Big Horn County Pre-Disaster Mitigation Plan

Basin, Burlington, Byron, Cowley, Deaver, Frannie, Greybull, Lovell, Manderson, and Big Horn County, WY.

Big Horn River Ice Jam, Greybull, Wyoming
March 9, 2014

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DRAFT: October 2015

EXECUTIVE SUMMARY

Bog Horn County, Wyoming, and the incorporated communities of Basin, Burlington, Byron, Cowley, Deaver, Frannie, Greybull, Lovell, and Manderson prepared and adopted a Pre-Disaster Mitigation Plan (PDM Plan) in 2010. This plan is a revision to ensure these ten local jurisdictions remain disaster-resistant.

This revision was prepared by Big Horn County with the assistance of contractor, Beck Consulting, and subcontractor, AMEC Foster Wheeler. The content of the plan relies on the advice and guidance of the Local Emergency Planning Committee (LEPC) and Mayors and Clerks of the incorporated towns. Both the LEPC and Mayors and Clerks actively participated in the update by determining the status of projects from the 2010 plan, validating natural hazards of concern, reviewing draft products, and identifying and prioritizing mitigation projects.

Information was available about the project through newspaper coverage and the county's website. Meetings--all open to the public--were held in Basin, Burlington, Deaver, and Greybull. The draft plan was made available through town and county websites and the public library for a four-week period starting in late October 2015.

The plan contains five chapters and several appendices with supporting information. The chapters include an introduction, a description of the planning process, the hazard profiles, mitigation actions, and monitoring and updating the plan. Local plans and sources were utilized as were state and national data bases. A total of nine natural hazards were prioritized and profiled for the county. The hazard profiles included information about past occurrences, vulnerability, potential impact, and future development. The nine hazards include; dam failure, drought, earthquakes, floods, hail, tornadoes, wildland fire, wind and winter storms.

The goals and action items in this plan revision were developed after consideration of:

- the projects identified in the 2010 PDM Plan,
- research of past disasters,
- the risks and vulnerabilities, and
- available resources and capacities.

Chapter IV contains the mitigation goals and actions--or projects. Ten goals (rewritten to address each local jurisdiction's needs individually) with a total of 45 projects were either carried over and/or developed during this revision process. Projects that had not been accomplished from the 2010 plan, that were still appropriate and meaningful were incorporated into the revision.

Goal One: Mitigate natural and human caused hazards to reduce the potential for property loss or damage, injury and loss of life for Big Horn County.

Goals 2-10 contain this same wording except to name the each specific jurisdiction.

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Chapter 1 INTRODUCTION

Hazard mitigation is any action taken before, during, or after a disaster to permanently eliminate or reduce the long-term risk to human life and property from natural and technological hazards.

Since the priority to implement mitigation activities is usually very low in comparison to the perceived threat, some important mitigation measures take time to put in place. Mitigation success can be promoted if accurate information is portrayed through complete hazard identification and impact studies, followed by effective mitigation management.

Hazard mitigation measures must be practical and cost effective, with consideration given to cultural, environmental, and political acceptability. Actions taken to limit the vulnerability of a society to hazards must not in themselves be more costly than the anticipated damages.

Hazard mitigation planning can occur at many points. One of the most effective points is when capital investment and land use decisions are made, based on vulnerability. Capital investments, whether for homes, roads, public utilities, pipelines, power plants, or public works, determine to a large extent the nature and degree of hazard vulnerability of a community. Once a plans or initiatives are in place, very few opportunities will present themselves over the useful life of the project or structure to correct any errors in location or construction with respect to the hazard vulnerability.

Purpose

This Plan serves to assist public officials and the citizens of the ten local jurisdictions to assess natural and human-caused hazards and vulnerabilities, and to identify measures within which to mitigate those hazards. Big Horn County developed and adopted a Multi-Hazard Mitigation Plan in 2003 and updated that plan in 2010. This 2015 PDM Plan revises and updates the most recent--2010 plan.

Additionally, the Disaster Mitigation Act (DMA) of 2000 requires local governments to develop and submit mitigation plans as a condition of receiving Pre-Disaster Mitigation (PDM) and Hazard Mitigation Grant Program (HMGP) project grants. DMA 2000 streamlines the delivery and utilization of disaster recovery assistance and places increased emphasis on local mitigation planning.

Specific Jurisdictions Participating in the Plan Update

The specific jurisdictions participating in the plan update are the incorporated communities of Basin, Burlington, Byron, Cowley, Deaver, Frannie, Greybull, Lovell, and Manderson, and Big Horn County. Each of these jurisdictions participated in the previous plan. There are no new participating jurisdictions. There are no other incorporated communities in the County.

Mitigation Goals

The goals in Big Horn County's 2015 PDM Plan update are organized by jurisdiction. Each of the ten local jurisdictions has one goal. Under each goal are projects specific to that jurisdiction. By organizing the plan in this way, it is easy for each community and the county to see exactly which projects they have determined are needed, which projects they are agreeing to with adoption, and which projects they will be responsible for working on.

The 2010 plan had eight goals. The LEPC—serving as the local planning team—revisited those goals at their first meeting in June 2015. The status of work accomplished on the 2010 goals is provided in Appendix B of this plan update. The LEPC made decisions to retain, discard, or deem the goals accomplished at that meeting.

The plan goals are as follows:

1. Reduce the potential loss of life and property from natural and human-caused disasters in Basin.
2. Reduce the potential loss of life and property from natural and human-caused disasters in Burlington.
3. Reduce the potential loss of life and property from natural and human-caused disasters in Byron.
4. Reduce the potential loss of life and property from natural and human-caused disasters in Cowley.
5. Reduce the potential loss of life and property from natural and human-caused disasters in Deaver.
6. Reduce the potential loss of life and property from natural and human-caused disasters in Frannie.
7. Reduce the potential loss of life and property from natural and human-caused disasters in Greybull.
8. Reduce the potential loss of life and property from natural and human-caused disasters in Lovell.
9. Reduce the potential loss of life and property from natural and human-caused disasters in Manderson.
10. Reduce the potential loss of life and property from natural and human-caused disasters in Big Horn County.

Scope and Plan Organization

The Big Horn County Pre-Disaster Mitigation Plan covers the entire county and all incorporated municipalities within, of which there are nine. The incorporated municipalities include Basin, Burlington, Byron, Cowley, Deaver, Frannie, Greybull, Lovell, and Manderson. These communities participated in the 2010 Big Horn County PDM Plan and the 2015 update.

This Plan is organized into five chapters with three supporting appendices. The appendices assist in understanding the hazard-specific issues facing the county and named towns within. The chapters are as follows:

Section 1: Introduction

This section provides background material to put the Plan and mitigation strategies into the context of Big Horn County's unique assets, resources, and hazards. The County Profile provides an overview of the county and the communities within its external boundaries; including geographic, demographic, economic characteristics, land use, and development trends.

Section 2: Planning Process

This section provides an overview of the process used to develop the Plan, including jurisdictional and public involvement. Appendix A contains the documentation for the planning process.

Section 3: Risk Assessment: Hazard Profile And Vulnerability

This section also presents information about historical disasters occurring throughout the county, and where applicable, the region. Historical analysis describes potential hazards, past impacts, potential losses, critical assets, public property valuations, and special population locations, and general vulnerability.

Section 4: Mitigation

This section uses the hazard and risk information presented in Section 3 to expand on the broad goals. A set of actions or projects are specified that can be accomplished to lessen the chances and/or severity of a potential disaster occurring within Big Horn County and its local communities. Recognizing the limitation of resources to accomplish all projects identified, this section also sets forth local priorities for the projects.

Section 5: Plan Maintenance and Implementation

This chapter describes how this plan is to be maintained and kept current. This section provides information on the implementation, monitoring and evaluation of the Plan.

Appendices

Appendix A: Flood Events

Appendix B: High Wind Events

Appendix C: Wildfire

Appendix D: Winter Storm Events

Appendix E: Status of the 2010 Plan Projects

Appendix F: Planning Process Documentation

Appendix G: Resolutions of Adoption

Authority

The Big Horn County PDM Plan meets the requirements of the Interim Final Rule published in the Federal Register on February 26, 2003, at 44 CFR Part 201 as part of the Disaster Mitigation Act of 2000. The Pre-Disaster Mitigation (PDM) Program was authorized by §203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 USC, as amended by §102 of the Disaster Mitigation Act of 2000. FEMA's planning regulation, 44 CFR Part 201, Hazard Mitigation Planning, establishes criteria for State and local hazard mitigation planning. Further noted are 2009 Wyoming Statutes - Title 19, Defense Forces and Affairs, “Wyoming Disaster and Civil Defense Act.” W.S. 19-13-101 to 414.

Chapter 2 PLANNING PROCESS

Process Followed to Update the Plan

The Plan was developed and prepared for Big Horn County by Barb Beck of Beck Consulting assisted by AMEC Foster Wheeler. Ms. Beck served as the prime contractor responsible for the overall process and products and specifically conducted all meetings in the county and writing Chapters 1, 2, 3, 5, and 6. AMEC Foster Wheeler prepared the hazard identification and risk assessment (HIRA) found in Chapter 4.

The planning process began in May 2015 and concluded in December 2015 with FEMA deeming the plan approvable by the local jurisdictions. The county obtained signed resolutions of adoption from the signatories in early 2016.

Figure 2-1 Mayors' and Clerks' meeting, Deaver, July 16, 2015

The content of the plan relies heavily on the advice and guidance of the Local Emergency Planning Committee (LEPC) and the chief elected officials and their staff. The LEPC served as the local planning team and represented a wide range of interests, served as a technical resource, guided the planning process, and finally reviewed the draft document for accuracy and completeness. LEPC and elected official involvement in the planning process is important for subsequent adoption and successful implementation of the plan.

The Mayors brought local knowledge of the situations in their jurisdictions.

Please see the meeting summaries below and the information in Appendix A for additional detail on how the jurisdictions, planning team (LEPC), other interests, and the public participated in the planning process.

How the Jurisdictions Participated in the Plan Update

The ten incorporated communities and Big Horn County participated in the planning process. Many of the communities are quite small with little or no paid staff--so elected official, clerk, and emergency responder participation was deemed the most appropriate engagement for them. Participation occurred in the following ways across all 11 jurisdictions:

- By providing key staff (County Planner, Mayors and Clerks) to participate in various meetings including public meetings, the Mayors' and Clerks' meeting, and the Local Emergency Planning Committee (LEPC) meetings,

- By issuing news releases during the planning process,
- By identifying actions taken on projects from the 2010 plan,
- By providing information on critical infrastructure and facilities,
- By providing existing plans and documents,
- By providing maps and GIS information,
- By providing contacts for critical information,
- By meeting with the contractor one-on-one as requested,
- By providing feedback on draft goals and identifying project needs,
- By posting project information on government websites or flyers on bill boards,
- By reviewing and commenting on the draft plan, and
- By adopting the plan once FEMA approval is obtained.

Opportunity for Involvement by Other Interests

There are two weekly newspapers in Big Horn County, the Lovell Chronicle and the Greybull Standard. News releases were provide to the papers. The County Sheriff has a webpage where information was posted on meetings. The County Emergency Manager has a non-emergency social media messaging system that was used to provide information to all interested parties. The LEPC represented a wide range of interests including law enforcement, fire, public health, elected officials, industry, etc. All meetings were open to the public and held in public facilities in locations around the County.

How the Planning Team Reviewed and Analyzed the Existing Plan

The LEPC—serving in the role of the planning team--contributed to the update of the plan in a number of ways. First, they reviewed the status of the projects in the existing plan. They identified natural disasters that had occurred since the 2010 update. They provided resources and contacts for the contractors. The LEPC reviewed the list of hazards from the 2010 plan and members identified the additional hazard of naturally-occurring toxic gas seeps which was incorporated into the 2015 HIRA. LEPC members shared information about the planning process with other members of their various organizations. The LEPC identified and validated the mitigation projects. And, finally, LEPC members were afforded the opportunity to review and comment on the draft plan.

How the Public Was Involved in the Planning Process

All meetings held to update the plan were open to the public. With the exception of the Mayors' and Clerks' meetings, the other meetings occurred at their regularly scheduled and noticed times and dates. A summary of each meeting is given below.

Meeting #1 – Summary

The first meeting for the project was a public meeting scheduled in Greybull on June 25, 2015, to kick-off the plan update. There were no attendees at this meeting. This may have been due to a conflict with a popular summer festival in the Lovell area.

Meeting #2 – Summary

The second meeting for the project was an LEPC meeting. This meeting took place in Greybull on June 25, 2015. There were xx members of the LEPC present at this meeting. A briefing paper was handed out

and contractor Beck went over the overall purpose and the reasons for updating the plan. The group brainstormed disasters that had occurred in the previous five years.

Meeting #3 – Summary

The third meeting for the project occurred in Deaver and was scheduled to take advantage of the mayors' and clerks' meeting. The briefing paper was passed out and explained. The mayors were asked to fill out a worksheet listing new development by type (residential, commercial, industrial, or government.) They were queried about whether they had a land use plan. Finally, each mayor identified the hazards they believed their community was vulnerable to from the list of county-wide hazards. Contractor Beck explained that each community must have at least one project in the plan in order to adopt it and be eligible for the benefits the plan provides.

Meeting #4 - Summary

The fourth meeting was a public meeting in Greybull. The meeting took place on August 27 at the County Weed and Pest building. Prior to the meeting, news releases were provided to the two in-county newspapers. The Town of Greybull posted the meeting on their website, the Sheriff's Office posted notice of the meeting on their website, and flyers were prepared and distributed electronically and posted around the community. Despite this effort there were just two attendees at the meeting. Contractor Beck announced the project to the public, went over the briefing paper, and explained how citizens could offer input and stay involved.

Meeting #5 - Summary

The fifth meeting was another meeting with the LEPC. The meeting took place in Greybull. LEPC members and others in attendance took the natural hazard quiz together. The quiz was an educational tool based on the HIRA research. LEPC members were invited to offer project ideas and also informed about how to stay involved and participate in review of the draft plan in the fall of 2015.

Meeting #6 – Summary

The sixth meeting coincided with the Mayors' and Clerks' meeting in the Town of Burlington on September 17. Each of the nine incorporated communities was represented by their mayor or town clerk, or both. The group took the natural hazard quiz with facts from the HIRA research together. Then, contractor Beck worked with the elected officials to identify mitigation projects for each community based on the specific hazards the communities were vulnerable to.

Meeting #7 – Summary

The final project meeting was held in Basin in conjunction with the County Commissioner's regularly scheduled meeting. The draft PDM plan was presented and the public comment period opened.

Following this meeting, the draft plan was available for a 30-day public review. The plan was available in hard copy at the Commissioners' office in Basin and the Emergency Management office in Lovell. Each community with a website posted the draft plan and the county posted the plan on the county's website. Legal ads announcing the availability of the draft plan were purchased in both the Greybull and Lovell newspapers. After the public comment period closed, all comments were addressed.

The Plan Review Tool was prepared and concurrent with the public comment period the plan was submitted to the Wyoming Office of Homeland Security for review. Following this review, the plan was submitted to FEMA. Once deemed approvable by FEMA, the local jurisdictions adopted the plan.

Review and Incorporation of Existing Plans

Copies of existing plans assisted in data collection, public involvement, methodology, and document review. Technical studies and data bases consulted for the HIRA are cited in the appropriate text. Local plans consulted for background information, project ideas, and to ensure consistency are listed in the table below.

Table 2-1 Local Plans

Name of Plan	Jurisdiction	Date	Remarks
Big Horn County Land Use Plan	County	2010	Goal D. Encourage development that is well planned with respect to environmental hazards… Strategies: protect riparian areas, floodplains and wetlands; consider wildfire, potential for flash flooding, soil capacity, and geological hazards. Maps include floodplains, slopes, wetlands.
Subdivision Regulations	County	2012	Soils map, identification of natural water courses and irrigation structures, review and recommendations from Fire Protection District required for minor and major subdivisions. May not locate in areas subject to flooding or floodplains, may not locate on slopes of 30% or more. Planning office may require additional studies related to limiting factors.
Community Wildfire Protection Plan, Addendum	County	2000 5, 2010	Information incorporated in Wildland Fire risk assessment section.
Natural Hazard Mitigation Plan	County	2010	This 2015 plan is an update of the 2010 plan which was consulted extensively.
Big Horn County EOP	County		Not current.
Basin Wyoming Master Plan	Basin	2012	Population increase slow and steady. Need for adequate emergency services identified. Floodplain mapped for NFIP 1977. Maps inadequate in area annexed since. Zoning since 1970's. Largely unchanged.
Town of Burlington Community Devel. Plan	Burlington	2004	404 parcels of land, 139 undeveloped. Fire hall completed 2004, can serve as shelter. Need municipal GIS system.

Name of Plan	Jurisdiction	Date	Remarks
Zoning Ordinance	Burlington	2005	Does not address natural hazards. Establishes building permit. References international bldg. codes.
	Byron	2007	Does not address natural hazards.
	Cowley	2007	Does not address natural hazards.
	Deaver		Does not address natural hazards.
Frannie Town Development Code	Frannie	2005	Requires compliance permit for subdivisions and mobile home parks. Evaluates proposals for slopes, floodplains, drainage, hydrology, and other natural resource conditions.
Greybull Community Development Plan	Greybull	2006	Big Horn River listed as recreation asset. Public Service goal to promote water conservation. Land development goal to work with County on subdivisions within 1 mile. Plans to use Greybull dike for pathway. 19 planning areas--no area for natural resource hazards or floodplain. (Appendix A: recommendations for dated zoning code. Appendix B: marketing plan.)
Muni. Code, Title 18 Zoning	Greybull	2014	New developments required to submit erosion and runoff control plans.
Floodplain Ord. #790	Greybull	2013	Applies to all Special Flood Hazard Areas based on FEMA 2014 DFIRMS.
Lovell Master Plan	Lovell	2006	Little undeveloped land in Town. Recommendations to work with County on subdivisions within 1 mile and consider hazardous structures ordinance. Storm drainage system deemed inadequate. Development constraints were mapped.
Manderson	Manderson	N/A	Town has no land use plan or zoning.

Note: High Hazard Dam Emergency Action Plans are confidential and on file with the Big Horn County Office of Emergency Management.

Chapter 3 RISK ASSESSMENT AND HAZARD PROFILES

The Risk Assessment serves as a single source of hazard information for Big Horn County and participating communities within. Other plans may be referenced and remain vital hazard documents, but each hazard has its own profile in this plan. This portion of this Risk Assessment provides a brief overview of natural hazards that concern the county, and identifies the hazards that are profiled and analyzed further. The Risk Assessment provides the basis for many of the mitigation goals and proposed actions found later in the plan. The following hazards were identified and profiled in 2010 and revisited during the 2015 plan update:

- Dam Failure
- Drought
- Earthquake
- Flooding
- Damaging Hail
- High Winds and Downbursts
- Tornado
- Wildfire
- Severe Winter Weather

As the plan was updated in 2015, other hazards were brought up at planning meetings and reviewed for inclusion, but were ultimately not assessed. Hazardous material incidents, human health emergencies, livestock health emergencies, and terrorism events (particularly school and government focused threats) were identified as hazards for emphasis in subsequent mitigation planning efforts. Volcanic ash, lightning strikes, and landslides were considered but did not receive significant weight by the LEPC as a whole as they have not caused significant impacts in the past.

Other specific hazards discussed during the 2015 update, but ultimately not profiled further in this plan, included:

- Toxic gas seeps – the planning committee discussed toxic gasses seeping from the ground as a potential hazard for inclusion into the plan. There is scattered history of fires and explosions occurring in the region during digging for wells and other new development. However, because of the difficulty in forecasting events and the relatively small-scale nature of the hazard and its impacts, toxic gas seep was not given a full-scale assessment in the final plan.
- Livestock disease – the committee discussed different livestock diseases that have the potential to affect Big Horn County, including brucellosis and chronic wasting disease, disease from mass livestock casualty and tularemia. Upon further discussion, it was decided that since these types of incidents are covered by other agencies and plans, they would not be included in the mitigation plan.
- Human disease – the committee discussed different diseases and pandemics that could affect Big Horn County. Ultimately, it was decided that like livestock disease, human disease is covered by other plans and agencies, and would not be included in the mitigation plan.
- Sedimentation – sedimentation of the Yellowtail Reservoir was discussed as a potential hazard by the committee; upon further review, it was decided that sedimentation goes beyond the scope of this plan.

Introduction and Methodology

The Risk Assessment becomes the factual basis for proposed activities that aim to mitigate damage to the existing communities, and provides a planning foundation for mitigation actions. A risk analysis was conducted for each hazard and quantified using the information gathered to assess risk. The analysis addresses the potential amount of damage a hazard event can cause (hazard magnitude), in relation to how frequently such events are likely to occur (hazard frequency). Risk assessment activities included the mapping of hazard occurrences, the development of numerous charts and tables to display findings, and identification of at-risk critical facilities, operations, and populations. Strategies for both short-term and long-term mitigation and disaster risk reduction were then developed based on this evaluation, and are captured in Chapter 5 of this PDM Plan.

Hazard magnitude and frequency estimates rely on data gathered from a number of sources. Historical data, scientific projections, and inhabitants' subjective judgments are, again, used for this purpose. Magnitude estimates are generally based on the severity of potential impact on three critical vulnerabilities: human life, property, and services. FEMA has, however, recognized that there are other issues tied to community support of risk mitigation including social, cultural, and economical issues. The remainder of this section discusses the hazard profile elements relevant to the risk assessment and vulnerabilities associated with each hazard.

Identified Hazards

The county and participating towns and cities have identified nine (9) hazards with the greatest exposure that could affect or threaten communities and/or the unincorporated areas of the county in terms of structural, physical and economic impact. This Section describes the causes and characteristics of each hazard, documents how they have affected the county and its communities in the past, identifies the geographic extent of the hazard, the intensity of the hazard, and the likelihood of its occurrence. The assessment focuses on Big Horn County and the communities within. However, where applicable, hazards may be also discussed in relation to the Big Horn Basin and the Greater Yellowstone Region.

A risk assessment was conducted for each identified hazard or threat by researching recent and formal State and County hazard assessments, examination of historical documentation, and by identifying conditions or events that have affected the region in the past. Composite data from all sources was utilized to assign a quantitative magnitude for each hazard, based on the following criteria.

- **Loss Potential** Physical damages that may result if a hazard event occurs
- **Population Impacted** Relative amount of population at risk from hazard impacts
- **Probability** Likelihood that a given event would occur within 365 days
- **Jurisdictions at Risk** Jurisdictions that are at risk from the particular hazard

Vulnerability Overview

Many of the hazards and risks described in this plan can be, to a large degree, considered geographically random or "able to impact any time, any place." This includes tornado, high winds and downbursts, hail, severe winter weather, and seismic events. Non-random occurrences as they would relate to geography include hazards or threats of flooding, dam failure and wildfire. Vulnerability information is specific where possible to include vulnerability mapping under the proceeding individual hazard profiles, and also provided in a general format were appropriate.

Estimates for building and content values by jurisdiction are provided below in the following tables. This is provided as a baseline estimate of property exposure. While it is not likely that any hazards in the plan would have widespread impacts on the building stock of the County, the table below could be used as an estimate of loss in the unlikely event that a tornado, for example, impacted the Town of Basin.

Contents exposure is estimated as a percent of the improvement value (specifically, 50% of the improvement value for residential structures and 100% for non-residential structures), based on standard FEMA methodologies. Land values are not included in this analysis, because land remains following disasters, and subsequent market devaluations are frequently short-term and difficult to quantify. Additionally, state and federal disaster assistance programs generally do not address loss of land or its associated value.

Table 3-1 Big Horn County Building Asset Summary. Total Improved and Content Value by Jurisdiction.

Jurisdiction	Building Count	Improved Value	Est. Content Value	Total Exposure
Basin	589	$57,328,426	$29,899,255	$87,227,681
Burlington	111	$10,817,158	$5,720,260	$16,537,418
Byron	219	$17,731,145	$9,076,830	$26,807,975
Cowley	277	$35,945,476	$17,980,099	$53,925,575
Deaver	85	$5,591,893	$3,310,879	$8,902,772
Frannie	61	$3,564,071	$1,934,473	$5,498,544
Greybull	864	$75,129,468	$45,727,443	$120,856,911
Lovell	950	$90,779,510	$52,358,283	$143,137,793
Manderson	50	$2,984,500	$2,008,382	$4,992,882
Unincorporated	2,095	$249,667,366	$157,468,168	$407,135,534
Total	**5,301**	**$549,539,013**	**$325,484,069**	**$875,023,082**

Source: Big Horn County Assessor, accessed September 2015

Table 3-2 Unincorporated County Building Asset Summary.

Total Improved and Content Value by Jurisdiction.

Jurisdiction	Property Type	Building Count	Improved Value	Est. Content Value	Total Exposure
Unincorporated	Agricultural	452	$45,349,173	$45,349,173	$90,698,346
	Commercial	74	$11,112,164	$11,112,164	$22,224,328
	Exempt	2	$129,487	$129,487	$258,974
	Industrial	5	$6,255,982	$9,383,973	$15,639,955
	Residential	1,526	$182,986,741	$91,493,371	$274,480,112
	Vacant Land	36	$3,833,819	$0	$3,833,819
	Total	**2,095**	**$249,667,366**	**$157,468,168**	**$407,135,534**

Source: Big Horn County Assessor, accessed September 2015

Table 3-3 Town of Basin Building Asset Summary. Total Improved and Content Value by Jurisdiction.

Jurisdiction	Property Type	Building Count	Improved Value	Est. Content Value	Total Exposure
Basin	Commercial	57	$5,913,765	$5,913,765	$11,827,530
	Exempt	23	$2,880,712	$2,880,712	$5,761,424
	Residential	493	$42,209,555	$21,104,778	$63,314,333
	Vacant Land	16	$6,324,394	$0	$6,324,394
	Total	**589**	**$57,328,426**	**$29,899,255**	**$87,227,681**

Source: Big Horn County Assessor, accessed September 2015

Table 3-4 Town of Burlington Building Asset Summary. Total Improved and Content Value by Jurisdiction.

Jurisdiction	Property Type	Building Count	Improved Value	Est. Content Value	Total Exposure
Burlington	Agricultural	1	$66,113	$66,113	$132,226
	Commercial	8	$773,606	$773,606	$1,547,212
	Residential	98	$9,761,082	$4,880,541	$14,641,623
	Vacant Land	4	$216,357	$0	$216,357
	Total	**111**	**$10,817,158**	**$5,720,260**	**$16,537,418**

Source: Big Horn County Assessor, accessed September 2015

Table 3-5 Town of Byron Building Asset Summary. Total Improved and Content Value by Jurisdiction.

Jurisdiction	Property Type	Building Count	Improved Value	Est. Content Value	Total Exposure
Byron	Commercial	15	$1,494,509	$1,494,509	$2,989,018
	Residential	194	$15,164,641	$7,582,321	$22,746,962
	Vacant Land	10	$1,071,995	$0	$1,071,995
	Total	**219**	**$17,731,145**	**$9,076,830**	**$26,807,975**

Source: Big Horn County Assessor, accessed September 2015

Table 3-6 Town of Cowley Building Asset Summary. Total Improved and Content Value by Jurisdiction.

Jurisdiction	Property Type	Building Count	Improved Value	Est. Content Value	Total Exposure
Cowley	Commercial	14	$1,891,605	$1,891,605	$3,783,210
	Residential	249	$32,176,987	$16,088,494	$48,265,481
	Vacant Land	14	$1,876,884	$0	$1,876,884
	Total	**277**	**$35,945,476**	**$17,980,099**	**$53,925,575**

Source: Big Horn County Assessor, accessed September 2015

Table 3-7 Town of Deaver Building Asset Summary. Total Improved and Content Value by Jurisdiction.

Jurisdiction	Property Type	Building Count	Improved Value	Est. Content Value	Total Exposure
Deaver	Agricultural	3	$162,287	$162,287	$324,574
	Commercial	3	$284,782	$284,782	$569,564
	Exempt	1	$741,082	$741,082	$1,482,164
	Residential	73	$4,245,456	$2,122,728	$6,368,184
	Vacant Land	5	$158,286	$0	$158,286
	Total	**85**	**$5,591,893**	**$3,310,879**	**$8,902,772**

Source: Big Horn County Assessor, accessed September 2015

Table 3-8 Town of Frannie Building Asset Summary. Total Improved and Content Value by Jurisdiction.

Jurisdiction	Property Type	Building Count	Improved Value	Est. Content Value	Total Exposure
Frannie	Commercial	3	$337,481	$337,481	$674,962
	Residential	57	$3,193,983	$1,596,992	$4,790,975
	Vacant Land	1	$32,607	$0	$32,607
	Total	**61**	**$3,564,071**	**$1,934,473**	**$5,498,544**

Source: Big Horn County Assessor, accessed September 2015

Table 3-9 Town of Greybull Building Asset Summary. Total Improved and Content Value by Jurisdiction.

Jurisdiction	Property Type	Building Count	Improved Value	Est. Content Value	Total Exposure
Greybull	Commercial	125	$16,334,397	$16,334,397	$32,668,794
	Residential	737	$58,786,092	$29,393,046	$88,179,138
	Vacant Land	2	$8,979	$0	$8,979
	Total	**864**	**$75,129,468**	**$45,727,443**	**$120,856,911**

Source: Big Horn County Assessor, accessed September 2015

Table 3-10 Town of Lovell Building Asset Summary. Total Improved and Content Value by Jurisdiction.

Jurisdiction	Property Type	Building Count	Improved Value	Est. Content Value	Total Exposure
Lovell	Commercial	122	$13,694,505	$13,694,505	$27,389,010
	Exempt	4	$330,213	$330,213	$660,426
	Residential	820	$76,667,129	$38,333,565	$115,000,694
	Vacant Land	4	$87,663	$0	$87,663
	Total	**950**	**$90,779,510**	**$52,358,283**	**$143,137,793**

Source: Big Horn County Assessor, accessed September 2015

Table 3-11 Town of Manderson Building Asset Summary. Total Improved and Content Value by Jurisdiction.

Jurisdiction	Property Type	Building Count	Improved Value	Est. Content Value	Total Exposure
Manderson	Commercial	3	$1,034,120	$1,034,120	$2,068,240
	Residential	45	$1,948,523	$974,262	$2,922,785
	Vacant Land	2	$1,857	$0	$1,857
	Total	**50**	**$2,984,500**	**$2,008,382**	**$4,992,882**

Source: Big Horn County Assessor, accessed September 2015

Content value is estimated as a percent of structure replacement value per HAZUS 2.0:

- Industrial 150%
- Agriculture 100%
- Commercial 100%
- Residential 50%
- Vacant Land 0%
- Exempt (Schools and Govt.) 100%

Structural Vulnerability

Structural vulnerability may be a factor in consideration of high wind and tornadic events, as well seismic activity. The ability of buildings to withstand these onslaughts of nature must be considered in many types of planning, not the least of which is mitigation planning.

Table 3-12 provides information on building or construction requirements regulated by each jurisdiction. Lovell, Greybull, Cowley and Byron have adopted the International Building Code, and also have inspectors to enforce code requirements. The towns of Burlington and Deaver have adopted the International Building Code, but do not have inspectors to enforce the code. Big Horn County, Basin, Manderson, and Frannie have not adopted the International Building Code to date. Which years each participating jurisdiction adopted the code is not known.

Table 3-12 Community Building Codes - Status By Community

Community	Existing Building Codes	Building Inspectors
Big Horn County (unincorporated areas)	No	No
Lovell	Yes	Yes
Greybull	Yes	Yes
Basin	No	No
Byron	Yes	Yes
Burlington	Yes	No
Manderson	No	No
Frannie	No	No
Cowley	Yes	Yes
Deaver	Yes	No

Information Provided By Each Town/City Administrative Office.

As International Building Codes are adopted by more and more local jurisdictions, building inspectors are employed, inspections take place, and new construction under these codes occurs, vulnerability is expected to decrease. An example of regulation that helps to decrease vulnerability, would be that future buildings constructed within an identified floodplain provide that the lowest floor in new structures are elevated above stated levels to meet program requirements. These types of regulations

and codes help to decrease vulnerability as time goes on. Currently there are no known plans for subdivisions in identified non-random event hazard areas.

Vulnerable Populations

All populations are considered in this Plan. However, there are some populations that may be considered in groupings or as congregate for purposes of planning. Populations as categories of groups include incorporated towns and cities, school populations, hospitals, nursing homes, daycares, jails, and those individuals that are unable to self-evacuate (UTSE.)

Critical Facilities

Critical facilities provide a service essential to preservation of life or property, or exist as a facility critical to the welfare of the community are identified. The following table is based on information from Big Horn County GIS and list critical facilities by jurisdiction.

