Satellite operations				
Monitoring orbital variation			X	
Monitoring command & control anomalies		X	X	X
Ground-to-spacecraft communications			X	X
Aviation:				
Middle-latitude communication (VHF)				X
Polar-cap communication (HF)		X	X	
Navigation (VLF)		X	X	
High-altitude polar flights			X	

[57] http://en.wikipedia.org/wiki/Space_weather (Accessed 3/27/2014)
[58] Updated: October 1, 2007 http://www.swpc.noaa.gov/info/SolarEffects.html (Accessed 3/27/2014)

Solar-Geophysical Phenomena monitored by SWPC	Solar Phenomena	Solar Radiation Hazards	Geomagnetic Activity	Solar Radio Interference
Electric Power Distribution			X	
Long-line telephone communications			X	
HF communication			X	
Pipeline operations			X	
Geophysical exploration			X	
Scientific satellite studies - Shuttle, Spacelab, solar physics, solar constant measurement, ozone variation, interplanetary missions	X		X	
Scientific rocket studies - Sun, magnetosphere, ionosphere, upper atmosphere	X		X	
Scientific ground studies - Sun, interplanetary medium, magnetosphere, troposphere; geomagnetic, seismological, biological	X		X	

Technological and Human-Caused Hazards

Wyoming faces technological and human-caused hazards. A technological threat addressed in this chapter is hazardous materials release. Wyoming has fixed facilities utilizing and storing hazardous materials and hazardous materials are also transported through the state's highway system, railway, or pipeline. Of the human-caused hazards, this chapter will address biological, chemical, explosives and radiological attacks and sabotage. This chapter will focus more on the impact of these hazards and mitigation actions taken than an in-depth description of each hazard or potential delivery system.

Wyoming currently has eight emergency response regions. In 2004 Wyoming divided the state into seven response regions. An additional, eighth region was carved out in the northwest portion of the state in 2012. Each region was provided Homeland Security Grant funds to establish and maintain a Regional Emergency Response Team (RERT). The teams were established as a mitigation effort, with the goal of minimizing state-wide response time and thereby reducing economic, property and human losses caused by technological and human-caused hazards. Federal and local funding has been utilized to purchase necessary response and personal protection equipment and provide training. Further, state funds have funded RERT responses. The following **Table 83** outlines the types of responses completed by each regional team over the life of the Teams.

Wyoming has identified more than 250 critical infrastructure targets. WOHS is a member of the Wyoming FBI Joint Terrorism Task Force. The task force has reviewed and prioritized 12 of these targets as being most favorable targets for a terrorist attack resulting in a loss of this critical infrastructure. The importance of these targets by the FBI has resulted in these targets as being classified at the "SECRET LEVEL."

Attacks and sabatoge are hazards with which Wyoming has had experience in fairly recent history. Wyoming is one of a few states who have had their infrastructure targeted in a conspiracy to sabotage through utilization of explosives against the oil pipelines and refineries, including a natural gas plant. One individual was convicted in federal court on two counts of Title 18, Section 2339(a) USC (providing material support to terrorists), Title 18, Section 373 USC (soliciting a crime of violence); Title 18, Section 842 USC (unlawful distribution of explosives); and Title 26, Section 5861(d) USC (possession of an unregistered destructive device {hand grenade}). In November 2007 he was sentenced to 30 years in federal prison.

Table 83. RERT Mission Assignments 2004-2015

	TYPE	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7	Region 8	TOTAL	State
WMD											**Funds**
C B R N E	**Chemical**	1			1					**2**	$3,692.37
	Biological	3	19	2	3	3	2	12	1	**45**	$29,137.98
	Radiological	1	1		1					**3**	$352.82
	Nuclear										
	Explosive	7	23	12	73	12	31	15	3	**176**	$67,613.17
Executive Protection	**Bomb Squad**		14	2	6	1		1	1	**25**	$21,940.48
	IED K9		4		1	1	1			**7**	$6,095.84
	Hazmat (RERT)	1	3					9	1	**14**	$27,047.91
HAZMAT	**Fixed Facility**	8	5	15	6		4	7		**45**	$41,414.56
	Truck/Highway	16	16	24	5	3	6	23	3	**96**	$106,811.05
	Rail			1	2	1	1	1		**6**	$11,827.41
	Pipeline						1			**1**	$3,500.68
	Aircraft		2	3				2		**7**	$856.95
	Orphan Drum	2	1		1		1	3		**8**	$7,509.89
CRIMINAL	**Clandestine Drug Lab**	7	3	11	9	12	5	13	2	**62**	$60,580.85
	Arson K9			37						**37**	$17,902.71
	Crime Scene Aid		2	2	2	4		3		**13**	$18,509.90
SUPPORT	**Structure Fire**		2	1	1			1		**5**	$2,139.83
	Wildland Fire			1	1					**2**	$128.73
	Rural Search & Rescue			3						**3**	
	Flood		2	2	1	2	1			**8**	$38,249.40
	Coroner Recovery		3	7						**10**	
RESCUE	**High Angle**		1					1		**2**	$3,053.56
	Confined Space		1							**1**	
	Ice							1		**1**	
	Swift Water		1	1						**2**	$1,738.73
TRAINING	**Field Training**				7		4	1		**12**	$592.24
	Field Exercise/Drill	1	3	6	21		1	1		**33**	
	TOTALS	**47**	**106**	**130**	**141**	**39**	**58**	**94**	**11**	**626**	**$470,697.06**

A general definition of *hazardous material* is a substance or combination of substances which because of its quantity, concentration, or physical, chemical, or infectious characteristics, may either (1) cause, or significantly contribute to, an increase in mortality or an increase in serious, irreversible, or incapacitating reversible, illness; or (2) pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported, disposed of, or otherwise managed.

The U.S. Department of Transportation (DOT), U.S. Environmental Protection Agency (EPA), and the Occupational Safety and Health Administration (OSHA) all have responsibilities in regards to hazardous materials and waste. Presented below are the various definitions and general responsibilities of each of the agencies.

The U.S. DOT, which has control over transported hazardous materials, uses the following definition: hazardous material means 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 under Section 5103 of Federal Hazardous Materials Transportation Law (49 U.S.C. 5103). 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), and materials that meet the defining criteria for hazard classes and divisions in part 173 of sub-chapter C of this chapter. The U.S. DOT has nine classes of hazardous material:

- Explosives;
- Compressed gasses: flammable gasses, non-flammable compressed gasses, poisonous gasses;
- Flammable liquids: flammable (flash point below 141 degrees), combustible (flash point 141 degrees – 200 degrees);
- Flammable solids: flammable solids, spontaneously combustible, dangerous when wet;
- Oxidizers and organic peroxides: oxidizer, organic peroxide;
- Toxic materials: material that is poisonous, infectious agents;
- Radioactive material;
- Corrosive material: destruction of human skin, corrode steel at a rate of 0.25 inch per year; and
- Miscellaneous.

The EPA also has responsibility for hazardous materials, chemicals, and wastes that have the potential to be released into the environment through stationary facilities. The EPA addresses the need for facilities with hazardous waste substances to store containers in some kind of containment system through the Resource Conservation and Recovery Act. Stationary containers such as tanks, as well as portable storage containers such as 55-gallon drums, are required to have a system that will protect the environment from this waste if a leak were to occur. Hazardous waste regulations appear in Title 40 of the Code of Federal Regulations (CFR). Portable container containment is addressed under Subpart I, Use and Management of Containers (EPA 40 CFR 264.175). Facilities dealing with the storage of hazardous materials may also be required to have containment if they are to meet the Uniform Fire Code (UFC) standards. Within the UFC standards, Section 80, Division III refers to “Hazardous Materials Storage Requirements” pertaining to containers and tanks and Division IV refers to “Spill Containment” with regard to hazardous materials.

The Emergency Planning and Community Right-to-Know Act (EPCRA) requires certain regulated entities to report information about hazardous chemicals and substances at their facilities to federal, state, and local authorities. The objective is to improve the facilities, or government agency's ability to plan for and respond to chemical emergencies, and to give residents information about chemicals present in their communities. The President has issued Executive Orders to federal agencies that mandate their compliance with certain EPCRA requirements. Part of EPA's mission is to ensure that federal facilities comply with these requirements. Sections 301 and 303 of EPCRA mandate the creation of two organizations; The State Emergency Response Commission (SERC) and the Local Emergency Planning Committee (LEPC). Sections 311-312 of EPCRA require facilities to submit material safety data sheets or Tier II forms (lists of hazardous chemicals on-site above threshold quantities) to SERCs, LEPCs, and local fire departments.

In addition to EPCRA, there is a Risk Management Program (RMP). When Congress passed the Clean Air Act Amendments of 1990, it required EPA to publish regulations and guidance for chemical accident prevention at facilities using extremely hazardous substances. The Risk Management Program Rule (RMP Rule) was written to implement Section 112(r) of these amendments. The rule, which built upon existing industry codes and standards, requires companies of all sizes that use certain flammable and toxic substances to develop a RMP, which includes a(n):

- Hazard assessment that details the potential effects of an accidental release, an accident history of the last five years, and an evaluation of worst-case and alternative accidental releases;
- Prevention program that includes safety precautions and maintenance, monitoring, and employee training measures; and
- Emergency response program that spells out emergency health care, employee training measures, and procedures for informing the public and response agencies (e.g. the fire department) should an accident occur.

By 1999 a summary of each facility's risk management program (known as a RMP) was to be submitted to EPA, making the information publicly available. The plans are required to be revised and resubmitted every five years. A summary of the RMP facilities by county can be reviewed in **Figure 117.**

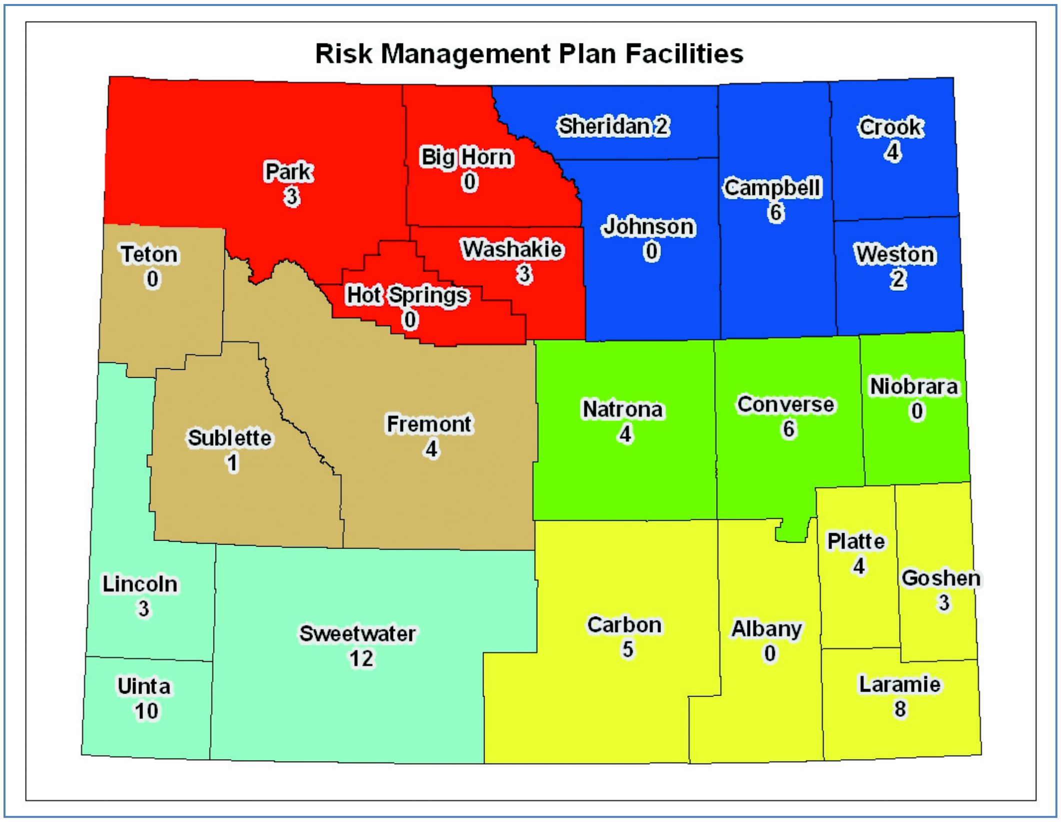


Figure 117. Number of Risk Management Plan Facilities by County

The Risk Management Plan is intended to reduce chemical risk at the local level by informing local fire, police, and emergency response personnel (who must prepare for and respond to chemical accidents), and is useful to residents in understanding the chemical hazards in communities.

OSHA, established under the U.S. Department of Labor by the OSHA Act of 1970, regulates the storage and use of toxic and hazardous substances as they relate to worker health and safety. OSHA regulations are found in Title 29 of the CFR, Part 1910, Subpart H.

History and Probability of Future Events

Two other individuals were investigated for terrorism activity by FBI and local authorities, and pled guilty in U.S. District Court for the destruction of interstate power lines. During 2003 two subjects were convicted in the U.S. District Court, District of Wyoming, for violation of Title 18, Section 1366(a) USC (destruction of an energy facility). On October 30, 2003, both subjects were sentenced to two years, six months in federal prison, three year's probation and restitution in the amount of $1,035,431. This act of terrorism involved the destruction of a critical interstate power line by removing bolts to the power line tower. The original tower cascaded to other towers causing failure. The towers were located in Sweetwater County. Power failures occurred in several western states including the city of Los Angeles, California.

Terrorism risk assessments and response actions relative to terrorist threats to Wyoming's infrastructure is addressed in Wyoming's State Operations Plan. The State Operations Plan is in compliance with the National Response Framework, and applicable portions of the Wyoming State Operations Plan are incorporated into this plan by reference.

Probability

Highly Likely = Value 4
449 RERT Incident Responses ÷ 10 years = 45 Man-Made Hazard events every year or a >100 % annual probability of a Man-Made Hazard event

Risk Factor

Risk Factor Value

Technological & Human-Caused Hazard Risk Factor Value = 2.8 [(Probability Highly Likely 4 x .30) + (Impact 2 x .30) + (Spatial Extent 2 x .20) + (Warning Time 4 x .10) + (Duration 2 x .10)]

Vulnerability Summary

Risk Factor Approach and Results

There are 2 risk factors and summaries presented here. The first was part of a hazard prioritization effort in 2014 that uses several risk indicators and the second was part of a stakeholder worksheet distributed and used for a plan update in 2015 and is specific to impact of hazards only.

The 2014 risk factor values were obtained via a survey that yielded 45 responses, including County Coordinators and Emergency Managers, WOHS staff, NGO civilians, and the Wyoming Dam Safety Officer. The risk factor looks at five risk categories for each hazard: probability, impact, spatial extent, warning time, and duration. Each category is assigned a value ranging from 1 to 4 and a weighing factor for each category was applied. The highest possible risk factor value is 4.0. The sum of all five categories equals the final value, as demonstrated in the example equation below:

Risk Factor Value =

[(Probability x .30) + (Impact x .30) + (Spatial Extent x .20) + (Warning Time x .10) + (Duration x .10)]

Results are presented below and an explanation of the risk factor criteria follow. The hazard with the highest risk potential is flood with a value of 3.1. Others ranking high are tornado and winter storm/blizzard.