Table 3-13 Critical Facilities by Community

Jurisdiction	Critical Facility Type	Facility Name	Address
Basin	Ambulance	Big Horn County Rural Dist #1 and Atwood Ambulance	419 West C Street
Basin	Day Care	Absaroka Basin-Greybull Head Start	609 Rue Ave
Basin	Day Care	Children's Resource Center	117 S 4th St
Basin	Day Care	Home Away From Home	708 South 5th St
Basin	Fire Hall	Big Horn County Fire Dist #2 Basin	105 South 3rd Street
Basin	Government	Big Horn County Courthouse Annex	417 Murphy Street
Basin	Government	Big Horn County Courthouse, includes District Court of the 5th Judicial Dist and Circuit Court	420 West C Street
Basin	Government	Big Horn County Road and Bridge	412 Murphy Street
Basin	Government	Big Horn County Search and Rescue	427 Murphy Street
Basin	Government	Chamber Meeting Building	407 West C Street
Basin	Health Clinic	Big Horn Clinic	156 North 6th Street
Basin	Local Government	Basin Town Hall and Garage	209 - 211 South 4th Street
Basin	Mental Health	Big Horn County Counseling	116 South 3rd Street
Basin	Nursing Home	Wyoming Retirement Center	890 HWY 20 South
Basin	Police	Garage Shop and Police Department	309 West B Street
Basin	Pump Station	Pump Station	150 1/2 East B Street
Basin	School	Laura Irwin Elementary School	101 South 12th Street
Basin	School	NOWCAP Head Start Basin Center	965 North 6th Street
Basin	School	Riverside High AG Shop Building	919 West B Street
Basin	School	Riverside High School	919 West B Street, PO Box 151

Jurisdiction	Critical Facility Type	Facility Name	Address
Basin	School	Riverside High School Football Concessions / Press Box	Arlington Avenue
Basin	School	Riverside High School Track Football Storage Building and Track	Maloney Park
Basin	School	School District Administration Building and Bus Garages	416 South 3rd Street
Basin	School	School District Garage	4th and A Street
Basin	Sewage Treatment Building	Basin Sewage Lagoon Pond and Treatment Building (US Hwy 20 S)	290 North Street
Basin	Shelter	Laura Irwin Elementary School	101 South 12th Street
Basin	Shelter	Riverside High School	919 West B Street, PO Box 151
Basin	Sherriff	Big Horn County Sheriff's Dept. Shop	418 Murphy Street
Basin	Sherriff	Big Horn County Sheriff's Office, South Communications, and Jail	415 Murphy Street, PO Box 47
Basin	Substation	Substation (new 2010)	554 North 8th Street
Basin	Substation	Substation (South end of town)	2nd and Big Horn
Basin	Utility	Big Horn Rural Electric Company	208 South 5th Street
Basin	Water Facility	Pre-Settling Basins (old water plant)	150 East B Street
Basin	Water Facility	Raw Water Holding Tank	1600 West B Street
Basin	Water Facility	Raw Water Pump House	1500 West B Street
Basin	Water Filter Plant	Water Filter Plant	153 East B Street
Basin	Water Tank	Purified Water Tank (in town limits) West of town and S of Hwy 30	1700 West B Street
Basin	WYDOT	WYDOT District 5 Headquarters - Mechanic Shop	218 West C Street
Basin	WYDOT	WYDOT District 5 Headquarters - Office	218 West C Street
Basin	WYDOT	WYDOT District 5 Headquarters - Storage	218 West C Street
Burlington	Ambulance	Big Horn County Ambulance Dist #4	109 Main (Hwy 30)
Burlington	Fire Hall	Big Horn County Fire Dist #4 Burlington / Otto / Emblem	109 Main (Hwy 30)
Burlington	Local Government	Burlington Town Hall	101 West Poplar Avenue
Burlington	Local Government	Burlington Town Shop	101 West Poplar Avenue
Burlington	School	Burlington Schools (Elementary, JR & SR High Complex)	108 School Avenue
Burlington	Shelter	Burlington Shelter	108 School Avenue
Burlington	Shelter	LDS Church Burlington	114 Cedar Avenue
Byron	Day Care	Michele Freeman's Daycare	37 S Big Horn St

Jurisdiction	Critical Facility Type	Facility Name	Address
Byron	Local Government	Byron Town Hall	35 South Pryor Street
Byron	Police	Byron Police Department	35 South Pryor Street
Byron	School	Byron Elementary	30 East Main Street
Byron	School	Rocky Mountain High School	30 East Main Street
Byron	Shelter	Rocky Mountain High School	30 East Main Street
Byron	Water Tank	Water Tower	West Platte Avenue
Cowley	Day Care	Deb's Day Care	221 E Main St
Cowley	Day Care	Rocky Mountain Elementary Preschool	101 S Division
Cowley	Garage	Cowley Town Maintenance Shop / City Garage	81 East Main Street
Cowley	Government	Community Hall	51 East First Street South
Cowley	Government	Road and Bridge Shop and Storage	95 North 2nd Street West
Cowley	Local Government	Cowley Shop	105 North 2nd Street West / 81 east main?
Cowley	Local Government	Cowley Town Hall and Police Department	20 South Division Street
Cowley	School	Big Horn Academy Admin Building	South Division Street
Cowley	School	Big Horn County School District #1 (under construction)	Highway 310, South end of town
Cowley	School	Big Horn County School District #1 Superintendant	176 South 3 East
Cowley	School	Rocky Mountain Elementary School	101 South Division Street
Cowley	Shelter	LDS Church Cowley	52 East Main
Cowley	Shelter	Rocky Mountain Elementary School	101 Division Street
Cowley	Water Tank	Water Tower	East 1st Street North
Deaver	Fire Hall	Big Horn County Fire Dist #5	First Avenue West
Deaver	Local Government	Deaver Town Hall	180 First Street
Deaver	School	Rocky Mountain Middle School Complex	176 West 3rd Street
Deaver	Shelter	Rocky Mountain Middle School	176 West 3rd Street
Frannie	Fire Hall	Frannie Fire Hall District #5	Fifth Street
Frannie	Local Government	Frannie Town Hall	325 Cedar Street
Frannie	School	Frannie Grade School	Fifth Street and Cedar Street
Greybull	Day Care	Apple Dumpling Day Care	216 Hilltop Dr
Greybull	Day Care	Lil ' Red Wagon Childcare and Learning Center	200 3rd Ave South
Greybull	Day Care	Little Wranglers	608 Greybull Ave
Greybull	Day Care	Stepping Stones Montessori	346 Greybull Ave
Greybull	Fire Hall	Greybull Fire Hall / Emergency Medical	141 North 6th Street
Greybull	Fire Siren	Emergency Fire Siren	170 North 7th Street

Jurisdiction	Critical Facility Type	Facility Name	Address
Greybull	Fire Siren	Emergency Fire Siren	24 South 5th Street
Greybull	Government	Herb Asp Community Hall	Corner of South 6th Street and First Avenue
Greybull	Local Government	Greybull Town Hall	24 South 5th Street
Greybull	Police	Greybull Police Department	24 South 5th Street
Greybull	Public Health	Big Horn County Public Health	417 South 2nd Street
Greybull	School	Big Horn County School District #3 Admin and Bus Barn	636 14th Avenue North
Greybull	School	Greybull Elementary School	125 6th Avenue South
Greybull	School	Greybull High School Complex	600 North 6th Street
Greybull	School	Greybull Middle School Complex	600 8th Avenue North
Greybull	Senior Citizens Center	Senior Citizens Center	417 South 2nd Street
Greybull	Shelter	Greybull Elementary School	125 6th Avenue South
Greybull	Shelter	Greybull High School	600 North 6th Street
Greybull	Shelter	Greybull Middle School	600 8th Avenue North
Greybull	Shelter	Old High School Gym	-
Greybull	State Government	Wyoming Game and Fish Warden Station - Office/Residence	434 6th Avenue North
Lovell	Ambulance	North Big Horn Ambulance #53 Service Housing / Equipment	1115 Lane 12
Lovell	Day Care	-	195 E 7th St
Lovell	Day Care	Absaroka Head Start of Lovell	750 1/2 Kansas Ave
Lovell	Day Care	Children's Resource Center	435 E 5th St
Lovell	Day Care	Leonhardt Day Care	352 W Main St
Lovell	Day Care	Marie Thomas Day Care	144 W Main St
Lovell	Day Care	Teddy Bear Daycare	172 E 2nd St
Lovell	EOC	Emergency Management Building	355 East 5th Street
Lovell	Equipment	Contractor's Equipment (Bair Equipment Company)	213 East 3rd Street
Lovell	Fire Hall	Big Horn County Fire Dist #1 Lovell / Cowley / Byron	314 Nevada Avenue
Lovell	Government	Big Horn County Courthouse Annex, includes Circuit Court	355 East 5th Street
Lovell	Government	Chamber of Commerce	287 East Main Street
Lovell	Government	Search and Rescue Buildings / Equipment	256 East 5th Street
Lovell	Health Clinic	Strong Tree Clinic	342 E. Main
Lovell	Hospital	North Big Horn County Hospital and Clinic	1115 Lane 12
Lovell	Local Government	Lovell Town Office and Public Works Shop	336 Nevada Avenue

Jurisdiction	Critical Facility Type	Facility Name	Address
Lovell	Local Government	Lovell Town Shop	337 Montana Avenue
Lovell	National Guard	Wyoming National Guard Armory	360 East 5th Street
Lovell	Nursing Home	NEW HORIZONS ASS LIV/CARE CNTR	1111 LANE 12
Lovell	Police	Lovell Police Department	355 East 5th Street
Lovell	Public Health	Lovell Public Health Nurse and WIC	757 Great Western Avenue
Lovell	School	Big Horn County School District #2 Central Offices	Great Western Avenue
Lovell	School	Lovell Elementary School	520 Shoshone Avenue
Lovell	School	Lovell High School	502 Hampshire Avenue
Lovell	School	Lovell Middle School	325 West 9th Street
Lovell	School	Lovell Schools Gym	502 Hampshire Avenue
Lovell	Senior Citizens Center	Lovell Senior Citizens Center	757 Great Western Avenue
Lovell	Shelter	LDS Church Lovell	50 West Main
Lovell	Shelter	Lovell Elementary School	520 Shoshone Avenue
Lovell	Shelter	Lovell High School	502 Hampshire Avenue
Lovell	Shelter	Lovell Middle School	325 West 9th Street
Lovell	Water Tank	Water Tank	974 Shoshone Avenue
Lovell	WYDOT	WYDOT Shop / Garage	450 East 5th Street
Lovell	WYDOT	WYDOT Storage	450 East 5th Street
Manderson	Fire Hall	Big Horn County Fire Dist #3 Manderson	515 North Sherman Avenue
Manderson	Garage	Bus Garage	157 East 1st Street
Manderson	Local Government	Manderson Town Hall	100 Railway Street
Manderson	School	Cloud Peak School (Manderson Elementary and Middle Schools)	170 School Avenue
Manderson	Shelter	Cloud Peak School	170 School Avenue
Unincorporated	Airport	North Big Horn County Airport (Cowley)	600 Road 7 1/2 or 185 Park Avenue
Unincorporated	Airport	South Big Horn County Airport (Greybull)	2441 Highway 20
Unincorporated	Day Care	Little Joys Daycare	1223 Rd 11
Unincorporated	Day Care	Tammie's Childcare	1062 Lane 13
Unincorporated	Fire Hall	Shell Volunteer Fire and Ambulance Dept	Smith Avenue
Unincorporated	Government	Lovell Community Center	1910 US Highway 310
Unincorporated	Hospital	South Bighorn County Hospital, includes Midway Clinic and BlueJacket Nursing Home	388 Hwy 20 South
Unincorporated	Local Government	Shell Community Hall	Smith Avenue
Unincorporated	Mental Health	Big Horn Basin Counseling Services	1114 Lane 12

Jurisdiction	Critical Facility Type	Facility Name	Address
Unincorporated	Sewage Treatment Building	Sewer Control and Storage Building	1 Mile North of Greybull
Unincorporated	Shelter	LDS Church Basin	400 Hwy 20 South
Unincorporated	State Government	Battle Mountain Patrol Cabin	-
Unincorporated	State Government	Game and Fish Yellowtail Wildlife Habitat Management Area Warden Station	10 Mile NE of Lovell
Unincorporated	State Government	Patrol Cabin Storage Shed	-
Unincorporated	State Government	Patrol Cabin	Bald Mt 2 Mi N Lovell
Unincorporated	State Government	WY Game and Fish Tillet Springs Station / Hatchery	195 County Road 16
Unincorporated	State Government	Wyoming Game and Fish / Residence	955 Road 18
Unincorporated	Water Tank	250,000 Water Tank	2 Miles SW of Greybull
Unincorporated	Water Tank	Airport Water Tower / 650,000 Gallon	244 US Hwy 20
Unincorporated	Water Tank	Water Tank	1 Mile East of Greybull
Unincorporated	Water Tank	Water Tank	Image Drive
Unincorporated	Water Tank	Water Tank and Chlorinator House	Trapper Creek (Shell Area)
Unincorporated	Water Tank	Water Tower	Ash Street
Unincorporated	Water Tank	Well Head and Water Tank	3 Miles East of Greybull
Unincorporated	Water Well Building	Burlington Water Well Building	760 Lane 39
Unincorporated	WYDOT	Pole Creek - Well House	912 US 14, West of Burgess Jct, Milepost 64.3
Unincorporated	WYDOT	WYDOT Pole Creek - Storage	912 US 14, West of Burgess Jct, Milepost 64.3
Unincorporated	WYDOT	WYDOT Storage	450 East 5th Street

Source: Big Horn County GIS

Dam Failure

Narrative

Dam failure can be described as "the unintended release of impounded waters" and can fail for one or a combination of reasons. An unintended release can occur as a result of:

- A component failure of a structure that does not result in a significant reservoir release, or

- An uncontrolled breach failure that leads to a significant release. With an uncontrolled breach failure of a manmade dam there is a sudden release of the impounded water, sometimes with little warning. The ensuing flood wave and flooding have enormous destructive power.

Dams rarely fail, either completely or partially, but when they do they may be a life and safety hazard for those downstream. Overtopping failures result from uncontrolled flow of water over, around, and adjacent to the dam. Approximately 70% of dam 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% of dam failure. Deformation of the foundation or settling of the embankment can also result in dam failure.

Federally-Controlled Dams

In 1981, the U.S. Army Corps of Engineers completed an inspection program for non-federal dams under the National Dam Inspection Act (P.L. 92-367). This was a four-year work effort and included compiling an inventory of about 50,000 dams and conducting a review of each state's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of dams. There were 1,458 dams in Wyoming that were reviewed by the Corps at that time. Part of the inspection included evaluating the dams and assigning a hazard potential based on the effects downstream should one of the dams fail. 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 the nearest downstream community, population density of the community, and age of the dam. High hazard dam failures would involve property losses over $1 million and have probable loss of life. Significant hazard dam failures would cause over $1 million in property damage and involve possible loss of life.

These classifications are based on the consequences if a dam were to fail, not on the potential of failure, or the existing condition of a dam. Hazard potential classification is not a guarantee of safety.

State-Inspected Dams

The Wyoming State Engineer's Office (WSEO) is in charge of inspecting dams throughout the State that are over 20 feet high or with a storage capacity of 50 acre-feet or more and are not federally inspected. As a part of the regulatory process the WSEO inspects these dams once every five years.

The State of Wyoming has adopted FEMA's risk classifications as set forth in FEMA's *Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams*. These classifications describe potential losses and damages anticipated in down-stream areas that could be attributable to failure of a dam during typical flow conditions.

High Hazard Potential - Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life. There are three high hazard potential dams located in Big Horn County, and an additional 21 high hazard potential dams located outside Big Horn County that have the potential to negatively affect the planning area.

Significant Hazard Potential - Dams assigned the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure. There are four significant potential dams located in Big Horn County, and an additional 12 significant potential dams located outside Big Horn County that have the potential to negatively affect the planning area.

Low Hazard Potential - Dams assigned the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property. There are 35 low hazard potential dams located in Big Horn County.

Big Horn County is part of Water Division #3 under the WSEO regional office in Riverton. WSEO field hydrographers reside in the Big Horn Basin and are assigned to the six water districts that are a part of Big Horn County. Copies of all inspection reports for each of the dams are available at the WSEO headquarters office in Cheyenne. Inspection reports are also available at the WSEO District Offices for dams and structures located in their specific district.

Past Occurrences

Rarely do dams completely or partially fail to become a significant downstream hazard. There has been one catastrophic dam failure within the U.S. Rocky Mountain region in recent history. This event occurred 250 miles west of Big Horn County over the Wyoming state line, and was due to an engineering and structural failure of Idaho's Teton Dam. A 305-foot high U.S. Bureau of Reclamation earth-filled structure, situated near the Montana and Wyoming borders on the Teton River. It failed completely as it was being filled for the first time over a period of several months. When it was filled to near capacity, it released the contents of its reservoir at 11:57 AM on June 5, 1976. Eleven people perished and over 13,000 cattle were killed. Inundation areas were 40 miles wide in some places. The Bureau of Reclamation set up claims offices and by January 4, 1977, disaster victims filed over 4,800 claims totaling $194 million. Originally scheduled to end in July 1978, the Claims Program continued into the 1980s. At the end of the Claims Program in 1987, the federal government had paid 7,563 claims for a total amount of $322 million. Total damage estimates have ranged up to $2 billion, and the dam was never rebuilt.

There is no known occurrence of a past dam failure in Big Horn County, or of dams upstream from county boundaries that affected Big Horn County. However, dams identified outside of the county whose complete or partial failure would have a negative impact on Big Horn County will be discussed as significant hazards for the purposes of this Plan. The dams that are of biggest concern to the County are discussed below. Figures XX and XX show the locations of these dams within and around the county.

Vulnerability

There are at least four reservoirs and dams that, should they be compromised, have the capacity to cause loss of life and property destruction throughout Big Horn County or at least minor property

damage. There are 39 secondary dams scattered throughout the county that are less critical, but should also be recognized as having a potential for impacting downstream populations or property.

Primary Dams

Dam sites whose failure would have potentially the biggest impact on Big Horn County and its towns and cities actually lie outside the County boundaries. Those sites are listed below:

Roach Gulch Reservoir and Dam (also known as the Greybull Valley Dam) is physically located in Park County, immediately west of the Big Horn County boundary on the Greybull River. The dam is an earthen dam, 151 feet in height; owned and maintained by the Greybull Valley Irrigation District and serving over 400 shareholders. Its purpose is to divert and store water from the Greybull River for downstream crop irrigation and agricultural use. The reservoir's surface area is 691 acres and its capacity is rated at 33,169 acre feet. Roach Gulch Dam is located in Park County, just above the western edge of the Big Horn County line.

Roach Gulch Dam is classified as a high hazard dam by the Wyoming State Engineers Office, based on predicted consequences if a dam failure were to occur. At average capacity, the Sunshines and Roach Gulch Reservoir combined hold approximately 140,000 acre feet of water.

The Farmer's and Bench Canal diversion structure is located below Roach Gulch Reservoir, 1.5 miles west of the Big Horn County line and one half mile south of County Road 40.

Upper and Lower Sunshine Reservoirs and Dams collect and store water high above the town of Meeteetse in Park County for agricultural irrigation use. The dam releases water into the Greybull River on its journey down into the Big Horn Basin and east to Roach Gulch Dam and Reservoir, from which water is again regulated for irrigation practices. The water continues through Big Horn County on its way to the Bighorn River. The Sunshines are owned and maintained by the Greybull Valley Irrigation District, and are inspected every five years by the Wyoming State Engineers Office or as necessary.

Buffalo Bill Dam and Reservoir**,** six miles west of Cody in Park County, regulates the Shoshone River and provides incidental flood control on the Shoshone River. Described as a concrete arch structure of constant radius, the structural height is 325 feet and the volume is 82,900 cubic yards. This was one of the first high concrete dams built in the United States. It began storing water in 1910. The Shoshone River flows west to east from the dam, eventually traveling just north of the town of Lovell and emptying into Big Horn Lake and the Big Horn River. The Buffalo Bill Dam provides the irrigation water supply for 93,113 acres, supplemental service for 14,561 acres, and produces power that is fed into a grid system serving an area that extends into three States.

Boysen Dam and Reservoir is an earthen dam located on the Wind River, approximately 20 miles south of Thermopolis in Fremont County. The Wind River becomes known as the Big Horn River downstream from the reservoir; eventually, the river flows into Manderson in southern Big Horn County.

The first dam in the Boysen area was constructed of concrete in 1908, and was replaced by a second structure which became operational in December, 1952. The current dam is operated by the U.S. Federal Bureau of Reclamation, and is an earth-filled dam with a structural height of 220 feet. Hydroelectric power is tied into the transmission lines to Alcova, Thermopolis, and Pilot Butte-Thermopolis, and provides irrigation water through storage for lands below and above the reservoir.

Total flood damages reduced by the reservoir since construction totaled about $75.0 million by the end of 1998.

Shell Reservoir and Adelaide Lake are located in eastern Big Horn County, high above the unincorporated town of Shell, collecting water from snow melt and small streams located in the Big Horn Mountains. Waters from the lake and reservoir contribute to Shell Creek, which flows west approximately 15 miles after leaving the town of Shell, eventually joining the Big Horn River several miles north of the town of Greybull.

Figure 3-1 Big Horn County Dams

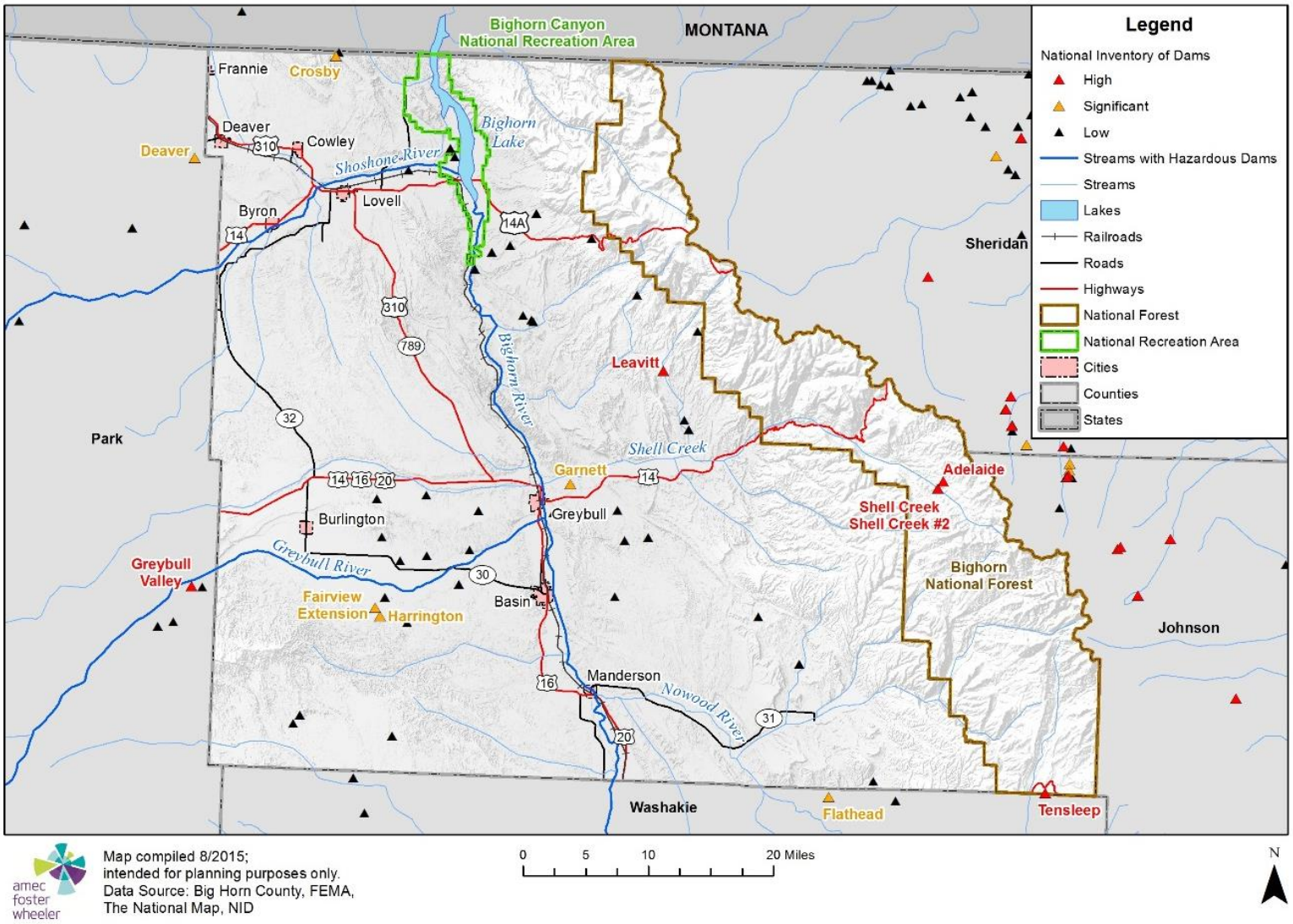
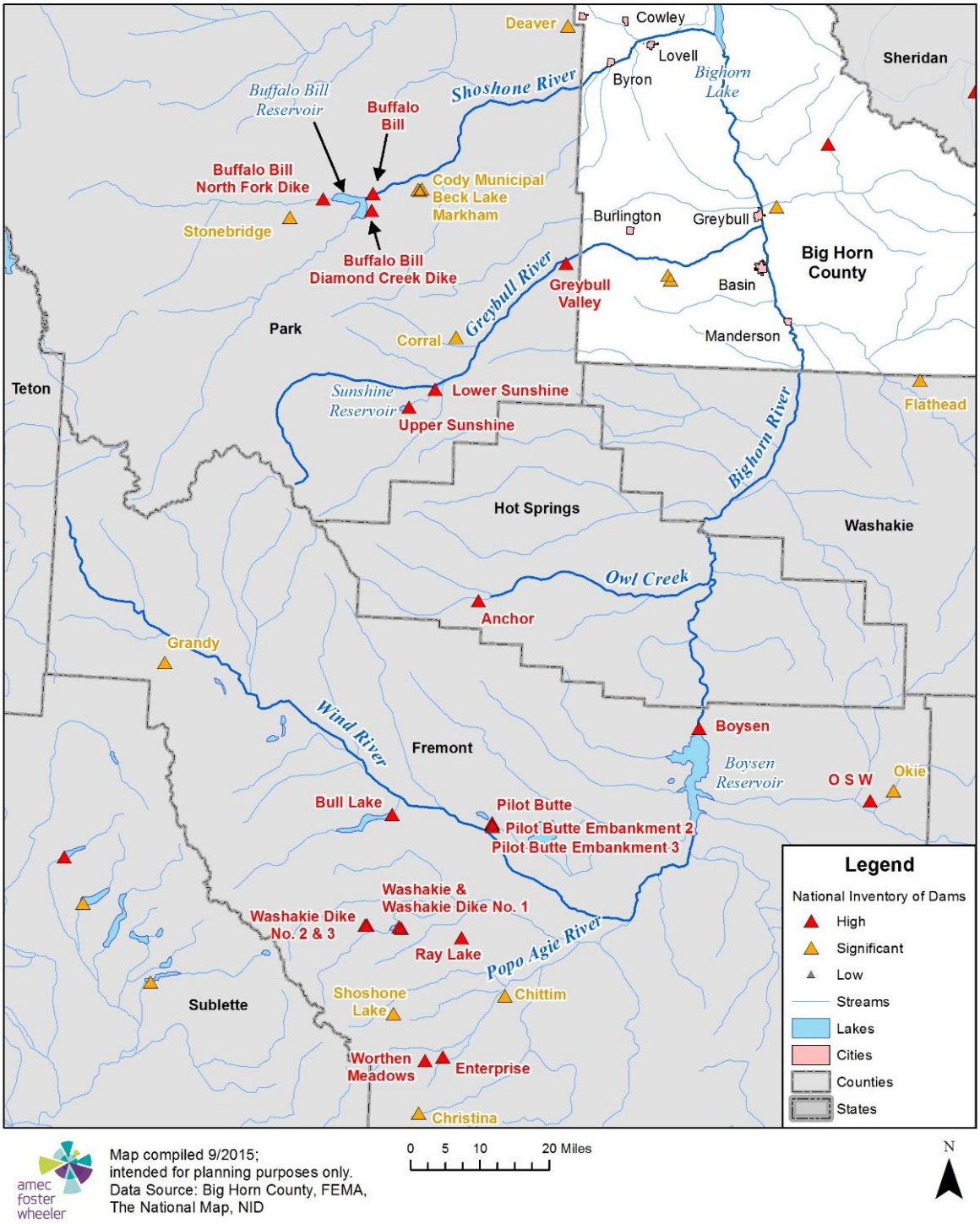


Figure 3-2 Dams Located Outside Big Horn County



Downstream Emergency Action Plans (EAPs) for Roach Gulch and Sunshine Reservoirs were completed during Fall 2009 by the Greybull Valley Irrigation District. EAPs for both Boysen and Buffalo Bill Bureau of Recreation dams include inundation maps and downstream warning and notification plans, including local emergency services agencies and municipal contacts to be used in the event of a breach or imminent threat.

Secondary Dams

There is an extensive network of secondary downstream reservoirs, dams, canals, water control structures, and ditches used to convey water from primary canals. Most canals, secondary dams and smaller reservoirs are serviced by the Buffalo Bill, Boysen, Roach Gulch, or Upper and Lower Sunshine Reservoirs and Dams.

Three of these secondary dams have been designated by the Wyoming State Engineers Office to be high risk dams, and four to be significant risk dams.

The Wyoming State Engineers Office submitted a list of WSEO-inspected secondary dam structures existing within Big Horn County. The Big Horn County Emergency Management Coordinator can provide lists of WSEO-inspected dams upon request.

Potential Impact

Although earthquake or seismic activity has received a very low priority rating in terms of a detrimental impact to Big Horn County, active faults lie very close to both Boysen and Buffalo Bill Cody Dams. The Buffalo Bill Cody Dam exists near what is known to be one of the most seismically active areas of the United States, that of the Yellowstone Caldera. This geothermal region experiences 1000 to 2000 measurable earthquakes each year, and has been known to experience as many as 3,000 such events in a matter of months. A swarm of small earthquakes occurred January 17, 2010 to February 1, 2010, documenting 1620 measurable seismic occurrences in that two-week period. The largest of these shocks registered a magnitude of 3.8.

It is difficult to predict the larger impact to life and property that may occur as a result of secondary washouts and breaches of these smaller water storage and conveyance systems downstream, should any of the aforementioned five primary dams actually fail. It is conceivable that a “domino effect” could be experienced should one of the major dams breach, compromising some of the smaller downstream dams.

Finally, Bureau of Reclamation and the Greybull Irrigation District’s predictions are based on a “sunny day” breach. Any event may be influenced by already bank full streams, rivers, and canals that occur in most years, at various times of the year due to spring run-off or heavy rains in the mountains, compounded by a sudden influx of water from a dam failure.

Table 3-14 briefly presents flood water crest predictions in a worst-case breach in a “sunny day” event for each of the three dams for which inundation predictions have been made available. These predictions do not take into account variables such as downstream river and canal capacity at time of breach, ground saturation, or seasonal factor. Nor do they address possible secondary impacts from smaller irrigation reservoir and waterway damage.

Table 3-14 Worst Case Predictions from Dam Emergency Plans for Big Horn County

(Buffalo Bill, Roach Gulch, Boysen)

Projected depth of water at cross points are predicted maximum depth of flood waters.

	2 Mile Corner @ Burlington SBE 4,404 ft	Otto Area SBE 3,891 ft	Manderson SBE 3,891 ft	Greybull River Road/Hwy 30 Intersection	Basin SBE 3,878 ft	Greybull SBE 3,793 ft	Byron SBE 4,029 ft	Lovell SBE 3,832 ft
Buffalo Bill Cody Dam on the Shoshone (SBE 5,125 ft.)							2.5 hrs 27 ft	3.1 hrs 15 ft
Roach Gulch Dam **Greybull River** (SBE 4,815 ft.)	1.5 hrs 18 ft	2.6 hrs 9 ft		4.5 hrs 11 ft		6 hrs 10 ft		10.73 hrs 16 ft
Boysen Dam, Fremont County **Big Horn River** (SBE 4,608 ft)			8 hrs 45 ft		9 hrs 45 ft	11 hrs 59 ft		

SBE – Stream Bed Elevation

Sources: 2010 Hazard Mitigation Plan; Boysen Dam EAP; Buffalo Bill Dam EAP; Roach Gulch Emergency Preparedness Plan

Besides rural farm and ranch operations and residences along the Greybull, Nowood, Shoshone and Big Horn Rivers, the most vulnerable concentrated populations in terms of a dam failure of Roach Gulch Dam, Buffalo Bill, or Boysen Dam are the City of Greybull or the Town of Manderson.

Boysen Dam Impact Description

Emergency Action Plans (EAPs) published by the Bureau of Reclamation vary somewhat from HAZUS 100-year flood predictions regarding a breach of the Boysen Dam. While Town of Basin expression is very similar for either a dam breach or 100-year flood event. However, Town of Manderson, and City of Greybull expressions differ in that regard.

Manderson

In the 100-year flood mapping, public buildings appeared to be unaffected in the Town of Manderson. However, Bureau of Reclamation inundation maps indicate the town as being entirely inundated, including Cloud Peak Middle School and the Town Hall. At 100% inundation, public property at risk is predicted to be the Fire Hall, the Middle School, and the Town Hall and sewage lagoons. A bar and

restaurant, the federal post office, and as many as 100 private residences within the town may be involved in a 100 year-flood. The value of public property exposed is $11.7 million. Flooding of Cloud Peak School could impact as many as 120 students and staff.

Greybull

While the Greybull Middle and High School is not included in 100-year flood mapping, Bureau of Reclamation inundation maps display the city as being entirely inundated, including Greybull Middle and High Schools. The population of Greybull is 1,815. Based at 100% inundation of the incorporated city, $41.5 million worth of public buildings and equipment may be exposed to flood waters. Identified public property includes the Greybull Fire Station & Ambulance, City Hall, Municipal Police Dept, Community Center, Library, Greybull Elementary School, the middle and high schools, and the Herb Asp Community Center. The exposure figure does not include private property valuation and should be considered to be a low end valuation for maximum damage from a potential failure of the Boysen Dam.

Numerous private residences would be exposed to flood waters. In addition to the assets listed above, other property identified and not included in a valuation are two banks, the federal post office, the USDA Service Center, a historic hotel, BNSF offices, three bulk petroleum products distributors, several auto parts stores, restaurants, flower shops, quilting & clothing stores, several bars, numerous churches, several doctor's offices, a lumber yard, an agricultural farm products store, hair salons and numerous other private sector businesses. Values are not available for bridges, roads, culverts and other infrastructure that may be affected in a severe flooding event.

Buffalo Bill Cody Dam Impacts

The Bureau of Reclamation published and released an updated EAP for the Buffalo Bill Dam and Reservoir in 2007, which supersedes all past EAPs for that structure. The updated EAP included at least one major change impacting Big Horn County and the City of Lovell.

Past inundation mapping indicated that at least 85% of the City of Lovell would be flooded and probably destroyed. 2007 EAP has softened this prediction drastically due to a change in prediction methodology and calculations. 2007 inundation maps express that the sewage lagoons, several homes, and a lime stockpile behind the Western Sugar Factory would be of concern. The lime stockpile may be of significant environmental concern should it get into a waterway. Western Sugar is involved in ongoing efforts to decrease the stockpile.

Roach Gulch Dam Impacts

Roach Gulch Reservoir and Upper and Lower Sunshine Reservoirs are held by dams that have the potential to cause downstream damage on the Greybull River should a breach occur. This group of three reservoirs and dams residing in Park County are privately owned and maintained by the Greybull Valley Irrigation District, and inspected and permitted by the Wyoming State Engineer's Office. Each dam has a dam tender that lives on-site. However, surveillance systems on the dams are basically non-existent.

Greybull Valley Irrigation District inundation mapping and the downstream notification list involve at least 74 families and well over 200 people who reside in the inundation areas. Ranches north and east of Roach Gulch Dam would be the first residences to be inundated following a breach of the dam, with as little as 19 minutes notice. The next 7 miles of ranch residences may have 90 minutes to relocate or try to protect their families and employees, or evacuate their homes. The city of Greybull may be

severely impacted. Time predictions were calculated by the Denver firm that engineered the dam. Roach Gulch flood crest depth predictions are uncertified and non-engineered.

Sunshine Reservoirs & Dam Impacts

Upon examination of inundation predictions and mapping, Greybull Valley Irrigation District personnel express that a breach of the Sunshine Dams would inundate downstream Big Horn County residents and property as described in inundation impact predictions for a Roach Gulch breach.

Shell Reservoir and Adelaide Lake

The dams for both the reservoir and lake are owned and maintained by the Shell Irrigation District. Both classified as high risk structures by the WSEO, due to the impact to people below the dams should one or both fail. There are no inundation maps available; however the minimum amount of exposure may be considered to be to the City of Greybull's well house, chlorinator house and water tank, located in the Trapper Creek area. The Town of Shell is unincorporated, and includes a rural volunteer fire department, a community center, and several eating establishments, as well as numerous residences, ranches, and small acreages.

Specific Concerns

An artificial embankment exists below the confluence of the Greybull and Big Horn Rivers, and within the Town of Greybull. This earth-filled structure is inspected for maintenance every year by the Army Corp of Engineers and currently provides significant protection. However, the levee does encircle the town almost three sides to protect the town from flooding on the Greybull River. Should either the Roach Gulch or Boysen Dams fail, it is difficult to anticipate whether this levee will be able to withstand the impending crest of water. Currently the structure as it exists is pending certification as stipulated under Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10).

The well providing the Town of Burlington with domestic water is located within the flood plain for an occurrence of flooding caused by a breach of the Roach Gulch Dam. The well is located on Lane 39.

Future Development

Future development around Big Horn County should take into account the impact of any nearby dam breach. Inundation maps and emergency action plans should be consulted in the planning of new development, where applicable.

Summary

The Boysen, Roach Gulch, and Buffalo Bill Dams will impact Big Horn County should the structural integrity be compromised. Failure to notify downstream populations within the county may lead to hundreds of millions of dollars in damage and loss of life.

Further consideration must be given to the fact that water control afforded by these dams and reservoirs serve a very important role for Big Horn County's economic base. Secondary impacts and crop damage may result from the loss of downstream water control structures and diversions taking quite some time to replace.