Table 84. Risk Factor Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	
Flood	4.0	2.6	2.8	2.6	3.1	3.1
Winter storm	4.0	2.3	3.5	2.0	2.9	3.1
Tornado	4.0	2.7	2.3	3.5	1.9	3.0
Earthquake	3.0	2.8	2.8	3.6	2.4	2.9
Wildfire	3.0	2.5	2.8	2.9	3.3	2.8
Wind	4.0	1.7	3.1	2.4	2.3	2.8
Dam Failure	3.0	2.6	2.6	2.9	2.6	2.7
Hail	4.0	1.8	2.4	3.3	1.4	2.7
Drought	3.0	1.7	3.6	1.4	3.8	2.7
Avalanche	4.0	1.6	1.4	3.3	1.4	2.5
Lightning	4.0	1.5	1.5	3.4	1.3	2.4
Landslide	3.0	1.7	1.4	3.4	2.1	2.3

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	Risk Factor
Weight	*30%*	*30%*	*20%*	*10%*	*10%*	
Subsidence	2.0	1.5	1.3	2.7	2.2	1.8
Expansive Soils	1.0	1.3	1.9	2.6	2.3	1.6

A risk ranking was then assigned to each hazard based on the following thresholds: high risk = 3.0 or higher; moderate risk = 2.0-2.9; low risk = 0.1-1.9.

Table 85. Wyoming Hazard Risk Ratings

Risk Level	Hazards
HIGH RISK (3.0 or higher)	Flood, Winter Storm, Tornado
MODERATE RISK (2.0 – 2.9)	Earthquake, Wildfire, Wind, Dam Failure, Hail, Drought, Avalanche, Lightning, Landslide
LOW RISK (0.1 – 1.9)	Subsidence, Expansive Soils

Probability is based on the likelihood of a hazard event occurring in a given year. This calculation is obtained by dividing the number of recorded occurrences by the number of recorded years. A numerical value from 1 to 4 was assigned based on the probability an event would occur. Following is a table outlining the criteria used to determine probability:

Table 86. Probability Criteria and Ratings

Probability: What is the likelihood of a hazard event occurring in a given year? [value: 30%]		
Degree of Risk Level	**Criteria**	**Value**
Unlikely	Less than 1% Annual Probability	1
Occasional	Between 1 & 10% Annual Probability	2
Likely	Between 10 & 90% Annual Probability	3
Highly Likely	Greater than 90% Annual Probability	4

The other risk factor values [impact, spatial extent, warning time, and duration] were assigned a value by individuals experienced with Wyoming hazards and by members of the public. During the planning process, County Coordinators, Wyoming Office of Homeland Security staff, public health staff, members of the Unable to Self Evacuate Core Advisory Group, members of the public and others with knowledge of Wyoming hazards were asked to evaluate hazards using the risk factor system. The values for Impact, Spatial Extent, Warning Time, and Duration were obtained using this method. A copy of the completed risk factor scoring sheets used to calculate each hazard's risk factor values can be found in **Appendix C**.

The following criteria were used to rate impact, spatial extent, warning time, and duration for use in the risk factor calculation:

Table 87. Impact Criteria Ratings

Impact: In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs? [Value: 30%]		
Degree of Risk Level	**Criteria**	**Value**
Minor	Very few injuries, if any. Only minor property damage & minimal disruption on quality of life. Temporary shutdown of critical facilities.	1
Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.	2
Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.	3
Catastrophic	High number of deaths/injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.	4

Table 88. Spatial Extent Criteria and Ratings

Spatial Extent: How large of an area could be impacted by this hazard event? Are impacts localized or regional? [value 20%]		
Degree of Risk Level	**Criteria**	**Value**
Negligible	Less than 1% of area affected	1
Small	Between 1 & 10% of area affected	2
Moderate	Between 10 & 50% of area affected	3

Large	Between 50 & 100% of area affected	4

Table 89. Warning Time Criteria and Ratings

Warning Time: Is there usually some lead time associated with the hazard event? Have warning measures been implemented? [Value: 10%]	
Criteria	**Value**
More than 24 hours	1
12-24 hours	2
6-12 hours	3
Less than 6 hours	4

Table 90. Duration Criteria and Ratings

Duration: How long does the hazard event usually last? [Value: 10%]	
Criteria	**Value**
Less than 6 hours	1
Less than 24 hours	2
Less than 1 week	3
More than 1 week	4

2015 Impact Ratings from Stakeholder Worksheets

As part of the Wyoming State Mitigation Plan 2015 Update Stakeholder Worksheet, respondents were asked to indicate an impact rating for the identified hazards based on the updated risk assessment and on their perception of statewide impacts from a worst-case plausible hazard event, based on the following criteria. These are the same criteria that the 2014 risk ranking uses for Impact.

- **Minor**: Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.
- **Limited**: Minor injuries only. More than 10 percent of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.
- **Critical**: Multiple deaths/injuries possible. More than 25 percent of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.
- **Catastrophic**: High number of deaths/injuries possible. More than 50 percent of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.

There were 17 responses to the risk factor survey, including County Coordinators and Emergency Managers, WOHS and WYDOT staff.

Results were given a numeric value (Minor 1, Limited 2, Critical 3, and Catastrophic 4) and an average was calculated, similar to the 2014 risk factor methodology. The following shows the results, using the same ranking thresholds (high risk = 3.0 or higher; moderate risk = 2.0-2.9; low risk = 0.1-1.9) as the 2014 risk factor. Results from the 2015 impact analysis completely support 2014 impact criteria ratings, as shown in the table below.

Table 91. Results of 2014 and 2015 Impact Ratings

Hazard	2014	2015	Risk Level
Dam Failure	2.6	2.8	*Moderate*
Earthquake	2.8	2.4	*Moderate*
Flood	2.6	2.6	*Moderate*
Tornado	2.7	2.6	*Moderate*
Wildland Fire	2.5	2.6	*Moderate*
Winter Storm	2.3	2.3	*Moderate*
Avalanche	1.6	1.4	*Low*
Drought	1.7	1.8	*Low*
Expansive Soil	1.3	1.2	*Low*
Hail	1.8	1.8	*Low*
Landslide	1.7	1.7	*Low*
Lightning	1.5	1.3	*Low*
Mine Subsidence	1.5	1.2	*Low*
Wind	1.7	1.7	*Low*

Summary of Risk and Vulnerability by Hazard

Using Chapter 3 Risk Assessment, WOHS described the distribution of losses across the state, with specific reference to critical facilities; and the jurisdictions most threatened by the identified hazards and most vulnerable to damage and loss associated with hazard events in the following table.

Table 92. Risk and Vulnerability Summary

Hazard	Distribution of losses across the State, with specific reference to quantifying losses to critical facilities.	Jurisdictions most threatened by the identified hazards and most vulnerable to damage and loss associated with hazard events.
Avalanche	Avalanche losses, both loss of life and property losses, are focused in western Wyoming, where steep, mountainous areas are located. No losses to critical facilities have been recorded.	Jurisdictions most threatened by avalanche include mountainous back-country recreation areas in Western Wyoming and transportation routes located in the western mountains where steep terrain exists.
Dam Failure	Losses from dam failure are infrequent in Wyoming. The most significant losses occurred in Natrona and Teton Counties early in the 1900s. No losses to critical facilities were recorded in those dam failures, due to the number of years since they occurred.	The greatest number of high-hazard (high impact) dams are located in Carbon, Fremont and Johnson Counties. Of those counties, Fremont County has the largest population and greatest social vulnerability. Of them, Johnson County's population is expected to experience the greatest percentage population increase over the next 20 years.
Drought	Losses from drought are most significant in Wyoming's state-wide agricultural industry. No losses to critical facilities are recorded for drought.	Because drought in Wyoming impacts agriculture most greatly, population growth is not as significant impact as with many other natural hazards. While all Wyoming counties generate agricultural production, counties perhaps most vulnerable to loss associated with drought are actually those with lower populations including Niobrara, and Hot Springs Counties.
Earthquake	Estimated potential earthquake losses are most significant in Western Wyoming (Teton, Lincoln and Uinta Counties) due to the likelihood of an earthquake combined with population growth estimates. Statewide, critical facilities exposed to earthquake include the State Penitentiary, the State Hospital, and the State Capitol among others with the top 25 vulnerable critical facilities valued in excess of $37 million.	Teton, Lincoln, Uinta and Sublette Counties are those most likely to experience an earthquake. Of those, Uinta and Sublette counties are more socially vulnerable to loss while Teton County currently has the greatest population and is experiencing a greater percentage of growth.
Expansive Soils	Building exposure to expansive soil losses are greatest through the center of the state and extent from the east to the west state border. Losses to critical facilities due to expansive soils in Weston, Natrona, Fremont, Teton and	Counties most threatened by expansive soils include Weston, Natrona, Fremont, Lincoln, Teton and Crook Counties. Of those Counties, Fremont, Natrona and Weston Counties are the most socially vulnerable to loss. Natrona County is also the most densely populated

	Lincoln Counties could near $1.2 billion.	and Teton County is experiencing the greatest growth percentage.
Flood	Natrona County has the highest building loss estimate due to flooding, followed by Sweetwater, Big Horn and Sheridan Counties. Critical facilities exposed to 1% annual chance of flooding statewide is nearly $25 million, with the greatest concentrations in Hot Springs, Fremont and Laramie Counties.	Recent flood response and disaster declaration history would indicate the communities of Baggs and Saratoga in Carbon County, Lander in Fremont County, Lusk in Niobrara County and Buffalo in Johnson County are most threatened by flooding. Flood hazard maps reflect expected losses are greatest in Natrona, Big Horn, Sweetwater, Teton, and Sheridan Counties. Of those five, the most socially vulnerable are Natrona, Big Horn and Sweetwater Counties with the highest populations in Natrona and Sweetwater Counties. Areas of concern, where population growth rate intersects with developable land in flood hazard areas are Crook, Laramie, Natrona, Johnson and Sublette Counties.
Hail	Hail events and hazard losses have been most significant in the eastern plains of Wyoming. Over the past 5 years state-owned structures have experienced $1.3 million in losses from hail events. State-owned structures are clustered in Cheyenne, Laramie County and in Gillette, Campbell County making these facilities at high risk of hail damage.	Eastern portions of the state are more susceptible to hail than the west. The largest population center is in Cheyenne where damaging hail is frequent. Laramie, Weston, Campbell, Platte, Goshen and Niobrara Counties are most socially vulnerable, with Campbell, Laramie and Weston Counties experiencing the greatest percentage of population growth.
Landslide	Wyoming mountainous areas are subject to landslides. Highway and road closures have resulted from landslides and the damage they cause to Wyoming's Highway system. WyDOT completes road repairs related to landslides at a cost of approximately $300,000 annually. No state-owned structures have been damaged by landslides.	Landslides are most prevalent in Wyoming's Northwest (Teton, Park, Lincoln, Sublette & Fremont Counties) mountain ranges, but may also occur in other Wyoming mountains. Of the five counties above, population growth is most significant in Sublette (74%) and Teton (24%) Counties with Sublette being the more socially vulnerable of the two.
Lightning	Lightning occurs statewide with greatest historical losses in Teton ($616,000), Natrona ($362,000), Albany ($347,000), Fremont ($294,000) and Crook ($293,000) Counties over the past 55 years. State facilities located in Park (140), Crook (117), Teton (88), and Weston (66) are potentially at highest	Lightning occurs statewide with greatest historical losses in Teton ($616,000), Natrona ($362,000), Albany ($347,000), Fremont ($294,000) and Crook ($293,000) Counties over the past 55 years. Of those, Natrona has the largest population currently, and Teton County is experiencing the greatest growth percentage.

	risk to lightning. Losses to state-owned facilities over the past five years are $7,600)	
Mine Subsidence	Mine subsidence is a potential hazard statewide. There are no recorded losses from mine subsidence to state-owned facilities, though there are 117 facilities in Crook County (most located in Sundance), 99 facilities in Sweetwater County (most located in Rock Springs), and 218 state-owned facilities in Carbon County (most of which are in Rawlins).	Crook County and the City of Rock Springs in Sweetwater County each indicate mine subsidence is a medium hazard in their risk assessment. Maps indicate Carbon County has the highest prevalence of subsidence. Of those three counties, Sweetwater has the greatest population and Crook County is experiencing the greatest percentage of population growth. Sweetwater County (Rock Springs) has the greatest social vulnerability of the three.
Tornado	There have been tornadoes resulting in losses in all Wyoming counties with the greatest number of tornadoes concentrated in the eastern portion of the state. The most significant losses from tornado occurred in Campbell ($6,230,000) and Laramie ($5,171,000) Counties. There is one loss to a state-owned structure recorded totaling $4,251. The Laramie County has the greatest number of state-owned structures, valued at $1 billion that may be at highest risk to tornado damage.	Counties most threatened by tornado are located in the eastern plains of Wyoming. All eastern counties' mitigation plans reflect either a medium or high risk from tornado. Those with most socially vulnerable populations include Laramie, Weston, Johnson, and Natrona Counties. Of the communities at risk for tornado, the State Capitol and Laramie County Seat, Cheyenne, has the greatest population (59,000) followed closely by Casper (55,000). Gillette in Campbell County has the highest projected population growth (43%).
Wildfire	The wildfire hazard exists statewide. There are recorded losses for 10 of Wyoming's 23 counties. Greatest recorded historical losses occurred in Natrona ($4.3 million) and Fremont Counties ($2.6 million). There have been eight wildfire events impacting state-owned structures, resulting in $40,591 in damage. The state owns just under 1,400 structures exposed to wildland interface fires at a value of just over $5.2 billion. Critical facilities exposed to wildfire hazard total just over 600 with a value of $1.9 billion.	All Wyoming Counties recognize wildfire as a risk, with a heavy majority ranking wildfire as a high risk. Those with the highest existing risk are Teton, Lincoln, Albany, Sheridan, Carbon and Park Counties based on the number of square miles of developed land in the wildland interface. Fremont and Natrona Counties experienced the most loss-causing wildfire events and dollar losses. Of those listed, Fremont, Natrona, and Carbon Counties are the most socially vulnerable. Crook, Carbon, Converse, Albany and Teton Counties have the greatest square miles of undeveloped land in the wildland interface. Of these counties, Converse, Teton, and Crook Counties have the greatest percentage of potential growth.

Wind	Wind has generated $21.5 million in damage statewide, with no county exempt from losses. Recorded losses over the past 55 years in Laramie ($3.6 million), Goshen ($2 million), Platte ($1.9 million), Campbell ($1.8 million) and Albany ($1.6 million) Counties lead the way. State-owned facilities experienced nearly $200,000 in losses from 30 wind events over the past 4 years.	Wind has generated $21.5 million in damage statewide, with no county exempt from losses. Laramie ($3.6 million), Goshen ($2 million), Platte ($1.9 million), Campbell ($1.8 million) and Albany ($1.6 million) Counties lead the way with damage costs. Fremont and Laramie Counties experienced the greatest number of wind events. Of those counties, Fremont County is the most socially vulnerable and Campbell and Fremont Counties have the greatest percentage of potential growth (43% and 17% respectively) and Laramie County has the highest existing population.
Winter storm	Winter storms impact the entire state, with the greatest historic dollar losses in the northeast quadrant. State-owned structures experienced 21 loss-generating events totaling $568,000 over the past 4 years. Critical facilities in the northeast include structures occupied by Dept of Corrections, Dept. of Family Services, Dept. of Health, WyDOT, Game and Fish, State Engineers Office and the Wyoming Supreme Court.	Winter storms impact the entire state. Carbon County has had the greatest number of deaths (6) and Albany County has experienced the greatest number of injuries (39). Weston and Natrona Counties experienced the greatest monetary damages, with just over $7 million in damages for each of the two counties. Niobrara, Converse, Crook and Weston Counties have each received a presidential disaster declaration due to winter storms. Of the counties listed above, Natrona and Weston Counties are most socially vulnerable. Converse and Crook Counties are projected to experience the greatest percentage of growth.

Mitigation Strategy

At their November 16, 2015 meeting, the State Advisory Committee Mitigation Sub-Committee reviewed the previous plan's goals and developed the following mitigation plan mission statement, goals, and objectives:

Mission Statement: Reduce or eliminate risk to human life and property from natural hazards

Goal 1: Strengthen Public Infrastructure.
Strengthen and improve transportation routes, water and sewer infrastructure, the electrical grid, the energy grid, and airports.

Goal 2: Improving State and Local Mitigation Capabilities.
Improve State and Local GIS and Mitigation Planning capabilities.
Improve Local floodplain management capabilities.

Goal 3: Reduce Economic Losses due to Hazard Events
Reduce infrastructure losses; transportation in particular
Reduce tourism losses
Reduce agriculture losses

Goal 4: Reduce State and Local Cost of Response and Recovery
Reduce costs due to flooding events.
Improve detection and/or warning of hazards before damage and impacts occur.

State Capability Assessment

State Laws and Regulations Related to Hazard Mitigation

Wyoming Statute includes a number of measures that relate to hazard mitigation as well as to development in hazard-prone areas, as follows:

1. The Surface Water Drainage Utility Act, Wyoming Statute § 16-10-101 et seq., addresses the authority of local governments to create storm drain systems.

2. The Wyoming Relocation Assistance Act of 1973, Wyoming Statute § 16-7-101 et seq. provides procedures for the relocation of residents when lands are appropriated by local, state, and federal governments.

3. The Powers of County Commissioners, Wyoming Statute § 18-5-101 states: Each board of county commissioners may provide for the physical development of the unincorporated territory within the county by zoning all or any part of the unincorporated territory.

4. County Planning and Zoning Commissions, Wyoming Statute § 18-5-101 et seq. are authorized to: Promote the public health, safety, morals and general welfare of the county, each board of county commissioners may regulate and restrict the location and use of buildings and structures and the use, condition of use or occupancy of lands for residence, recreation, agriculture, industry,

commerce, public use and other purposes in the unincorporated area of the county. However, nothing in W.S. 18-5-201 through 18-5-207 shall be construed to contravene any zoning authority of any incorporated city or town and no zoning resolution or plan shall prevent any use or occupancy reasonably necessary to the extraction or production of the mineral resources in or under any lands subject thereto.

5. The Board of Land Commissioners, Wyoming Statute § 36-2-101 et seq., states: The governor, secretary of state, state treasurer, state auditor, and superintendent of public instruction, being constituted a "board of land commissioners" by the provisions of section 3, article 18, of the constitution of the state of Wyoming, shall as such board, have the direction, control, leasing, care and disposal of all lands heretofore or hereafter granted or acquired by the state for the benefit and support of public schools or for any other purpose whatsoever, subject to the limitations contained in the constitution of the state, and the laws enacted by the legislature. The board shall have the power and authority to take such official action as may be necessary in securing title to land grants, or any other lands acquired by the state.

6. The Wyoming Homeland Security Act, Wyoming Statute § 19-13-101 et seq. states:

   "Homeland security" means the preparation for and the carrying out of all emergency functions essential to the recovery and restoration of the economy by supply and resupply of resources to meet urgent survival and military needs, other than functions for which military forces are primarily responsible, necessary to deal with disasters caused by enemy attack, sabotage, terrorism, civil disorder or other hostile action, or by fire, flood, earthquake, other natural causes and other technological, industrial, civil and political events. These functions include without limitation the coordination of fire-fighting services, police services, medical and health services, rescue, engineering, attack warning services, communications, radiological events, evacuation of persons from stricken areas, emergency welfare services (civilian war aid), emergency transportation, existing or properly assigned functions of plant 5protection, temporary restoration of public utility services, mitigation activities in areas threatened by natural or technological hazards, and other functions related to civilian protection, together with all other activities necessary or incidental to the preparation for any carrying out of the foregoing functions.

Development in Hazard Prone Areas

State laws could be amended to integrate and promote mitigation when development occurs within hazard-prone areas. A rural state in many ways, Wyoming is home to beautiful, mountainous areas frequently sought after for development, frequently without consideration of fire, avalanche or landslide hazards. Undeveloped areas near stream beds are also sought for development, as streams represent both beautiful surroundings and have a recreational benefit to unsuspecting homeowners. There are other areas within Wyoming which are prone to natural hazards and seem on the surface to represent a wonderful location for development.

This is particularly true for developers and potential homebuilders from highly urbanized and regulated locations who seek the solitude and beauty of rural Wyoming settings. Those coming to Wyoming from other states are unaware of the inherent hazards associated with open spaces in Wyoming. They expect protective legislation to exist in Wyoming, just as it does in urbanized areas outside of Wyoming. This can lead to unfortunate circumstances resulting in property damage, injury and even loss of life. State regulations restricting development in hazard-prone areas or ensuring mitigation be incorporated into development would benefit residents new to the state, as well as residents who have lived in the state for generations.

The current mindset of Wyoming residents is such that developers and homebuilders are expected to consider mitigation options on their own, without laws regulating and requiring mitigation. The idea that the government be permitted to dictate what can and cannot be done on someone's personal property is abhorrent to the populous overall and incorporation of these regulations vehemently opposed. While residents appreciate the pursuit of mitigation within development, and personally choose to pursue mitigation, they vehemently oppose regulating the incorporation of mitigation into development. This mindset is likely to continue into the future until unfortunate events occur where lives are lost and property significantly impacted.

The Wyoming Office of Homeland Security legislation is currently housed in the Transportation Committee. Seeking and promoting opportunities to partner with other legislative committees with a goal of integrating mitigation would benefit Wyoming residents. Improving legislative support of mitigation bill sponsorship is another opportunity for improved mitigation actions statewide.

State Pre-Disaster Programs Related to Hazard Mitigation

The state plays an important role in creating opportunities, coordinating and supporting mitigation actions. At the state level, mitigation is achieved through a number of departments in a variety of ways. Departments within state government are responsible, within their statutory authorities, to provide assistance and support to local jurisdictions when the local jurisdictions are unable to cope with a disaster or emergency situation.

Upon implementation of the State Operations Plan (SOP), state agencies are responsible for the implementation of their assigned emergency support functions (ESFs). Multiple agencies are involved in mitigation in their areas of responsibility. For example, the Wyoming Forestry Division develops fire plans and implements projects addressing Wildland Urban Interface (WUI) areas subject to fire hazards. The Table below describes Wyoming State agency programs, potential funding sources, and their respective federal partners. Many of Wyoming's State Agencies have mitigation activities inherent to their mission. Each state agency has completed and maintains their own strategic plan, which outlines mitigation strategies (along with other strategies) they expect to pursue in the upcoming biennium.

Table 93. State Agency Capabilities and State Funding Sources

State Agency	Mitigation Programs & Policies	Potential Mitigation Funding Opportunities	Partnering Federal Agency
Department of Agriculture	• Request disaster declarations • Conduct Drought Contingency Workshops • Provide list of grass for rent from adjacent states	• Administer rangeland monitoring programs	US Department of Agriculture (USDA) provides assistance for natural disaster losses resulting from drought, flood, fire, freeze, tornadoes, pest infestation, and other calamities and administers grant programs
Department of Administration & Information	• Maintain State Asset Inventory for use in Risk Assessment	• Utilize State Coordinator instead of Contractors to develop Local Mitigation plans	• FEMA: Geographic Information System Team
State Engineer's Office	• Ensure the safety and structural integrity of water storage facilities • Conduct on-site inspection of dams • Review new or rehabilitation storage construction plans • Conduct Water Forums for education and awareness of western water issues. • The State Engineer's Office oversees the drilling of wells	• Assists with flood inundation (dam break) models to see the impacts of high hazard dam breaches. • Development of emergency action plans, exercises, and inspections. • Inspect new dams constructed in coalbed natural gas generating areas. • The state supports the Dam Safety Program through several legislatively supported positions.	• FEMA: National Dam Safety Program
Department of Environmental Quality	• Work to eliminate safety hazards and repair environmental damage resulting from past mining activities.	• Provide assistance to communities impacted by mining. • Preserve and restore watersheds through	• EPA: Administers Superfund Cleanup Sites and

State Agency	Mitigation Programs & Policies	Potential Mitigation Funding Opportunities	Partnering Federal Agency
	• Provide education and awareness regarding Subsidence Insurance • Conducts ecological risk assessments at possible leak sites • The Department of Environmental Quality (DEQ) is the state agency that oversees the installation of sewer systems	voluntary implementation of nonpoint source pollution reduction projects by individual landowners, local groups, and other state, local, and federal government agencies	Tribal Assistance Programs
Department of Fire Prevention and Electrical Safety	• Per W.S. 35-9-103, the WY Council on Fire Prevention adopts rules and regulations to establish minimum fire standards for all new commercial building construction • State Fire Marshal and six Regional Fire Inspection Offices review and enforce commercial building permits for Counties without building codes	• Provide fire code training	• USFS
State Forestry Division	• Conduct timber management and harvest for long term forest health and productivity • Manage fires on 3.6 million surface acres of state trust land and conduct cooperative fire management on private and federal lands • Oversees various aspects of construction	• Forestry Collaborative Assistance Program • See snow fencing program in WYDOT below • Provides pre-disaster funding for wildland fire mitigation and hazard planning. Assists land owners with fuel reduction	• USFS
State Geologic Survey	• Develop hydro-geologic maps to assess and investigate aquifer systems, recharge boundaries, flood zones, and erosion potential • Develop geologic hazard maps to assist city, county, and state officials in siting,		• USGS

State Agency	Mitigation Programs & Policies	Potential Mitigation Funding Opportunities	Partnering Federal Agency
	land using planning, mitigation practices, and response preparation • Provide education and awareness on earthquakes, landslides, volcanic eruptions, expansive soils, and windblown deposits • Administer "Did you feel an earthquake" and "Report a landslide" programs		
Office of Homeland Security	• Administers FEMA's grants programs • Updates and maintains the State Mitigation Plan • Reviews Local Mitigation Plans • Updates and maintains the State Threat and Hazard Identification and Risk Assessment (THIRA) • Prepares the State Preparedness Report (SPR) • Provides administrative support for the Search and Rescue Committee and the State Emergency Response Commission (SERC) • State NFIP Coordinator provides resources for local floodplain administrators, including CRS	• FEMA's HMA Grant Programs (HMGP, PDM, and FMA) • Homeland Security Grant Program (HSPG) • Emergency Management Performance Grant Program (EMPG) • Community Assistance Program (CAP) • Community Rating System (CRS) • Waste Isolation Pilot Plant Grant (WIPP) • Public Safety Communications Commission Grant (PSCC) • Hazardous Materials Emergency Preparedness Grant (HMEP)	• FEMA • NFIP
Department of Transportation	• Bridge Scour Vulnerability study to identify scour critical structures • Structure seismic retrofits completed on high risk existing structures; also part of design process on new structures. • Developed Field Guide for	• The Wyoming Living Snow Fence Program is a cooperative effort between WYDOT, WY State Forestry Division, local Conservation Districts and private landowners to implement windbreak	• NWS • FHWA

State Agency	Mitigation Programs & Policies	Potential Mitigation Funding Opportunities	Partnering Federal Agency
	Bridge High-Flow Monitoring and Emergency Procedures • Conduct bridge inspections at least every two years for all on and off system bridges • Maintain database of landslide and rock fall locations • Avalanche Guard towers, four Gazex gas exploders, two Obellx gas exploders, 90 snow supporting structures, one M101-A1 Howitzer, hand charges, and occasional helicopter bombing." • Action identified in 11/16 meeting: Conduct state facility vulnerability analysis for landslide and avalanche hazards with GIS overlay/proximity analysis. Compare social vulnerability data to known hazard areas. Roll these into the other GIS/data related action. • Conduct long term monitoring of active slides • Maintain a master agreement for consulting services for emergency assessment and design for geologic events • Draft Transportation Asset Management Plan, which addresses resiliency and risk concerns related to climate change and environmental factors • Long Range Transportation Plan addresses risk concerns related to climate and environmental factors • Dynamic messaging signs are utilized to warn the traveling public of road surface hazards	plantings for the purpose of snow catchment along state highways. Living snow fence plantings enhance state and county efforts to keep roads safe and open during periods of adverse winter weather while reducing highway maintenance expenditures. The program provides funds to cover the costs of planting and maintaining LSF projects. WYDOT provides $100,000 annually to the Program.	

State Agency	Mitigation Programs & Policies	Potential Mitigation Funding Opportunities	Partnering Federal Agency
	and visibility hazards ahead and impending weather hazards • Falling rock hazards next to highways are mitigated as funding allows • Avalanche areas near highways are monitored for stability and safety • Landslide areas near highways are monitored for movement utilizing electronic equipment and maintenance staff site observation visits		
Water Resources Data Systems	• Provide several climate data products related to precipitation and temperature, including climate-related GIS mapping and long-term drought monitoring • Provide enhanced drought-monitoring products • Assist in the development of the State Water Plan	• Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) is a network of volunteers that measure and map precipitation using low-cost measurement tools, stressing training and education, and utilizing an interactive web-site	• NWS • USDA

Wyoming Office of Homeland Security

The Wyoming Office of Homeland Security (WOHS) employs one full-time employee dedicated to mitigation for the state. The State Hazard Mitigation Officer (SHMO) coordinates and implements Hazard Mitigation Assistance Grants, which currently include the Pre-Disaster Mitigation (PDM), the Flood Mitigation Assistance Grant (FMA), and the Hazard Mitigation Grant Program (HMGP). Additionally, the SHMO maintains the Wyoming Multi-Hazard Mitigation Plan and Hazard Mitigation Administrative Plans. The SHMO assists local jurisdictions by reviewing their local mitigation plans, facilitating mitigation training for state and local officials and develops mitigation partnerships. Implementation of mitigation actions throughout the state is slow, but steady with progress made as time and funding allow.