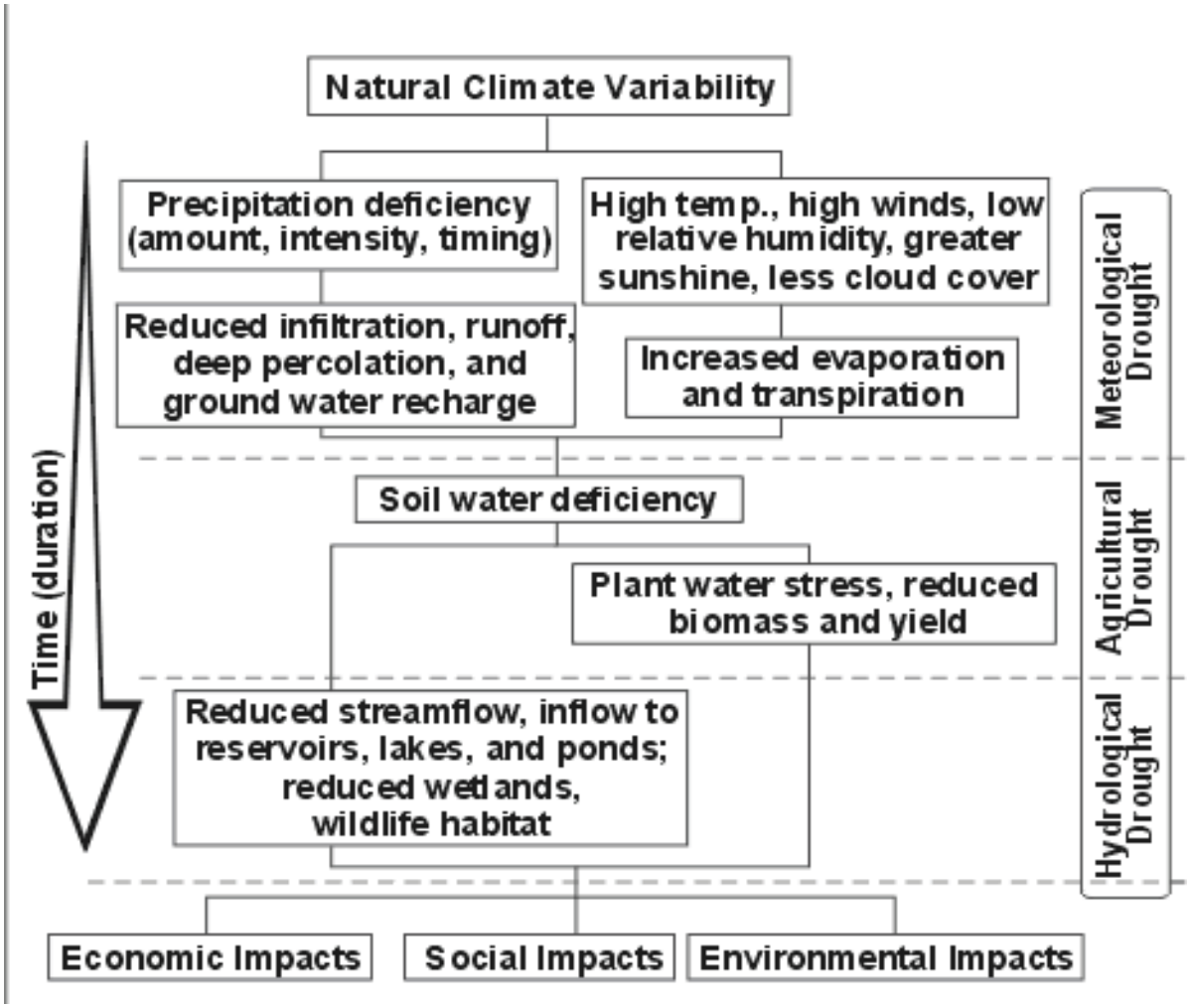
Loss Potential: **High**
Population Impacted: **High**
Probability: **Low**
Jurisdictions at Risk: **All towns and properties in pre-identified inundation areas**

Drought

Narrative

Drought is human society's most costly, natural weather-related disaster by far. It indirectly kills more people and animals than the combined effects of hurricanes, floods, tornadoes, blizzards, and wildfires. Unlike other disasters that quickly come and go, drought's long-term unrelenting destruction has been responsible for mass migrations and lost civilizations. The 1980 and 1988 droughts in the U.S. resulted in approximately 17,500 heat-related deaths and an economic cost of over $100 billion. 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 3-3 Drought Progression Chart



Source: www.nws.noaa.gov

The first stage of drought is known as a meteorological drought. The conditions at this stage include any precipitation shortfall of 75% 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.

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 (**Figure 3-3).**

Past Occurrences

The nation's fifth driest state, drought is a reoccurring hazard in Wyoming. Wyoming was gripped by a drought cycle described as moderate to severe from 1999 until conditions eased in mid-2008, according to the State Climate Office; drought returned again to the state in 2012-2013. Winter precipitation in the state of Wyoming is usually two to six times less than summer precipitation and these so-called seasonal droughts are normal in Wyoming's semi-arid 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 *(Source: Wyoming Multi-Hazard Mitigation Plan, 2014)*.

The Dust Bowl era of the 1930s affected 50,000,000 acres of land across the West, including most of Wyoming. In the 1950s, the Great Plains again suffered a severe water shortage. The worst drought in 50 years occurred in 1988 and affected 35 states including Wyoming. As direct result of this, large fires burned across large parts of the American West in 1988, including the conflagration in Yellowstone Park *(Source: National Weather Service)*. Big Horn County was part of the larger area affected by these earlier droughts.

Figure 3-4 Percentage of Wyoming in Drought by Category, 2000 - 2015

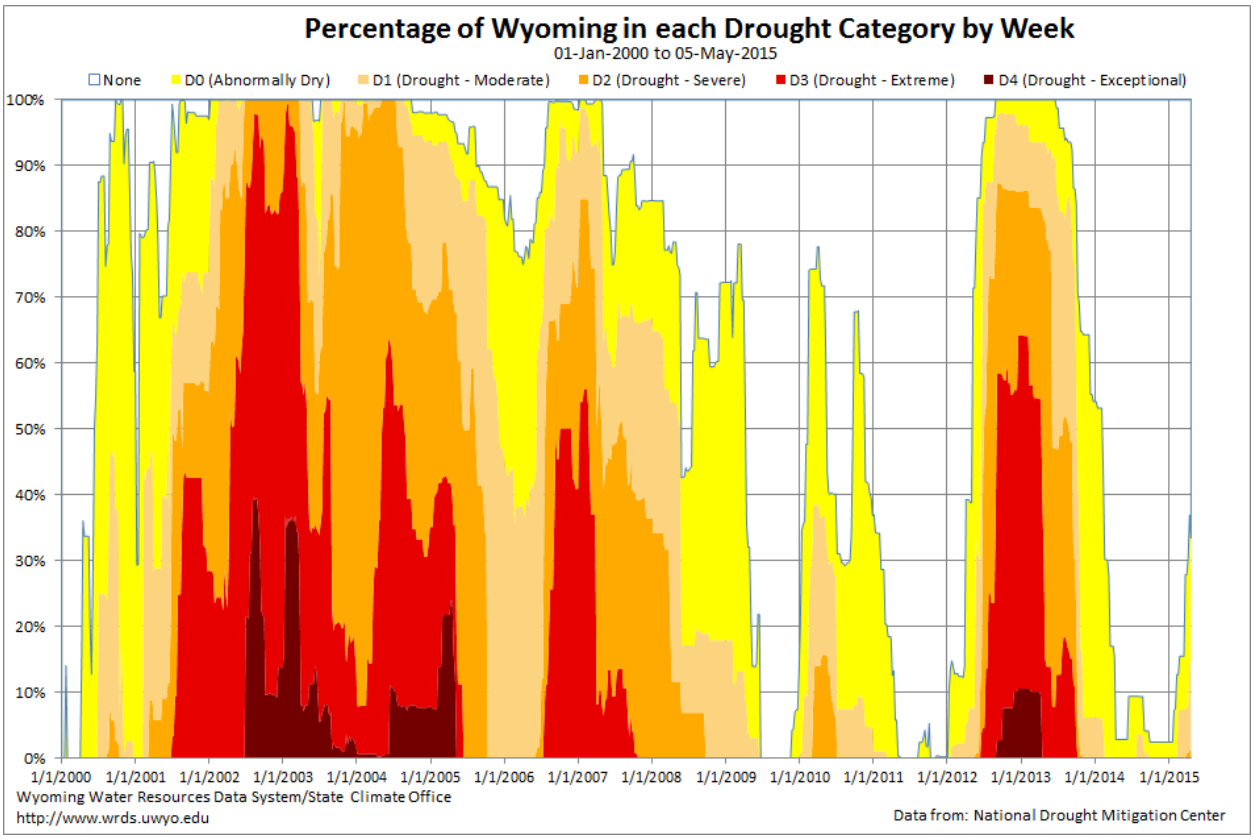


Figure 3-4 from the National Drought Mitigation Center shows that at the peak of the most recent (2013) drought, more than 10% of Wyoming fell in the 'Exceptional Drought' (D4 or dark red) category, and 100% of Wyoming experienced at least 'Abnormally Dry' conditions. The U.S. Drought Monitor also provides maps of historic drought conditions by state. The U.S. Department of Agriculture (USDA), the National Oceanic and Atmospheric Administration (NOAA), and the National Drought Mitigation Center (University of Nebraska-Lincoln) collaborate on this weekly product, which is released each Thursday. Multiple drought indicators, including various indices, outlooks, field reports, and news accounts are reviewed and synthesized. In addition, numerous experts from other agencies and offices across the country are consulted. The result is the consensus assessment presented on the USDM maps. The image is color-coded for four levels of drought intensity. An additional category, 'Abnormally Dry,' (D0 or yellow) is used to show areas that might be moving into a drought, as well as those that have recently come out of one. USDM map data dating from 2000 reveal that Big Horn County experienced drought conditions at least as severe as the rest of the State of Wyoming for the past three drought periods in 2013, 2007 and 2003 (**Figure 3-5**, **Figure 3-6** and **Figure 3-7**, respectively).

Figure 3-5 State of Wyoming Drought Conditions, January 2013. Big Horn County in Circle.

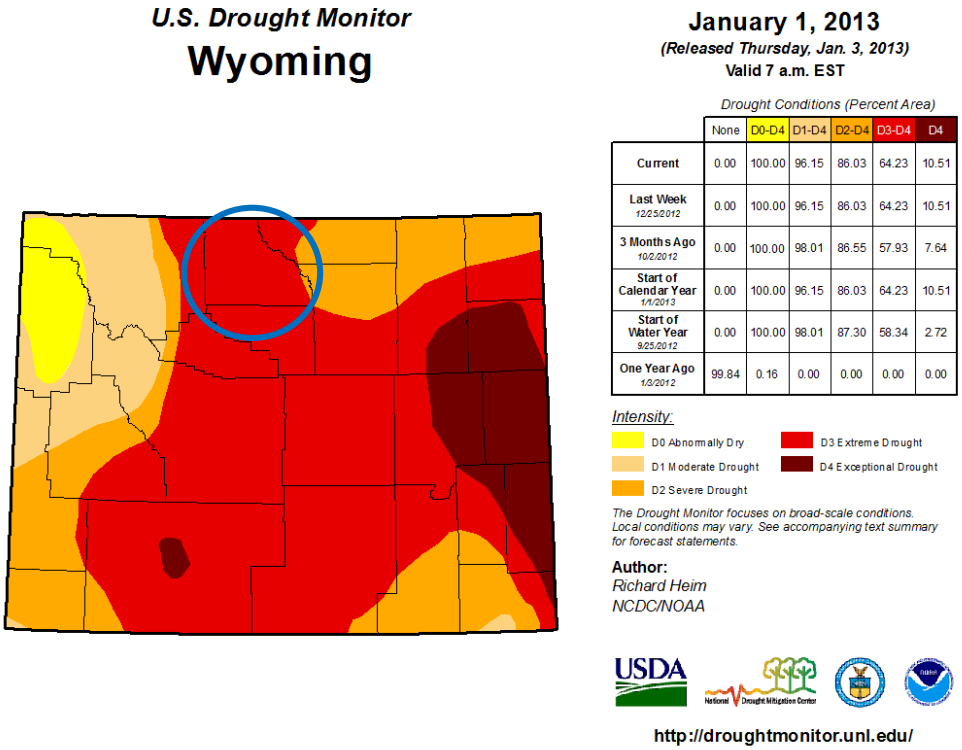


Figure 3-6 State of Wyoming Drought Conditions, January 2007. Big Horn County in Circle.

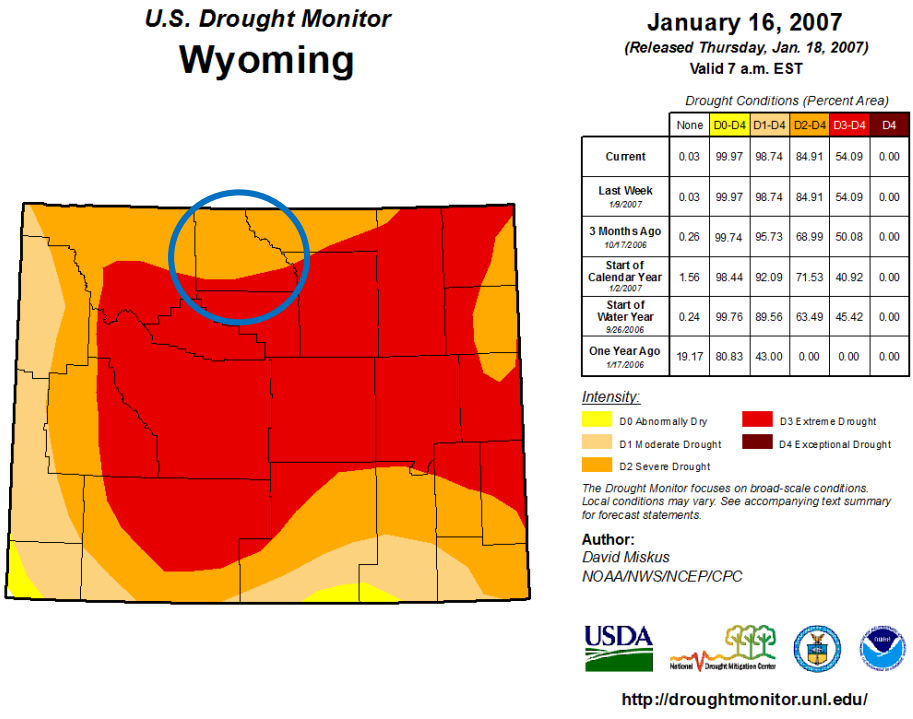
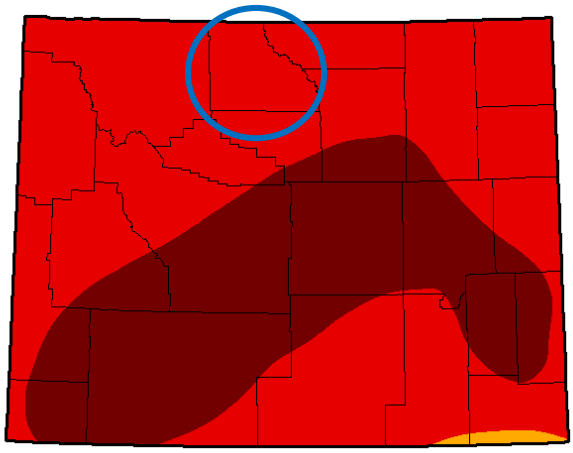


Figure 3-7 State of Wyoming Drought Conditions, January 2003. Big Horn County in Circle.

U.S. Drought Monitor

Wyoming



January 28, 2003

(Released Thursday, Jan. 30, 2003)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	100.00	99.41	36.50
Last Week 1/21/2003	0.00	100.00	100.00	100.00	99.26	34.84
3 Months Ago 10/29/2002	0.00	100.00	100.00	100.00	83.99	9.92
Start of Calendar Year 12/31/2002	0.00	100.00	100.00	100.00	86.03	13.58
Start of Water Year 10/1/2002	0.00	100.00	100.00	100.00	93.18	21.28
One Year Ago 1/29/2002	0.00	100.00	86.87	62.60	23.47	0.00

Intensity:

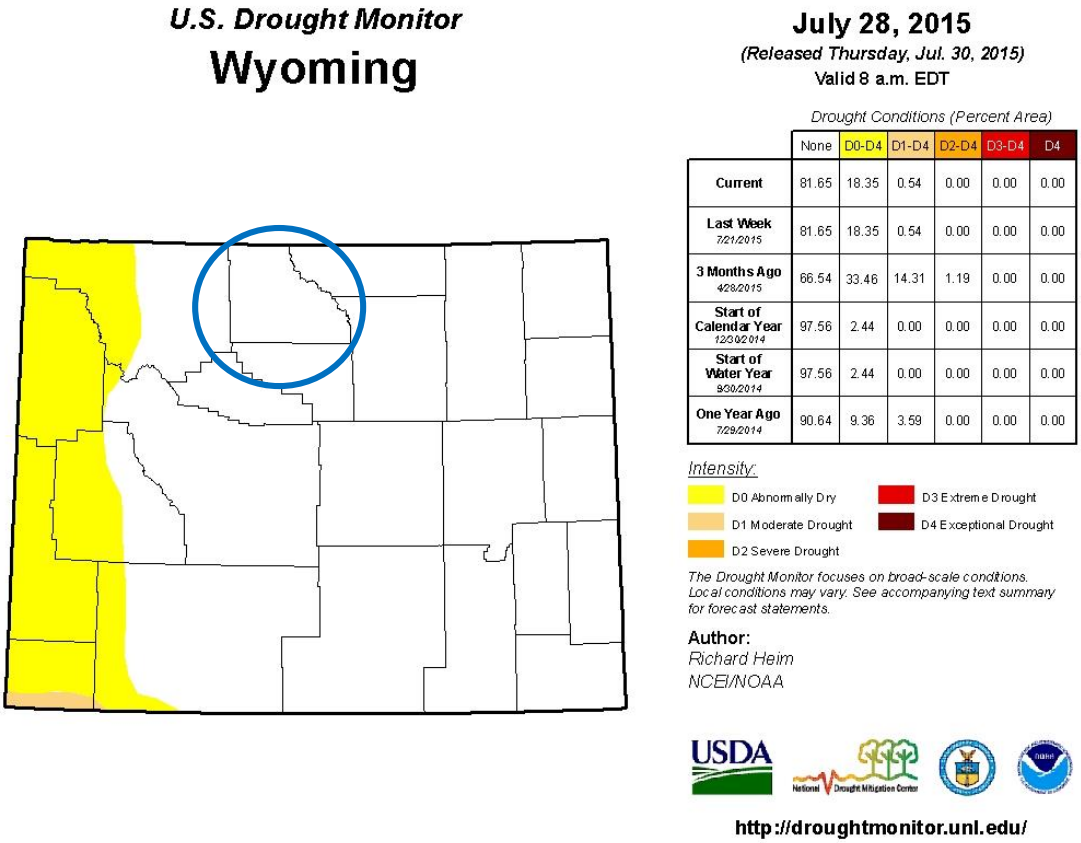
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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

Author:
Brad Rippey
U.S. Department of Agriculture

http://droughtmonitor.unl.edu/

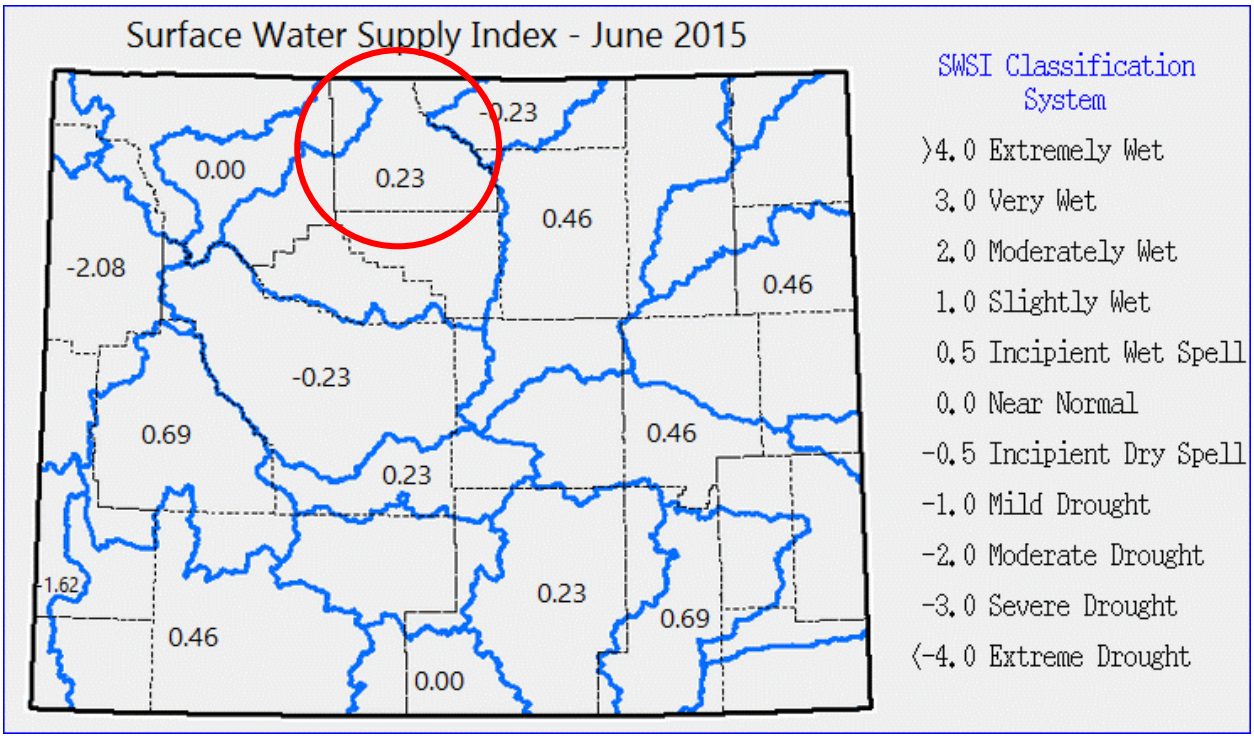
Figure 3-8 State of Wyoming Drought Conditions, July 2015. Big Horn County in Circle.



Source: http://droughtmonitor.unl.edu/

As of July 28th, 2015 approximately 18% of the State of Wyoming qualifies as 'Abnormally Dry' (D0 or yellow) with less than 1% in the 'Moderate Drought' (D1 or light orange) category, see **Figure 3-8**. As of this same timeframe, there were no drought conditions in Big Horn County

Figure 3-9 State of Wyoming Drought Conditions by Surface Water Supply. Big Horn County in Circle.



Source: http://www.wrds.uwyo.edu/wrds/nrcs/swsimap/swsimap.html

This observation is corroborated by current data from the Surface Water Supply Index (SWSI) from the Water Resources Data System (WRDS) at the University of Wyoming. The Surface Water Supply Index is computed using only surface water supplies for the drainage (shown in blue). The computation includes reservoir storage, if applicable, plus the forecast runoff. The index is purposely created to mirror the Palmer Drought Index (PHDI, **Figure 3-9**), with near normal conditions centered at 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. The watershed basins within and around Big Horn County (circled in red) are all in positive territory, describing near normal conditions.

Impacts

Impacts from drought can include the following:

- Economic losses to agricultural producers (crops and livestock)
- Physical and mental health issues in those suffering losses
- Water supply interruption for business and industry
- Water quality problems
- Reduced soil and vegetation moisture
- Vegetation mortality, insect infestations
- Impacts to fish and wildlife populations
- Increase in wildland fires and associated losses

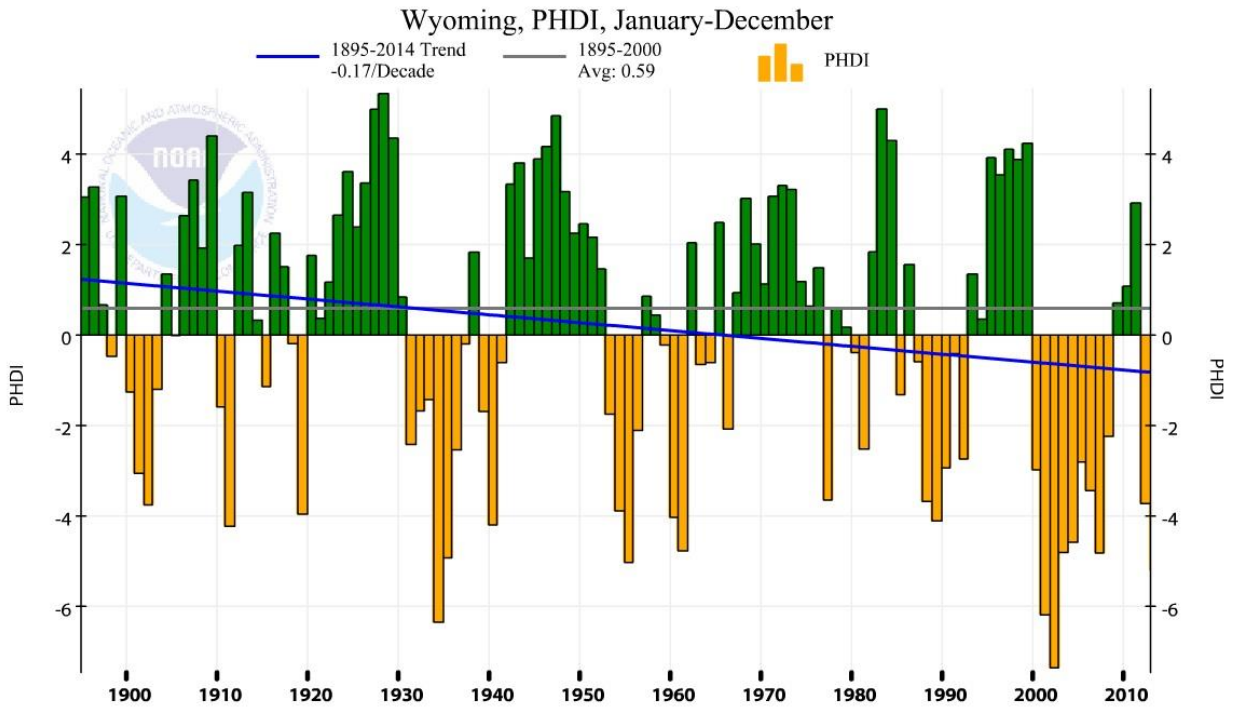
Frequency

Despite the near normal current conditions in Big Horn County, the American West (including all of the State of Wyoming) remains extremely vulnerable to cyclical drought conditions.

Figure 3-10 Palmer Drought Index

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

Figure 3-11 Wyoming Palmer Hydrological Drought Index 1895-2014



Source: www.ncdc.noaa.gov

According to over 100 years of precipitation data from the National Climate Data Canter (NCDC) the State of Wyoming experiences negative Palmer Hydrological Drought Index years at least once every decade and, in some decades (like 2000 through 2010), negative years outnumber positive years.

The average PHDI in Wyoming from 1895-2000 was calculated at 0.59, or slightly wetter than normal conditions (the grey trend line in **Figure 3-11**). However, when accounting for the years between 2000 and 2014, the average PHDI is shown to be decreasing at a rate of 0.17 PHDI points per decade (the blue trend line in **Figure 3-11**). If this trend continues, Big Horn County must be prepared for dyer conditions in the future.

Vulnerability

Big Horn County's mountain forests are more vulnerable to timber fires during sustained periods of drought. As water storage and collection reservoirs located in the mountains for crop irrigation deplete, crop production in the county can decrease 35 to 65% each year, as evidenced in Table 4.15. In an area where six inches of precipitation annually is all that can be expected, a sustained drought is devastating as water tables begin to regress. Drought may greatly increase the number of wildfire events, and brings on secondary problems such as insect infestations, plant disease, wind erosion and other secondary biological impacts. The recovery period even after drought periods begin to diminish can be lengthy. The agricultural community may take years to restock and recover financially. Towns and cities may take some time to attract industry back to the area and reestablish local business.

Big Horn County's economy is based on mining interests, agribusiness, rail transportation, gas and oil production, and employment by schools and local government. The economic blow of drought on agriculture has been somewhat softened by insurance resources made available to producers. It should also be noted that Big Horn County has an extensive network of irrigation canals connected to other areas. Rainfall is only one factor for the amount of water available for irrigation for agriculture; melting snowpack in other areas can produce enough water to continue irrigation even if the county itself is dry. Even with this added water source, the county's economic base is extremely vulnerable to extended drought periods and extended recovery from those cycles.

Agricultural data is generally used as a way to measure the negative economic impacts due to drought, however this model has limitations because it does not take into account the potential dollar losses caused by wildfires due to drought or losses in tourism revenue. In addition, there are limitations in determining agricultural losses. Facts to be considered are:

- USDA Agricultural Survey Statistics rely entirely on the willingness and availability of producers within a county to respond to quarterly surveys. Participation can be unreliable.
- Federal crop disaster declarations are most often multi-county, multi-hazard declarations, covering a variety of events in any given year (i.e., grasshoppers, hail, drought, etc.) thus these agencies cannot provide drought-attributed losses directly to each county.
- Policies have changed drastically regarding requirements by the USDA. Producers are now required to carry some level of crop disaster coverage in order to be eligible for future federal disaster dollars.

Potential Losses

The following graphs illustrate the relationship between agricultural production and drought conditions by comparing pre-drought (1996-2000) crop output to drought (2001-2008) crop output. 2012 production is also included as it was the most recent year data was available. All data is from http://quickstats.nass.usda.gov and the U.S. Agricultural Census.