The WOHS annually completes a Threat and Hazard Identification and Risk Assessment (THIRA), identifies gaps in capacity and capability, and prepares the State Preparedness Report (SPR). In addition to the mitigation grants, the Wyoming Office of Homeland Security (WOHS) administers several grant programs including the Homeland Security Grant Program (HSGP), Emergency Management Performance Grant (EMPG), Hazardous Materials Emergency Preparedness Grant (HMEP), Community Assistance Program Grant (CAP), Waste Isolation Pilot Plant Grant (WIPP), and Public Safety Communications Commission Grant (PSCC). Each of these grants is strategically utilized to maintain and close gaps in Wyoming's capacity to prevent, protect, mitigate, respond, and recover from disasters and emergencies. Further, the WOHS provides administrative support for the Search and Rescue Committee, the State Emergency Response Commission (SERC), and the School Safety Commission. County Coordinators and WOHS meet quarterly to coordinate efforts, discuss areas of concern, exercise and train together.

Wyoming National Flood Insurance Program

The Wyoming Office of Homeland Security administers the NFIP for Wyoming, and is continually encouraging communities to join the program through community assistance visits. Some jurisdictions are not participating in the National Flood Insurance Program (NFIP), and as such may not have local ordinances to govern the construction of buildings in flood prone areas. Local homeland security coordinators, city and county planners, and local residents are also active in encouraging NFIP participation. Table 94 lists counties and communities participating in NFIP.

Table 94. National Flood Insurance Program Participation

County and community names	County and community names	County and community names
Albany County	Shoshoni	Cody
Laramie	**Goshen County**	Meeteetse
Big Horn County	Fort Laramie	Powell
Basin	Lingle	**Platte County**
Greybull	Torrington	Chugwater
Lovell	**Hot Springs County**	Guernsey
Manderson	East Thermopolis	Wheatland
Campbell County	Kirby	**Sheridan County**
Gillette	Thermopolis	Clearmont
Wright	**Johnson County**	Dayton
Carbon County	Buffalo	Ranchester
Baggs	Kaycee	Sheridan
Dixon	**Laramie County**	**Sublette County**
Elk Mountain	Burns	Big Piney
Medicine Bow	Cheyenne	**Sweetwater County***
Rawlins	Pine Bluffs	Green River
Riverside	**Lincoln County**	Rock Springs
Saratoga	Afton	**Teton County**
Converse County	Cokeville	Jackson
Douglas	Diamondville	Uinta County

County and community names	County and community names	County and community names
Glenrock	Kemmerer	Bear River
Crook County*	Opal	Evanston
Hulett	Star Valley Ranch	Lyman
Moorcroft	**Natrona County**	Mountain View
Sundance	Casper	**Washakie County**
Fremont County	Evansville	Tensleep
Dubois	Mills	Worland
Hudson	**Niobrara County***	**Weston County***
Lander	Lusk	Newcastle
Riverton	**Park County**	* County does not participate in NFIP

Repetitive Loss Program

The National Flood Insurance Program provides insurance for properties located in floodplains. In conjunction with this program, FEMA administers the Repetitive Loss Program, which focuses on properties having sustained repetitive losses. Both the Pre-Disaster Mitigation (PDM) Grant Program and the Hazard Mitigation Grant Program (HMGP) provide funding for property acquisition, structure relocation, or flood-proofing measures as a means of preventing repetitive losses. In Wyoming, there are nine repetitive loss properties. Four of the nine properties are insured. The repetitive loss properties are located in Saratoga, Goshen County, Cheyenne, Laramie County, and Park County.

Evaluation of State Mitigation Capabilities

Wyoming agency capabilities have remained relatively stable throughout recent history. Current leadership has worked to keep campaign promises of small, efficient government and maintain a balanced budget. This has resulted in minimal impact (either positive or negative) on mitigation activities in throughout the state.

On the other hand, mitigation implementation challenges remain. Because of the reliance on mineral extraction, Wyoming frequently experiences boom-bust cycles in public funding. This results in funding challenges for the management and funding of mitigation projects. Mitigation staffing has consistently been a challenge as state agencies have been asked to do more with less in ‘bust’ times, and opportunities to pursue mitigation are ‘put on the back burner’ early in ‘boom’ times while other priorities are pursued.

With a fairly practical populous, residents who have been in the state for some time recognize the value of investing a dollar now to save four dollars (or more) in the future, which is what mitigation does. However, families new to the state are not always as practical or as likely to be aware of risks inherent to the area they’ve chosen to live in, and even practical, long-term residents can be negatively impacted by natural hazards. Educating the public on natural hazards and what they can do to mitigate their impact remains an ongoing effort. Some opportunities to mitigate hazards are lost because of an uninformed public who choose not to pursue mitigation for their family or the community.

Another significant barrier to mitigation implementation is the inability of poor jurisdictions to provide the required match. With limited staff to accomplish daily tasks, their capacity to invest time on mitigation grant funding applications is also limited, even if they could locate the required match. A cycle of damage from disasters, repair, slow recovery and new, repetitive damage continues because of funding shortages and limited capacity.

WOHS has opportunities to coordinate and work together with other state agencies to pursue mitigation activities. By making risk assessment data more readily available to local communities, they will be able to develop more informed mitigation strategies and make more informed mitigation project decisions. These efforts have been pursued through the state's mitigation planning process. The current planning process revealed new data sources which were not previously utilized. Communication between agencies has led to improvements and has the potential to lead to additional improvement.

Post-Disaster Mitigation Programs

The state manages one federal fund related to post-disaster hazard mitigation, FEMA's Hazard Mitigation Grant Program (HMGP). The state program is guided by the Wyoming Hazard Mitigation Grant Program Administrative Plan. After a Presidential Disaster Declaration, funds are made available for hazard mitigation projects and planning. The Hazard Mitigation Grant Program may provide Wyoming with an amount equal to 15 percent of the total disaster grants awarded by FEMA after the declaration. The funds may be used to fund up to 75 percent of eligible mitigation measures identified in the Wyoming Multi-Hazard Mitigation Plan, with the state or local government providing the remaining cost-share from non-federal sources.

There are limited opportunities to utilize state agency funding to advance mitigation actions. One budget line item, with limited funding, is available to assist Wyoming communities facing disaster situations. The Disaster Contingency Fund is established to supplement local resources expended during a disaster/emergency situation. However, it is not intended to reimburse all expenses. The Disaster Contingency Fund is a fund "of last resort." This fund is also utilized to meet the state's match requirements for disaster assistance.

Local Mitigation Capabilities

Local mitigation implementation capacity varies from county to county based on population, economy, and level of risk, funding, and staffing levels. An effective way for local jurisdictions to address hazard mitigation is through land use policies and regulations and the enforcement of building codes. These factors place limitations on the state's ability to initiate, implement, or administer mitigation programs, particularly those which would address development in hazard prone areas. Comprehensive hazards data have been supplied to all counties in Wyoming by the Wyoming Office of Homeland Security and the Wyoming State Geological Survey. In addition, all counties have been supplied with hazards analyses and vulnerability assessments for pertinent natural hazards. State agencies have been supplied with the Wyoming Multi-Hazard Mitigation Plan, and key agencies were involved with the creation of this plan update.

Table 95 summarizes existing mitigation capabilities of each county and some of their incorporated cities. The information was derived from county websites, the most current Local Mitigation Plan, and through completed worksheets from the County Coordinators.

Table 95. Local Mitigation Capabilities

County	Building Codes	Comprehensive Planning	Floodplain Management	GIS & Planning	Land Use Regulations	Mitigation Plan	Additional Capabilities
Albany	2012 IBC 2012 Fire Code	2014 County Land Use Plan Update City of Laramie updating in 2015	DFIRM: 06/16/11 County has a Flood Damage Prevention Resolution (req's. 2' of freeboard) and Wastewater Regulations Laramie Requires 1' of freeboard	GIS Director Six Planning Dept. staff	Subdivision Regulations Zoning	Approved; Expires 7/6/20	Grants Manager assists depts. with state and fed grant applications Rock River Website Rock River EOP Laramie has an Open Space Plan
Big Horn	County does not have building codes Town of Greybull has codes	Land Use Plan approved 1/6/10, encourages farming and other rural uses	Risk MAP FIRM: 02/19/14; Floodplain development permit process and website	Staff and Online Map Server	Planning and Zoning Commission Subdivision and Zoning Regulations	Approved; Expires 1/27/16	Town of Greybull has planning/zonin g commission
Campbell	Bldg. Division administers many codes City of Gillette and Town of	2013 County Update 2014 Town of Wright	DFIRM: 01/02/08	Campbell County GIS Dept. City of Gillette GIS	2015 Zoning Map	Approved; Expires 11/20/16	

County	Building Codes	Comprehensive Planning	Floodplain Management	GIS & Planning	Land Use Regulations	Mitigation Plan	Additional Capabilities
	Wright have building codes	2013 City of Gillette		Dept. Wright Building Official			
Carbon	County enforces a building code.	Comprehensive Land Use Plan last updated in 2012 City of Rawlins recently updated their Comprehensive Plan	FIRM: 01/16/87 (Zone A, C, and X) Flood Damage Prevention Ordinance The Town of Baggs has identified a need to update their Storm Water Management Plan	Currently hiring a GIS Specialist The City of Rawlins has a Planner The Town of Saratoga has a City Engineer	2015 Zoning Update 2006 Subdivision Regulations include "mountain subdivision" restrictions addressing wildfire Rawlins and Medicine Bow have MOUs to regulate subdivisions on their borders.	Approvable Pending Adoption	The County Fire Warden developing a Community Wildfire Protection Plan The town of Saratoga is working on floodplain projects
Converse	County does not have codes.	2015 Converse County Land Use Plan includes the incorporated	Risk MAP FIRM: 11/04/09 2009 Flood Damage	Planning and Zoning Commission	2015 Subdivision Regulations requires	Approved; Expires 2/27/17	Currently accepting bids to build snow fencing

County	Building Codes	Comprehensive Planning	Floodplain Management	GIS & Planning	Land Use Regulations	Mitigation Plan	Additional Capabilities
	City of Douglas and Town of Glenrock have building codes	cities and towns. Includes a lot of references to preserving natural areas, wetlands, etc.	Prevention Ordinance		storm sewer improvement		Natural Resource Planning Board: 7 members appointed by the County to manage multiple uses of fed and state land, etc Converse Area New Development Organization=Economic Development
Crook	No Building Codes in the County City of Sundance and Town of Moorcroft have building permit processes	2014 Land Use Plan with limited restrictions	Towns of Moorcroft and Sundance FIRM: 02/02/07 2006 Flood Damage Prevention Ordinance in City of Sundance	Growth & Development Office Reviews Subdivisions	No Zoning, but does have a Planning Commission City of Sundance has an updated Zoning Ordinance	Approved; Expires 12/21/18	City of Sundance has a Land Use Planning Commission Town of Moorcroft is experiencing growth due to mineral industries

County	Building Codes	Comprehensive Planning	Floodplain Management	GIS & Planning	Land Use Regulations	Mitigation Plan	Additional Capabilities
					Town of Moorcroft adopted a Mobile Home Ordinance in 2013 to address rapid growth due to mineral industries		
Fremont	Building Codes for Commercial only Cites have zoning and building codes. South Pass City has Historic Zoning for building appearance.	County has minimal Land Use Plan City of Lander 2012 Master Plan	DFIRM: 02/05/14 Permits are required for construction in those areas within FEMA designated flood hazard zones around Lander, Dubois and Hudson.	GIS Map Server and GIS Technician Planning Department w/5 staff	Fremont County has no general zoning Does have Subdivision Regulations	Approved; Expires 7/12/17	The Wind River Reservation is Zoned Residential/Agricultural. Reservation Zoning is administered by the Shoshone and Arapaho Joint Tribal Council
Goshen	No building codes in County Municipalities have building	1996 Land Use Plan	FIRM: 03/01/86 1983 Flood Damage Prevention Ordinance Risk Map Discovery Meeting held March 2,	Planning and GIS Website; one County Planner	Confined Animal Feeding and Subdivision Regulations	Expired-In the process of updated	Goshen County Planning Commission County Emergency

County	Building Codes	Comprehensive Planning	Floodplain Management	GIS & Planning	Land Use Regulations	Mitigation Plan	Additional Capabilities
	codes		2015		Municipalities have zoning		Response Plan
Hot Springs	No County building codes. Town of Thermopolis enforces the 2006 IBC.	2002 Land Use Plan	East Thermopolis FIRM: 03/23/99; Thermopolis FIRM: 01/20/99 Countywide: NSFHA	Thermopolis utilizes a private engineering contractor	Thermopolis has a Town Code	No Plan	2014 Natural Resources Plan for state and federal lands
Johnson	No County Building Code City of Buffalo has Building Codes Town of Kaycee does not have building codes	2005 Land Use Plan Buffalo Comprehensive Plan includes Chapter 10: Development Limitations that includes floodplains, steep slopes, problem soils and water supply.	NSFHA; City of Buffalo FIRM 04/03/84, and Town of Kaycee FIRM 02/20/08 Johnson County unincorporated area is not mapped. The County is considered Zone C	Johnson County has GIS capability through the Planning Office City of Buffalo Planning Commission City of Buffalo Planning Office	Developing County zoning regulations City of Buffalo has zoning and subdivision regulations Septic Permits	Approved; Expires 10/12/18	2014 Emergency Operations Plan 2010 CWPP Airport Master Plan
Laramie	Laramie County and Cheyenne enforce building codes	2001 Comprehensive Plan is currently being updated: the current plan	FIRM: 01/17/07 2011 Floodplain development permit	Large staff of Planners and Building Officials	2011 Land Use Regulations include strict parameters	Approved; Expires 2/25/18	2011 County Emergency Response Plan 2010

County	Building Codes	Comprehensive Planning	Floodplain Management	GIS & Planning	Land Use Regulations	Mitigation Plan	Additional Capabilities
		identifies flood, landslides, slope disturbances, wildland fire, seismicity, ground subsidence, and expansive soils.		Has Cooperative GIS Program with City of Cheyenne County Grants Department	for drainage design, which include taking flood magnitudes and frequencies into account.		Community Wildfire Protection Plan Cheyenne The Board of Public Utilities Water and Wastewater Master Plan includes a drought risk assessment and makes several recommendations for projects.
Lincoln	County enforces a building code	2013 Comprehensive Plan	DFIRM: 11/16/11 Planning Dept. administers floodplain development permits	Planning Dept. with 5 staff	Zoning and subdivision ordinances	Expired	
Natrona	County enforces numerous bldg. codes	July 2014 County Development Plan: notes the floodplains and wetlands are unsuitable for development.	DFIRM: 05/18/15	GIS Dept. w/2 staff members Planning Dept. administers	County subdivision, Zoning, and Nuisance Regulations 2004 Town	Approved; Expires 9/18/16	Casper has a Planning and Zoning Dept. and floodplain mgmt. website Casper has

County	Building Codes	Comprehensive Planning	Floodplain Management	GIS & Planning	Land Use Regulations	Mitigation Plan	Additional Capabilities
				zoning and subdivision regulations	of Lusk Municipal Code		been a Tree City USA for 17 years.
Niobrara	Town of Lusk administers bldg. permits	The County has a very general land use plan that is no longer current.	Town of Lusk FIRM: 03/18/86 All Zone A, C and X	No planning staff in the county or on retainer to the county or its communities.	NA	Approvable Pending Adoption	2015-2020 Niobrara County Conservation District Land and Resource Plan speaks to the conservation of floodplains, wetlands, environmental quality, etc.
Park	Building Permit Req'd for: new structures, enlarge, reconstruct, or change use.	1998 Land Use Plan	FIRM: 06/18/10 Floodplain and Small Wastewater Permits	Planning Dept. w/4 staff	2015 Development Standards and Regulations	Approved; Expires 11/20/16	Cody has a 2014 Master Plan: Future Land Use Map shows areas preserved as open space/agricultu re
Platte	County Administers Zoning and	2008 Comprehensive Plan, speaks to	FIRM: 07/01/11	Planning & Zoning Dept. and Board	Zoning Rules and Regulations	Expired 3/31/2009	County Planning & Zoning offices