Figure 3-12 Pre and Post Drought Production of Barley, Big Horn County

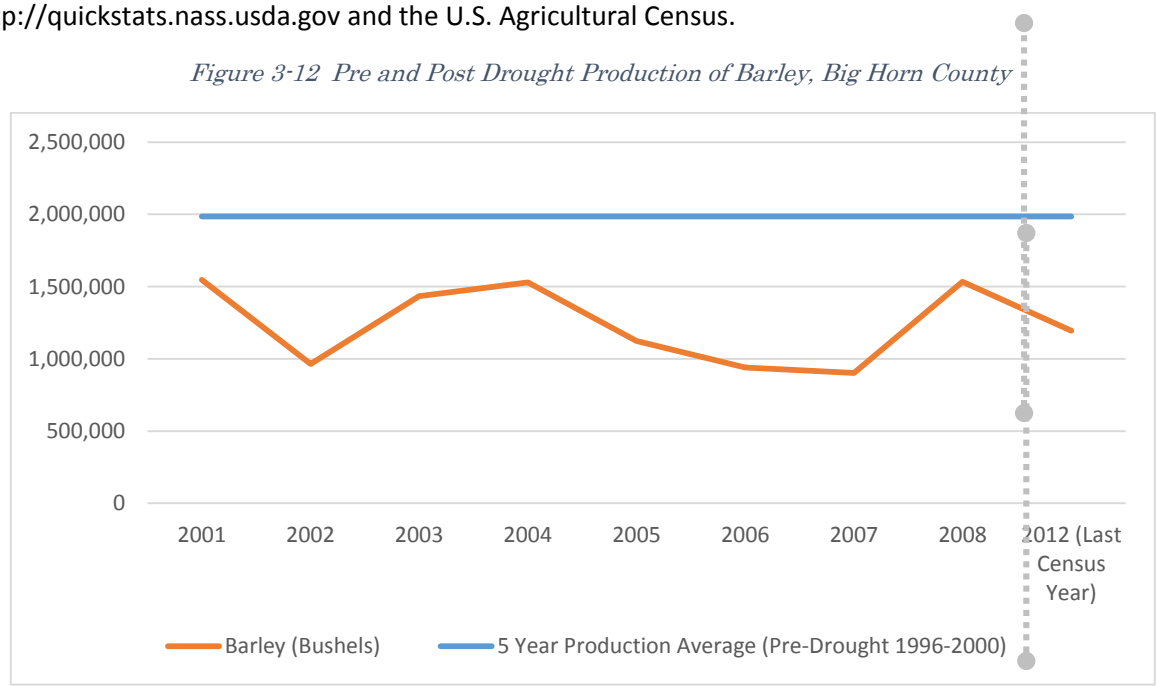


Figure 3-13 Pre and Post Drought Production of Beans, Big Horn County

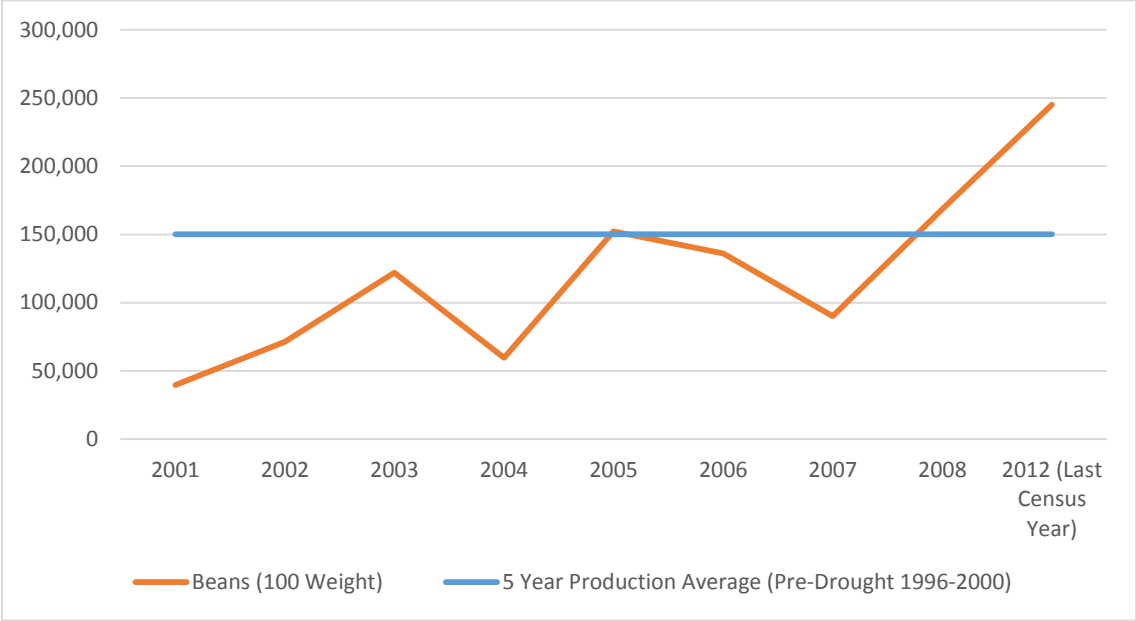


Figure 3-14 Pre and Post Drought Production of Corn for Silage, Big Horn County

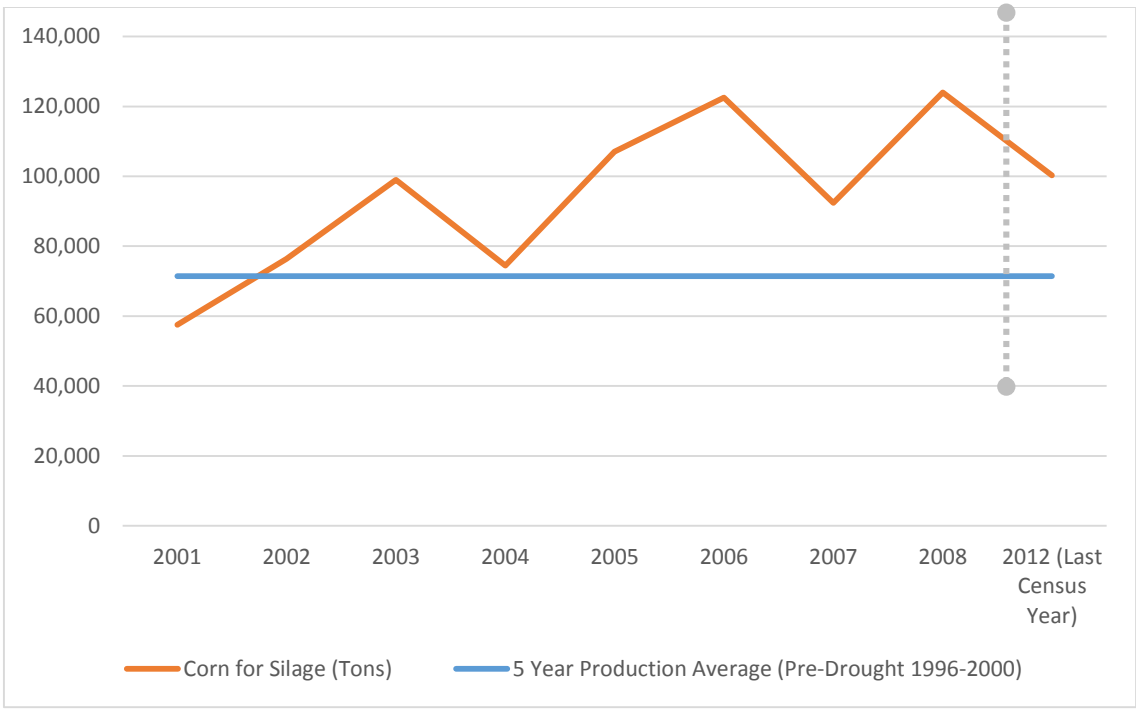


Figure 3-15 Pre and Post Drought Production of Corn for Grain, Big Horn County

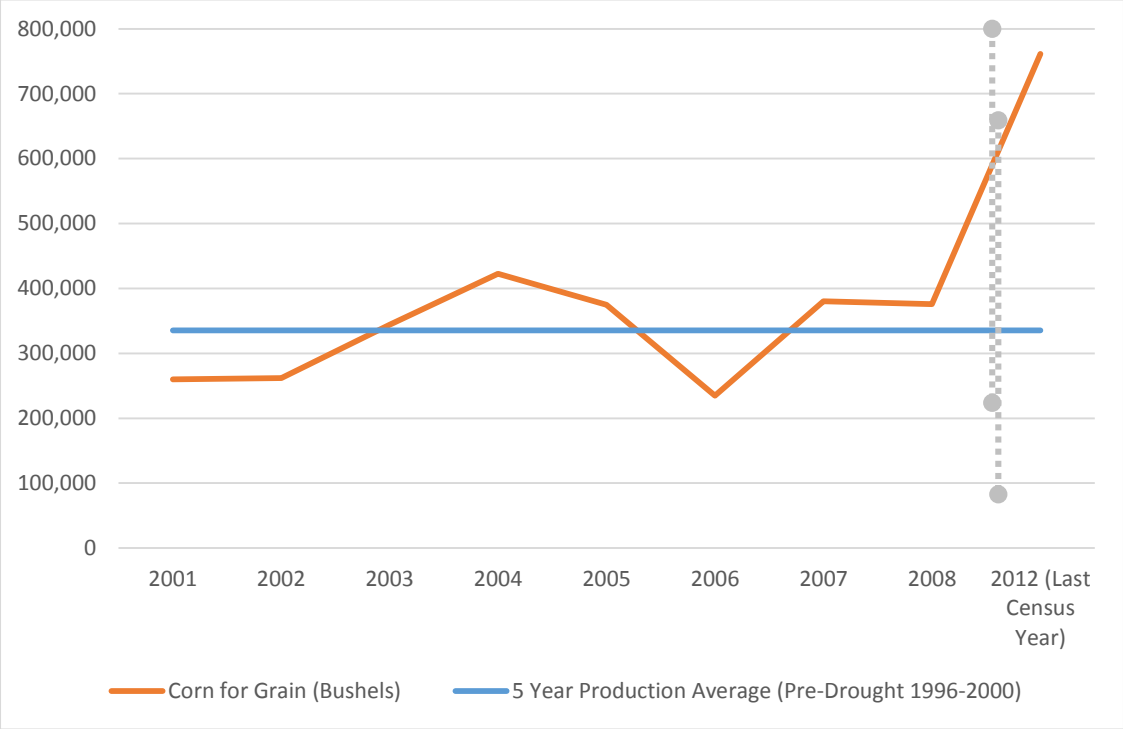


Figure 3-16 Pre and Post Drought Production of Oats, Big Horn County

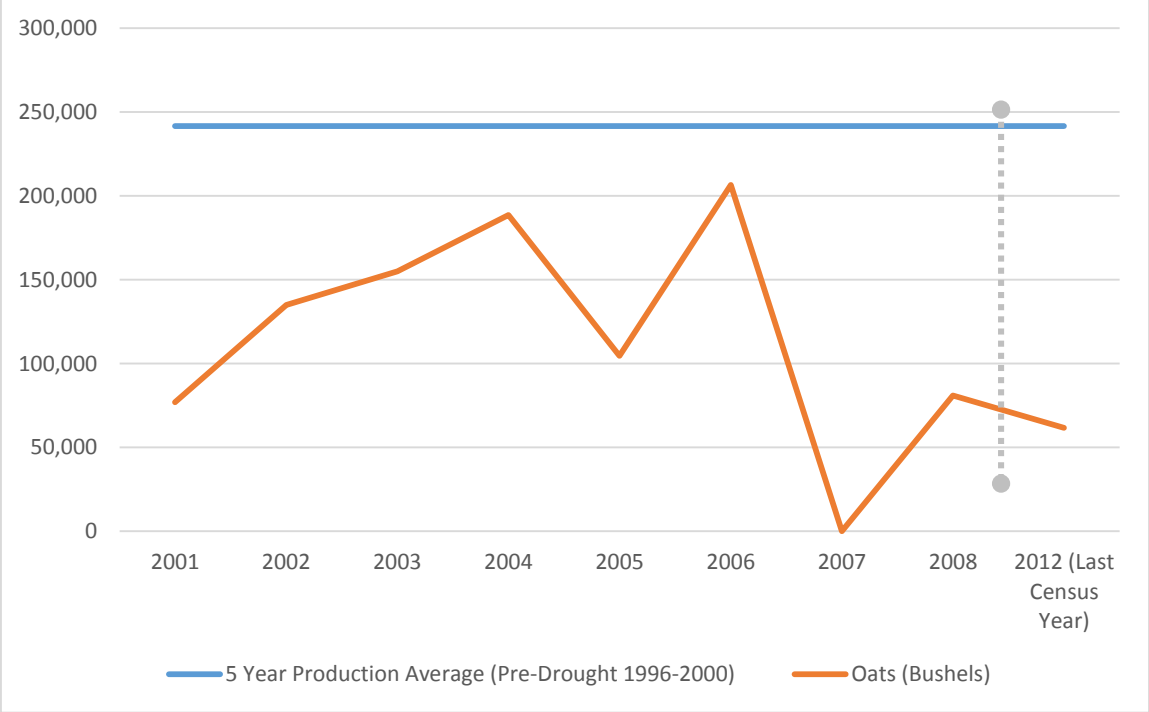


Figure 3-17 Pre and Post Drought Production of Sugarbeets, Big Horn County

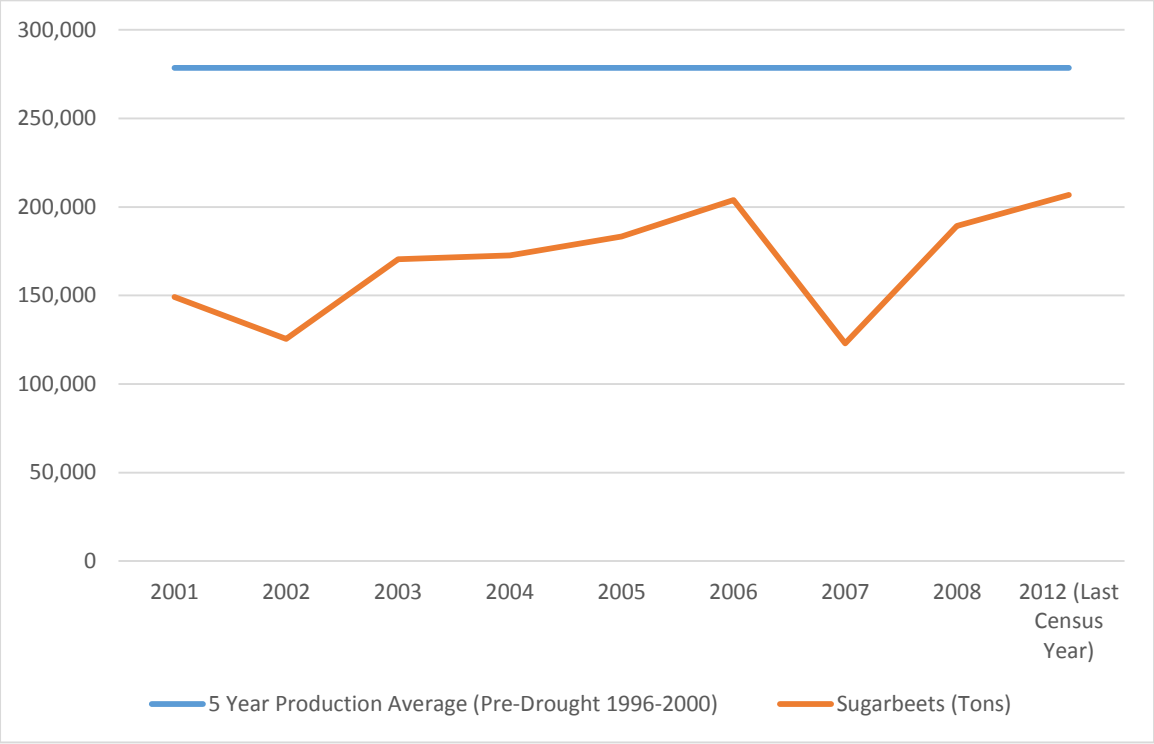


Figure 3-18 Pre and Post Drought Production of All Wheat, Big Horn County

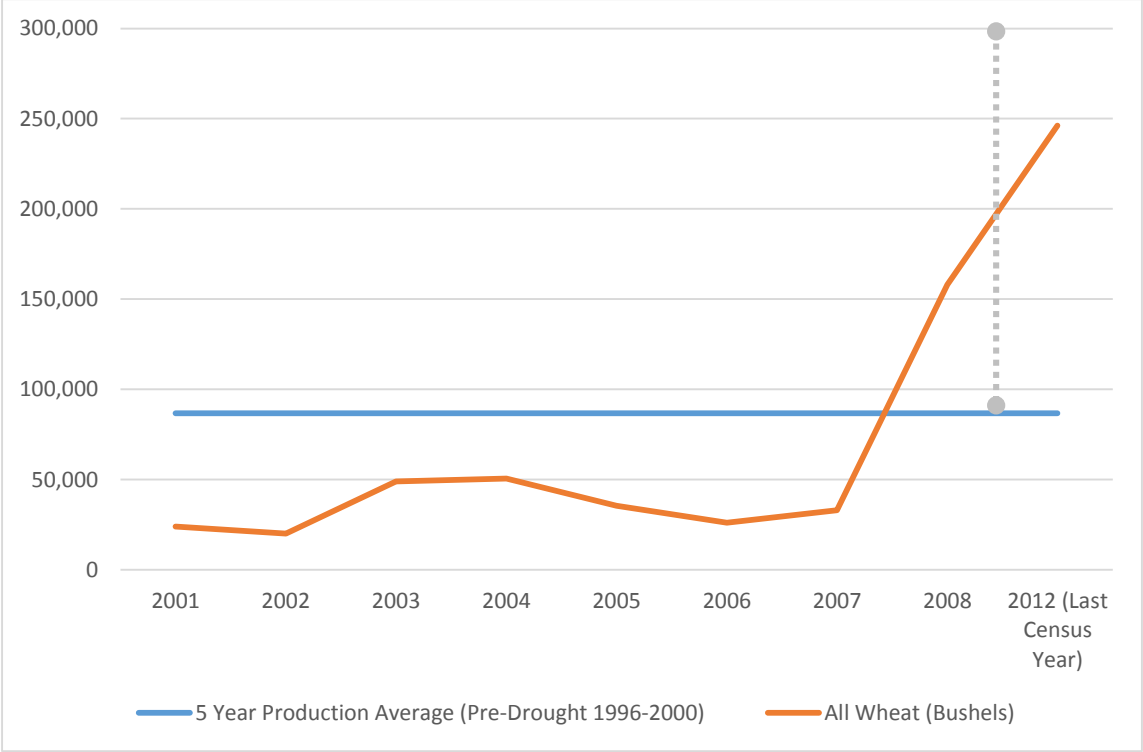


Table 3-15 Summary of Agricultural (Crop) Impacts to Drought, Big Horn County

	5 Year Production Average (Pre-Drought 1996-2000)	8 year Production Average (Drought 2001-2008)	Change in Production (Pre-Drought to Drought)	% Change in Production (Pre-Drought to Drought)	2012 Production (Last Census Year)
Barley (Bushels)	1,986,000	1,247,163	-738,838	-37.20%	1,194,746
Beans (100 Weight)	150,020	104,888	-45,133	-30.08%	245,031
Corn for Silage (Tons)	71,440	94,150	22,710	31.79%	100,231
Corn for Grain (Bushels)	335,300	331,813	-3,488	-1.04%	761,569
Oats (Bushels)	241,500	135,357	-106,143	-43.95%	61,587
Sugarbeets (Tons)	278,600	164,650	-113,950	-40.90%	206,850
All Wheat (Bushels)	86,750	49,500	-37,250	-42.94%	246,270

Source: http://quickstats.nass.usda.gov and the US Agricultural Census

As the graphs and summary chart above identify, there are significant impacts to crops in a drought versus a non-drought period. All key commodities, with the exception of corn, have negative production numbers when comparing drought versus non-drought averages. The 2015 dollar value of the losses for barley, oats, sugarbeets, and wheat during this 8 year period is nearly $1B or $11.6M per year. This equals roughly 10% of all agricultural output for Big Horn County *(Sources: http://www.agcensus.usda.gov, http://www.indexmundi.com/commodities).*

As mentioned previously, there are limitations when using agricultural production as a proxy to measure impacts due to drought, however the data illustrate a strong relationship between the two and the County should be aware of the potential losses in this sector.

Agricultural production losses do not reflect the loss of grazing or rangeland, a staple of sheep and cattle production in Big Horn County. Most agricultural livestock growers in Big Horn County depend on rangeland grazing to produce a calf crop each year.

Future Development

Drought vulnerability will increase with future development as there will be increased demands for limited water resources. Given that population growth, number of farms and associated new development is limited in Big Horn County, future development is unlikely to exacerbate drought conditions in the short term *(Source: www.agcensus.usda.gov)*

Summary

The likelihood of a future drought occurring in Big Horn County is 100%. According to NOAA interpretations using the Wyoming Palmer Hydrological Drought Index, Wyoming will experience multi-year drought cycles every 25 years, averaging 10 years in duration. Drought years are often accompanied by an increase in wildfire activity, which occur due to both human and natural causes and at every elevation throughout the county. The county's agricultural production, agribusiness, and support services are vulnerable to severe drought cycles.

Loss Potential: **High**

Population Impacted: **Medium**

Probability: **High**

Jurisdictions at Risk: **All**

Earthquake

Narrative

An earthquake (also known as a quake, tremor or temblor) is the perceptible shaking of the surface of the Earth, which can be violent enough to cause loss of life and property. They result from the sudden release of energy in the Earth's crust that creates seismic waves. The most common types of earthquakes are caused by movements along faults or by volcanic forces, although they can also result from explosions, cavern collapse, and other minor causes not related to slowly accumulated strains. The seismicity, or seismic activity of an area refers to the frequency, type and size of earthquakes experienced over a period of time.

Earthquake intensity is measured by the Modified Mercalli Scale (see Table 5-16) which quantifies effects felt by an earthquake, and is different than moment magnitude, which is measured by the Richter Scale.

Table 3-16 Modified Mercalli Scale

Modified Mercalli Scale	Perceived Shaking	Potential Damage	Description
I	Not Felt	None	Not felt except by a very few under especially favorable circumstances
II	Weak	None	Felt only by a few persons at rest, especially on upper floors of buildings; delicately suspended objects may swing
III	Weak	None	Felt quite noticeably indoors, especially on upper floors of buildings, but many don't recognize it as an earthquake; standing automobiles may rock slightly; vibration like truck passing; duration estimated
IV	Light	None	During the day felt indoors by many, outdoors by few; some awakened at night; dishes, windows, doors disturbed; walls make creaking sound; sensation like heavy truck striking building; standing automobiles rocked noticeably
V	Moderate	Very Light	Felt by nearly everyone, many awakened; some dishes, windows, and so broken; cracked plaster in a few places; unstable objects overturned; disturbances of trees, poles, and other tall objects sometimes noticed; pendulum clocks may stop
VI	Strong	Light	Felt by all, many frightened and run outdoors; some heavy furniture moved; a few instances of fallen plaster and damaged chimneys; damage slight
VII	Very Strong	Moderate	Everybody runs outdoors; damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken; noticed by persons driving cars
VIII	Severe	Moderate to Heavy	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures; panel walls thrown out of frame structures; fall of chimneys, factory stacks, columns, monuments, walls; heavy furniture overturned; sand and mud ejected in small amounts; changes in well water; persons driving cars disturbed
IX	Violent	Heavy	Damage considerable in specially-designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse; buildings shifted off foundations; ground cracked conspicuously; underground pipes broken
X	Extreme	Very Heavy	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked; rails bent; landslides considerable from river banks and steep slopes; shifted sand and mud; water splashed, slopped over banks
XI	Extreme	Very Heavy	Few, if any, masonry structures remain standing; bridges destroyed; broad fissures in ground; underground pipelines completely out of service; earth slumps and land slips in soft ground; rails bent greatly

XII	Extreme	Very Heavy	Damage total; waves seen on ground surface; lines of sight and level distorted; objects thrown into the air

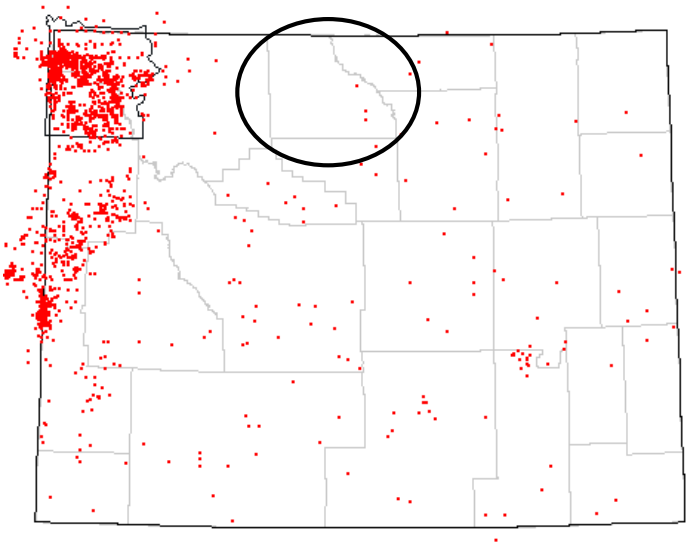
Past Occurrences

Prior to the 1950s, most earthquakes were detected and located by personal reports. After the Hebgen Lake earthquake in 1959 near Yellowstone Park, monitoring in Wyoming started to improve and earthquakes were more commonly located by seismometers.

Since 1871, the state has logged some 47,000 earthquakes, with the majority of the events taking place in the western third of the state (see **Figure 3-19**) where the majority of the active, or Quaternary Period, faults are identified.

Figure 3-19 Wyoming Earthquake Epicenters > 2.5 Magnitude, 1871 to 2015.

Yellowstone NP in Outline, Big Horn County in Circle.



Source: http://www.wrds.uwyo.edu

Most Wyoming earthquakes outside of Yellowstone National Park occur as a result of movement on faults. If the fault has moved within the Quaternary geological period, or last 1.6 million years, the fault is considered to be active. Active faults can be exposed at the surface or deeply buried with no significant surface expression. Historically, no earthquakes in Wyoming have been associated with exposed active faults. The exposed active faults, however, have the potential to generate the largest earthquakes. As a result it is necessary to understand both exposed and buried active faults in order to generate a realistic seismological characterization of the state.

There are approximately 80 Quaternary faults mapped in Wyoming, with 26 considered active and none located in Big Horn County. (*Source: www.wsgs.wyo.gov)* 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. Earthquake risks related to Boysen Dam are of concern to Big Horn County as explained in the dam failure section of this plan. 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 Baroil is capable of generating magnitude 6.5 to 6.7 earthquakes. Despite the lack of faults in the northern part of the state, it is estimated that an earthquake of 6.5 magnitude is possible anywhere in the state, including Big Horn County (Source: Wyoming Multi-Hazard Mitigation Plan, 2014).

Figure 3-20 Exposed Known or Suspected Active Faults in Wyoming

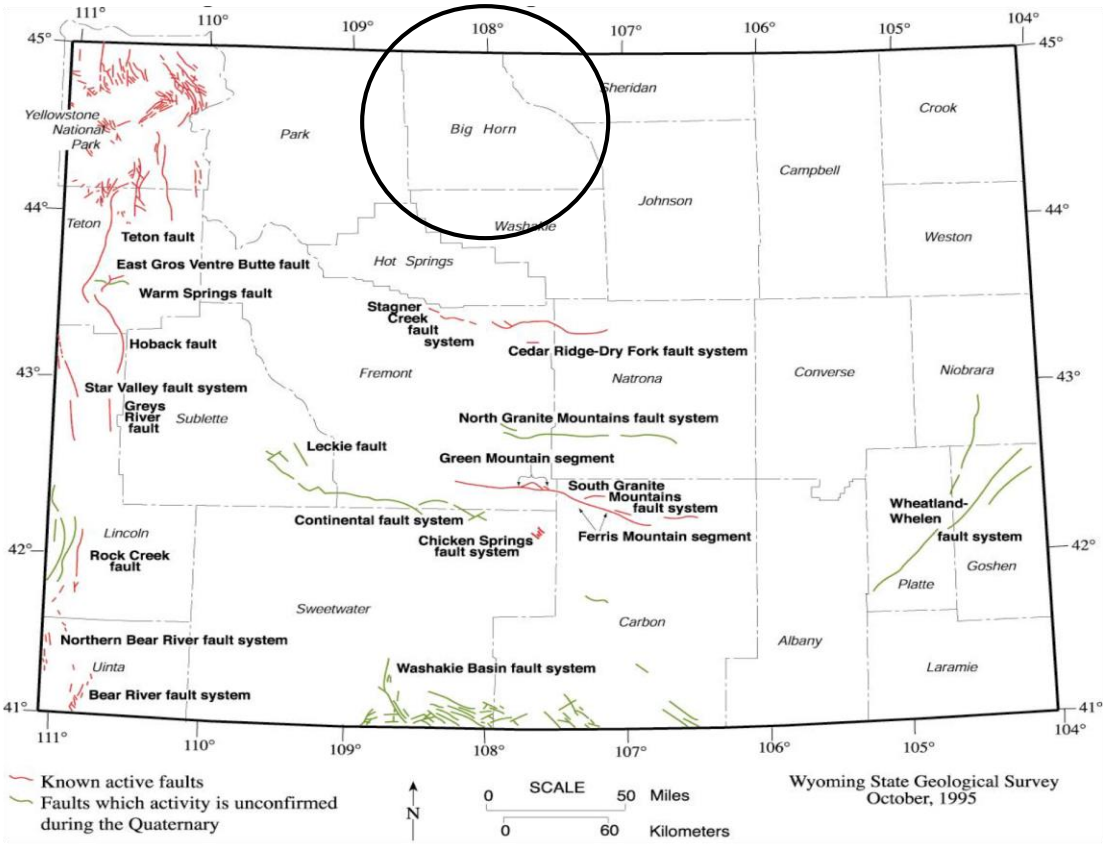


Table 3-17 List of Seismic Events, Big Horn County 1967 - 2014

Location	Date	Moment Magnitude (Richter)	Damage or Injuries
12 MI ENE of Hyattville	11/17/25	N/A	NO
Dome Lake Area	11/18/25	N/A	NO
12 MI ENE of Shell	9/2/62	N/A	NO
15 MI S of Hyattville	9/19/74	4.4	NO
10 MI N of Hyattville	2/13/98	3.0	NO
20 MI SW of Hyattville	9/7/10	2.3	NO
28 KM N of Greybull	8/13/13	2.3	NO
10 KM ENE of Worland	3/2/14	2.9	NO

Source: http://earthquake.usgs.gov

Eight magnitude 2.5 and greater earthquakes have been recorded in or near Big Horn County since the mid-1920s (see **Table 3-17**). The first was recorded on November 17, 1925. This intensity V event was located in the southeastern portion of the county, approximately 12 miles north/northeast of Hyattville. People in Sheridan, Fort McKenzie, and at Dome Lake Resort in the Big Horn Mountains reported feeling the earth- quake tremors. The tremors shook cabins, pictures, and furniture. A "distinct roar" heard at Dome Lake was attributed to a possible earthquake induced landslide (Casper Daily Tribune, November 18, 1925). One day later, on November 18, 1925, people in the Dome Lake area reported feeling another tremor (Sheridan Post Enterprise, November 19, 1925). No damage was reported from either event.

On September 2, 1962, an earthquake was recorded 12 miles east-northeast of Shell. No one reported damage or feeling this event. (U.S.G.S. National Earthquake Information Center).

On February 12, 1998, in approximately the same location as the 1925 event. No one reported feeling this magnitude 3.0 event (U.S.G.S. National Earthquake Information Center).

Impacts

Impacts from earthquakes identified include the following:

- Injury/loss of life
- Loss of utilities (gas, electric, water, wastewater, etc.)
- Increased risks to emergency responders
- Injuries associated with loss of utilities
- Transportation interruption
- Damage to buildings/structures

Frequency

Based on past occurrences since 1974, Big Horn County is likely to experience one 3.0 or greater earthquake approximately every fifteen years; however also based on past occurrences, the earthquakes are likely to cause little to no damage.

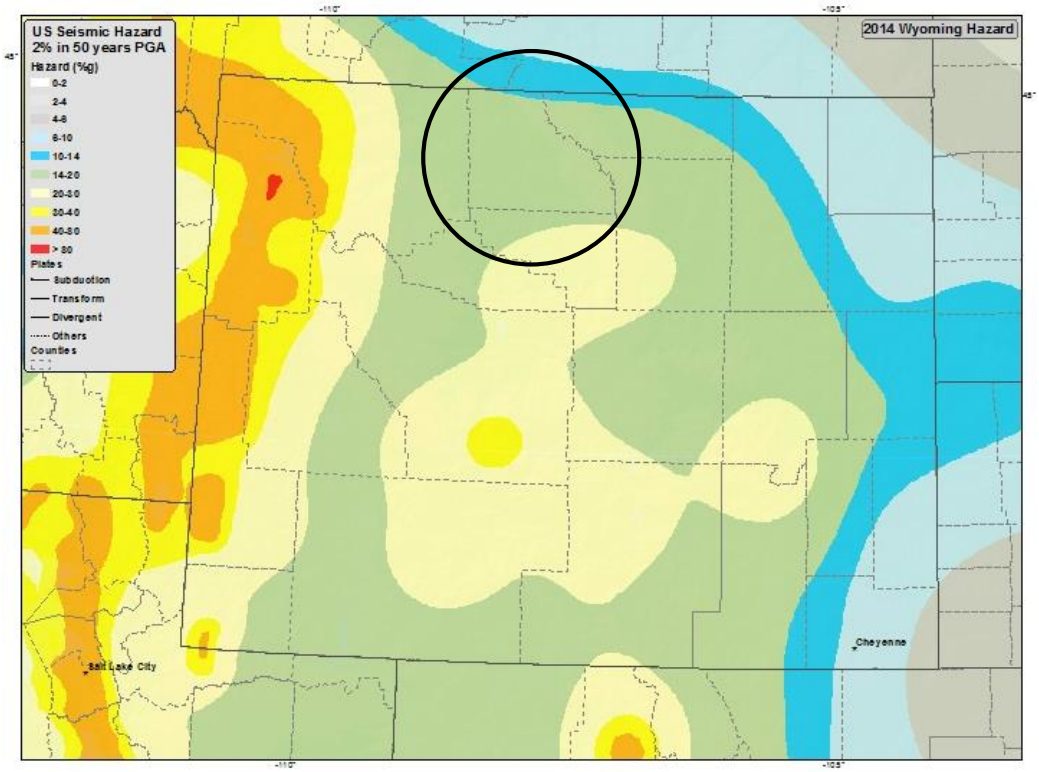
Vulnerability

Because of the limited historic record, it is possible to underestimate the seismic hazard in Big Horn County if historic earthquakes are used as the sole basis for analysis. Earthquake and ground motion probability maps give a more reasonable estimate of damage potential in areas without exposed active faults at the surface, such as Big Horn County. There are no known exposed active faults with a surficial expression in the county. As a result, no fault-specific analysis can be generated for Big Horn County.

According to the United States Geological Survey, a 2,500 year probabilistic seismic event in Big Horn County would produce a Peak Ground Acceleration (PGA, see **Figure3-21**) between 14% to 20% of g (gravity). This scenario takes into account various seismic sources and represents a more worst-case scenario.

Figure 3-21 2% in 50 year Seismic Hazard Measured in Peak Ground Acceleration (M/s).

Big Horn County in Circle.



Source: USGS.gov

Many federal regulations require an analysis of the earthquake potential in areas where active faults are not exposed, and where earthquakes are tied to buried faults with no surface expression. Regions with a uniform potential for the occurrence of such earthquakes are called tectonic provinces. Within a tectonic province, earthquakes associated with buried faults are assumed to occur randomly, and as a result can theoretically occur anywhere within that area of uniform earthquake potential. In reality, that random distribution may not be the case, as all earthquakes are associated with specific faults. If all buried faults have not been identified, however, the distribution has to be considered random. "Floating earthquakes" are earthquakes that are considered to occur randomly in a tectonic province.

The U.S. Geological Survey (USGS) publishes probabilistic acceleration maps for 500, 1000, and 2,500-year time frames. As the historic record is limited, it is nearly impossible to determine when a 2,500-year event last occurred in the county. Because of the uncertainty involved, and based upon the fact that the International Building Code utilizes 2,500-year events for building design, it is suggested that the 2,500-year probabilistic maps be used for Big Horn County analyses. This conservative approach is in the interest of public safety.

The probability-based worst-case scenario could result in the following damage at locations throughout the county:

Intensity VI Earthquake Areas: Intensity VI earthquakes are characterized by strong shaking with light damage. Some heavy furniture can move and there may be some instances of fallen plaster and damaged chimneys.

- Basin
- Burlington
- Byron
- Emblem
- Greybull
- Hyattville
- Lovell
- Manderson
- Otto

Intensity V Earthquake Areas: Intensity V earthquakes are characterized by moderate shaking with very light damage. Dishes and windows can break and plaster can crack. Unstable objects may overturn. Tall objects such as trees and power poles can be disturbed.

- Cowley
- Deaver
- Frannie

Potential Losses

The Wyoming State Geological Survey conducted a study in 2011 to model loss estimations for 16 earthquake scenarios in order to quantify the magnitude of earthquake impacts around the state. 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 *(Source: Wyoming Geological Survey, "Wyoming Earthquake Hazard and Risk Analysis: HAZUS-MH Loss Estimations for 16 Earthquake Scenarios, 2011)*

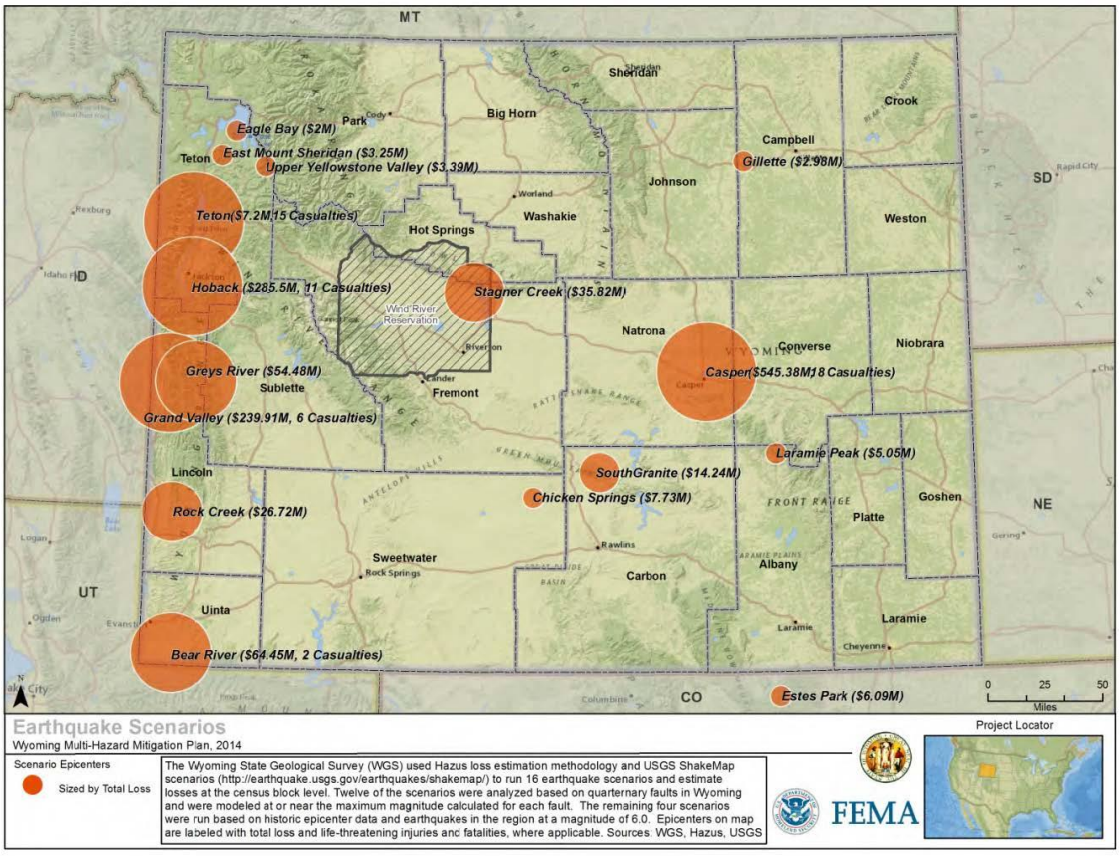
HAZUS (Hazards U.S.) is a nationally standardized, GIS-based, risk assessment and loss estimation computer program that was originally designed in 1997 to provide the user with an estimate of the type, extent, and cost of damages and losses that may occur during and following an earthquake. It was developed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

The study included information regarding the likelihood of damage to local and regional infrastructure, including fire stations, police stations, sheriffs' departments, schools, and hospitals. The 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 map in **Figure 3-22** 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. None of the scenarios modeled indicated losses in Big Horn County

Figure 3-22 HAZUS-MH Earthquake Scenarios for Wyoming, 2014



(Source: Wyoming Multi-Hazard Mitigation Plan, 2014)

In the Wyoming Multi-Hazard Mitigation Plan, HAZUS 2.1 was used to develop losses associated with a 2,500 year probabilistic earthquake scenarios for each county in the State of Wyoming. This scenario uses USGS probabilistic seismic contour maps to model ground shaking with a 2% probability of being exceeded in 50 years (or a 2,500 year event). Total losses include building, contents, inventory, and income-related losses.

There are two methods for ranking counties to determine where earthquake impacts may be the greatest. Either loss ratios or total damage figures can be used. 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, since it gives an indication of the percent of damage to buildings.

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

In this model, Big Horn County ranked 16th (out of 23 counties) in potential losses (see **Table 3-18**).

Table 3-18 HAZUS 2.1 Model, Big Horn County Potential Losses

Rank	Total Losses	Loss Ratio	Level 1	Level 2	Level 3	Level 4
16th	$25.9M	4%	0-10	0	0	0

Wyoming Multi-Hazard Mitigation Plan, 2014

The total damage figure by itself does not reflect the percentage of building damage, since small damage to a number of valuable buildings may result in a higher total damage figure than may be found in a County with fewer, less expensive buildings, with a higher percentage of damage.

In this scenario, South Big Horn County Hospital located at 388 United States Highway in the town of Basin is the only critical facility at risk. It is estimated that the facility would remain at 73% functionality on day one after the disaster, and would reach 95% functionality by day 14.

In summary, it is estimated that if a worse case event occurred in Big Horn County, $25.9M in building related damage could occur. The probability of such an event is 2% in 50 years, or once every 2,500. Though the probability is low, WSGS studies indicate the possibility of a 6.5 magnitude could occur anywhere in the state.