County	Building Codes	Comprehensive Planning	Floodplain Management	GIS & Planning	Land Use Regulations	Mitigation Plan	Additional Capabilities
	Building Permits Wheatland has bldg. codes	floodplain protection and forest fire and wildland fire protection		that meets monthly	cover use and subdividing land		shared with Town of Wheatland
Sheridan	County Enforces Bldg. Codes	2009 Comprehensive Plan includes Future Land Use Plan that shows landslide areas, floodplain, and groundwater vulnerability areas.	Risk MAP FIRM: 01/16/14	GIS Coordinator and interactive website Planning Dept. City of Sheridan has a GIS Division and GIS Web Viewer that includes DFIRM layer	Zoning and Division of Land Rules and Regulations	Approved; Expires 5/13/19	Comp. Plan emphasis on land conservation and open space priorities. City of Sheridan has extensive Planning capabilities 2009 Sheridan County Wildland Fire Mitigation Plan
Sublette	Res. and Commercial Building Codes are in place but there is no	2011 -2015 Comprehensive Plan Update Completed	FIRM: 01/01/08(L) Building Elevation Certificates Req'd	One County Planner Town of Pinedale has	Zoning and Development Regulations In place but not inspected	Expired	County Planning Commission Town of

County	Building Codes	Comprehensive Planning	Floodplain Management	GIS & Planning	Land Use Regulations	Mitigation Plan	Additional Capabilities
	enforcement Town of Pinedale administers Bldg Permit Process			Zoning/Engineering Dept. Sublette County WebServer includes DFIRM	or enforced		Pinedale Planning & Zoning Commission
Sweetwater	County adopted IFC not IBC City of Rock Springs has bldg. codes	2002 Comprehensive Plan 2011 Growth Management Plan City of Rock Springs Master Plan	Rock Springs FIRM: 07/20/98 Rock Springs Floodplain Dev't Permit and LOMRs	Sweetwater County Map Server County Land Use Director City of Rock Springs Planner	2015 Zoning Resolution Update 2012 Subdivision Regulations	Plan not accepted by County Commissioners City of Rock Springs Approved; Expires 5/24/18	
Teton	Teton County adopted 2012 ICC codes on 4/1/2014. Town of Jackson adopted 2012 ICC codes	2012 Jackson/Teton County Comprehensive Plan	Risk MAP FIRM: 09/16/15	No internal GIS department. Has outside GIS contractor that works with multiple agencies and Counties in WY.	Land Use Codes include a Natural Hazard Protection Standards, including steep slopes, unstable soils, faults, floodplains,	Expired 2/24/15 Currently under revision with contractors and in final phases. Added Teton Conservation District as a	Teton County and the Town of Jackson in 2014 the Community Wildfire Protection Plan (CWPP) which addresses wildfire mitigation.

County	Building Codes	Comprehensive Planning	Floodplain Management	GIS & Planning	Land Use Regulations	Mitigation Plan	Additional Capabilities
				Planning and Building Depts. in both Teton County and Town of Jackson.	and Wildland Urban Interface	signatory to help address wildfire, flood, and conservation mitigation issues.	A water improvement district on Flat Creek in the Town of Jackson has been formed to address flooding mitigation.
Uinta	County administers building codes	2011 Comprehensive Plan Evanston is updating their Comprehensive Plan	DFIRM: 02/17/10 Nice flood Insurance webpage	GIS and Planning staff	Zoning Permitting of Small Septic Systems Subdivision and Land Use Regulations.	Approved; Expires 2/29/16	City of Evanston has a Planning Dept.
Washakie	County and Cities administer building permits Worland ICC adoptions: IBC, IPSDC, IRC Ten Sleep administers	2002 Comprehensive Plan	DFIRM: 03/02/09 Washakie County Flood Damage Prevention Resolution, 2009 City of Worland Flood Hazard Mitigation Plan, 2002	Planner/ Floodplain Administrato r GIS by Contractor Worland Part-time Community Development	2012 Subdivision Regulations Small septic permits 2009 Worland City Code	Approved; Expires 9/18/16	Road and Bridge Dept. works on culverts County Wildland Urban Interface ordinance Preliminary Report: Sage

County	Building Codes	Comprehensive Planning	Floodplain Management	GIS & Planning	Land Use Regulations	Mitigation Plan	Additional Capabilities
	building codes			/ Building Inspector			Creek Watershed, Worland, WY 1985
Weston	Building Codes (C9ty)	1977 Land Use Plan	Newcastle FIRM: 04/02/02	Planning Dept. City of Newcastle has a City Engineer	Subdivision regulations, mapping, grant writing, comprehensive planning and coordinating projects	No Plan	County Planning & Zoning Commission Weston County Wildfire Protection Program assists private landowners with cost-share funding to help mitigate Fire Danger Banner on the Website

Evaluation of Local Mitigation Capabilities

Wyoming remains a "Home Rule" state, making local building codes, zoning and other land use regulations inconsistent across the state. In previous plans, the state noted a lack of local building codes, zoning, and other land use regulations. The updated table above shows that most counties and many cities and towns have these capabilities in place and update them regularly. Local jurisdictions now appear to see some mitigation value in land-use regulations, zoning laws and building codes. This change may have occurred as a result of state-wide flooding in 2011. The flooding significantly impacted the majority of Wyoming Counties, generated a Presidential Disaster Declaration (Disaster #4007), and may have prompted communities to protect their residents from hazards through zoning and building codes.

The WOHS has limited staff to assist local communities incorporate mitigation into the capabilities noted above. However, opportunities exist to pursue outreach and education to local jurisdictions. These are being pursued, sometimes when opportunities present themselves... and sometimes by creating opportunities for outreach and education. The WOHS recognizes there is a need to provide more technical assistance and funding to assist local communities expand upon or improve mitigation capabilities. WOHS plans to begin assisting local jurisdictions with their mitigation planning while reducing overall mitigation planning costs and working toward a regional approach to mitigation.

In the past each county has been responsible to pursue and fund their mitigation plan. With this new initiative, WOHS will begin promoting and implementing regional mitigation planning. This will be pursued utilizing Federal EMPG grant funds matched at the state level, making local, regional mitigation plans FREE to local jurisdictions. Wyoming is divided into eight emergency response regions. The state plans to pursue a regional mitigation plan in each of the eight emergency response regions, two regions each year over the next four years. The WOHS plans to contract with a planner and will manage the contract and the contractor will facilitate local jurisdiction mitigation planning. This process will represent a fairly significant change in current mitigation planning processes and will only be possible through collaborative efforts and with support at the local level.

Past, Current and Potential Federal Mitigation Funding Sources

Federally funded pre-disaster mitigation programs include FEMA's Pre-Disaster Mitigation (PDM) program, Flood Mitigation Assistance Program (FMA), Community Assistance Program (CAP), Community rating System (CRS), Dam Safety Program, Risk MAP, and the National Flood Insurance Program. The Federal Highway Administration funds the Federal Aid Highway Program, and the U.S. Department of Agriculture funds the National Fire Plan. **Table 96** identifies federally funded pre-disaster mitigation programs, which the state administers. Funding varies from year to year as its contingent on Congressional authorization. Administration authority is identified for each program. Other than major corporations which might support a local program within their county or near vicinity, no statewide local program funding has been identified. Funding sources listed in **Table 96** are not intended primarily for mitigation activities but could be considered for use by grant applicants for multi-objective projects. Since the previous plan was approved a number of mitigation actions have been funded. Additionally, the State Agency Capabilitiy assessment above, describes how numerous Wyoming State agencies have funded mitigation initiatives throughout the state.

Table 96. Federal Mitigation Funding Sources

Name	Description	Federal Agency
AmeriCorps	Provides funding for volunteers to serve communities, including disaster prevention.	Corporation for National & Community Service
Community Development Block Grant (CDBG)	States sometimes receive a CDBG Supplement, following a disaster, intended for mitigation projects in the affected areas.	U.S. Department of Housing and Urban Development (HUD)
Clean Water Act Section 319 Grants	Provides grants for a variety of activities related to non-point source pollution runoff mitigation.	Environmental Protection Agency (EPA)
Economic Development Administration Grants and Investments	Invests and provides grants for community construction projects, including mitigation activities.	U.S. Department of Commerce
Emergency Watershed Protection	Provides funding and technical assistance for emergency measures to protect impaired watershed easements.	U.S. Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS)
Environmental Quality Incentives Program	Provides funding and technical assistance to farmers and ranchers to promote agricultural production and environmental quality as compatible goals.	USDA-NRCS
Housing and Urban Development Grants	Provides a number of grants related to safe housing initiatives.	HUD
North American Wetland Conservation Fund	Provides funding for wetland conservation projects.	U.S. Fish and Wildlife Services (FWS)
Natural Resources Conservation Service Programs	Provides funding through a number of programs for the conservation of natural resources.	USDA-NRCS
Partners for Fish and Wildlife	Provides assistance to states in the planning for the development, utilization, and conservation of water and related land resources.	FWS
Planning Assistance to States	Provides assistance to states in the planning for the development, utilization, and conservation of water and related land resources.	U.S. Army Corps of Engineers (USACE)

Name	Description	Federal Agency
Rural Development Grants	Provides grants and loans for infrastructure and public safety development and enhancement in rural areas.	USDA, Rural Development
Rural Fire Assistance Grant (RFA)	Funds fire mitigation activities in rural communities.	U.S. Forest Service - National Interagency Fire Center
SBA Pre-Disaster Mitigation Loan Program	Provides low-interest loans to small businesses for mitigation projects.	U.S. Small Business Administration
Small Flood Control Projects	U. S. Army Corps of Engineers has authority to construct small flood control projects.	USACE
Streambank & Shoreline Protection	U. S. Army Corps of Engineers has authority to construct streambank stabilization projects.	USACE
Wetland Program Development Grants (WPDG)	Provides funding for studies related to water pollution prevention.	EPA

Prioritizing Local Assistance

All mitigation planning and project grant applications are considered for funding. Suggestions for application improvement are provided. Prior to 2010, Wyoming's Office of Homeland Security's (WOHS) mitigation program had experienced significant turnover in the SHMO position, with five individuals in the roll over a six-year period. WOHS has been rebuilding the mitigation program since late in 2010. To date, through the rebuilding process Wyoming has not been over-subscribed. Therefore, since the last update all qualified applications received have been submitted for review at the regional and national levels. It is anticipated this will not continue, and that difficult decisions will have to be made in the future regarding grant applications to forward on to the regional and national levels. Hazard Mitigation Grant Program (HMPG) applications will be forwarded beyond the state level based on the guidelines developed and outlined in the HMGP Administrative Plan. Other FEMA mitigation planning and project grant applications will be forwarded to regional and national competition based on stated national priorities and maximizing benefits to Wyoming residents. Grant application reviews at the state level may also include consideration for communities with highest risk, most intense development pressures and repetitive loss properties.

When a funding opportunity becomes available from FEMA in the form of grant guidance, all local jurisdictions and state agencies receive notification informing the jurisdiction or agency of the funding opportunity. Notification to additional, interested individuals and entities are also made. The notice includes an overview of the grant guidance explaining eligible and ineligible projects, as well as a reference to online grant guidance. Application deadlines are explained as well as the expected method of application, including Notices of Intent. Suggested FEMA protocols are followed for PDM, FMA and HMGP-funded plans, including adhering to the Wyoming HMGP Administrative Plan.

Mitigation projects accomplished from 2010 forward are documented in Table 97 below.

Table 97. Mitigation Projects Implemented 2010 - Present

Big Horn	**2 Total Projects**					
Disaster Number	**Project Number**	**Project Title**	**Program Area**	**Status**	**Date Approved**	**Date Awarded**
1923	0005	Big Horn County Sheriff CAD System & Enhanced 911	HMGP	Approved	05/14/2012	~
4007	0002	BIG HORN COUNTY-WIDE WARNING & NOTIFICATION SYSTEM	HMGP	Approved	11/09/2012	~
Carbon	**2 Total Project**					
Disaster Number	**Project Number**	**Project Title**	**Program Area**	**Status**	**Date Approved**	**Date Awarded**
4007	0004	TOWN OF SARATOGA RIVER BANK ARMORING NEAR PEDESTRIAN BRIDGE TO VETERANS ISLAND	HMGP	Approved	04/19/2013	~
4007	0006	SARATOGA RIVER BANK ARMORING NEAR TOWN'S PUBLIC WORKS FACILITY	HMGP	Approved	04/19/2013	~
Crook	**1 Total Project**					
Disaster Number	**Project Number**	**Project Title**	**Program Area**	**Status**	**Date Approved**	**Date Awarded**
1923	0002	CROOK COUNTY MULTI-JURISDICTIONAL MULTI-HAZARD MITIGATION PLAN	HMGP	Approved	05/14/2012	~

Fremont	**1 Total Project**					
Disaster Number	**Project Number**	**Project Title**	**Program Area**	**Status**	**Date Approved**	**Date Awarded**
4007	0008	WYO DEPT OF TRANSPORTATION-FREMONT CNTY WIND RIVER BANK ARMORING & STABILIZATION	HMGP	Approved	01/23/2013	~
Johnson	**1 Total Project**					
Disaster Number	**Project Number**	**Project Title**	**Program Area**	**Status**	**Date Approved**	**Date Awarded**
4007	0001	Johnson County Multi-Jurisdictional Multi-Hazard Mitigation Plan Update	HMGP	Approved	11/09/2012	~
Laramie	**2 Total Projects**					
Disaster Number	**Project Number**	**Project Title**	**Program Area**	**Status**	**Date Approved**	**Date Awarded**
~	PDMC-PL-08-WY-2011-001	Cheyenne/Laramie County MultiHazard Mitigation Plan	PDM	Obligated	09/16/2011	09/23/2011
~	FMA-PJ-08-WY-2004-001	City of Cheyenne Henderson Basin Flood Control Improvement Project	FMA	Obligated	05/26/2005	01/12/2010
Lincoln	**1 Total Project**					
Disaster Number	**Project Number**	**Project Title**	**Program Area**	**Status**	**Date Approved**	**Date Awarded**
~	PDMC-PL-08-WY-2005-004	Pre-disaster Mitigation Plan for Lincoln Co., WY	PDM	Obligated	07/18/2005	04/16/2010
Park	**1 Total Project**					
Disaster Number	**Project Number**	**Project Title**	**Program Area**	**Status**	**Date Approved**	**Date Awarded**
~	PDMC-PL-08-WY-2010-002	Park County Multi-jurisdictional Hazard Mitigation Plan	PDM	Obligated	08/23/2010	08/25/2010

Sheridan	2 Total Projects					
Disaster Number	Project Number	Project Title	Program Area	Status	Date Approved	Date Awarded
4007	0007	SHERIDAN COUNTY- TONGUE RIVER BANK ARMORING PROJECT	HMGP	Approved	02/26/2013	
4007	0009	SHERIDAN COUNTY KOOI ROAD MITIGATION-TONGUE RIVER BANK STABILIZATION	HMGP	Approved	01/23/2013	
Statewide	**1 Total Project**					
Disaster Number	**Project Number**	**Project Title**	**Program Area**	**Status**	**Date Approved**	**Date Awarded**
~	PDMC-PL-08-WY-2005-008	Update and Expansion of Wyoming Multi-Hazard Mitigation Plan	PDM	Obligated	07/26/2005	04/16/2010
Unita	**1 Total Project**					
Disaster Number	**Project Number**	**Project Title**	**Program Area**	**Status**	**Date Approved**	**Date Awarded**
~	PDMC-PL-08-WY-2008-001	Uinta County Update Multi-Hazard Multi-Jurisdiction Mitigation Plan	PDM	Obligated	09/05/2008	12/14/2010
Washakie	**1 Total Project**					
Disaster Number	**Project Number**	**Project Title**	**Program Area**	**Status**	**Date Approved**	**Date Awarded**
~	FMA-PL-08-WY-2010-001	Washakie County Flood Mitigation Plan	FMA	Obligated	09/02/2011	09/07/2011

Wyoming Mitigation Action Plans

The Wyoming State and Local Stakeholders that participated in the October 19, 2015 webinar were asked to review the 2011 mitigation actions and make recommends to the 2016 mitigation strategy based on their local mitigation plans and area of expertise. At their November 16, 2015 meeting, the State Advisory Committee Mitigation Sub-Committee was asked to review the previous plan's mitigation actions as well as the Stakeholders recommends and to develop a final list of mitigation actions for the 2016 plan update. The complete list of the 2011 mitigation actions can be found in the Appendix. Many actions are similar to those found in previous plans but were re-organized and re-worded as part of this update based on current State priorities as well as mitigation actions found in Wyoming's most current Local Mitigation Plans.