A critical asset within the county and serving many thousands of people are the South Big Horn Water Supply Pipeline and the Northern Supply Pipeline, under the management of the Big Horn Regional Joint Powers Board (BHRJPB). Other water systems that could be impacted are the Shoshone Municipal Pipeline, Shell Pipeline System and Cowley Water Supply. Shifting of the earth in a seismic event, causing an alteration in aquifer characteristics and artesian well-functioning or pipeline breaks, could cause interruption of potable water supplies to several hundred or many thousands of people.

Consideration may be given to the higher seismic risk of Boysen Dam located in Fremont County and the Buffalo Bill Cody Dam in Park County and bordering Yellowstone National Park. Should either of those Bureau of Reclamation dam structures fail, impact to Big Horn County through flooding on the Big Horn or Shoshone Rivers would result in minor to significant damage to Big Horn County and the various residents and towns along those waterways. Readers should refer to the Dam Failure Profile of this Plan for further discussion.

Future Development

Growth in the County in recent years is exposing more buildings, infrastructure, and people to the earthquake hazard, though buildings built to modern codes and standards should, in general, be more resilient. Future development and in particular critical facilities should consider seismic hazards during design and construction.

Summary

The documented history of seismic activity in Big Horn County is negligible. If an event were to occur in Big Horn County, HAZUS-MH predictions indicate monetary impacts of $25.9M in terms of structure, contents, and income losses. Based on USGS 2500 Year Probabilistic Peak Acceleration predictions, and corresponding Modified Mercalli Intensity Scale values of intensity levels V and VI, injury and loss of life would be limited in the event of seismic occurrence.

Loss Potential: **Low**

Population Impacted: **Low**

Probability: **Low**

Jurisdictions at Risk: **All**

Flooding

Narrative

Floods have caused significant damage in Wyoming, and are one of the more significant natural hazards in the state. They can cause loss of life and 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. 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.

Floods generally fall into one of these three categories:

Riverine Flooding: Riverine flooding occurs on rivers, creeks, and streams as water levels rise, either from excessive precipitation, rapid snowmelt, dam failure, or ice jams. An ice jam is a stationary accumulation of ice that restricts flow. Ice jams can cause considerable increases in upstream water levels, while at the same time downstream water levels may drop. Types of ice jams include freeze up jams, breakup jams, or combinations of both. These types of floods can be slow or fast rising, but generally develop over a period of many hours or days.

Flash Floods: Unlike riverine flooding, flash flooding can happen anywhere. Flash floods occur with little or no warning and can reach full peak in only a few minutes. A flash flood usually results from intense storms dropping large amounts of rain within a brief period.

Urban Flooding: Urban flooding is the result of the construction of impervious surfaces (roads, parking lots, building footprints, etc.) and the ground's decreased ability to absorb rainfall. Urban flooding is the result of sustained periods of rainfall and the inability of urban storm water systems to effectively drain the water. This can result in anything from minor flooding in basements and crawlspaces to entire streets being inundated with flowing water.

Past Occurrences

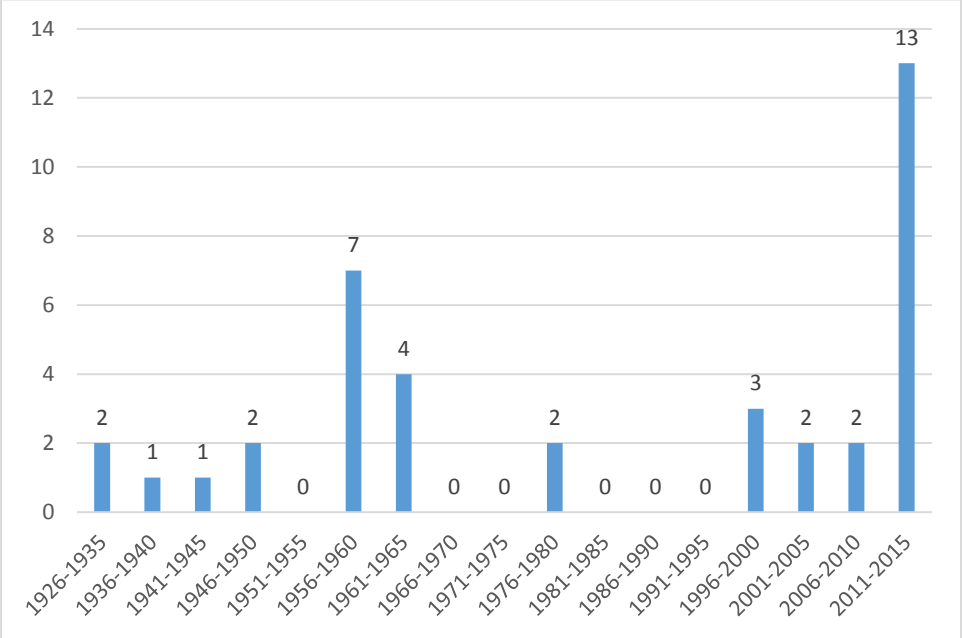
Flooding events occurring within the boundaries of Big Horn County are generally attributed to three factors (1) winter thaws and spring break up on the Big Horn River (sometimes with associated ice jams), (2) rapid snow melt and or heavy rains in higher elevations, and (3) spring or summer deluges that result in flash flooding. The most damaging flood occurred in July of 1962 in northern Big Horn Basin when severe thunderstorms and heavy rains of 4 to 6 inches with 6 to 9 inches of hail and high gusty winds caused widespread damage and flash flooding in the Cowley, Byron, Penrose, and Lovell areas. Total damage was estimated at $2,475,000. Below is a summary of flood and flash flood data in Big Horn County from 1928 to 2014, a full list of flood events can be found in **Appendix A**.

Table 3-19 Summary of Flood Events, Big Horn County 1928 - 2014

Total Events	**39**
Total Reported Deaths/Injuries	**0**
Total Damage (Crops)	**$180,000**
Total Damage (Property)	**$5,618,250**

Source: Nation Climatic Data Center, National Oceanic and Atmospheric Administration-NOAA, Wyoming Emergency Management Agency Storm Data

Figure 3-23 Flood Events by Year in Big Horn County, 1928 – 2014



Source: http://www.ncdc.noaa.gov

Major flooding has occurred in September 1928, February 1948, and both February and July of 1962.

The flood of 1928 occurred when a cloudburst in the Cold Creek area just south of Thermopolis caused an unusual amount of water to flow down the Bighorn River, under the Burlington Northern Railroad Bridge, and into the town of Manderson.

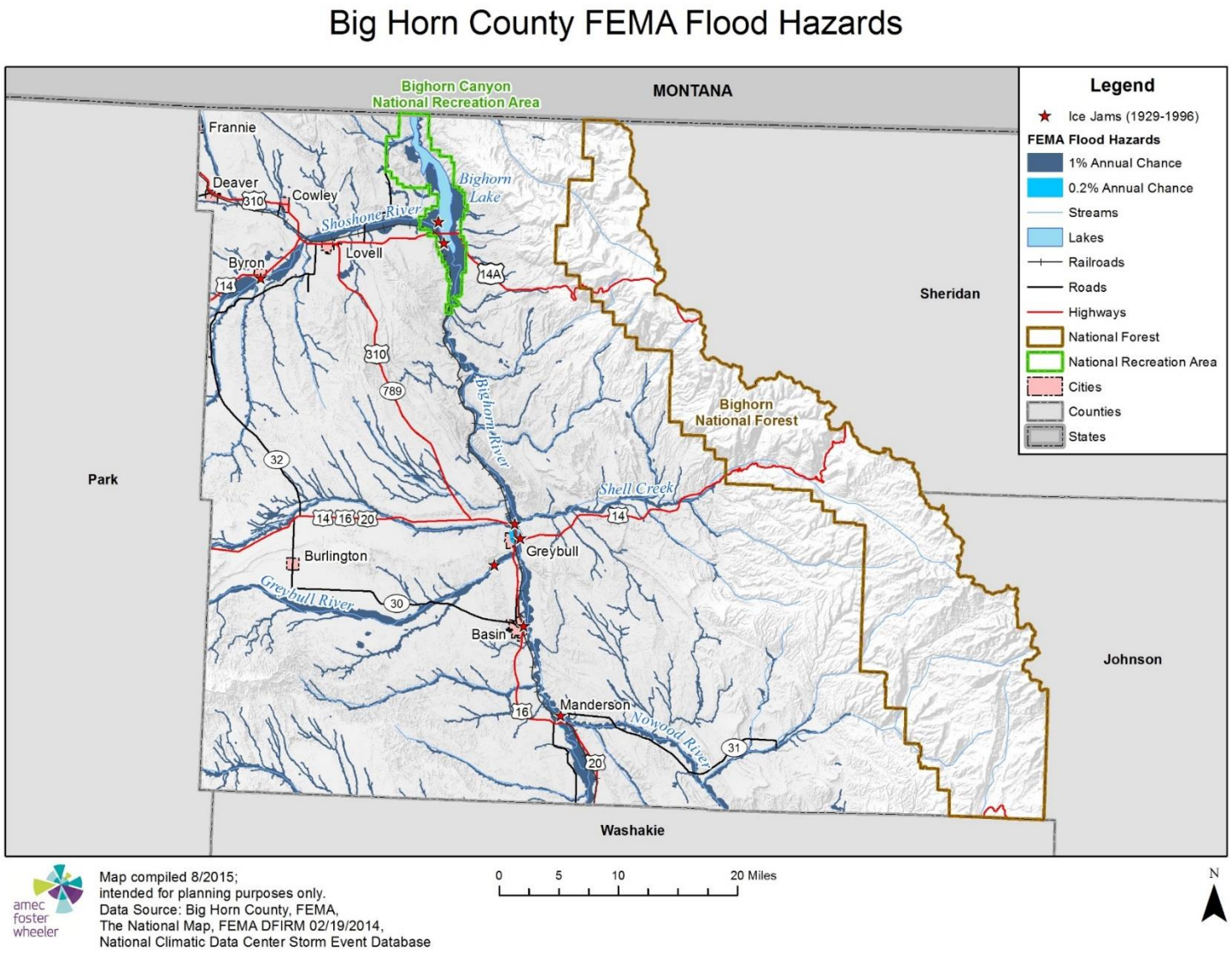
On February 19, 1948, an ice jam formed at the mouth of the Nowood River causing the river to back up and cover the town of Manderson with floodwaters.

The February 15, 1962 flood was also caused by an ice jam by ice formed on the Bighorn River. Manderson received the brunt of the flood on a Monday and was still under water early on Wednesday. The U.S. Bureau of Reclamation closed the Boysen Dam (upstream on the Bighorn River) to hold all water from the area until the flood danger had passed. Exceedance frequencies cannot be applied to floods created by ice jams; but, in 1944, the Bighorn River recorded a flow of 17,900 cubic feet per second (cfs). This flow could be classified as a 75-year flood, but there is no record of damage in the community from this flood. Sheet flow flooding results only when flooding is due to ice jamming effects.

On March 7, 2014, a two-mile long ice jam along the Bighorn River caused significant rises in river stages from Worland to Greybull. Water levels rose to within two feet of the top of the Greybull levee on March 9th. Overall, the levee performed as designed enduring the ice jamming without breach and experiencing no visible damage from the chunks and slabs of ice that had caused water levels to rise. Even where the river reached its closest point to the top of the levee, the jam itself prevented the slabs of ice, which had settled along the levee's riverside bank, from moving and gouging into the levee embankment. (*Source: http://www.nwo.usace.army.mil/)*

In the Town of Manderson, the area north of the Burlington Northern Railroad and west of Sherman Avenue is subject to shallow sheet flow flooding. This comes as a result of shallow overtopping of the railroad from the old highway crossing. That water which overtops the railroad near the business section of Manderson will travel northerly through town, but should stay on the west side of Sherman Avenue. Velocities and depths should be low in this area, with depths less than 2.0 feet during flooding conditions. See **Figure 3-24** for a map of ice jams in Big Horn County

Figure 3-24 Big Horn County FEMA Flood Hazards



Impacts

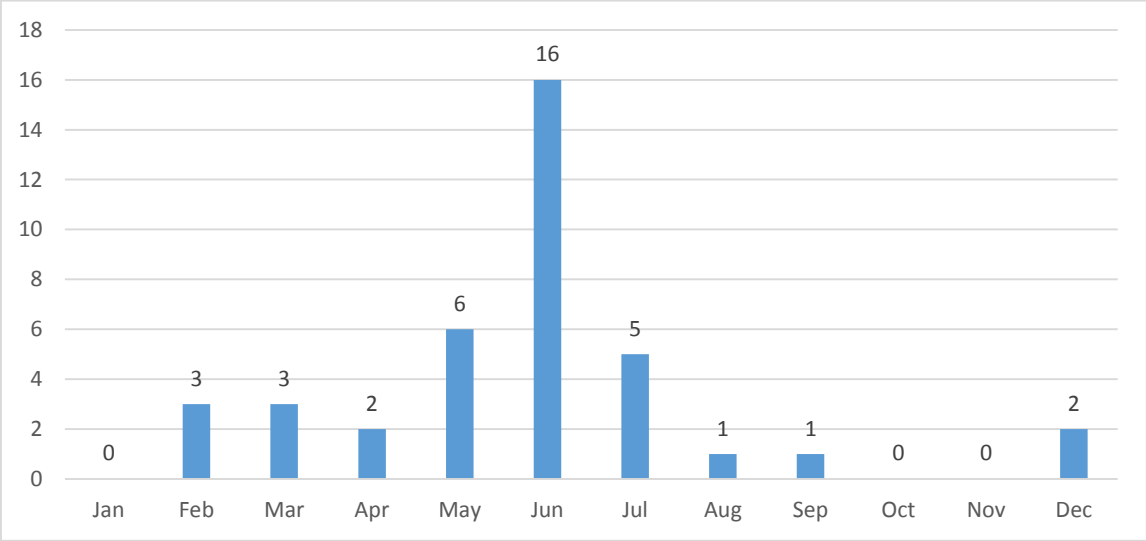
Impacts that could occur from flooding include:

- Injury
- Loss of life
- Injury and loss of life to livestock, pets, fish and wildlife
- Damage to and loss of property and infrastructure
- Interruption of transportation and commerce
- Contamination of surface and ground waters

Frequency

Historic data show that late spring through early summer is the most likely timeframe for flood events in Big Horn County, with a clear peak in the month of June. During this timeframe, snowmelt from the higher elevations of the Bighorn Mountains can inundate the Greybull and Bighorn Rivers that are fed from the various draws and creeks.

Figure 3-25 Summary of Flood Events by Month, Big Horn County 1928 - 2014



Source: Nation Climatic Data Center

Based on documented historical events, including estimates of reported infrastructure and agricultural losses to Big Horn County, the County experiences a flood event approximately once every 2.2 years. These events can usually be attributed to high intensity spring thunderstorms in the foothills that can cause flash flooding in the riverine valleys below.

Vulnerability

Flash flooding is the largest source of concern in Big Horn County since 1962, according to NCDC reports. Since records started being kept (c. 1950) around 50% of flood impacts have been the result of flash floods.

Flash flooding is perilous and is somewhat difficult to predict. Big Horn County Road and Bridge has identified the following areas in the county as those with perennial flood problems due to either flash flooding, or flooding due to snowmelt and heavy spring rains:

- Greybull River Road between Hwy. 30 and Greybull
- Road 8 south of Burlington,
- Bear and Beaver Creek Areas
- Crystal Creek and Crooked Creek.

There is also concern regarding the proliferation of dense vegetation along primary rivers in Big Horn County (Big Horn, Greybull, Nowood, and Shoshone Rivers) and various associated tributaries to those rivers. Tributaries include, but are not limited to Shell, Dry, Elk, and Sage Creeks.

This dense vegetation, consisting primarily of an overgrowth of Russian Olive trees, could be a detrimental factor and increase flood impacts by inhibiting the flow of flood waters in a flood plain or in some cases contributing to deeper channels and higher velocity flows. Russian Olive is a non-native tree that can out-compete native vegetation, interfere with natural plant succession and nutrient cycling, and tax water reserves, similar to the problems salt cedar presents. The State of Wyoming declared the Russian Olive a noxious weed in 2007.

Eradication efforts are necessarily a collaborative effort between federal, state, and local government agencies and private landowners. The Wyoming Natural Resources Conservation Service (NRCS) and the Wyoming Game and Fish Department (WGF) will assist landowners in removing the initial biomass. It is the up to local landowners to replant the areas and develop a weed management strategy to maintain control.

Future control measures are loosely planned to attack the infestation on smaller tributaries and canals first, ultimately reaching the Big Horn River to control the prolific growth of these invasive, non-native species covering vast acres along that primary river.

The Big Horn County Weed and Pest Control District provides numerous resources for landowners to permanently eliminate groves of Russian Olive trees on private property. The District, part of the County government, provides a cost share program for eradication, a guide for best management practices in replanting treated areas as well as landowner agreements that allow the land managers to treat high priority areas on private property. *(Source: http://www.bhcountyweedandpest.com/)*

Flood Control Measures and Specific Concerns

In Manderson, an embankment constructed by the Chicago, Burlington and Quincy Railroad (now Burlington Northern Railroad) along their right-of-way affords some protection from open-water floods on the Bighorn River. This embankment is approximately 1,700 feet long with an average height of six feet and a top width of six to eight feet. A levee that is approximately 1,800 feet long and has an average height of four feet and a six-foot top width is located on the east side of the town along the Nowood

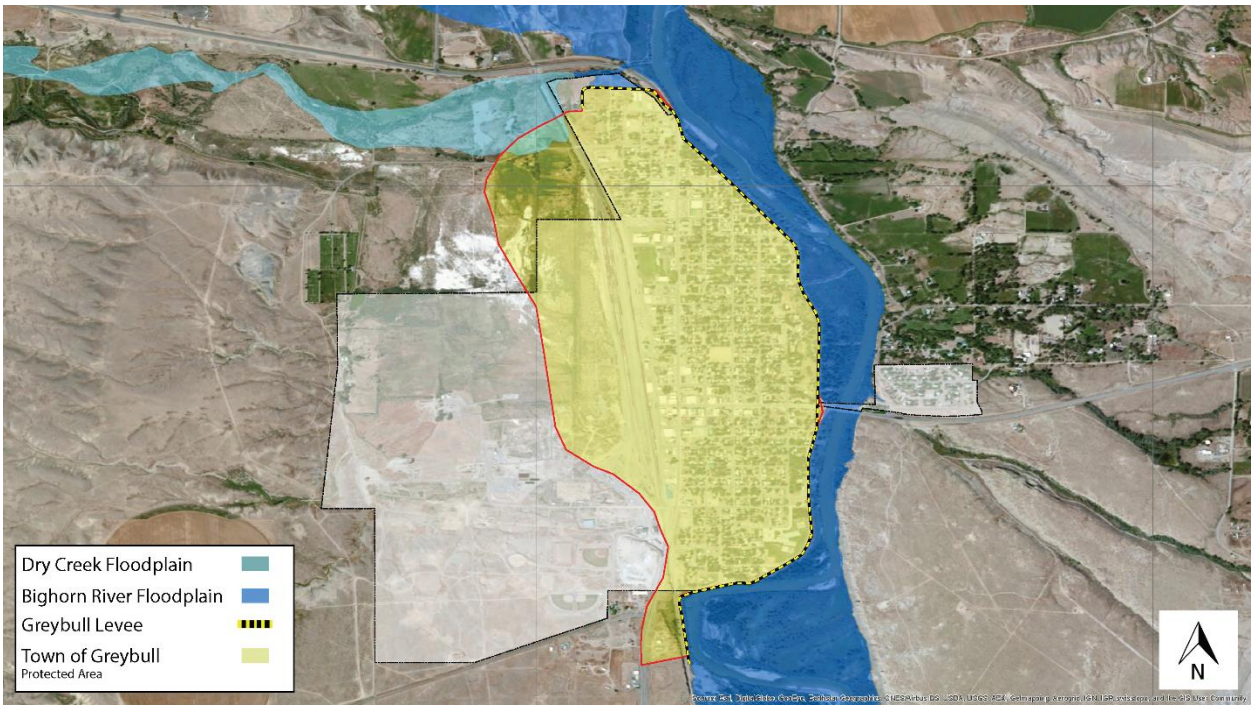
River. This levee affords partial protection from floods on that stream. These levees are not federally certified.

An emergency flood-fighting plan was formulated by the U.S. Army Corps of Engineers in 1956 for the Town of Manderson. This plan set up a program to establish central headquarters and a chain of command to organize a flood-fighting team from local volunteers. The Manderson levees are of little value in the event of an ice jam flood, as evidenced by the 1962 flood. The levee along the Nowood River is overtopped and flanked in any major flood. Lack of local equipment and rapid rise of water would make it impractical to construct an emergency levee of the length required for protection. The left bank of the Nowood River at Manderson is subject to erosion during floods. This would cause additional problems when attempts were made to construct an emergency dike in this area.

The Boysen Reservoir, which is located approximately 70 miles south of Manderson, has 673,330 acre-feet of storage that is reserved for flood control on the Bighorn River. This storage is used to retain flood peaks until they can be released slowly after the passage of the storm.

The threat of ice jams as a precursor to flooding is monitored closely by Big Horn County and municipalities contained with the boundaries of the county. However, the occurrence of flooding in Big Horn County in correlation with ice jams has greatly decreased following the creation of the Yellowtail Dam on the Big Horn River, upstream of the Town of Lovell.

Figure 3-26 Town of Greybull, Levee Structure and Protected Area



Source: US Army Corps of Engineers National Levee Database

The entire Town of Greybull is adjacent to the Bighorn River (see **Figure 3-26**), but is protected from the 1% annual chance flood by a levee. Construction of the Greybull levee was authorized in 1950 by the

Flood Control Act. Construction, contracted by the U.S. Army Corps of Engineers, began in June 1958 and was completed in July 1959. The Town of Greybull fully assumed operations and maintenance responsibility for the levee in November 1959.

This earthen structure is inspected for maintenance every year by the Army Corp of Engineers and provides significant protection. The Town underwent a levee certification process in 2013. This included an engineering study to provide data and information certified by a licensed engineer demonstrating the levee meets, and will continue to meet, the minimum standards of Title 44, Code of Federal Regulations Section 65.10 (44 CFR §65.10). FEMA's standards address hydrologic, hydraulic, geotechnical, operational, and maintenance aspects of levee performance. When a levee is accredited by FEMA, the levee is recognized as providing flood protection for the base flood (1% annual chance or 100 year flood). As a result of this effort the levee was accredited for base flood protection. The levee is now in need of recertification and the town is committed to working towards that goal. The 2014 DFIRM shows the Town as in the Shaded X or 0.2% annual chance zone, indicating that there is still susceptibility to floods greater than the 100 year event.

National Flood Insurance Program Participation

Flooding is different from most other hazards in that riverine flooding problems are managed through a national insurance system called the National Flood Insurance Program (NFIP) under the Federal Emergency Management Agency (FEMA). FEMA conducts a Flood Insurance Study (FIS) of a region to identify the community's risk levels. The FIS includes statistical data for river flow, rainfall, topographic surveys, as well as hydrologic and hydraulic analyses. After examining the FIS data, FEMA creates Flood Insurance Rate Maps (FIRMs) delineating the different areas of flood risk. Land areas that have a 1% annual chance for flooding are called Special Flood Hazard Areas (SFHAs), or floodplains.

The 2010 Big Horn County Multi-Hazard Mitigation Plan incorporated a HAZUS flood loss analysis provided by the WOHS. In 2013, FEMA performed a flood mapping study and Risk MAP Flood Risk Report for the County. The Risk Report, most recent FEMA Flood Insurance Study (February 2014), and GIS analysis using the 2014 FIRM maps were used to update the flood risk analysis.

Table 3-20 FEMA NFIP and FIRM Map Data, Current September 2015

Community Name	Initial FHBM or FIRM Identification Date	FIRM Effective Date	NFIP Participation and date joined
Town of Basin	19-Feb-14	19-Feb-14	Yes – 2/19/14
Big Horn County (Unincorporated Areas)	2-Aug-77	19-Feb-14	Yes – 11/01/98
Town of Burlington	No SFHA	No SFHA	Not in NFIP; no SFHA identified
Town of Byron	19-Feb-14	19-Feb-14	Not in NFIP Sanctioned on 2/19/15

Town of Cowley	19-Sep-75	19-Feb-14	Not in NFIP Sanctioned on 9/19/1976
Town of Deaver	19-Feb-14	19-Feb-14	Not in NFIP Sanctioned on 2/19/15
Town of Frannie	19-Feb-14	19-Feb-14	Not in NFIP Sanctioned on 2/19/15
Town of Greybull	21-Jun-74	19-Feb-14	Yes – 2/19/80
Town of Lovell	8-Aug-75	19-Feb-14	Yes – 10/01/86
Town of Manderson	13-Sep-74	19-Feb-14	Yes – 4/16/79

Source: Big Horn County Flood Insurance Study, 2014 and FEMA Community Status Book

According to FIS and Community Status Book data, the communities of Byron, Cowley, Deaver and Frannie do not participate in the NFIP which makes them ineligible for flood insurance through the program. The community of Burlington does not participate either, but there are no flood hazard areas identified in the community so they are not required to.

Potential Losses

As the most recent Digital Flood Insurance Rate Maps (DFIRMs) illustrate, all communities in Big Horn County (with the exception of Burlington) have some vulnerability to the 1% annual chance flood or in some cases the 0.2% or 500 year flood. In terms of total dollar damage due to flooding, Big Horn is the third most vulnerable county in Wyoming, behind Natrona and Sweetwater, based on the HAZUS study completed by WOHS.

An updated GIS-based flood risk assessment was completed with the 2015 update of this plan. The overlay analysis utilized parcel data with assessed values and the current DFIRM. **Table 3-21** shows improved values at risk in the 1% and 0.2% annual chance flood zones.

Content values were estimated as a percentage of building value based on their property type, using FEMA/HAZUS estimated content replacement values. This includes 100% of the structure value for agricultural, commercial, exempt, and utility, 50% for residential, 150% for industrial and 0% for vacant land use classifications. Flood damage or loss is proportional to the depth of flooding in the structure. A 25% damage factor was applied to each flood zone's total value of improvements and estimated content to obtain a loss estimate. This analysis is based on FEMA depth-damage loss curves, and assumes a two foot deep flood. Land value was not included in this analysis as the land itself is usually not a loss.

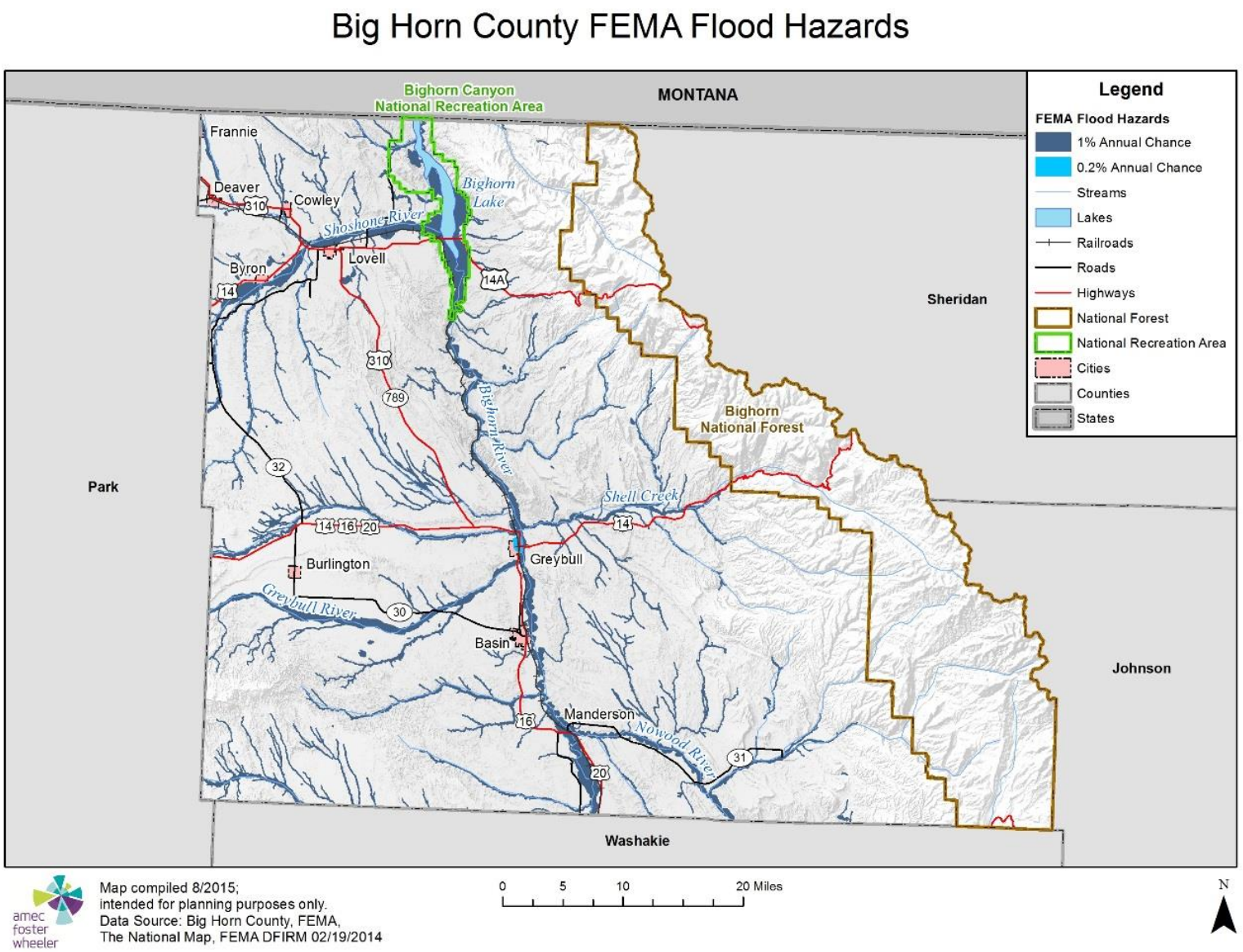
The entire county has 1,020 buildings at risk to flooding, with a total improved value of $92,603,872, a content value of $63,031,685, a total value of $155,635,557 and a loss estimate of $38,908,889. The majority of the loss would be associated with a 0.2% annual chance flood. The following section details this loss in further detail by jurisdiction.

Table 3-21 Potential Loss Summary for Flood Scenarios. All Big Horn County.

DFIRM Zones	Property Count	Improved Value	Content Value	Total Value	Potential Loss at 25%
1% Annual Chance	241	28,258,559	$23,890,582	$52,149,141	$13,037,285
0.2% Annual Chance	779	64,345,313	$39,141,103	$103,486,416	$25,871,604
Total	**1,020**	**$92,603,872**	**$63,031,685**	**$155,635,557**	**$38,908,889**

Source: Amec Foster Wheeler GIS analysis using Big Horn County Assessor data and 2014 DFIRM

Figure 3-27 Bighorn County FEMA Flood Hazards



Unincorporated Big Horn County

Unincorporated Big Horn County entered into the emergency NFIP on April 4th, 1997 and entered into the regular NFIP program on November 1st, 1998. The County has a FIRM effective date of April 4th, 1997. As of April 16, 2015 the County has 16 policies in force totaling $3,189,200. Three claims have been paid since inception totaling $47,439.55 with no repetitive losses.

Table 5-22 below shows improved values at risk in the 1% and 0.2% annual chance flood zones.

Unincorporated Big Horn County has 178 buildings at risk with a total improved value of $24,190,632, a content value of $21,216,795, a total value of $45,407,427 and a loss estimate of $11,351,857, mostly to residential and agricultural structures. According to the 2013 Flood Risk Report produced for Big Horn County by FEMA, the unincorporated county faces a potential displaced population of 200 residents, seven of whom would need emergency housing assistance.

Table 3-22 Potential Loss Summary for Flood Scenarios. Unincorporated Big Horn County.

DFIRM Zones	Property Type	Property Count	Improved Value	Content Value	Total Value	Potential Loss at 25%
1% Annual Chance	Agricultural	63	$7,502,537	$7,502,537	$15,005,074	$3,751,269
	Commercial	1	$976,201	$976,201	$1,952,402	$488,101
	Industrial	2	$4,882,110	$7,323,165	$12,205,275	$3,051,319
	Residential	112	$10,829,784	$5,414,892	$16,244,676	$4,061,169
	Vacant Land	**178**	**$24,190,632**	**$21,216,795**	**$45,407,427**	**$11,351,857**
0.2% Annual Chance	-	-	-	-	-	-
	Total	-	-	-	-	-
	Total Flood	**178**	**$24,190,632**	**$21,216,795**	**$45,407,427**	**$11,351,857**

Source: Amec Foster Wheeler GIS analysis using Big Horn County Assessor data and 2014 DFIRM

There are 14 critical assets at risk in unincorporated Big Horn County:

- The BNSF Railway Company's Commercial Land Mobile Towers at BNSF MP 397.7 Greybull East E AEI
- The Lamax Construction Private Land Mobile Towers at 4402 Orchard Bench Road
- The Greybull Public School District 3 Private Land Mobile Towers at 636 14Th Ave N
- The Wyo-Ben Inc Private Land Mobile Towers
- The M-I LLC Private Land Mobile Towers
- The Greybull Private Land Mobile Towers at WW PS - 0.38 MI NE OF CR26 & US14 Intersection
- The Sewer Control and Storage Building one mile North of Greybull

- M-I SWACO LLC Teir II Hazmat at PO BOX 832
- The Private Land Mobile Towers owned by Lovell, City Of at 336 Nevada Ave
- The Private Land Mobile Towers owned by Fire Protection District 1 at 8 Km S US 310 & US 42 3 Km W
- Marathon Oil's Private Land Mobile Towers at Byron Field 1.5 mi ENE
- Marathon Oil's Private Land Mobile Towers at Garland Battery 2
- Marathon Oil's Private Land Mobile Towers at 1.5 mi E
- The Greybull Valley Irrigation District's Diversion Dam at Greybull River 8 1/2 mi SW

Sources: Big Horn County Assessor, www.cama.state.wy.us/

Town of Basin

The Town of Basin entered into the emergency NFIP program on June 30th of 2000 and entered into the regular NFIP on February 19th, 2014 with the same FIRM effective date (see **Figure 3-28** on next page). As of April 16th, 2015 the Town has no policies in force, no claims and no repetitive losses.

Table 3-23 below shows improved values at risk in the 1% and 0.2% annual chance flood zones.

The town has two buildings at risk with a total improved value of $143,430 and a loss estimate of $53,786. According to the 2013 Flood Risk Report produced for Big Horn County by FEMA, the Town of Basin faces a potential displaced population of eight residents. There are no critical facilities in the 1% annual chance flood zone.