Table 98. Wyoming Mitigation Action Plans

Action #1	Sponsor FEMA Mitigation Trainings
Priority	High
Action Description	Work with FEMA Region VIII staff to schedule, promote, and provide logistic support for FEMA trainings as follows: • Offer FEMA's Benefit Cost Analysis Model (BCA) training once per year. Promote the training to engineering firms as well as County Coordinators. • Offer FEMA's HMA Application Development training once per year prior to the request for applications for PDM and FMA. • Offer the Local Mitigation Planning Workshop at least once in the next five years to County Coordinators and mitigation planning contractors. • Offer the Planning for a Resilient Community Workshop at least once in the next five years for local community decision-makers, such as mayors, city councilmembers, planners, and county commissioners to build capacity beyond the County Coordinators and encourage integration of mitigation into other planning mechanisms.
Hazard(s) Addressed	All
Goal(s) Achieved	Goal 2: Improving State and Local Mitigation Capabilities.
Responsible Agency	WY Office of Homeland Security
Partnering Agencies	FEMA
Cost Estimate	Less than $5,000/course Printing of student manuals, snacks, etc. for each training
Benefits	Increases local representative capabilities to develop approvable local mitigation plans and eligible mitigation grant applications as well as integrate mitigation into other local government mechanisms.
Timeline	2016-2021

Action #2	Procure BCA Contractor
Priority	Medium
Action Description	Develop a Request for Qualifications and/or a Request for Proposals for an Engineering firm that can complete the Benefit Cost Analysis (BCA) for Sub-Applicants to FEMA's HMA Grant Programs, on an ongoing basis.
Hazard(s) Addressed	All
Goal(s) Achieved	Goal 1: Strengthen Public Infrastructure. Goal 2: Improving State and Local Mitigation Capabilities. Goal 3: Reduce Economic Losses due to Hazard Events
Responsible Agency	WY Office of Homeland Security
Partnering Agencies	FEMA
Cost Estimate	$50k-$100k/year
Benefits	Increases probability of mitigation grant applications being found to meet the requirement.
Timeline	2016-2021

<table>
<tr><th>Action #3</th><th>Public Education & Awareness Campaign</th></tr>
<tr><td>Priority</td><td>High</td></tr>
<tr><td>Action Description</td><td>Develop a public education and awareness campaign regarding the hazards of outdoor recreation in Wyoming.

Develop a public information announcement regarding the dangers of the avalanche and lightning hazards in Wyoming.

Work with Federal partners such as the National Park Service, the US Forest Service and local subject matter experts, such as the ski resorts and vendors to craft public announcements/messages about the dangers of avalanches and lightning.
Could potentially be a canned announcement statewide or a specific message for certain times of the year and/or that can be applied to a specific area.

Find an alternative to television and radio news outlets, given the limited coverage such as social media. Could use the Digital Information Response Team (DIRT) to post information on social media sites, such as Twitter, WOHS's Facebook page, public website, and internal website.
Subscribe to lightning monitoring system, such as Vaisala
</td></tr>
<tr><td>Hazard(s) Addressed</td><td>Avalanche and Lightning</td></tr>
<tr><td>Goal(s) Achieved</td><td>Goal 4: Reduce state and local cost of response and recovery</td></tr>
<tr><td>Responsible Agency</td><td>WY Public Information Officer</td></tr>
<tr><td>Partnering Agencies</td><td>SHMO</td></tr>
<tr><td>Cost Estimate</td><td>Less than $10,000</td></tr>
<tr><td>Benefits</td><td>Reduce losses of life and costs of response and recovery</td></tr>
<tr><td>Timeline</td><td>2018-2020</td></tr>
</table>

Action #4	Develop GIS Layers for State and Local Risk Assessments
Priority	High
Action Description	Work with WSGS and FEMA to create GIS layers that demonstrate the risk to Avalanche, Earthquake (including Liquefaction), Expansive Soils, and Flooding for use by local communities in their planning and decision-making, such as: • Work with WSGS to map avalanche pathways; • Investigate, in detail, quaternary faults to better determine earthquake hazard; • Improve GIS mapping of areas subject to the liquefaction hazard; • Develop Expansive Soils mapping; and • Work with FEMA to update the Hazus analysis that was completed in 2010.
Hazard(s) Addressed	Avalanche, Earthquake, Expansive Soils, and Flood
Goal(s) Achieved	Goal 2: Improving State and Local Mitigation Capabilities
Responsible Agency	WOHS and WSGS
Partnering Agencies	FEMA
Cost Estimate	Staff Time
Benefits	Improved Risk Assessments
Timeline	2016-2017

Action #5	Improve Dam Failure Awareness
Priority	Low
Action Description	Provide improved Dam Failure risk awareness, warning, and response information to local communities in their planning and decision-making, including: • Leverage existing notification systems for downstream notification in case of failure; • Predefine the geographic area(s) to be called using inundation maps; • Brief emergency managers on the high hazard dams in their county; and • Conduct Emergency Action Plan exercises for potential dam failure.
Hazard(s) Addressed	Dam Failure
Goal(s) Achieved	Goal 4: Reduce State and Local Cost of Response and Recovery
Responsible Agency	Wyoming State Engineer's Office
Partnering Agencies	WOHS, Bureau of Reclamation, and FEMA
Cost Estimate	Staff Time
Benefits	Reduce loss of life and property due to dam failure
Timeline	2016-2021

Action #6	Promote Drought Education and Water Conservation
Priority	Low
Action Description	Improve upon the ongoing program of drought education and water conservation techniques, including: • Educate residents on water saving techniques; • Maintain drought emergency plan; • Monitor water supply; • Encourage drought tolerant landscaping; and • Seek additional opportunities for water storage and water conservation.
Hazard(s) Addressed	Drought and Wildfire
Goal(s) Achieved	Goal 3: Reduce Economic Losses due to Hazard Events
Responsible Agency	Wyoming Water Development Commission
Partnering Agencies	WOHS, SEO, USDA, Bureau of Reclamation, and local Conservation Districts
Cost Estimate	Staff Time
Benefits	Drought has an obvious impact on the farming and ranching community but can also have a significant economic impact on tourism. i.e., less water means less bird, fish, and game observing and hunting. Drought also contributes to the Wildfire threat.
Timeline	2016-2021

Action #7	Retrofit Critical Facilities for Earthquake
Priority	Medium
Action Description	Develop a plan to retrofit state and local government-owned buildings, essential facilities, including schools, shelters, culverts, and bridges for earthquake survivability, including: • Determine which facilities are within hazard prone areas; • Conduct preliminary engineering surveys to determine the level of retrofit necessary and develop cost estimates; • Conduct preliminary benefit/cost analyses; • Prioritize retrofit projects; and • Prepare grant applications for those projects determined to be cost effective and with the greatest benefit.
Hazard(s) Addressed	Earthquake
Goal(s) Achieved	Goal 1: Strengthen Public Infrastructure. Goal 3: Reduce Economic Losses due to Hazard Events
Responsible Agency	WOHS
Partnering Agencies	FEMA
Cost Estimate	$25-$50k
Benefits	Protect critical facilities and prevent loss of life and government function due to earthquake damage.
Timeline	2016-2021

Action #8	Stabilize and Improve Local Floodplain Management
Priority	High
Action Description	Improve capability at the local level to maintain compliance with the requirements of the National Flood Insurance Program through: • Providing flood risk and insurance education; • Monitoring and updating local government regulations that influence how land and buildings are developed; • Providing model ordinances and/or language amendments that better restrict development in the floodplain; • Encourage floodplain administrators to enforce the ordinances they have in place; • Find ways to discourage turnover in the local floodplain administrator positions, which creates turmoil; • Participate in Risk MAP projects, specifically in Carbon and Goshen Counties; and • Ensure that what the state has on file for the most up to date floodplain mapping is properly being used in local planning.
Hazard(s) Addressed	Flood
Goal(s) Achieved	Goal 2: Improving State and Local Mitigation Capabilities Goal 4: Reduce State and Local Cost of Response and Recovery
Responsible Agency	Wyoming State NFIP Coordinator
Partnering Agencies	FEMA
Cost Estimate	Staff Time
Benefits	Reduce the need to re-train new floodplain administrators to maintain continuity of implementing of the program.
Timeline	2016-2021

<table>
<tr><th>Action #9</th><th>Implement Flood Mitigation Projects</th></tr>
<tr><td>Priority</td><td>High</td></tr>
<tr><td>Action Description</td><td>Work with sub-applicants to develop eligible flood mitigation project applications, through the following:

Generate cost estimates for raising or removing structures; and
Prioritize local flood mitigation projects, such as:

Structural acquisitions in the floodplain;
Flood proofing critical facilities; and
Local drainage improvement projects.

Promote utilizing natural systems protections to prevent and restore natural floodplain functions, such as:

Sediment and erosion control;
Stream restoration;
Forest management;
Conservations easements; and
Wetland preservation.

Continue to find ways to increase the number of early warning stream stage continuous recorders throughout state.

Modify existing infrastructure and structures to protect them from flooding</td></tr>
<tr><td>Hazard(s) Addressed</td><td>Flood</td></tr>
<tr><td>Goal(s) Achieved</td><td>Goal 1: Strengthen Public Infrastructure.
Goal 3: Reduce Economic Losses due to Hazard Events
Goal 4: Reduce State and Local Cost of Response and Recovery</td></tr>
<tr><td>Responsible Agency</td><td>SHMO</td></tr>
<tr><td>Partnering Agencies</td><td>FEMA</td></tr>
<tr><td>Cost Estimate</td><td>$25k-$1million</td></tr>
<tr><td>Benefits</td><td>Reduce losses due to flooding including loss of human life, critical infrastructure, economic impacts, etc. Improve resiliency to flooding events.</td></tr>
<tr><td>Timeline</td><td>2016-2021</td></tr>
</table>

Action #10	Improve State and Federal Floodplain Management Coordination
Priority	High
Action Description	Participating in the upcoming Wyoming Silver Jackets Program with the goal of improving collaboration among the network of partners who work on floodplain risk analysis and management issues.
Hazard(s) Addressed	Flood
Goal(s) Achieved	Goal 2: Improving State and Local Mitigation Capabilities.
Responsible Agency	Wyoming State NFIP Coordinator
Partnering Agencies	FEMA
Cost Estimate	Staff Time
Benefits	Improve coordination and collaboration among the federal and state agencies working on flood related risk analysis and mitigation.
Timeline	2016-2021

Action #11	Improve Severe Weather Radar Coverage Statewide
Priority	High
Action Description	There is currently a gap in radar coverage in Campbell County that includes the City of Gillette. There are Doppler radars in Billings, Riverton, Cheyenne, and Rapid City but the coverage limited. There is also a significant hole in weather radar between the Wind River Range and the Wyoming Range in Southwest Wyoming. WOHS needs to work with the Wyoming State Climatologist to lobby the NWS or local news outlets to fill the radar gap to improve warning systems.
Hazard(s) Addressed	Flood, Hail, Lightning, Tornado, and Winter Storm
Goal(s) Achieved	Goal 4: Reduce State and Local Cost of Response and Recovery
Responsible Agency	Wyoming State Climatologist
Partnering Agencies	NWS
Cost Estimate	Staff Time
Benefits	Improved warning times and data for future analysis.
Timeline	2016-2021

Action #12	Improve Structural Resilience to Wind and Hail Damage
Priority	Low
Action Description	Research building construction techniques and other mitigation ideas to reduce the impacts from hail and wind events. Provide the results of the research to local decision-makers and property owners for their voluntary use.
Hazard(s) Addressed	Hail and Wind
Goal(s) Achieved	Goal 3: Reduce Economic Losses due to Hazard Events
Responsible Agency	SHMO
Partnering Agencies	FEMA
Cost Estimate	Staff Time
Benefits	Provides a voluntary solution that can save property owners money while avoiding building codes, which are unpopular in rural Wyoming.
Timeline	2016-2021

Action #13	Monitor and Mitigate Landslide-Prone Areas
Priority	Low
Action Description	Monitor landslide-prone areas (manually and through the use of technology) and promote mitigation techniques, such as: • Install catch-fall nets for rocks at steep slopes near roadways; • Improve set-backs at land-slide prone locations; and • Update and revise landslide mapping in population centers, potential development areas, and infrastructure corridors.
Hazard(s) Addressed	Landslide
Goal(s) Achieved	Goal 2: Improving State and Local Mitigation Capabilities Goal 4: Reduce State and Local Cost of Response and Recovery
Responsible Agency	Wyoming State Geological Survey
Partnering Agencies	FEMA
Cost Estimate	$100-$500k
Benefits	Provide local decision makers in landslide prone areas justification for restricting development to protect lives and property.
Timeline	2016-2021

Action #14	Develop a Model Landslide Ordinance
Priority	Low
Action Description	Develop a grant application to hire a contractor to assist the State to: • Develop a model ordinance that local governments could use to restrict development in landslide prone areas; and • Provide the model ordinance to local officials to incorporate into mitigation plans, land use regulations, and codes.
Hazard(s) Addressed	Landslide
Goal(s) Achieved	Goal 2: Improving State and Local Mitigation Capabilities Goal 4: Reduce State and Local Cost of Response and Recovery
Responsible Agency	SHMO
Partnering Agencies	Wyoming State Geological Survey
Cost Estimate	$50k
Benefits	Could prevent the economic impacts of landslides.
Timeline	2016-2021

Action #15	Abate Mine Subsidence
Priority	Low
Action Description	Continue to investigate and prioritize abandoned mine projects, including: • Grout mined-out areas in developed communities; • Map mined-out areas; • Abate underground coal mine fires; and • Remediate new subsidence as it occurs.
Hazard(s) Addressed	Subsidence
Goal(s) Achieved	Goal 3: Reduce Economic Losses due to Hazard Events Goal 4: Reduce State and Local Cost of Response and Recovery
Responsible Agency	Wyoming Demartment of Environmental Quality
Partnering Agencies	
Cost Estimate	$100-$500k
Benefits	Reduces the threat to live and property due to abandoned mine collapse.
Timeline	2016-2021

Action #16	Build Tornado Shelters
Priority	Low
Action Description	Develop a phased project that results in the construction of tornado shelters in schools in the form of auditoriums/gymnasiums/community centers, similar to the Wichita Kansas School District example, including: • Research best practices; • Prioritize locations and/or choose a school district for a pilot project; • Conduct a cost/benefit review to determine if there is enough documented tornados to support the benefit cost analysis; • Apply for FEMA grant funds to complete the pilot; and • Construct new school structures that meet FEMA's standards for a tornado shelter. In the meantime, find a way to promote the Wheatland School project that utilizes fold-over lockers to shelter in place.
Hazard(s) Addressed	Tornado and Winter Storm
Goal(s) Achieved	Goal 1: Strengthen Public Infrastructure. Goal 4: Reduce State and Local Cost of Response and Recovery
Responsible Agency	SHMO
Partnering Agencies	FEMA
Cost Estimate	$100k-$200k
Benefits	Prevent loss of life due to tornados
Timeline	2016-2021

Action #17	Improve Tornado Warning Systems
Priority	High
Action Description	Increase the number and improve the tornado warning systems statewide.
Hazard(s) Addressed	Tornado
Goal(s) Achieved	Goal 4: Reduce State and Local Cost of Response and Recovery
Responsible Agency	SHMO
Partnering Agencies	FEMA
Cost Estimate	$500k
Benefits	Prevent loss of life due to tornados.
Timeline	2016-2021

Action #18	Promote Firewise Program
Priority	Medium
Action Description	Work with the Wyoming Forestry Division to promote the adoption of Firewise Community initiatives, including: • Improve livestock evacuation plans in event of fire; • Reduce fuel load; • Encourage development of defensible space around structures and infrastructure; • Encourage fire-resistant landscaping; • Retrofit at-risk structures with ignition-resistant materials; • Increase wildfire risk awareness; • Educate property owners about wildfire mitigation techniques; and • Sponsor subdivision Firewise events (clean ups, etc.).
Hazard(s) Addressed	Wildfire and Flooding
Goal(s) Achieved	Goal 1: Strengthen Public Infrastructure. Goal 2: Improving State and Local Mitigation Capabilities. Goal 3: Reduce Economic Losses due to Hazard Events
Responsible Agency	SHMO
Partnering Agencies	FEMA
Cost Estimate	Staff Time
Benefits	Reduce losses to life and property due to wildfire.
Timeline	2016-2021

Action #19	Manage Impacts of Windblown Deposits
Priority	Medium
Action Description	Develop and implement strategies to mitigate the impacts of windblown deposits, that may include: • Revegetation of wildfire burned areas with netting in the short term; • Install live fences to prevent sand dune areas from blowing away; and • Mapping of windblown deposit and high wind areas.
Hazard(s) Addressed	Wind
Goal(s) Achieved	Goal 1: Strengthen Public Infrastructure. Goal 3: Minimize economic losses resulting from impacts of hazards.
Responsible Agency	SHMO
Partnering Agencies	FEMA
Cost Estimate	Less than 1 million
Benefits	Reduces property damage resulting from windblown deposits and maintains economic capacity.
Timeline	2016-2021

Action #20	Protect the Power Grid from Wind and Winter Storm
Priority	Medium
Action Description	Develop projects that will protect power lines and other energy infrastructure from damage due to high winds and blizzards, such as: • Power pole replacement and burying power lines; • Retrofit public and critical facilities structures to minimize wind damage; and • Encourage construction methods which include structural strengthening to minimize wind damage.
Hazard(s) Addressed	Winter Storm and Wind
Goal(s) Achieved	Goal 1: Strengthen Public Infrastructure. Goal 3: Reduce Economic Losses due to Hazard Events
Responsible Agency	SHMO
Partnering Agencies	FEMA
Cost Estimate	$1-$5 million
Benefits	Strengthens critical infrastructure, ensuring the energy supply to homes, businesses and government remains stable throughout a natural hazard event. Reduces damage to homes, businesses and government structures resulting from lack of heat during and following a winter storm.
Timeline	2016-2021

Action #21	Prepare for Winter Storms
Priority	Medium
Action Description	Work with partnering Preparedness agencies to: • Promote the three-day winter storm kit; • Improve livestock evacuation planning and livestock food stockpiling; • Improve outreach to vulnerable populations; • Encourage installation of fire and carbon monoxide monitors and alarms; and • Retrofit schools to be winter warming shelters by ensuring redundant heating and power sources (generators).
Hazard(s) Addressed	Winter Storm
Goal(s) Achieved	Goal 4: Reduce State and Local Cost of Response and Recovery
Responsible Agency	SHMO
Partnering Agencies	WY Department of Transportation
Cost Estimate	Staff Time
Benefits	Reduce loss of life due to winter storms.
Timeline	2016-2021

Project #22	Mitigate Road Closures due to Winter Storm and Wind
Priority	Medium
Action Description	Work with the Wyoming Department of Transportation to: • Increase dynamic signage on highways; • Increase use of living and traditional snow fences; and • Add additional webcams to roadways for better road condition monitoring.
Hazard(s) Addressed	Winter Storm and Wind
Goal(s) Achieved	Goal 1: Strengthen Public Infrastructure. Goal 3: Reduce Economic Losses due to Hazard Events.
Responsible Agency	SHMO
Partnering Agencies	WYDOT
Cost Estimate	1- 5 million
Benefits	Reduce loss of life and economic impact due to winter storms.
Timeline	2016-2021

Coordination of Local Mitigation Planning

Supporting the Development of Local Mitigation Plans

The Wyoming Office of Homeland Security supports, through funding and technical assistance, the development of local mitigation plans. Every county has received Homeland Security Grant Program (HSGP) and Emergency Management Program Grant (EMPG) funds each year since the last state mitigation plan update. Both of these grant programs promote planning as an eligible activity in their guidance. The State Hazard Mitigation Officer has facilitated and assisted in local mitigation planning efforts through face-to-face visits with local communities, directing mitigation discussions at local planning meetings, providing training opportunities, responding with written responses to inquiries, and participating in conference calls with local planners and FEMA Region VIII's planning team.

When a funding opportunity becomes available from FEMA in the form of grant guidance, all local jurisdictions and state agencies receive notification informing the jurisdiction or agency of the funding opportunity. Notification to additional, interested individuals and entities are also made. The notice includes an overview of the grant guidance explaining eligible and ineligible projects, as well as a reference to online grant guidance. Application deadlines are explained as well as the expected method of application, including Notices of Intent. Suggested FEMA protocols are followed including adhering to the Wyoming HMGP Administrative Plan.

In the years since the 2011 update multiple efforts were pursued to assist local jurisdictions with their mitigation planning process. Of those, the following actions represent the types of actions undertaken to assist local jurisdictions:

- HMGP, PDM and FMA funding for plan development was applied for, received, and awarded to subrecipients, and has been tracked utilizing quarterly reporting tools provided by FEMA and an internal grant tracking database.
- The Wyoming Office of Homeland Security made technical assistance available to all counties and has provided on-site technical assistance to requesting counties. Technical assistance included face-to-face meetings with one tribe, six local jurisdictions, and three counties.
- Mitigation information, mitigation status updates, and mitigation grant application updates were provided to all county coordinators in monthly conference calls.
- Presentations were given at multiple county coordinators' quarterly meetings.
- Countless phone calls and e-mails have been exchanged to discuss local mitigation issues, potential mitigation projects, and mitigation planning.
- The State Hazard Mitigation Officer has reviewed fifteen local multi-jurisdictional, multi-hazard mitigation plans, offered suggestions for improvements, and submitted the local plans to FEMA for their review and approval.
- September 2011—HMGP Applicant Briefings were presented statewide in coordination with FEMA Region VIII following flooding disaster DR-4007.
- January 2012—FEMA L212 Developing Quality Project Application Elements training was held in Casper.
- February 2012—Benefit Cost Analysis training was held in Casper.

- June 2012—Participated in four local Risk Map Meetings sharing mitigation information.
- 2012-2014—Participated in monthly Risk Map Conference Calls.
- January 2013—Attended Mitigation for Emergency Managers training in Casper, discussed local mitigation issues with County Coordinators in attendance at the training.
- May 2013—FEMA 154, ATC-20 and ROVER training was provided to assist with earthquake hazard planning activity at the local level.
- February 2014—Facilitated Mitigation Planning Discussion at a local community.
- June 2014—Participated in Community Flood Mapping Meeting.
- June 2014—Mitigation Presentation at a Fuels Mitigation Coordination Training Conference.
- July 2014—Mitigation Presentation at the Wyoming Geological Association.
- November 2014—Completed subrecipient mitigation project site visits.
- January 2105—Met with County Coordinators at annual Flood Summit.
- April 2015—Facilitated BCA Training.
- July 2015—Completed subrecipient site visit.
- August 2015—Facilitated Application Elements Training.
- August 2015—Mitigation Presentation to County Commissioners and Mayors in Niobrara County.
- October 2015—Acquisition Briefing to Political Leadership in Disaster Area.
- October 2015—Completed HMGP Applicant Briefings under DR-4227.
- November 2015—Completed HMGP Applicant Briefings under FM-5115.

The individual most likely to be responsible for development and implementation of the local mitigation plan is the County Coordinator. These individuals are frequently responsible for other activities, including implementation of the U.S. Department of Homeland Security grant programs. County Coordinators may not have sufficient resources to carry out mitigation programs, including development of multi-hazard mitigation plans.

As of December 2015, fourteen of Wyoming's 23 counties have multi-jurisdictional mitigation plans approved by the Federal Emergency Management Agency (FEMA). One multi-jurisdictional mitigation plan is 'approvable pending adoption. One single-jurisdiction mitigation plan has been approved. Eight counties and two tribes do not have approved plans. This represents an improvement since the last State plan updated in 2011, when 11 counties had approved multi-jurisdictional mitigation plans. WOHS will continue to assist local jurisdictions with development of multi–hazard mitigation plans through training facilitation, technical assistance, plan reviews, participation in planning meetings, and other opportunities as they become available.

Table 99. Local Mitigation Plan Status and Expiration Dates, as of 1/4/2016

County	Plan Status	Expiration Date
Albany	Approved	7/7/2020
Big Horn	In Review	1/28/2016
Campbell	Approved	11/21/2016
Carbon	Approvable Pending Adoption	7/21/2014
Converse	Approved	2/28/2017

Crook	Approved	12/23/2018
Fremont	Approved	7/13/2017
Goshen	Expired	1/9/2012
Hot Springs	No Plan	
Johnson	Approved	10/14/2018
Laramie	Approved	2/26/2018
Lincoln	Expired	8/6/2012
Natrona	Approved	9/19/2016
Niobrara	Approved	12/7/2020
Platte	No Plan	
Park	Approved	11/21/2016
Sheridan	Approved	5/14/2019
Sublette	Expired	8/21/2013
Sweetwater	No Plan	
Teton	Expired/In Review	2/25/2015
Uinta	Approved	9/30/2016
Washakie	Approved	9/19/2016
Weston	No Plan	
Rock Springs City*	Approved	5/24/2018

**Single jurisdiction plan*

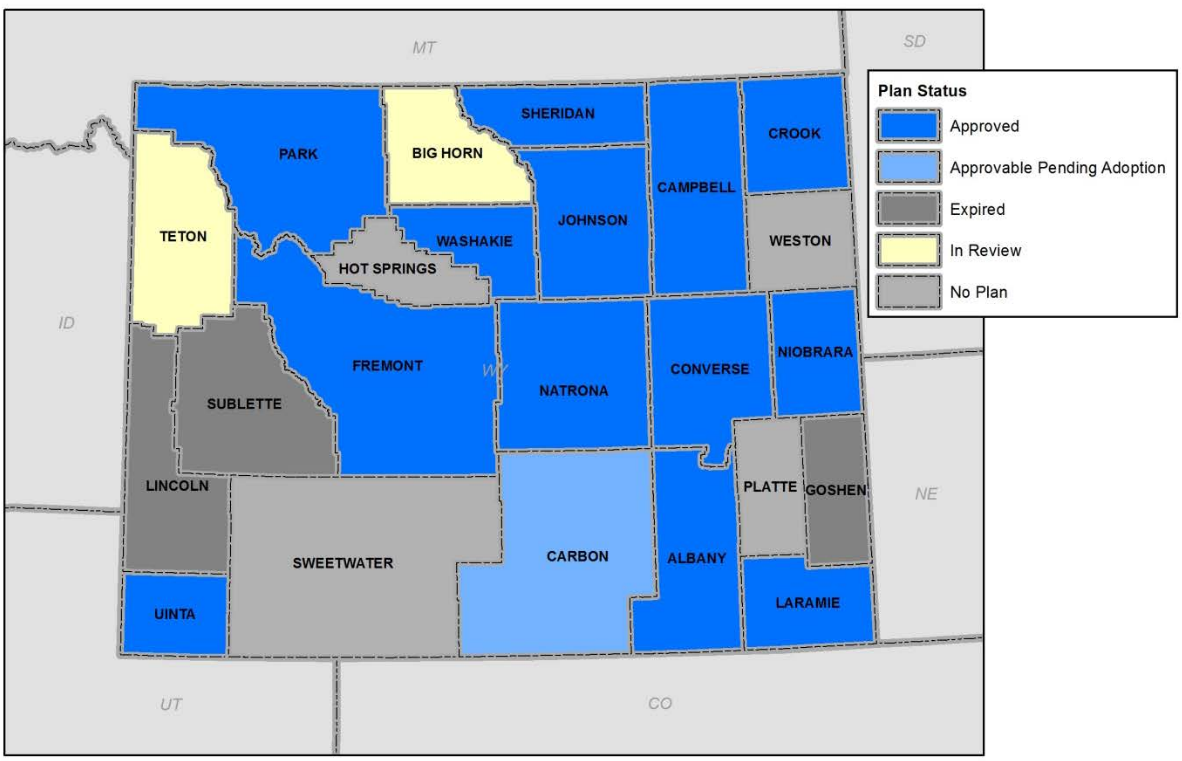


Figure 118. Wyoming Local Mitigation Plan Status as of January 4, 2016

State Process for Plan Reviews

The Wyoming Office of Homeland Security has committed to compressing the state review of the local mitigation plans into two - three weeks. Generally, local plans have been reviewed over the past three years within three-to-five working days.