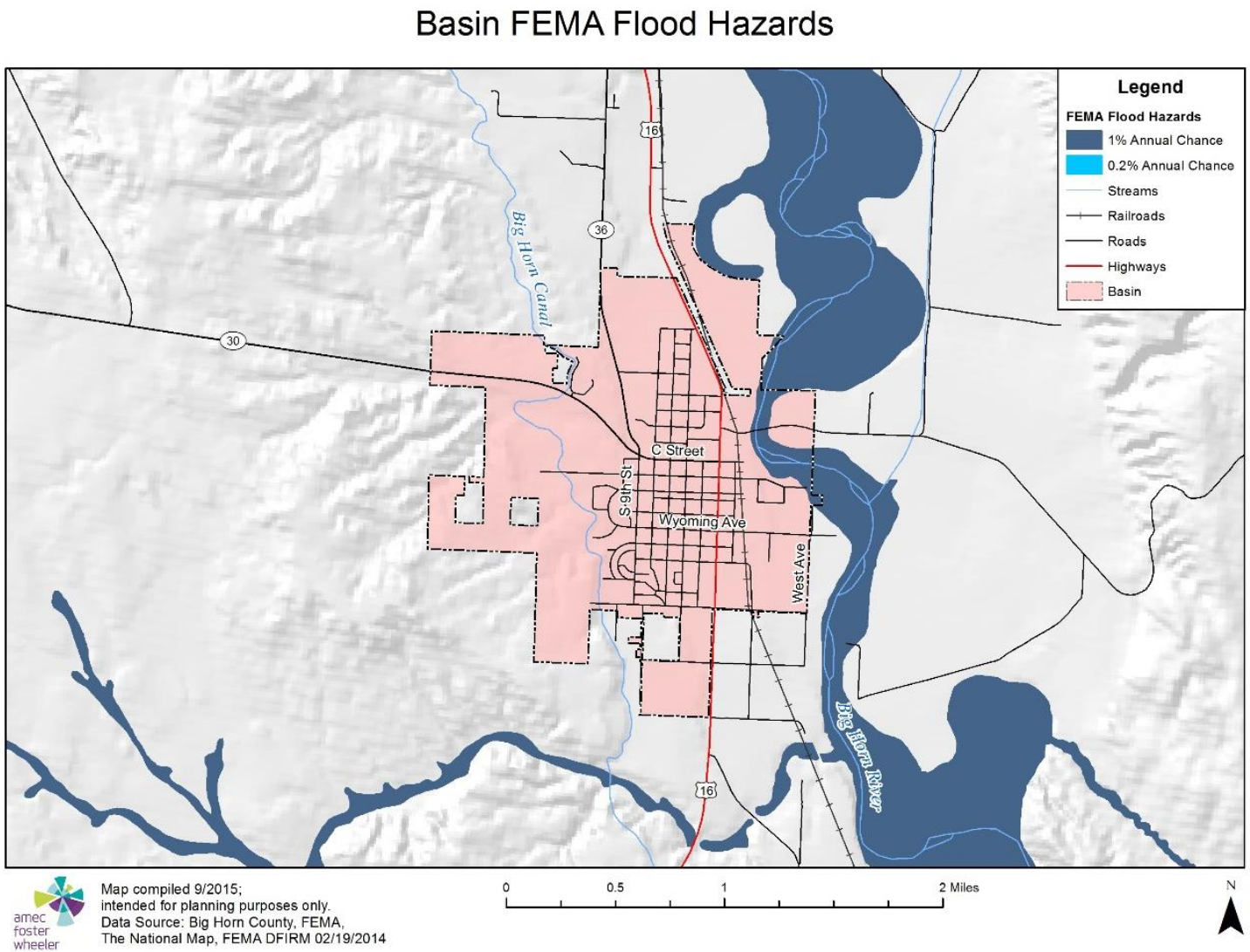
The 2010 Big Horn County Hazard Mitigation Plan also noted the potential vulnerability of the town river pump house, the Big Horn River Bridge and the town sewer lagoon, however none of these facilities appeared in the flood analysis performed for this plan as they did not appear in any flood hazard area.

Table 3-23 Potential Loss Summary for Flood Scenarios, Town of Basin

DFIRM Zones	Property Type	Property Count	Improved Value	Content Value	Total Value	Potential Loss at 25%
1% Annual Chance	Residential	2	$143,430	$71,715	$215,145	$53,786
	Total	**2**	**$143,430**	**$71,715**	**$215,145**	**$53,786**
0.2% Annual Chance	-	-	-	-	-	-
	Total	-	-	-	-	-
	Total Flood	**2**	**$143,430**	**$71,715**	**$215,145**	**$53,786**

Source: Amec Foster Wheeler GIS analysis using Big Horn County Assessor data and 2014 DFIRM

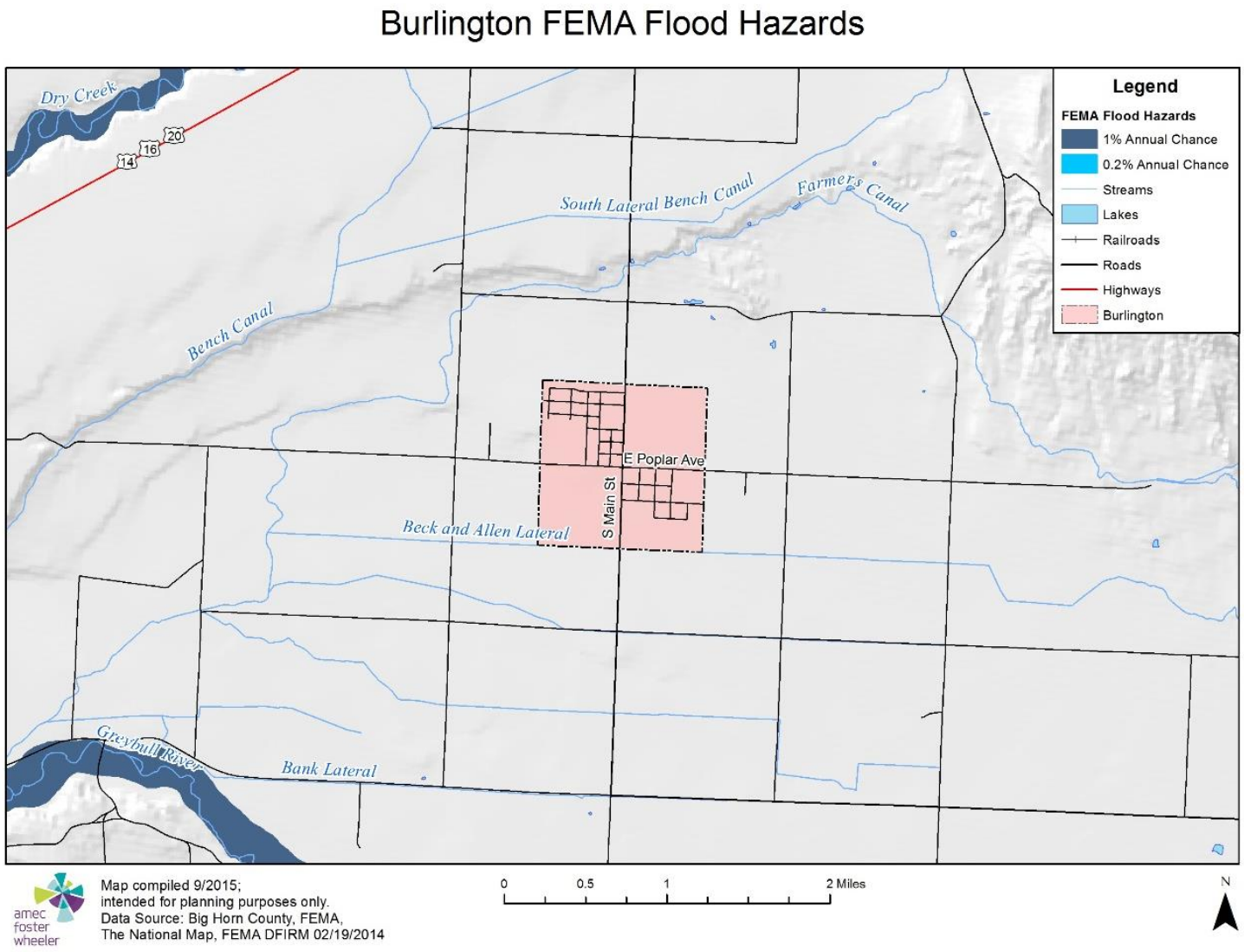
Figure 3-28 Basin FEMA Flood Hazards



Town of Burlington

As the most recent FIRM maps indicate (see **Figure 3-29** on next page), the Town of Burlington has no special flood hazard areas (SFHAs) in the municipal boundary.

Figure 3-29 Burlington FEMA Flood Hazards



Town of Cowley

As the most recent FIRM maps indicate (see **Figure 3-30** on next page), the Town of Cowley has some municipal area in the 1% annual chance flood zone. One commercial property is indicated at risk. As of September 19, 1976 the town has been sanctioned by the NFIP.

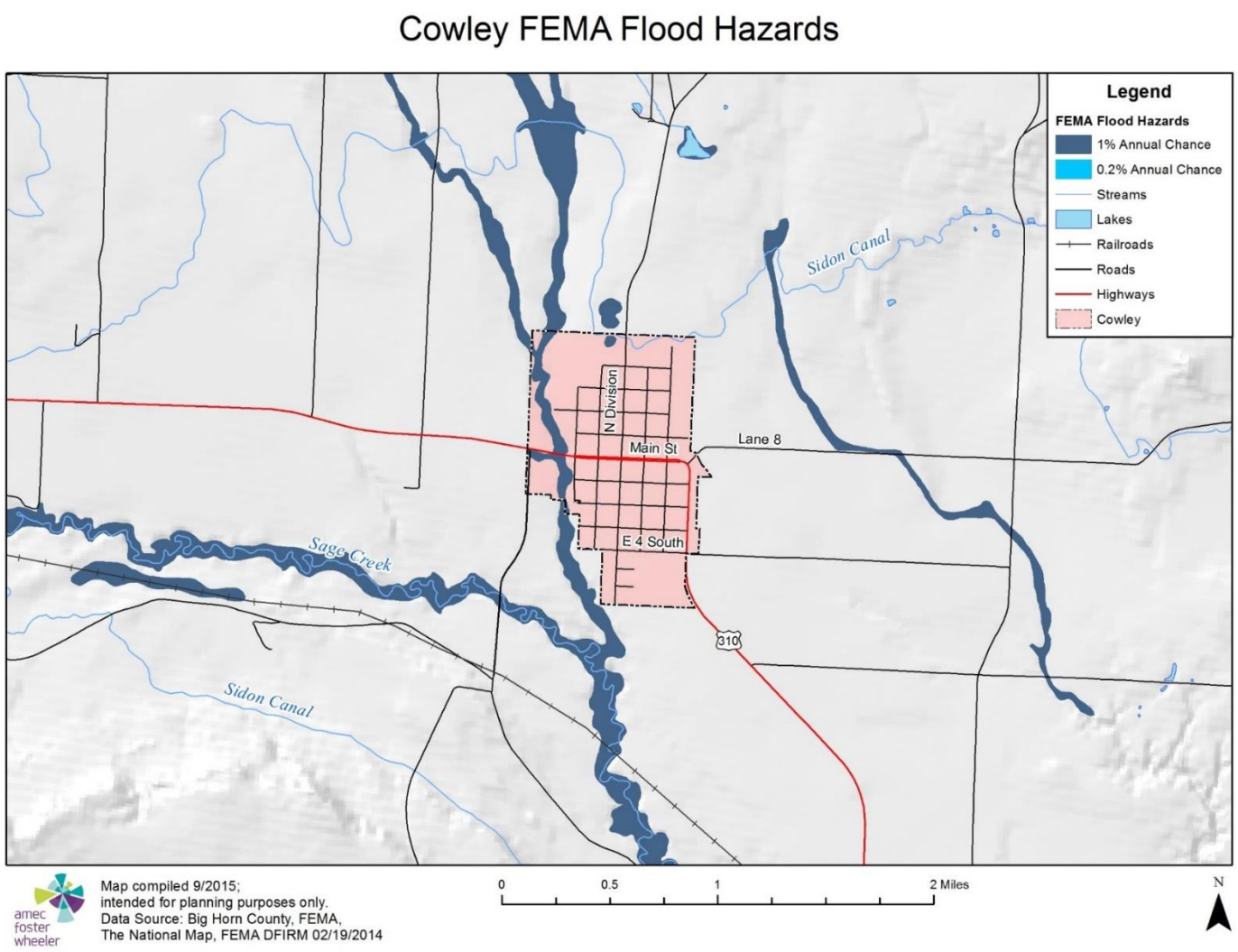
According to the 2013 Flood Risk Report produced for Big Horn County by FEMA, the Town of Cowley does not have a displaced population risk. There are no critical facilities identified as at risk.

Table 3-24 Potential Loss Summary for Flood Scenarios, Town of Cowley

DFIRM Zones	Property Type	Property Count	Improved Value	Content Value	Total Value	Potential Loss at 25%
1% Annual Chance	Commercial	1	$71,015	$71,015	$142,030	$35,508
	Total	**1**	**$71,015**	**$71,015**	**$142,030**	**$35,508**
0.2% Annual Chance	-	-	-	-	-	-
	Total	-	-	-	-	-
	Total Flood	**1**	**$71,015**	**$71,015**	**$142,030**	**$35,508**

Source: Amec Foster Wheeler GIS analysis using Big Horn County Assessor data and 2014 DFIRM

Figure 3-30 Cowley FEMA Flood Hazards



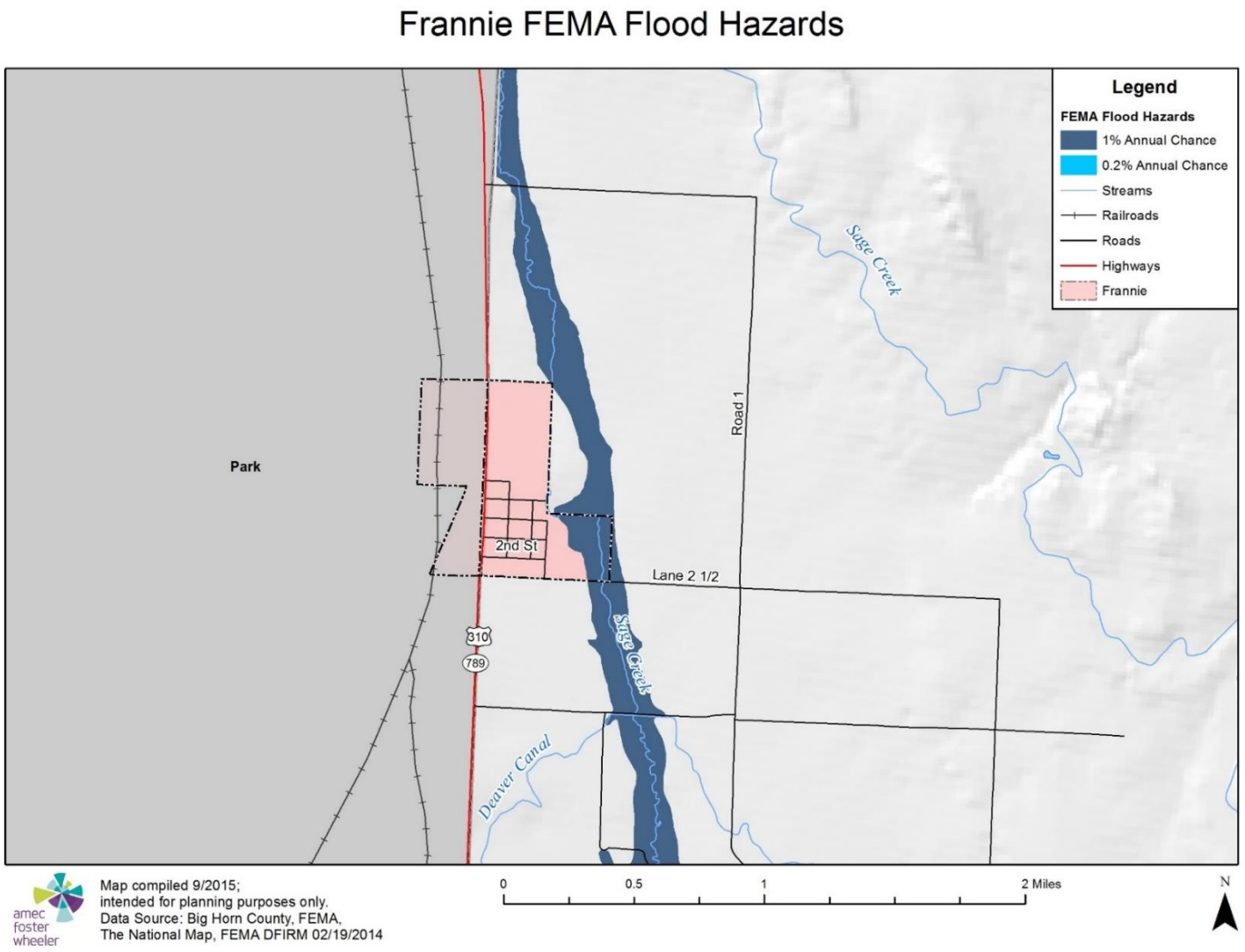
Town of Frannie

As the most recent FIRM maps indicate (see **Figure 3-31** on next page), the Town of Frannie has some municipal area in the 1% annual chance flood zone. As of February 19, 2015 the town has been sanctioned by the NFIP.

According to the 2013 Flood Risk Report produced for Big Horn County by FEMA, the Town of Frannie faces a potential displaced population of five residents, none of whom would need emergency housing assistance.

There are no critical facilities at risk.

Figure 3-31 Frannie FEMA Flood Hazards



Town of Greybull

The Town of Greybull entered into the emergency NFIP on March 16th, 1978 and entered into the regular NFIP program on February 19th, 1980 with a FIRM effective date of the same (see **Figure 3-32**). As of April 16, 2015 the Town has seven policies in force totaling $1,393,200. One claim has been paid since inception for $12,212.92 with no repetitive losses.

Table 3-25 below shows improved values at risk in the 1% and 0.2% annual chance flood zones. Most of the risk in the Town is within the 0.2% annual chance zone. The Town of Greybull has 782 buildings at risk with a total improved value of $64,463,003, a content value of $39,199,948, a total value of $103,662,951 and a loss estimate of $25,915,738.

According to the 2013 Flood Risk Report produced for Big Horn County by FEMA, the Town of Greybull faces a potential displaced population of 19 residents, one of whom would need emergency housing assistance in the case of a 1% chance flood. If the levee were to be breached, however, the Town would face a potential displaced population of 1,240 residents, 758 of whom would need emergency housing assistance.

Table 3-25 Potential Loss Summary for Flood Scenarios, Town of Greybull

DFIRM Zones	Property Type	Property Count	Improved Value	Content Value	Total Value	Potential Loss at 25%
1% Annual Chance	Residential	3	$117,690	$58,845	$176,535	$44,134
	Total	**3**	**$117,690**	**$58,845**	**$176,535**	**$44,134**
0.2% Annual Chance	Commercial	111	$13,927,914	$13,927,914	$27,855,828	$6,963,957
	Residential	666	$50,408,420	$25,204,210	$75,612,630	$18,903,158
	Vacant Land	2	$8,979	$8,979	$17,958	$4,490
	Total	**779**	**$64,345,313**	**$39,141,103**	**$103,486,416**	**$25,871,604**
	Total Flood	**782**	**$64,463,003**	**$39,199,948**	**$103,662,951**	**$25,915,738**

Source: Amec Foster Wheeler GIS analysis using Big Horn County Assessor data and 2014 DFIRM

There are no critical facilities in the 1% annual chance flood zone.

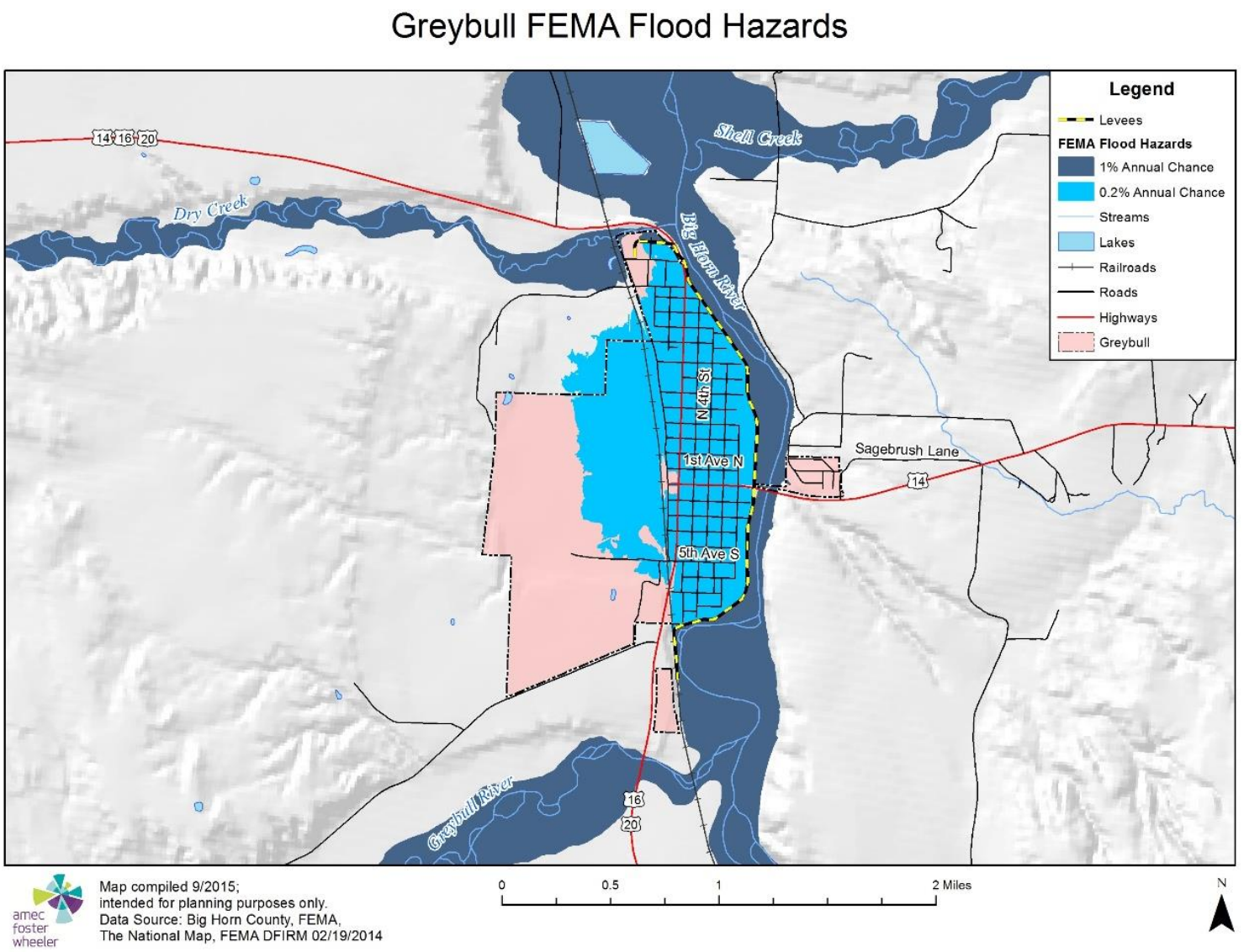
There are 40 critical facilities in the 0.2% annual chance flood (levee) zone:

- Antenna owned by WWC Holding Co., Inc. at 519 1st Ave. South
- Call Center owned by Wyoming Call Center at 648 5th Avenue North
- Community Center owned by Herb Asp Community Hall at Corner of South 6th Street and First Avenue
- Daycare owned by Stepping Stones Montessori at 346 Greybull Ave

- Daycare owned by Lil ' Red Wagon Childcare and Learning Center at 200 3rd Ave South
- Fire Hall owned by Greybull Fire Hall / Emergency Medical at 141 North 6th Street
- Fire Siren owned by Emergency Fire Siren at 24 South 5th Street
- Fire Siren owned by Emergency Fire Siren at 170 North 7th Street
- Library owned by Greybull Public Library at 325 Greybull Avenue
- Microwave Tower owned by Greybull, Town of
- Museum owned by Greybull Museum at 325 Greybull Avenue
- Park owned by City Park Restrooms at 300 Block South 2nd Street
- Police owned by Greybull Police Department at 24 South 5th Street
- Post Office owned by US Postal Service at 401 Greybull Avenue
- Private Land Mobile Towers owned by Greybull, Town of at 24 South 5Th St
- Private Land Mobile Towers owned by BNSF Railway Co BNSF Depot at 600 2nd Ave.
- Private Land Mobile Towers owned by Armadillo Express
- Private Land Mobile Towers owned by Greybull, Town Of at 24 South 5Th
- Private Land Mobile Towers owned by Mountain Construction Company
- Private Land Mobile Towers owned by Big Horn School District #3
- Private Land Mobile Towers owned by Big Horn County school District #3 at 125 5th Ave S
- Private Land Mobile Towers owned by BNSF Railway Co at 600 2nd Ave. N.
- Private Land Mobile Towers owned by Greybull, City Of City Hall at 24 S. 5Th Street
- Private Land Mobile Towers owned by Greybull, City Of at 24 South 5Th Street
- Public Health owned by Big Horn County Public Health at 417 South 2nd Street
- School owned by Greybull Elementary School at 125 6th Avenue South
- School owned by Greybull Middle School Complex at 600 8th Avenue North
- School owned by Greybull High School Complex at 600 North 6th Street
- School owned by Big Horn County School District #3 Admin and Bus Barn at 636 14th Avenue North
- Senior Citizens Center owned by Senior Citizens Center at 417 South 2nd Street
- Shelter owned by Greybull Elementary School at 125 6th Avenue South
- Shelter owned by Greybull Middle School at 600 8th Avenue North
- Shelter owned by Greybull High School at 600 North 6th Street
- Shelter owned by Old High School Gym at 600 North 6th Street
- Teir II Hazmat owned by Greybull Bulk Plant
- Town Hall owned by Greybull Town Hall at 24 South 5th Street
- US Department of Agriculture owned Natural Resources Conservation Service - Greybull Field Office at 408 Greybull Avenue
- US Forest Service owned US Forest Service Work Center at 1220 North 8th Street
- US Forest Service owned US Forest Service at 1220 North 8th Street
- WY Game and Fish owned Wyoming Game and Fish Warden Station, Office/Residence at 434 6th Avenue North

Sources: Big Horn County Assessor, www.cama.state.wy.us/

Figure 3-32 Greybull FEMA Flood Hazards



Town of Lovell

The Town of Lovell entered into the emergency NFIP on August 30th, 1976 and entered into the regular NFIP program on October 1st, 1986. The Town has a FIRM effective date of November 12th, 1991 (see **Figure 3-33** on next page). As of April 16th, 2015 the Town has no policies in force, no claims and no repetitive losses.

Table 3-26 below shows improved values at risk in the 1% and 0.2% annual chance flood zones.

The Town of Lovell has six buildings at risk with a total improved value of $644,276, a content value of $353,449, a total value of $997,725 and a loss estimate of $249,431. According to the 2013 Flood Risk Report produced for Big Horn County by FEMA, the Town of Lovell does not have a displaced population risk.

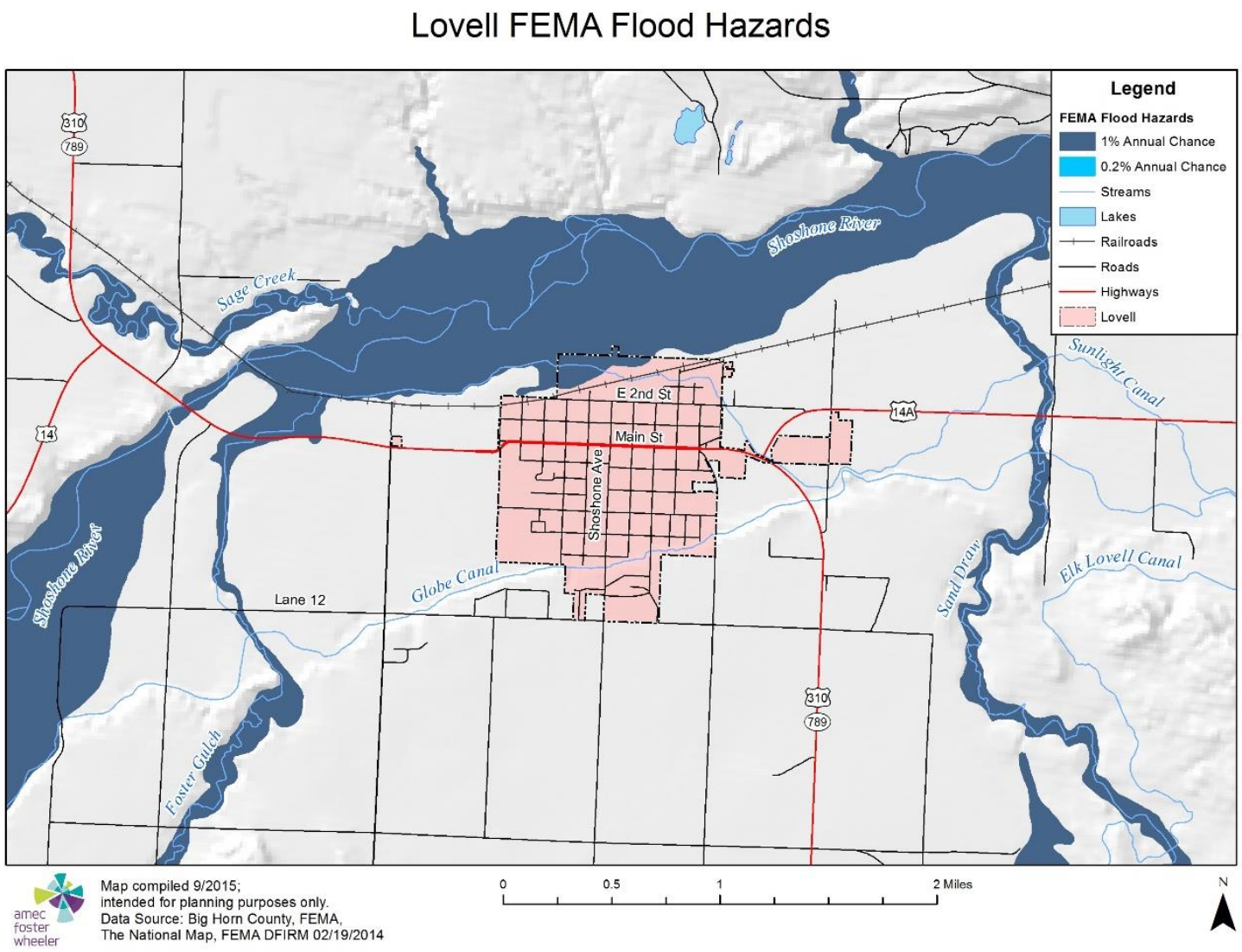
Table 3-26 Potential Loss Summary for Flood Scenarios, Town of Lovell

DFIRM Zones	Property Type	Property Count	Improved Value	Content Value	Total Value	Potential Loss at 25%
1% Annual Chance	Commercial	2	$62,621	$62,621	$125,242	$31,311
	Residential	4	$581,655	$290,828	$872,483	$218,121
	Total	**6**	**$644,276**	**$353,449**	**$997,725**	**$249,431**
0.2% Annual Chance	-	-	-	-	-	-
	Total	-	-	-	-	-
	Total Flood	**6**	**$644,276**	**$353,449**	**$997,725**	**$249,431**

Source: Amec Foster Wheeler GIS analysis using Big Horn County Assessor data and 2014 DFIRM

There are no critical facilities in the 1% annual chance flood zone:

Figure 3-33 Lovell FEMA Flood Hazards



Town of Manderson

The Town of Manderson entered into the emergency NFIP on April 29th, 1976 and entered into the regular NFIP program on April 16th, 1979 with a FIRM effective date of the same (see **Figure 3-34**). As of April 16, 2015 the Town has 11 policies in force totaling $6,541,900. Two claims have been paid since inception totaling $47,347.75 with no repetitive losses.

Table 3-27 below shows a number of improved values at risk in the 1% annual chance flood zones. The Town of Manderson has 49 buildings at risk with a total improved value of $2,981,483, a content value of $2,008,730, a total value of $4,990,231 and a loss estimate of $1,247,553. According to the 2013 Flood Risk Report produced for Big Horn County by FEMA, the Town of Manderson faces a potential displaced population of 69 residents, 16 of whom would need emergency housing assistance.

Table 3-27 Potential Loss Summary for Flood Scenarios, Town of Manderson

DFIRM Zones	Property Type	Property Count	Improved Value	Content Value	Total Value	Potential Loss at 25%
1% Annual Chance	Commercial	3	$1,034,120	$1,034,120	$2,068,240	$517,060
	Residential	44	$1,945,506	$972,753	$2,918,259	$729,565
	Vacant Land	2	$1,857	$1,857	$3,714	$929
	Total	**49**	**$2,981,483**	**$2,008,730**	**$4,990,213**	**$1,247,553**
0.2% Annual Chance	-	-	-	-	-	-
	Total	-	-	-	-	-
	Total Flood	**49**	**$2,981,483**	**$2,008,730**	**$4,990,213**	**$1,247,553**

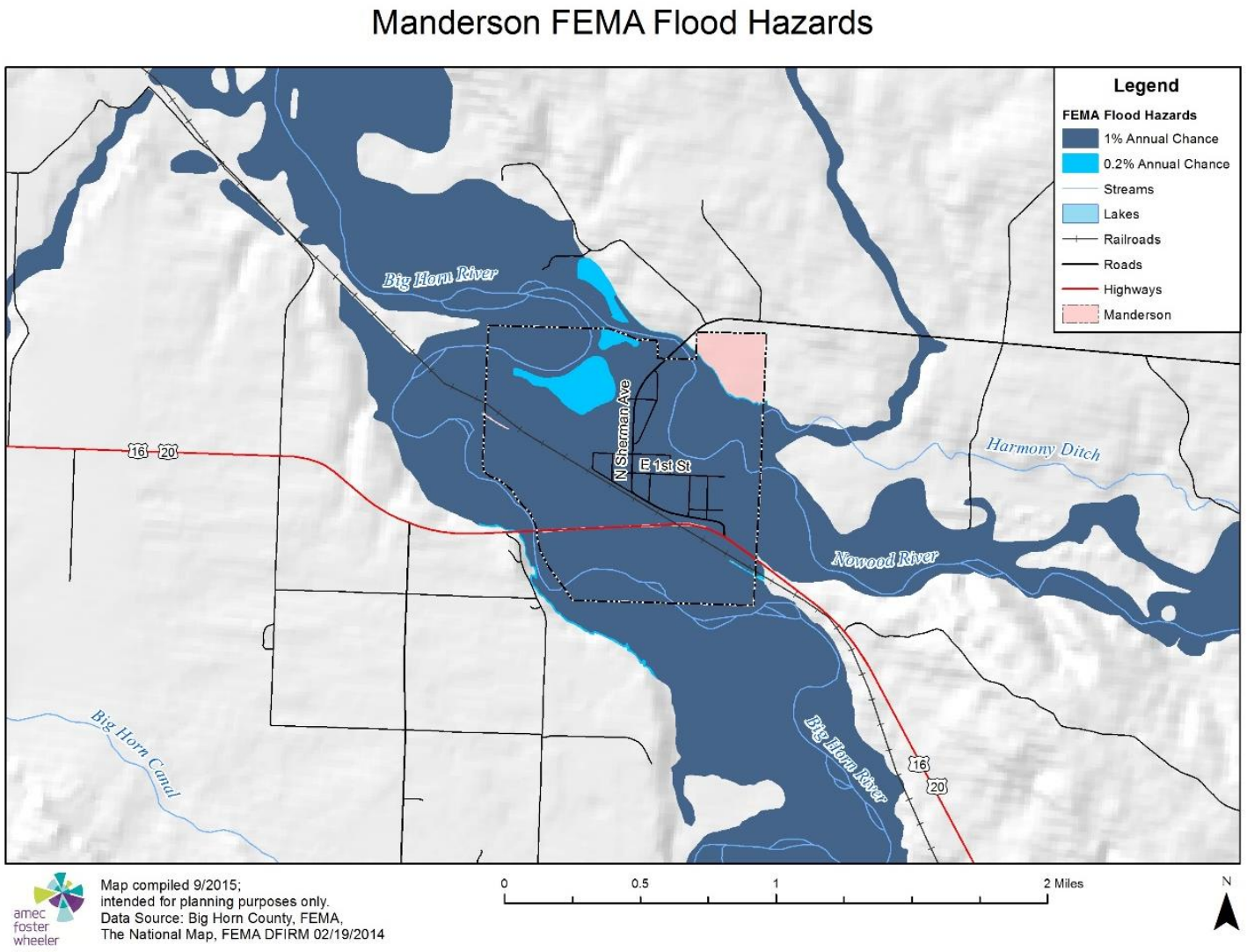
Source: Amec Foster Wheeler GIS analysis using Big Horn County Assessor data and 2014 DFIRM

There are seven critical facilities in the 1% annual chance flood zone:

- Bus Barn owned Bus Garage at 157 East 1st Street
- The Fire Hall owned by Big Horn County Fire Dist #3 at 515 North Sherman Avenue
- The Post Office owned by the US Postal Service at 193 North Sherman Avenue
- The Private Land Mobile Towers owned by the Big Horn Regional Joint Powers Board at Flow Control Near Intersection Of Railway Street And Pauly A
- School Cloud Peak School owned by Manderson Elementary and Middle Schools at 170 School Avenue
- The Shelter Cloud Peak School at 170 School Avenue
- The Manderson Town Hall at 100 Railway Street

Sources: Big Horn County Assessor, www.cama.state.wy.us/

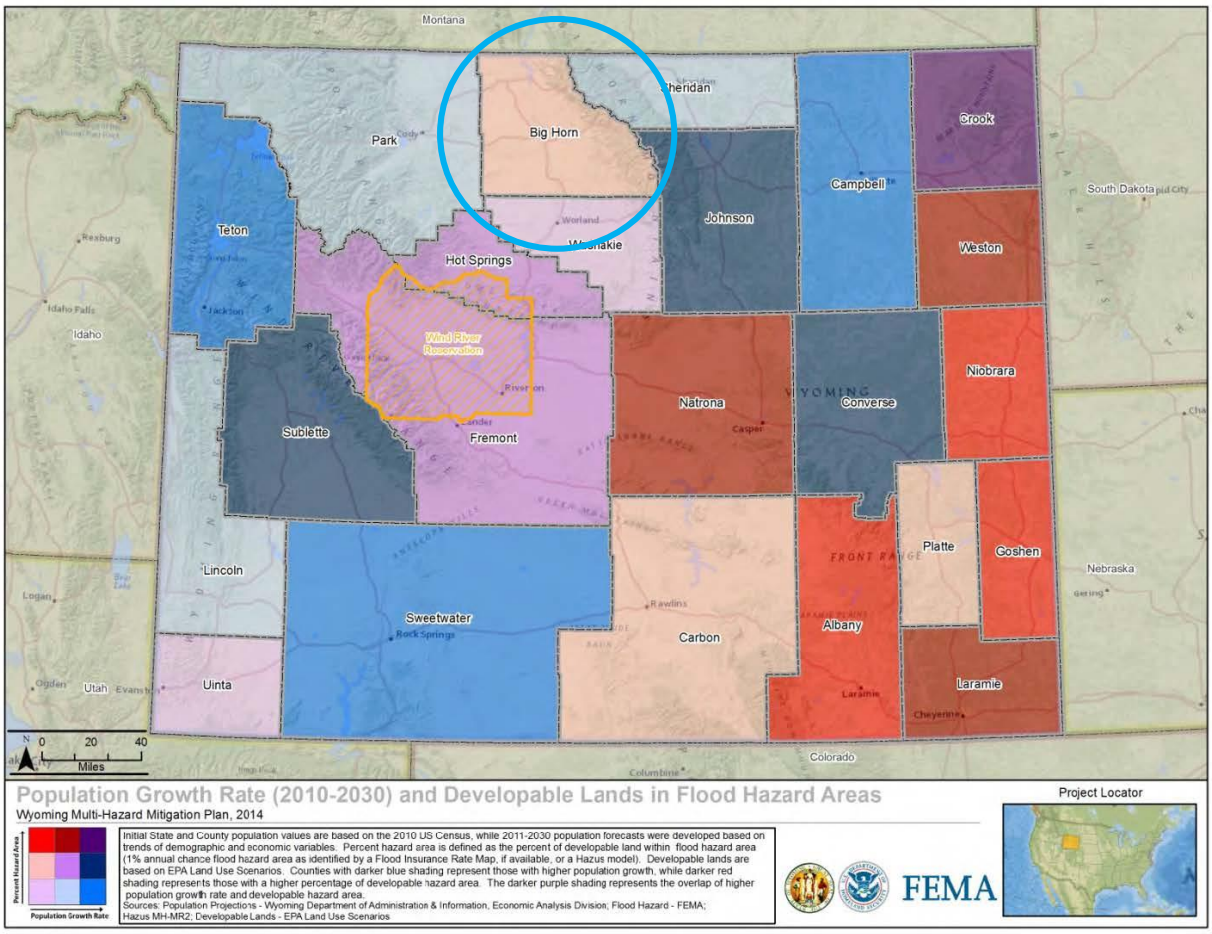
Figure 3-34 Manderson FEMA Flood Hazards



Future Development

Since nearly 90% of Big Horn County is federal and/or public land, most future development is likely to occur in areas that are already urbanized. Given that the County grew by an estimated 262 residents from April 2010 to July 2014, any development in a floodplain is likely to be limited and negligible. Nevertheless, towns should be aware of their flood hazard areas when granting building permits especially in towns like Frannie and Cowley where there are some identified flood hazard areas but the town does not participate in the NFIP.

Figure 3-35 Future Flood Hazard in Future Growth Area Wyoming, 2014. Big Horn County in Circle.



Source: Wyoming Multi-Hazard Mitigation Plan, 2014

The 2014 Wyoming Multi Hazard Mitigation Plan published an analysis of future flood hazard risk by developing a matrix that synthesized population growth projections with developable lands in flood hazard areas.

With this matrix approach, 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 purple shading represents overlap of high population growth rates and developable hazard areas.

Big Horn County, while having a significant amount of developable land in high hazard areas, has a low projected population growth rate to 2030. This means that flood hazard risks in Big Horn County are unlikely to change significantly in the next 15 years.

Summary

Based on documented historical events, including estimates of reported infrastructure and agricultural losses to Big Horn County, the County suffers a damaging flood event approximately every nine years. These events are typically spring or summer flooding that results when streams and rivers are already full and high temperatures or sudden rains in the mountains cause rapid snow melt to occur, causing flooding problems downstream, or sudden flash floods following in the wake of summer storms. Ice jams during the winter and spring months have also been problematic.

When water levels increase on the Big Horn River and flood watches commence, the Town of Manderson, the Town of Greybull, and rural homes and property along the river are the greatest concern. The less frequent 0.2% annual chance flood would have a significant impact on the County.

Loss Potential:	**High**
Population Impacted:	**Medium**
Probability:	**Medium**
Jurisdictions at Risk:	**All, with Manderson, Greybull and unincorporated areas higher risk.**

Damaging Hail

Narrative

Damaging hail events occur on a regular basis throughout the Big Horn Basin, usually associated with severe summer storms and wind events. Hailstones form when a super-cooled droplet collects a layer of ice and continues to grow, sustained by an updraft. Once the hailstone cannot be held up any longer by the updraft, it falls to the ground. Hail up to 2.5 inches in diameter has been reported in Big Horn County. Hail causes more than a billion dollars of property damage nationally each year, mostly to crops, but also can decimate structural sidings, take out windows, peel paint, and severely damage automobiles and equipment not protected or stored inside.

History

A comprehensive history of damaging hailstorms historically affecting Big Horn County is included in **Tab;e 3-28**. The data was derived from the monthly Storm Data reports generated and released by the National Oceanic and Atmospheric Administration's National Climate Center. Other sources are unpublished reports from the Wyoming Office of Homeland Security, newspaper accounts, and periodicals from public libraries.

The NCDC records any hail events with hailstones that are ¾ inch or larger in diameter, or any hail of a smaller diameter which causes property and/or crop damage, or casualties. According to the NCDC definition, there have been 22 hailstorms affecting the county since 1960, recorded at 52 separate locations. While deaths and injuries have been associated with these types of storms, such occurrences are most often the result of accompanying flooding and high winds, rather than hail.

Table 3-28 Summary Bighorn County Hail History 1960-2014

Number of Events	Cumulative Fatalities	Cumulative Injuries	Cumulative Property Damage	Cumulative Crop Damage
22	0	1	$101,000	$350,500

Source: National Climactic Data Center

Table 3-29 Bighorn County Hail History 1960-2014

Location	Date	Time	Hail Diameter	Fatalities	Injuries	Property Damage	Crop Damage
Big Horn County	7/6/1961	16:00	1.50 in.	0	0	$0	$0
Big Horn County	7/6/1975	16:00	0.75 in.	0	0	$0	$0
Big Horn County	6/25/1991	15:43	1.75 in.	0	0	$0	$0
Big Horn County	6/25/1991	16:10	1.75 in.	0	0	$0	$0
Big Horn County	9/10/1991	19:40	0.85 in.	0	0	$0	$0
Basin	6/13/1997	18:40	0.75 in.	0	0	$0	$0
Basin	7/19/1997	16:00	1.25 in.	0	0	$0	$0
Manderson	7/19/1997	16:20	0.75 in.	0	0	$0	$0
Lovell	8/8/1998	19:50	1.00 in.	0	0	$0	$0
Deaver	6/9/2000	13:00	0.88 in.	0	0	$0	$0
Cowley	6/9/2000	13:05	0.88 in.	0	0	$0	$0
Cowley	6/9/2000	13:11	1.00 in.	0	0	$0	$0
Greybull	6/26/2001	18:02	0.75 in.	0	0	$0	$0
Otto	6/1/2002	17:20	1.75 in.	0	0	$0	$0
Greybull	6/1/2002	17:30	0.88 in.	0	0	$0	$0
Greybull	6/1/2002	17:56	0.75 in	0	0	$0	$0
Burlington	8/21/2002	14:43	0.75 in.	0	0	$0	$0
Burlington	8/21/2002	14:50	1.75 in.	0	0	$0	$0
Emblem	8/21/2002	15:05	1.75 in.	0	0	$0	$0
Manderson	5/9/2005	16:15	0.75 in.	0	0	$0	$0
Byron	6/1/2005	12:20	1.00 in.	0	0	$0	$0
Burlington	6/1/2005	13:07	1.75 in.	0	0	$0	$0

Burlington	6/14/2006	11:42	1.00 in.	0	0	$0	$0
Burlington	6/14/2006	11:47	1.50 in.	0	0	$0	$0
Emblem	6/14/2006	11:50	2.00 in.	0	0	$0	$0
Emblem	6/14/2006	11:50	1.75 in.	0	0	$0	$0
Byron	6/14/2006	12:08	0.88 in.	0	0	$0	$0
Lovell	6/14/2006	12:10	1.75 in.	0	0	$0	$0
Lovell	6/14/2006	12:20	1.00 in.	0	0	$0	$0
Lovell	6/14/2006	12:25	2.00 in.	0	0	$12,000	$500
Lovell	6/14/2006	12:25	1.75 in.	0	0	$12,000	$275,000
Greybull	6/6/2007	14:15	1.00 in.	0	0	$0	$0
Byron	6/6/2007	14:55	0.88 in.	0	0	$0	$0
Hyattville	5/28/2008	17:15	0.75 in.	0	0	$0	$0
Basin	7/13/2009	14:45	0.75 in.	0	0	$0	$0
Burlington	8/7/2009	15:44	1.25 in.	0	0	$0	$0
Otto	8/7/2009	15:51	1.25 in.	0	0	$0	$0
Greybull	8/7/2009	16:10	2.00 in.	0	1	$75,000	$0
Greybull	8/7/2009	16:15	2.50 in.	0	0	$0	$0
Greybull	8/7/2009	16:17	2.00 in.	0	0	$2,000	$0
Byron	5/23/2013	21:31	1.00 in.	0	0	$0	$0
Cowley	5/23/2013	21:39	0.75 in.	0	0	$0	$0
Burlington	6/12/2013	16:05	1.00 in.	0	0	$0	$0
Emblem	6/12/2013	16:10	0.75 in.	0	0	$0	$0
Greybull	6/12/2013	16:35	1.00 in.	0	0	$0	$0
Burlington	6/13/2013	12:30	0.75 in.	0	0	$0	$0
Otto	6/13/2013	12:45	0.88 in.	0	0	$0	$0
Greybull	6/13/2013	12:55	1.00 in.	0	0	$0	$0
Hyattville	8/1/2013	15:41	0.75 in.	0	0	$0	$0
Lovell	5/31/2014	14:02	1.00 in.	0	0	$0	$0
Lovell	5/31/2014	14:12	0.88 in.	0	0	$0	$0
			TOTALS	**0**	**1**	**$101,000**	**$310,500**

Source: National Climactic Data Center

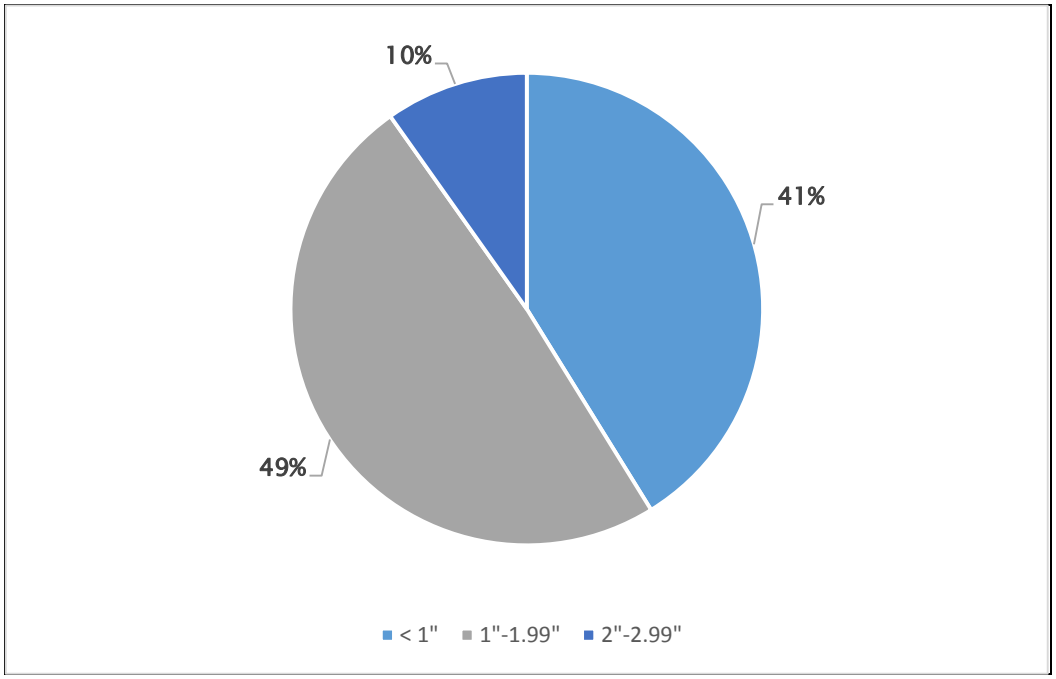
Based on historical data, an average hail event in Big Horn County occurs in June, somewhere between 12 p.m. and 5 p.m. It drops hail with a diameter between one and two inches. While most historical hail storms in Big Horn County don't result in major damage, recordable damage to property is in the $12,000 range per incident, mostly to rooftops and vehicles; crop damage is approximately $20,000 per incident. Historically, damage to crops is three times the amount of damage to property.

History shows a few outliers, summarized below:

On June 14, 2006, a hail storm struck approximately six miles east of Lovell. Dropping hail of approximately two inches in diameter, the storm substantially damaged two homes. Additionally, approximately 900 acres of sugar beets, over 100 acres of corn, and about 40 acres of alfalfa were destroyed by the large hail. While the storm caused no reported injuries or fatalities, it caused $12,000 in direct property damages and $275,000 in direct crop damage.

On August 7, 2009, a storm struck Greybull. Golf ball sized hailstones were numerous at a residence in Greybull, with stones reaching up to two inches in diameter. While the storm caused no reported crop damage, it did cause $75,000 in property damage. One injury is attributed to the storm.

Figure 3-36 Hail Events by Hail Diameter. Big Horn County 1959 – 2014.



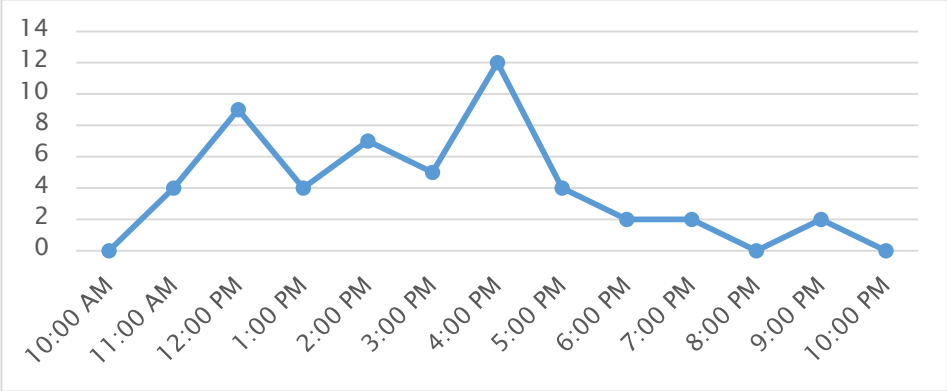
Source: National Climactic Data Center

Most public and personal property damage from hail is insured under private property insurance or crop insurance policies, serviced by multiple insurance providers. For this reason it is very difficult to get a true cumulative estimate of damage costs caused by hail events. Data collection regarding dollar damage to public and personal property holds significant gaps for this reason. There have been no FEMA disaster or state declarations for Big Horn County related to damaging hail, and no USDA disaster declarations as a result of hail damage in Big Horn County were found. Agricultural losses and claims met by crop insurance carriers due to hail damage are difficult to determine.

Vulnerability

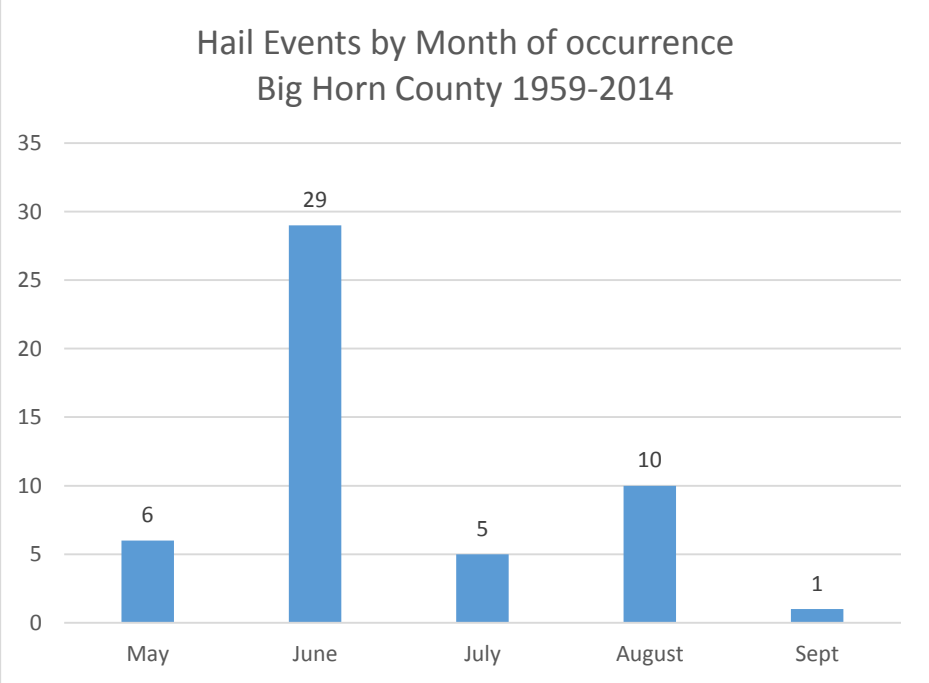
Hail storms present the largest threat to citizens and property in the month of June, between noon and five p.m. Figure 3-39 indicates the locations within the county having the highest likelihood of being affected are Greybull, Lovell, Basin, and the Byron and Emblem/Burlington areas. Based on historical data, Big Horn County can expect a damaging hail event an average of every two years.

Figure 3-37 Time of Day Hail Events in Big Horn County 1959-2014



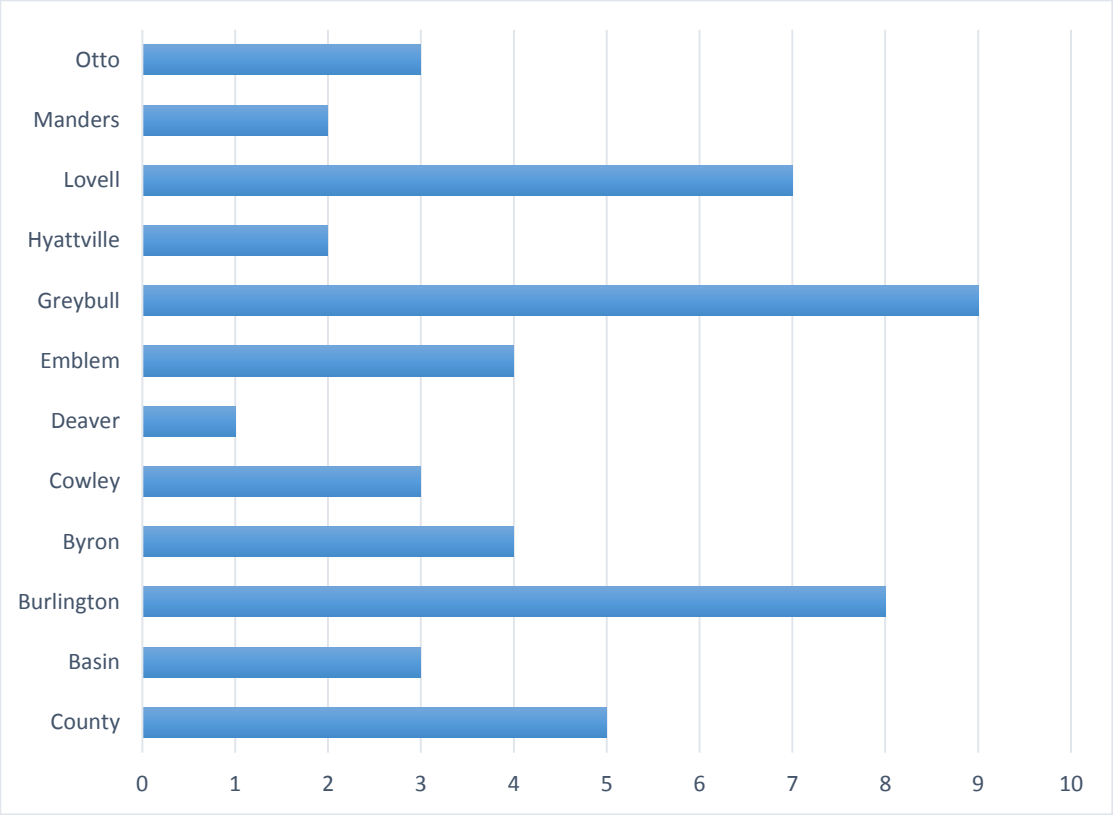
Source: National Climactic Data Center

Figure 3-38 Month of Occurrence - Hail Events in Big Horn County 1959 to 2009



Source: National Climactic Data Center

Figure 3-39 General Locations - Hail Events in Big Horn County 1959-2014



Future Development

Between 2010 and 2014, Big Horn County's population grew 2.2%. Hail can strike anywhere in the county, so any growth or new development in Big Horn County will increase exposure to hail damage. Insurance will be an important tool to offset the potentially substantial dollar losses associated with hail.

Summary

Big Horn County will continue to experience damaging hail events, based on an average recurrence interval of every two years. If the storms are damaging, damage estimate averages based on available data show and average of $12,000 in damage to property and $20,000 damage to crops. Hail damage to public and private property, and agricultural losses are expected to be heaviest in the Greybull, Lovell, Basin, and Burlington/Emblem areas.

Loss Potential: **High**

Population Impacted: **Low**

Probability: **High**

Jurisdictions at Risk: **All**

High Winds and Downbursts

Narrative

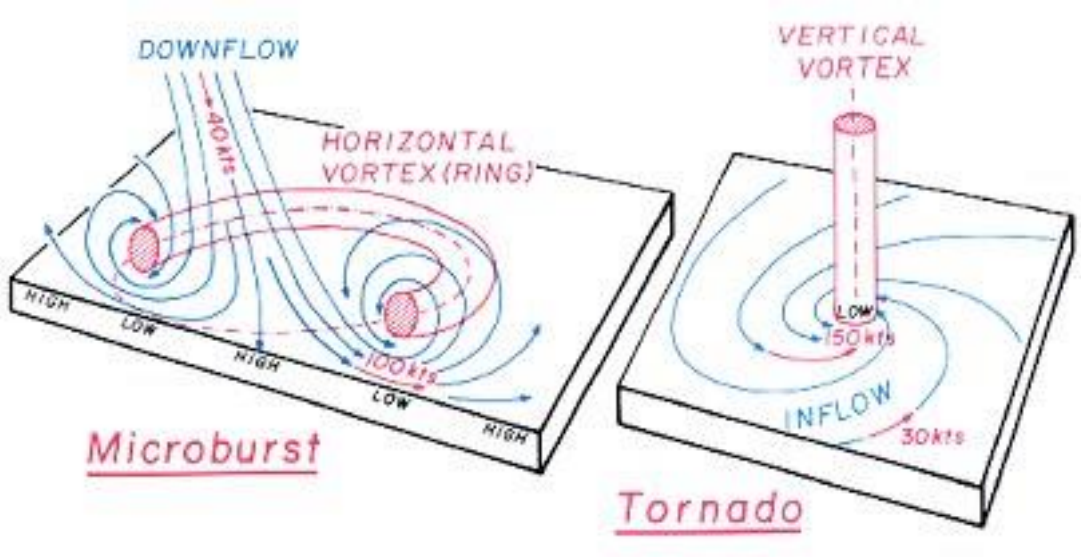
Wind, because of its constant presence in Wyoming, can be overlooked as a hazard. Upon analysis, wind can be a damage-inducing hazard and warrants review in Big Horn County. Wyoming's wind is also becoming an economic factor as renewable wind energy is developed around the state.

This profile examines the hazard that high winds present including downbursts, a subcategory of high winds. A downburst is a strong down draft which causes damaging winds on or near the ground. Downbursts are much more frequent than tornadoes, and for every one tornado there are approximately 10 downburst damage reports. Downbursts can be associated with either a heavy precipitation or non-precipitation thunderstorm (dry or wet downbursts), and often occur in the dissipating stage of a thunderstorm. Microbursts and macrobursts are categories of downbursts, classified by length of duration, velocity of wind, and radius of impact.

Microbursts generally last between five and 15 minutes and impact an area less than three miles wide. Macrobursts can last up to 30 minutes with winds up to 130 miles per hour and can impact areas larger than three miles in radius. Microbursts and macrobursts may induce dangerous wind shears, which can adversely affect aircraft performance, cause property damage and loss of life.

A downburst can occur when cold air begins to descend from the middle and upper levels of a thunderstorm (falling at speeds of less than 20 miles an hour). As the colder air strikes the Earth's surface, it begins to 'roll' outward. As this rolling effect happens, the air expands causing further cooling and having the effect of pulling the shaft of air above it at higher and higher speeds.

Figure 3-40 Schema of Microburst and Tornado



Source: www.erh.noaa.gov

Tornado - All wind flows INTO a tornado. Debris is often laying at angles due to the curving of the inflow winds.

Downburst - All wind flows OUT from a downburst. Debris is often laying in straight lines (hence the term "straight line winds") parallel to the outward wind flow.

Downbursts can be mistaken for tornadoes by those that experience them since damages and event characteristics are similar. Tornado winds can range from 40 to over 300 mph. Downbursts can exceed winds of 165 mph and can be accompanied by a loud roaring sound. Both downbursts and tornadoes can flatten trees, cause damage to homes and upend vehicles. In some instances, aerial surveying is the best method to determine what kind of event has taken place.

Figure 3-41 Aerial Image of Downburst Damage

Source: T. Fujita

In this photograph, trees are blown down in a straight line - a very strong indication of a downburst as opposed to a tornado.

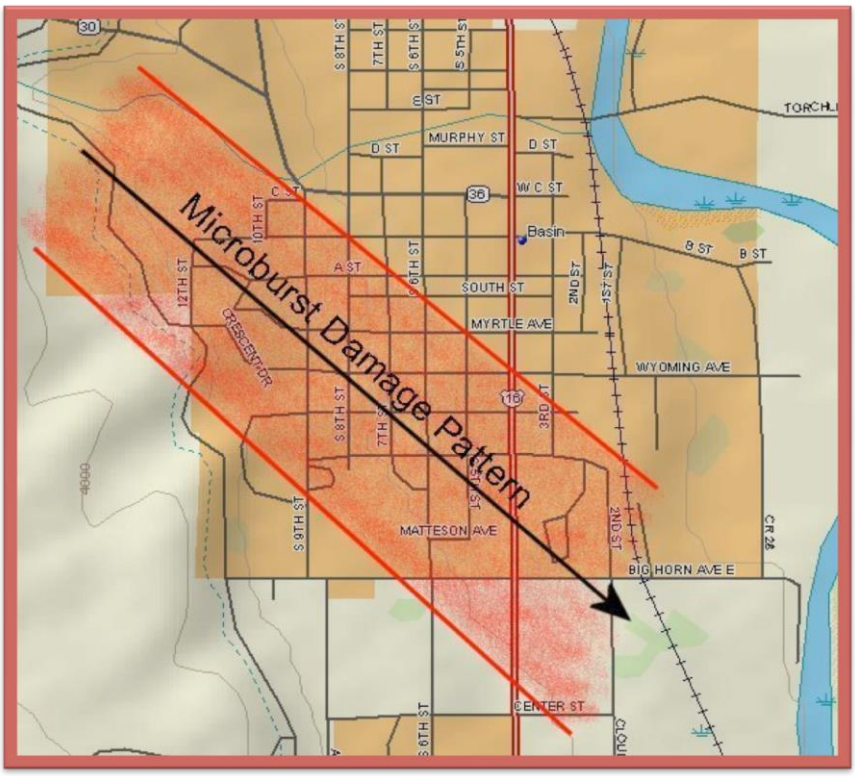
Past Occurrences

In Big Horn County most documented wind events causing damage typically range between 55 and 70 mph, and have been recorded at speeds up to 100 mph. Within the category of high winds, the county is susceptible to downbursts, as described by the NOAA Riverton Office following a July 31, 2004 event impacting the Town of Basin.

Taken from an account by the Big Horn Sherriff's Office: A weather station located in Basin near the northwest fringe of the damage only reported a wind gust of 20 mph as the storm began around 5:19 p.m. Phone calls to the Big Horn County Sheriff's Office began about the same time with a report of a tree blown over into the southbound lanes of US Highway 16/20 near Wyoming Avenue. Northwest of

town, three power poles were toppled by the strong wind. Soon after, a residence was reported to have lost the top layer of roofing material. By 5:26 p.m. calls were coming in from around town of numerous trees and limbs down. The greatest concentration of damage appeared to have occurred between 6th and 9th streets and South Street and Montana Avenue. A garage was struck by several large tree limbs, causing a gouge in the roof and tearing the gutters from the roof. Another report indicated that a van travelling south on US Highway 16/20 through Basin was struck in the driver's-side windshield by a flying tree limb. No injuries or deaths were reported during the event.

Figure 3-42 Microburst Path, Basin Wyoming July 2004



Source: http://www.crh.noaa.gov/riw/archive/basinmicro.php

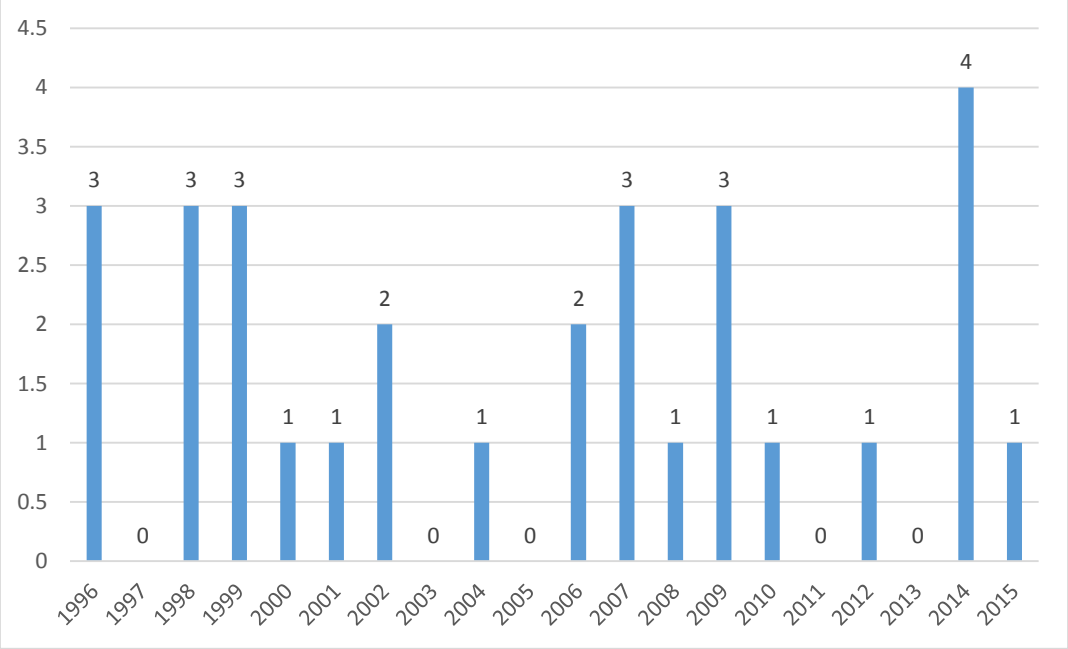
The National Climatic Data Center (NCDC) refers broadly to the Big Horn Basin in its data reports, as wind events tend to sweep from the east slopes of the Absaroka Range or from the direction of the Beartooth Range to the north, across the region and into the western slopes of the Big Horn Mountains. Data prior to 1996 was somewhat less detailed and provided limited information. However, occurrences specifically referring to Big Horn County as found in previous versions of this plan and NCDC database are summarized below. A complete list of wind weather events can be found in Appendix B.

Table 3-30 Summary of Wind Weather Events and Impacts. Big Horn County 1993 to 2015.

Total Number of High Wind Events	Total Property Damage	Total Fatalities	Total Injuries	Average Max Wind Speed (Knots)
35	**$262,000**	**1**	**1**	**58.5**

Source: NCDC, SHELDUS and NOAA

Figure 3-43 High Wind Events by Year. Big Horn County 1996 to 2015

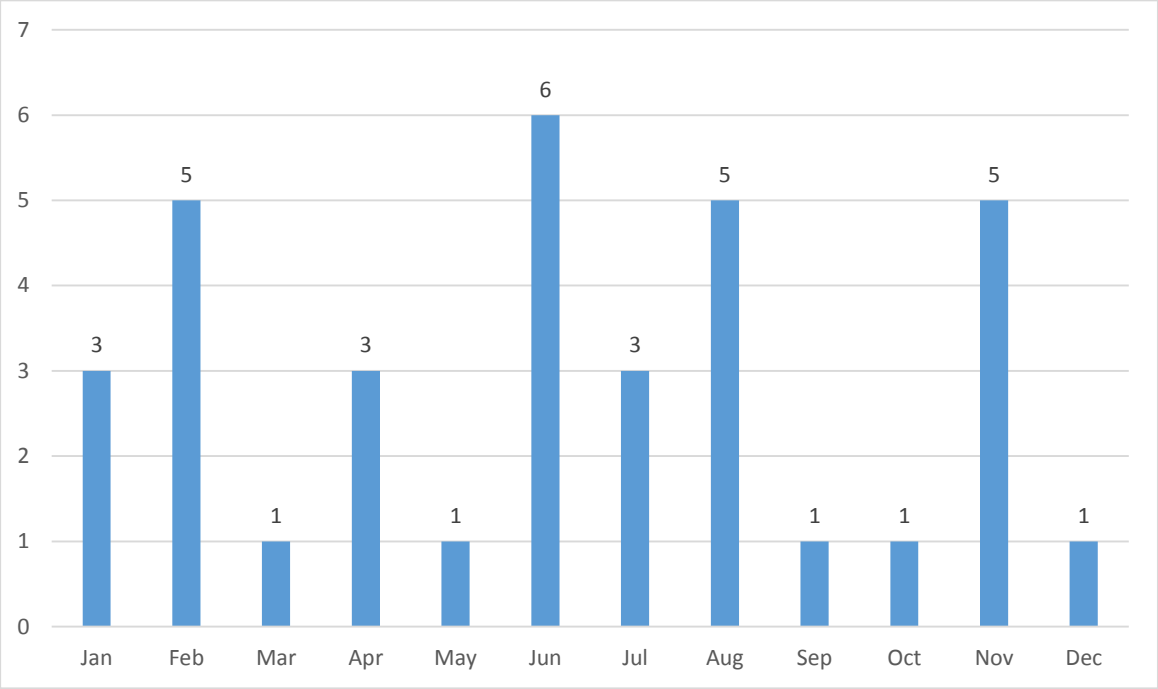


Source: NCDC

Frequency

Big Horn County experiences weather patterns that form or travel in the Basin region from any direction and foster high winds, downbursts, and tornadoes. Thirty-five (35) high wind events specifically impacting Big Horn County have been confirmed and documented since 1985.