Integrating Local Plans into the State Mitigation Plan

Local plans are coordinated and linked to the State mitigation plan at the time of the update of the plan through review of all current plans for determining jurisdictions most at risk to each hazard and identifying mitigation actions to roll up into the state plan as a state-wide initiative.

Criteria for Prioritizing Planning and Project Grants

Mitigation projects considered for funding must be in conformance with the goals and objectives stated in this plan, and a local plan, where applicable. Applications for federal funding must follow requirements outlined in respective program guidance and the following criteria which is included in 44 CFR 206.434:

- Project applicants must have FEMA-approved mitigation plans;
- Local projects must be in conformance with the local jurisdiction's mitigation plan;
- Must be cost effective (a benefit-cost ratio of 1:1 or better);
- Must be feasible and practical;
- Must be environmentally sound;
- Must contribute to a long-term solution, including repetitive loss properties; and
- Measures that, if not taken, will have a severe detrimental impact on the applicant, such as potential loss of life, loss of essential services, damage to critical facilities, or economic hardship on the community.

Grant applications for PDM and FMA grant programs will be reviewed by the WOHS to determine compliance with eligibility criteria. Applications will then be reviewed and ranked by the Senior Advisory Council (SAC) Mitigation Sub-Committee. They will assign values to each of the criteria identified in 44 CFR 206.434. Cost effectiveness, based on a cost-benefit analysis, is one of the most important criteria and will be weighted accordingly. The HMGP grant is administered similarly, as outlined in the HMGP Administration Plan.

In addition, ranking of projects for grant funding will include preference for those communities with the highest risks based on both local and state hazard assessments and those with the most intense development pressures. Consideration may be given for any measure or proposed project, from any county in the state, which is designed to reduce risk or future damage, hardship, loss, or suffering from disaster, so long as it meets the eligibility criteria established in 44 CFR, 206-434. Proposed projects/measures do not necessarily have to relate directly to the type of disaster for which a presidential declaration is issued and may be for all or part of the state of Wyoming.

Prioritizing Local Assistance

All mitigation planning and project grant applications are considered for funding. Suggestions for application improvement are provided. Prior to 2010 Wyoming's Office of Homeland Security's (WOHS) mitigation program had experienced significant turnover in the SHMO position, with five individuals in the role over a six-year period. WOHS has been rebuilding the mitigation program since late in 2010. To date, through the rebuilding process Wyoming has not been over-subscribed. Therefore, since the last update all qualified applications received have been submitted for review at the regional and national levels. Based on current interest in HMGP funding, it is anticipated this will not continue, and that difficult decisions will have to be made in the future regarding grant applications to forward on to the regional and national levels.

Upon notification by FEMA that HMGP funds will be made available, WOHS conducts face-to-face applicant briefings around the state. The briefing includes an overview of the program, eligibility criteria, application process, selection process, environmental requirements, cost/benefit analysis requirements, cost share requirements, and financial control/grant management information. Once project or planning applications are received, WOHS will review applications for completeness and activate the SAC Mitigation Sub-Committee to review and rank applications if more than one application is received. Selected applications will be forwarded to FEMA, and Grant Award Agreements prepared for FEMA-approved subrecipients. More detail on the award, monitoring, and project closeout process is available in the Wyoming Hazard Mitigation Grant Program Administrative Plan.

Hazard Mitigation Grant Program (HMPG) applications will be forwarded beyond the state level based on the guidelines developed and outlined in the HMGP Administrative Plan. Other FEMA mitigation planning and project grant applications will be forwarded to regional and national competition based on stated national priorities and maximizing benefits to Wyoming residents. Grant application reviews at the state level may also include consideration for communities with highest risk, most intense development pressures and repetitive loss properties.

Plan Maintenance

Plan Monitoring, Evaluating and Updating

The Wyoming State Mitigation Plan will be updated and submitted to the Federal Emergency Management Agency (FEMA) every five years as required by 44 CRF 201.4. In addition, the plan will be reviewed and updated as appropriate subsequent to a Presidential Disaster Declaration issued for Wyoming. In the interim, major policy or program changes may necessitate revision. The plan is a living document, with revisions expected to be incorporated as circumstances change.

The Wyoming Office of Homeland Security (WOHS) is responsible for plan maintenance and updates based upon plan evaluations conducted by WOHS and the following entities:

- Wyoming Senior Advisory Committee Mitigation Sub-Committee,
- Wyoming State Mitigation Agency Representative Stakeholders,
- County Homeland Security Coordinators.

Monitoring the Mitigation Strategy

The Wyoming Senior Advisory Committee (SAC) Mitigation Sub-Committee will meet twice a year either in person or via webinar to discuss the status of the mitigation strategy. The WOHS staff holds quarterly meetings with the County Homeland Security Coordinators.

The State Hazard Mitigation Officer (SHMO) monitors mitigation projects from inception to completion which utilize FEMA mitigation funding. This includes notifying potential subrecipients of HMA mitigation funding opportunities, scheduling and facilitating applicant briefings, accepting notices of interest for all Hazard Mitigation Assistance (HMA) Grants, responding to subrecipient questions, making arrangements for grant writing and Benefit Cost Analysis (BCA) training, facilitating the application process in e-Grants and accepting completed grant subapplications for prioritization by the SAC Mitigation Sub-Committee. Once subapplications have been prioritized, the SHMO submits subapplications to FEMA and acts as liaison between the subrecipient and FEMA, facilitating Request for Information (RFI) exchanges.

Upon award, the SHMO ensures Subrecipient Grant Award Agreements (GAAs) are prepared following state procedure and executed by all parties, that reimbursement requests are processed, quarterly reports are received from subrecipients and quarterly progress is relayed to FEMA, and that site visits are completed as necessary. Quarterly reports and reimbursements are tracked utilizing an internal, electronic grant-monitoring database. Reimbursements are paid promptly unless quarterly reports are late. Late quarterly reports trigger a delay in reimbursement until quarterly reports are received. Issues which may impact scope of work, environmental and historical preservation requirements, and/or the performance period are monitored via quarterly reports, e-mails, phone calls, and face-to-face interactions.

The SHMO also processes grant/mitigation project closeouts. The closeout is in process throughout the life of the project, with closeout documents completed as the project progresses, tracked for completeness and stored electronically.

Upon project completion, the closeout package is collated and submitted to FEMA. This process includes finalizing financial documents, a final site visit, final audit, environmental and historic preservation information is gathered from the subrecipient, and closeout letters are drafted and executed. The final package, once complete, is submitted to FEMA for their review and closeout at the Federal level. The SHMO is responsible to ensure FEMA has received all closeout documentation. Following completion of the closeout, all records are maintained as required under the Code of Federal Regulations (CFR).

Over the past five years, since the last state mitigation plan update, there has been limited review of progress made on actions and projects with respect to their contributions to the plan's goals. Instead the focus has been on building awareness of mitigation, kindling communities' awareness of the benefits mitigation brings to their residents, and on encouraging mitigation activity of any and all kinds. This has developed the mitigation program to the point that the upcoming five years are expected to generate greater interest in mitigation pursuits at local and state levels. It is believed this will allow for more strategic implementation of mitigation projects in the upcoming five years, with greater focus on mitigation projects' contributions to the plan's goals.

Over the next five years the SHMO anticipates reviewing progress on mitigation activities outlined in the state's mitigation plan at least annually. The review will occur throughout the mitigation grant application period, as proposed mitigation measures are reviewed to ensure they comply with the state's mitigation strategy. For previously-funded projects, reviews are expected to include monitoring of FEMA-funded, subrecipient projects and inquiries to other state agencies with mitigation activities outlined in the State's Mitigation Plan. WOHS leadership will be made aware of significant mitigation activity as it occurs. Additionally, mitigation progress will be reviewed in at least one County Coordinators' Quarterly Meeting each year, with the Senior Advisory Committee Mitigation Sub-Committee when activity occurs which requires their action, and with FEMA Region VIII counterparts periodically throughout the year.

The grant application prioritization process has been improved to incorporate the SAC Mitigation Sub-Committee in the prioritization/selection process at the state level when funding is oversubscribed. Other than application prioritization processes, the state's tracking of project initiation, status and completion status has not changed over the past five (5) years and is not expected to change in the ensuing five years.

While the mitigation program in Wyoming has been developing over the past five years, mitigation actions have been implemented as hoped and planned—though mitigation implementation is expected to increase in upcoming years. Each FEMA-funded mitigation activity complied with state and local mitigation strategies. Pre-Disaster Mitigation (PDM) Grant funding has resulted in seven (7) local multi-jurisdiction mitigation plan updates. One annex enhancing a local wildland-urban interface fire hazard mitigation chapter is currently underway utilizing a PDM grant. A Wyoming subrecipient was successful in obtaining 2014 PDM funding to support a flood mitigation drainage project in the state capital city.

A Flood Mitigation Assistance (FMA) Grant was utilized to enhance a local mitigation plan flood chapter.

Hazard Mitigation Grant Program (HMGP) funds have been put to work as well. HMGP is awarded to states following a presidentially-declared disaster and is 15 percent of the cost of repairs following a disaster. Wyoming does not experience large disasters, particularly when compared to other states, though they are significant for Wyoming. Because Wyoming has few disasters, and the disasters we do have are small, there is limited HMGP awarded to Wyoming. HMGP funding over the past five years provided two local mitigation plan updates, partially funded a CAD and 911 software system, stabilized three riverbanks protecting critical infrastructure and homes, and supported a county-wide notification system.

Two HMGP application periods are currently open. The first of the two opened with a flooding disaster declaration, DR-4227, on July 7, 2015. The second is a HMGP Pilot Program authorized by Congress for this year. The HMGP application period opened October 11, 2015, following a Fire Management Assistance Grant (FMAG) declaration, FM-5115. The first has an estimated $866,000 available and received multiple Notices of Interest (NOIs), totaling $4.75 million. Some of those are expected to drop out through the application process. However, Wyoming will likely be oversubscribed for HMGP under DR-4227. The second, FM-5115, is still accepting NOIs for two more weeks. However, with approximately $331,000 available, NOIs received to date total nearly $800,000. It is unknown if more NOIs will be received under FM-5115. These two HMGP application NOIs document interest in mitigation funding has significantly increased in Wyoming over the past five years.

Challenges to mitigation implementation in Wyoming have not changed significantly over recent years. Funding remains a constant challenge. Matching funds are limited at both local and state levels. Mitigation does best when local champions diligently pursue mitigation for their communities. However, individuals to champion mitigation measures are few. Capacity to promote and implement mitigation due to turnover remains a constant challenge. It is difficult to find and maintain skilled grant writers, government employees, and engineers interested in pursuing mitigation measures in Wyoming. Mitigation takes a village of multi-skilled people. Those who develop their skills move to other, more lucrative areas of interest or other areas of the country. Information sharing has improved over the past five years, but a lack of mitigation program knowledge remains as a hindrance to mitigation activity. These are all likely to remain a challenge into the foreseeable future.

One challenge that seems to have been diminishing over the past five years is political fears of liability once mitigation needs are identified in the planning process. While some Wyoming counties resist mitigation planning, the reasons seem to have changed somewhat from concerns about liability once the plan has been completed and adopted, to concerns about funding the planning process itself. The reason for resistance has changed, but limited changes in activity have occurred.

The SHMO position has stabilized, with the same individual in the SHMO role for the past five years. This represents a significant change and has helped Wyoming's mitigation activities, as there were five different individuals in the position over the previous five years. Additionally, mitigation opportunities are being communicated more frequently and more clearly, making for greater interest in, and successful implementation of mitigation measures.

Evaluating the Plan

As part of the evaluation process, the Wyoming Office of Homeland Security will conduct meetings with appropriate state and federal agencies, local jurisdictions, and members of the public. The following items will be addressed as part of the evaluation:

- Consistency with the "Standard State Hazard Mitigation Plan Review Crosswalk" provided by FEMA. Ensure FEMA comments from the previous plan review are incorporated into the new plan.
- Ensure risk assessment data is current. New information and maps will be incorporated into hazard profiles as needed. Hazard experts will validate the profiles.
- Evaluate state mitigation strategies to include progress on achieving objectives and the status/effectiveness of each of the proposed state mitigation projects.
- Ensure proposed mitigation measures address natural hazards that have occurred in the state since approval of the previous plan.
- Identify problems (technical, legal, financial, and other), which hinder or otherwise affect implementation of the plan and recommend action steps for resolving these issues.
- Recommend necessary revisions to risk assessment, objectives, proposed projects, and rankings, based on collection of new information, and update the plan to reflect major changes in policies, priorities, programs, and funding, as appropriate. Recommendations will include post-disaster hazard mitigation report findings.
- Incorporate, as necessary, information obtained from local mitigation plans, approved or unapproved by FEMA, which were submitted to WOHS since the most recent plan update to include documentation of local events, addition of recently collected geographic information systems (GIS) data, changes or additions of proposed mitigation projects, policies, codes, etc.
- Coordinate the Mitigation Plan with other state plans.
- Comply with all applicable Federal statutes and regulations in effect with respect to the periods for which the state receives grant funding, in compliance with U.S. Code 13.11(c) and will amend the plan whenever it is necessary to reflect changes in State or Federal laws and statues as required in U.S. Code 13.11(d).

Updating the Plan

The WOHS will update the plan to reflect necessary changes, annualy or as necessary, and submit the draft revisions to the Senior Advisory Committee Mitigation Sub-Committee for their review and comment. The Committee will ensure hazards and proposed mitigation actions remain relevant. If substantial changes are made to the plan, the revised plan will be submitted to the implementing state agencies for review.

At a minimum, a final draft of the revised plan will be submitted to FEMA at least 45 days prior to the five-year anniversary date. After receiving FEMA review comments and any necessary changes are made, a copy of the revised plan will be posted on the WOHS website. WOHS will keep this plan online with a request for comments to be submitted to WOHS. Updating the plan over the planning cycle will will run continuously through the planning cycle; comments received during this period will be incorporated, as appropriate, into the next draft plan revision. Critical and timely comments will be incorporated into the existing plan as soon as possible. The draft update of the plan will be completed by WOHS and/or WOHS contractors.

Changes in Plan Maintenance Methodology

During the 2015 update process, greater input from state and local agencyies was achieved, making the end product more valuable. Input included meetings with partner agencies and county coordinators. The process section describes the methods employed to broaden participations. Collaboration was pursued and received via phone calls, webinars, meetings, and emails.

Plan Integration

At their November 16, 2015 meeting, the Senior Advisory Committee Mitigation Sub-Committee agreed to improve the incorporation of the mitigation plan into other state planning mechanisms, as follows:

- The Risk Assessment will be forwarded to the State Department of Health for incorporation into their Hazard Identifcation and Risk Assessment.
- The Mitigation Strategy will be reviewed at the County Homeland Security Coordinators quarterly meetings. During the lunch portion of the agenda, mitigation 'hot topics' will be discussed, such as recent hazard events, mitigation planning updates, and Hazard Mitigation Assistance funding opportunities.
- The state updates the Wyoming THIRA and State Preparedness Report (SPR) annually and assists County Coordinators with their local THIRAs and CPRs (County Preparedness Report). The Mitigation Sub-Committee members work on these planning processes and will incorporate the mitigation plan into their processes and plans.