Figure 3-44 High Wind Events by Month. Big Horn County 1985-2015



Source: NCDC and Big Horn County MHMP 2010

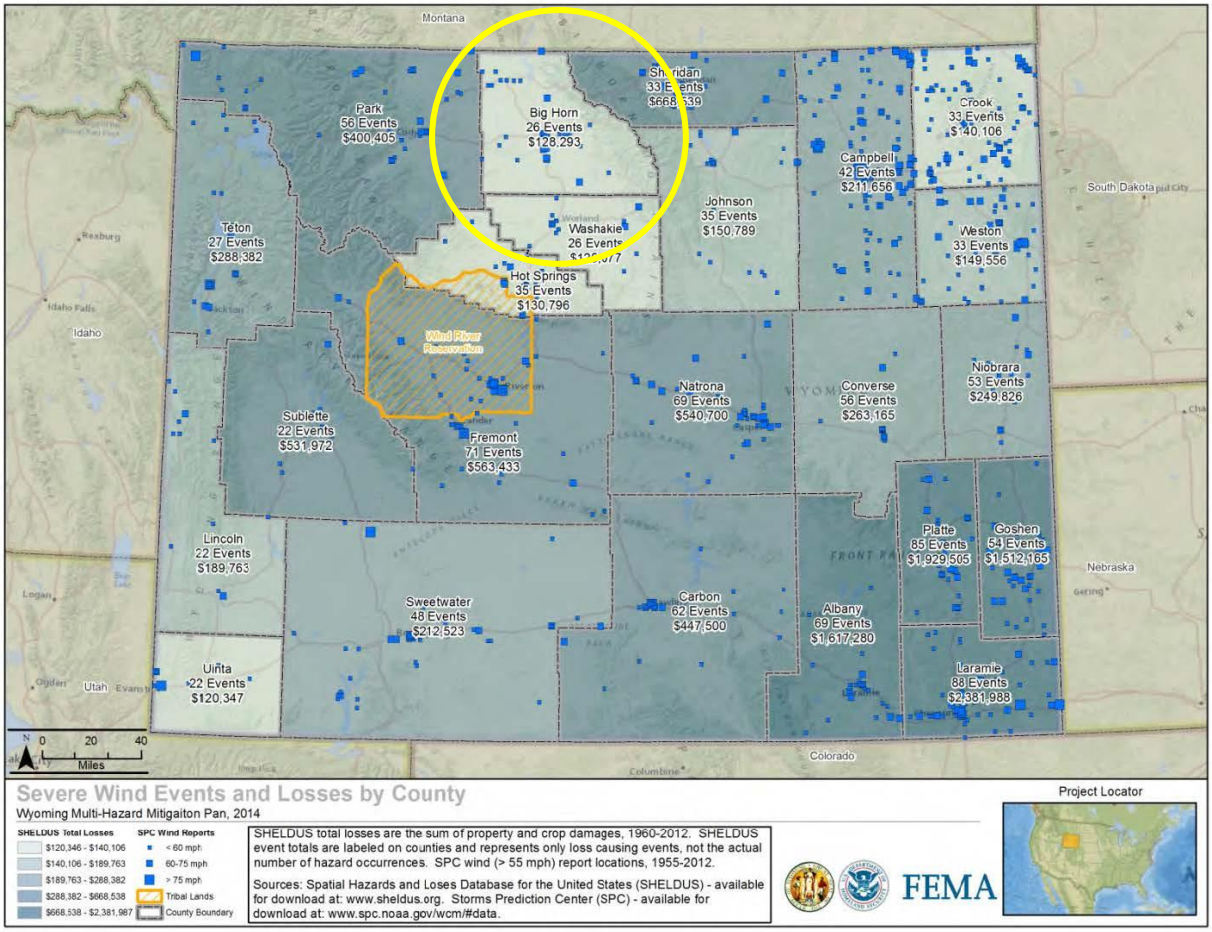
Big Horn County experiences an average of one significant high wind event per year, with a damaging event occurring approximately once every 3.8 years (1985 to 2015). Incidence of events appears to be randomly distributed, with no clear trends by time of year. See **Figure 3-44.**

Vulnerability

Vulnerability as it relates to location is random, as damaging winds have occurred everywhere in the county. Damage from high winds is often described in regional or broad areas, but downburst damage will impact a small area most generally less than three miles in diameter. Because state or presidential emergency or disaster declarations have not been necessary in the aftermath of wind events in Big Horn County, and because damage to personal property is dealt with by numerous private insurance companies, it is difficult to estimate actual monetary impacts that have occurred due to damaging winds. See section on Potential Losses for loss estimates based on reported damage. The county holds no record of crop loss due to wind

Potential Losses

According to the Spatial Hazards and Losses Database for the United States (SHELDUS) and the 2014 Wyoming Hazard Mitigation Plan, Big Horn County suffered 26 damage causing wind events between 1960 and 2012, and a cumulative $128,293 in damage as a result of these events ($4,934/event average).



Source: Wyoming Multi Hazard Mitigation Plan, 2014

Future Development

Historical data demonstrates that the most critical area of the state for high wind hazards is the eastern one third, excluding Big Horn County. Nevertheless, future residential or commercial buildings built to code should be able to withstand wind speeds of at least 150 miles per hour.

Summary

Many areas of the United States are prone to damaging wind events, and while Big Horn County may not be counted in a high category for occurrences across the nation, it does have a history of such episodes which should be anticipated for the future. Primary damage is structural and utility-borne. Although minimal deaths and injuries have been reported, the frequency of occurrence is due consideration, as well as the hazard to rural citizens and town populations from falling trees, power poles, and flying debris.

Photos and scattered reports document property damage (including damage to private utilities) occurring as a result of wind events, yet cumulative losses due to wind damage have been negligible.

Loss Potential:	**Low**
Population Impacted:	**Medium**
Probability:	**High**
Jurisdictions at Risk:	**All**

Tornado

Narrative

A tornado is a swirling column of air extending from a thunderstorm to the ground. Maximum winds in tornadoes are often confined to extremely small areas, and vary tremendously over very short distances, even within the funnel itself. Tornadoes can have wind speeds from 40 mph to over 300 mph, the majority displaying wind speeds of 112 mph or less. Erratic and unpredictable, they can move forward at up to 70 miles per hour, pause, slow down and change directions. Most have a narrow path, less than 100 yards wide and a couple of miles long. However, damage paths from major tornadoes can be more than a mile wide and 50 miles long.

Based on national statistics for 1970 – 1980, for every person killed by a tornado, 25 people were injured and 1,000 people received some sort of emergency care. Tales of complete destruction of one house next to a structure that is totally unscathed are well documented. Within a building, flying debris or missiles are generally stopped by interior walls. However, if a building has no partitions or has any glass, brick or other debris blown into the interior, the tornado winds can be life threatening. In order to examine tornado activity and the potential impact on Big Horn County and its residents, it is important to understand how tornadoes are rated.

Rating a Tornado

In 1971, Dr. T. Theodore Fujita of the University of Chicago devised a six-category scale to classify U.S. tornadoes into intensity categories, F0 through F5. These categories are based upon the estimated maximum winds occurring within the funnel. The Fujita Tornado Scale (or the "F Scale") became the definitive scale for estimating wind speeds within tornadoes based upon the damage done to buildings and structures. It is used extensively by the National Weather Service in investigating tornadoes (all tornadoes are now assigned an F scale), and by engineers in correlating damage to building structures and techniques with different wind speeds caused by tornadoes.

Table 3-31 Fujita Scale Description

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage Done
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages signboards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.

Recent Changes to Tornado Rating Scale

Devastating tornadoes in Jarrell, Texas on May 1997 and Moore/Oklahoma City on May 1999 demonstrated to that the wind estimates in the original F-scale may be too high. From 2000 to 2004, the Wind Science and Engineering Research Center at Texas Tech University, in cooperation with numerous expert meteorologists, civil engineers and the National Weather Service (NWS), developed an Enhanced Fujita Scale, or EF-scale. In addition to improving the ranking process, it was essential to the development team that the new EF-scale support and be consistent with the original F-scale. The EF-scale documentation includes additional enhanced descriptions of damage to multiple types of structures and vegetation with photographs, a PC-based expert system, and enhanced training materials.

In February 2007, the Enhanced Fujita scale replaced the original Fujita scale in all tornado damage surveys in the United States. The following table compares the estimated winds in the original F-scale with the operational EF-scale that is currently in use by the NWS.

Table 4.31 - The Enhanced Fujita Tornado Scale

	FUJITA SCALE		OPERATIONAL EF-SCALE	
F Number Fastest	**Fastest 1/4 – mile (mph)**	**3 Second Gust (mph)**	**EF Number**	**3 Second Gust (mph)**
0	40-72	45-78	0	65-85
1	73-112	79-117	1	86-110
2	113-157	118-161	2	111-135
3	158-207	162-209	3	136-165
4	208-260	210-261	4	166-200
5	261-318	262-317	5	Over 200

Past Occurrences

Tornado statistics, especially prior to the 1970s, must be viewed as incomplete since many twisters have occurred without being witnessed. Wyoming's open rangelands experience little if any damage from these storms, so many go unreported. Many documented tornadoes occurring in Big Horn County are given low ratings on the Fujita Scale (F0s and F1s) simply because tornadoes are often formed over open land and result in little or no damage.

There have been 32 tornadoes in Big Horn County documented by the National Climatic Data Center since 1958. A full accounting of those tornadoes can be found at the end of this chapter. A cumulative history is found in the following table:

Table 3-32 Summary Tornado History, Big Horn County

CUMULATIVE TORNADO HISTORY BIG HORN COUNTY 1958-2014				
NUMBER OF EVENTS	**INJURIES**	**FATALITIES**	**TOTAL RECORDED PROPERTY DAMAGE**	**TOTAL RECORDED CROP DAMAGE**
32	2	1	$352,500	$0

Source: National Climatic Data Center

Table 3-33 List Tornado History, Big Horn County

Location	Date	Time	Magnitude	Fatalities	Injuries	Property Damage	Crop Damage
County	6/3/1958	16:00	F2	0	0	$25,000	$0
County	6/26/1959	16:00	F2	1	1	$2,500	$0
County	7/28/1959	17:30	-	0	0	$2,500	$0
County	6/12/1962	16:00	F2	0	0	$2,500	$0
County	7/9/1962	16:00	F2	0	0	$2,500	$0
County	6/5/1964	15:10	-	0	0	$25,000	$0
County	7/24/1967	16:00	F2	0	0	$2,500	$0
County	6/20/1974	15:00	F1	0	0	$2,500	$0
County	6/20/1974	15:30	F1	0	0	$2,500	$0
County	7/20/1964	20:30	F1	0	0	$2,500	$0
County	7/4/1976	17:00	F1	0	0	$0	$0
County	6/18/1978	21:00	F1	0	0	$25,000	$0
County	7/4/1978	14:30	F2	0	1	$250,000	$0
County	7/24/1981	15:00	F1	0	0	$0	$0
County	5/3/1984	18:30	F0	0	0	$2,500	$0
County	8/2/1985	13:30	F3	0	0	$0	$0
County	6/18/1987	17:08	F0	0	0	$0	$0
County	7/12/1992	12:55	F0	0	0	$0	$0
Greybull	6/6/1997	16:58	F0	0	0	$0	$0
Basin	6/6/1997	17:00	F0	0	0	$0	$0
Greybull	6/6/1997	17:10	F1	0	0	$0	$0
Basin	6/13/1997	18:25	F0	0	0	$0	$0
Basin	6/13/1997	18:35	F0	0	0	$0	$0
Basin	7/24/1997	15:09	F0	0	0	$0	$0
Basin	6/26/2001	17:42	F0	0	0	$0	$0
Greybull	6/26/2001	17:56	F1	0	0	$0	$0
Byron	6/1/2005	12:29	F0	0	0	$0	$0
Lovell	6/1/2005	12:38	F0	0	0	$0	$0
Burlington	6/1/2005	12:40	F0	0	0	$0	$0
Rairden	6/1/2009	14:58	EF1	0	0	$5,000	$0
Emblem	8/12/2010	14:11	EF0	0	0	$0	$0
Cowley Airport	5/24/2014	13:36	EF0	0	0	$0	$0
TOTALS				**1**	**2**	**$352,500**	**$0**

Source: National Climatic Data Center

Frequency

Recorded tornadoes occurred during the months of May, June, July, and August, between 11 a.m. and 10 p.m. Historical ratings vary between F0 and F3 on the F-scale, or between EF-0 and EF-1 on the EF-scale. Most recorded tornadoes in the County are rated as F-0 or EF-0.

Two recorded injuries and one recorded fatality are attributed to these tornadoes. Cumulatively, the storms have caused $352,000 in recorded property damage, and $0 in recorded crop damage. Property

damage has been described as downed tree limbs and power outages, damage to homes, sheds and outbuildings to include roofs and chimneys, and downed timber on forest lands.

Figure 3-46 F-Scale Tornadoes By Rating. Big Horn County 1958 - 2005.

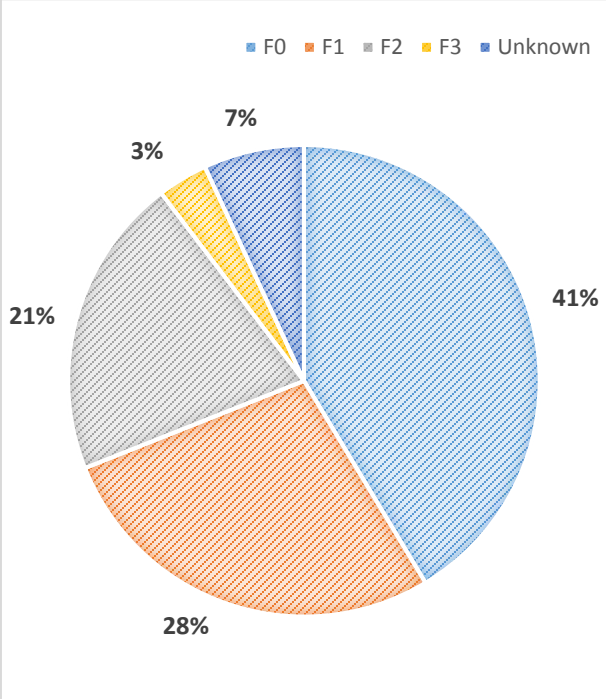


Figure 3-45 EF-Scale Tornadoes By Rating. Big Horn County 2007 - 2014

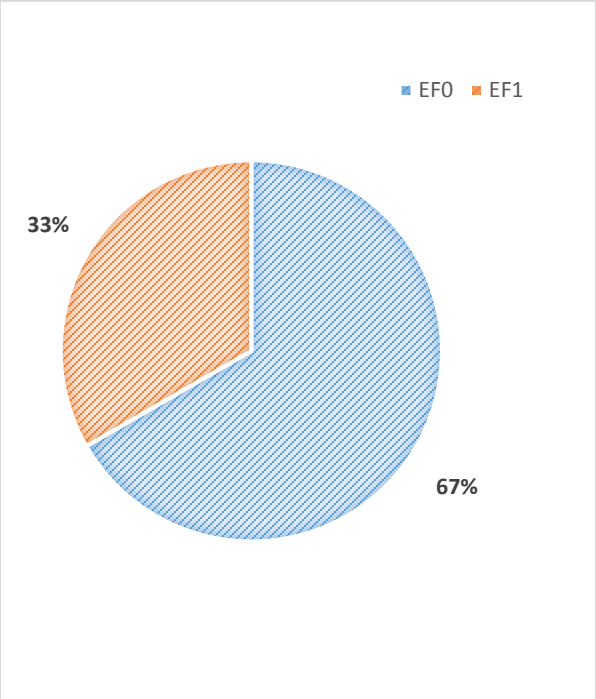


Figure 3-47 Historical Tornadoes by Month. Big Horn County 1959 - 2014

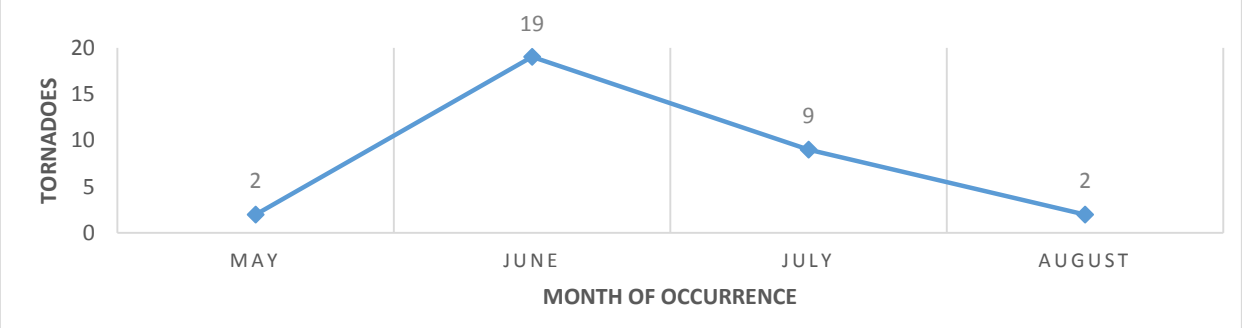
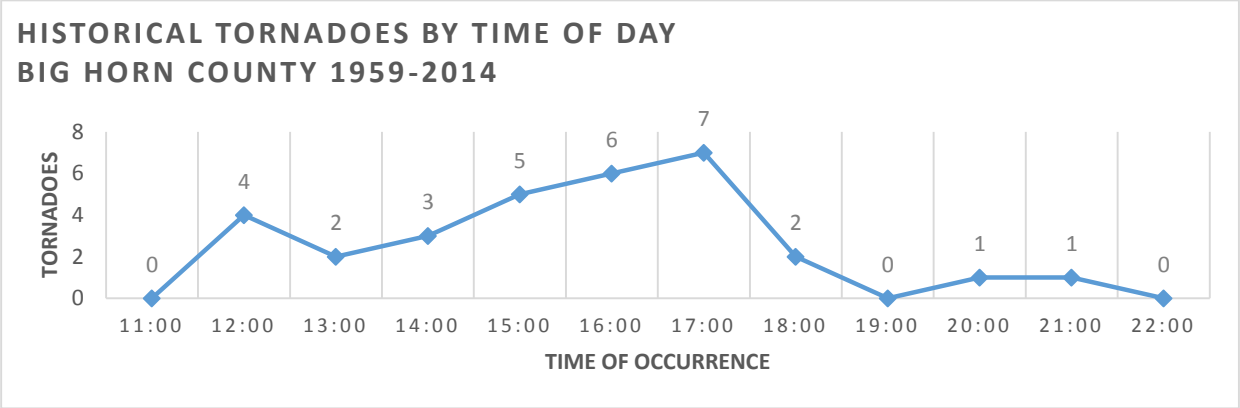


Figure 3-48 Historical Tornadoes by Time of Day. Big Horn County 1959 - 2014.



Most recorded tornadoes cause no recorded injuries, no recorded fatalities, and little to no damage to property ($2,500 - $25,000 range). However, there are a few notable exceptions in the County's tornado history.

On June 26, 1959, an F2 tornado 333 yards wide traveled 9.2 miles across the county, causing one direct fatality, one direct injury, and $2,500 in property damage in 1959 dollars.

On July 4, 1978, an F2 tornado 200 yards wide traveled five miles northeast across the county, uprooting numerous trees in over 800 acres of forest near Greybull. One woman was injured in a camper as it was rolled over by winds. Damages to a lodge at a dude ranch were also noted. Cumulative damages in 1978 dollars were $250,000 to property, and $0 to crops.

Vulnerability

Because of its rural composition, people or property within the county have not had a history of being severely impacted during past tornado incidents. While the F-Scale ratings of historical tornadoes in Big Horn County are low, those ratings are based on recorded damage. Recorded damage may have been much more substantial if these tornadic events had impacted one of the nine cities or towns within Big Horn County, rather than timber, outlying range, and farm acreage.

Several tornadoes per year have been consistently documented as occurring somewhere in Big Horn County almost every year for the past 51 years. These events occur at random locations throughout the jurisdiction, and for that reason all structures, critical facilities, essential services, and populations are considered vulnerable.

Future Development

Any future development that is exposed and above ground will be vulnerable to a direct or indirect hit by a tornado. In order to better withstand impacts from tornadoes or other high wind events, future residential or commercial buildings built to code should be able to withstand wind speeds of at least 150 miles per hour.

Summary

Tornadoes are a credible threat, and will continue to occur in Big Horn County. Depending on a tornado's size, ferocity and path, it can cause devastating damage to people, property and infrastructure.

A tornado in the County occurs on average every 1.75 years in June, between noon and 5 p.m. The tornado is rated EF-0 or EF-1, and does between $2,500 and $25,000 worth of damage to property, though it mostly strikes rural areas. This is due more to chance than any environmental factor, however, as inhabited areas are statistically equally at risk of a tornado strike; the potential for injuries, fatalities and damage in these areas is much greater.

These tornadic events are often accompanied by flash flooding and severe hail, and present a serious triple threat (flood and hail threats are addressed separately in this document, under respective profiles).

Loss Potential: **High**

Population Impacted: **Moderate**

Probability: **High**

Jurisdictions at Risk: **All**

Wildfire

Narrative

Defined as a highly destructive fire or any instance of uncontrolled burning in grasslands, brush or woodlands, wildfire has encroached into urban interface situations as more people move closer to forest settings. Furthermore, the past 100 years of wildland fire suppression have led to heavy vegetation growth, greatly increasing the potential fuel-load for a wildfire to burn.

Fires have historically played a natural role on western landscapes. For example, some species of trees occupy sites following fire until replaced by more shade-tolerant species. In some cases regeneration of vegetation can be enhanced by fire. Fires may have positive or negative effects, or both, depending upon the resources at risk in the fire area.

Wildfires can occur at any time of the year, but are most likely to occur during the spring, summer or fall. Thunderstorms that contain lightning frequently start wildfires, but they can also be caused by humans. Wyoming's semi-arid climate and rural character make the state vulnerable to catastrophic wildland fires, which comprise more than 50% of all fires in Wyoming.

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 following agencies:

- County and Local Fire Departments and Districts
- Wyoming Fire Academy
- Wyoming State Fire Marshall's Office
- Wyoming State Forestry Division
- Wyoming Office of Homeland Security (WOHS)
- Geospatial Multi-Agency Coordination (GeoMAC) Wildland Fire Support Maps

- National Parks Service (NPS) Fire Management Program
- US Fish and Wildlife Service Fire Management Program
- National Interagency Fire Center (NIFC)
- USDA Forest Service (USFS) Fire and Aviation Management
- US Bureau of Land Management

Past Occurrences

Big Horn County has a long history of wildfire, as a significant portion of the county is located in the Big Horn Mountains. 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.

Historically, most significant fires in Big Horn County have occurred in the eastern region, in and around the foothills and higher elevations of the Bighorn Mountains (Bighorn National Forest, US Forest Service, see **Figure 3-49**).

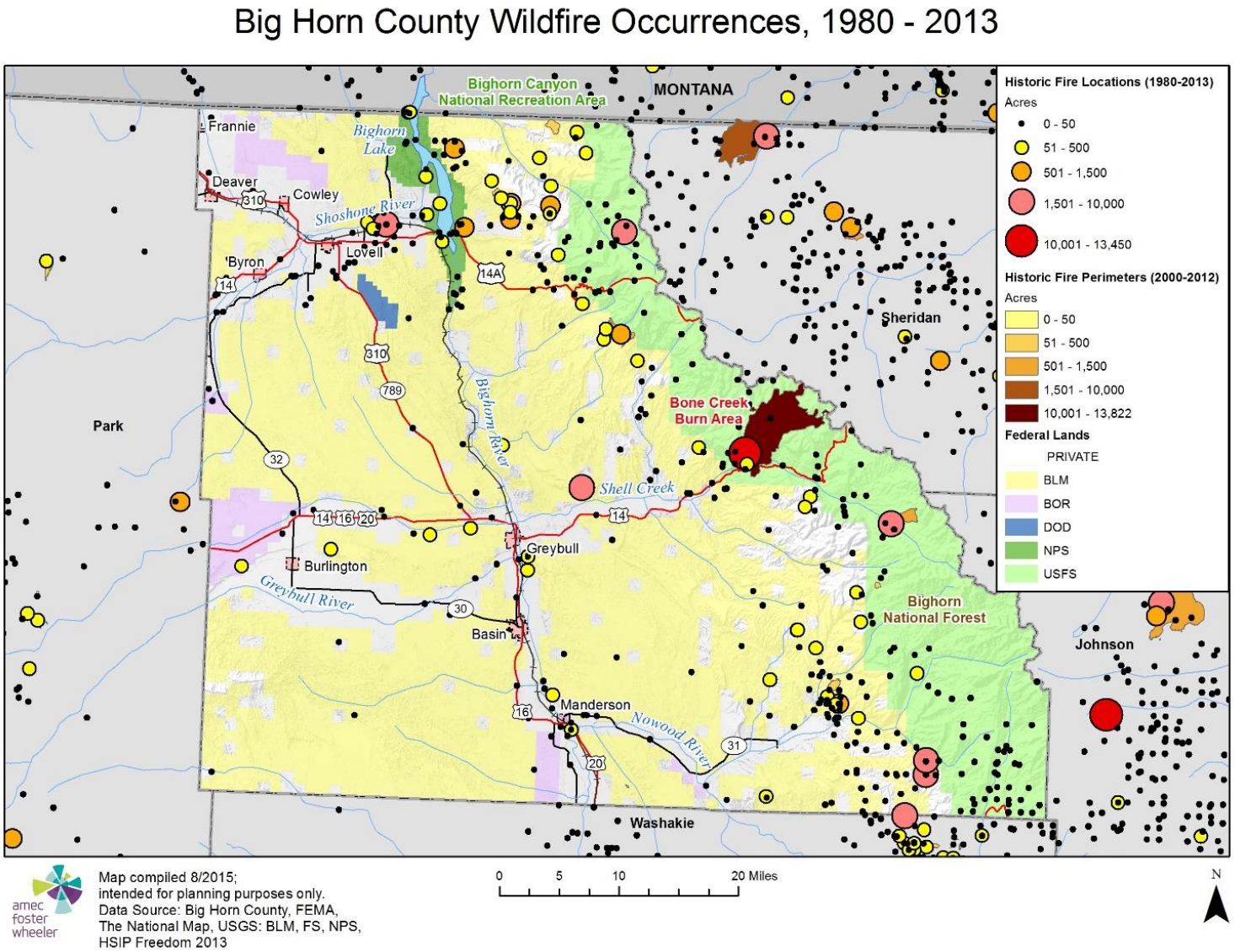
More recently there have been several fires affecting over 1,000 acres, and many smaller fires throughout the county (see **Table 3-31**). Lightning starts many wildfires, but a number of structures in Big Horn County have burned as a result of out-of-control irrigation ditch burning to clear vegetation and debris for agricultural field operations (*Source: Wyoming Multi-Hazard Mitigation Plan 2014).*

Table 3-34 Major (+1,000 Acres) Fires – Big Horn County 1975 to 2015

Name	Year	Acres Burned
Meadowlark Lake Fire	1975	1,900
Dorn Draw Fire	1988	1,514
Intermission Fire	1988	1,800
Little Mountain Fire	1997	1,083
Copper Fire	2003	2,500
Bone Creek Fire	2007	13,450
Reservoir Fire	2011	2,200

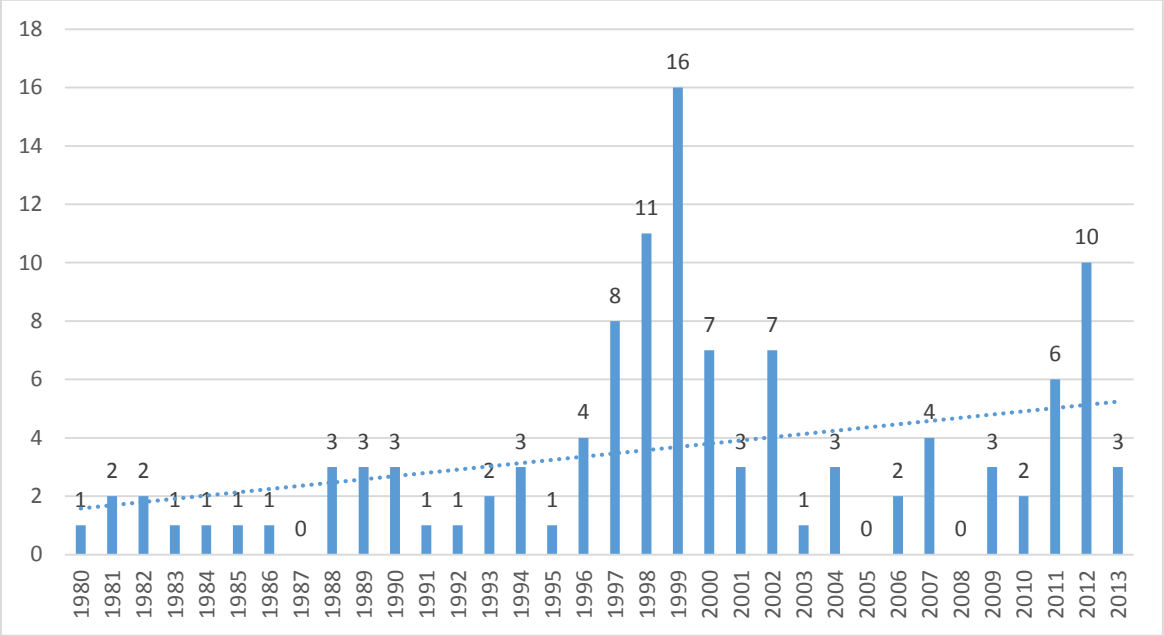
Sources: Big Horn County WRDS, HSIP Freedom

Figure 3-49 Big Horn County Wildfire Occurences, 1980 - 2013



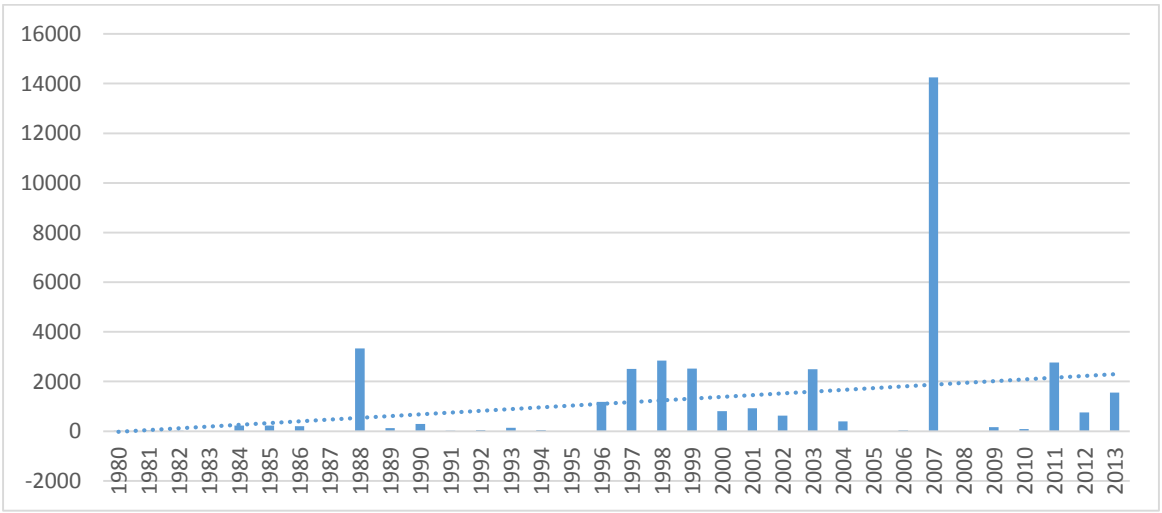
The clear upward trend in wildfires is a cause of concern as the wildland urban interface (WUI) increases while resources to manage and control wildfires remain limited. A total of 116 significant (more than 10-acre) fires have been recorded in Big Horn County since 1980 **(**see **Figure 3-50).** Total acres burned by year also show an upward trend, with over 38,000 acres burned in Big Horn County since 1980.

Figure 3-50 Number of Wildfires per Year – Big Horn County 1980 to 2013



Sources: Big Horn County WRDS, HSIP Freedom

Figure 3-51 Total Acres Burned by Year - Big Horn County 1980-2013



Sources: Big Horn County WRDS, HSIP Freedom

Impacts

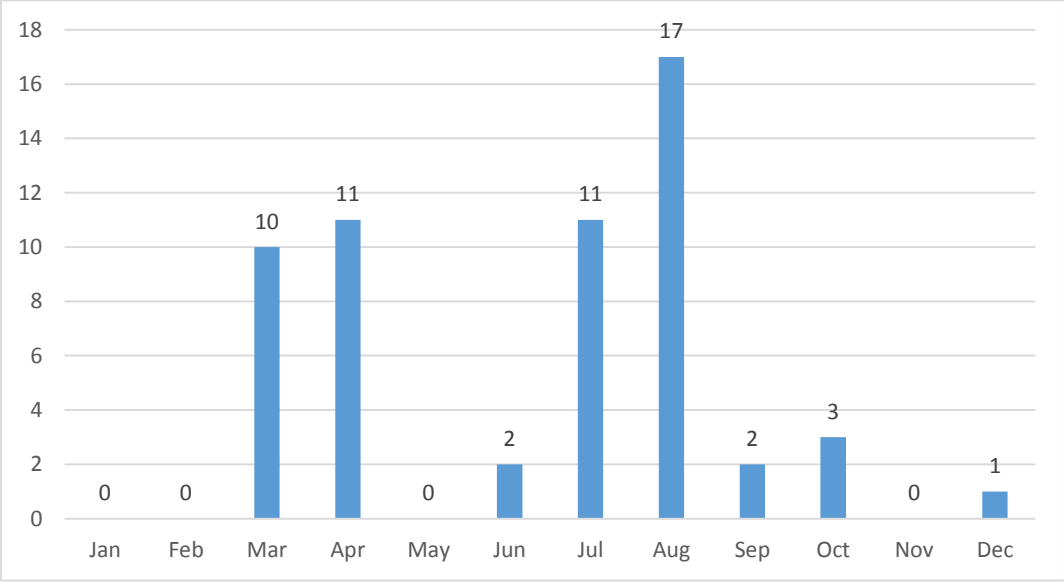
Potential impacts from wildland fires include the following:

- Loss of life (human, livestock, fish and wildlife)
- Loss of property
- Evacuations
- Transportation and business interruption
- Natural resource impacts to air and water quality

Frequency

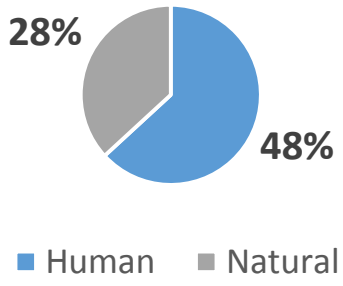
Fires in Big Horn County are likely to occur in either early spring or late summer, as the frequency distribution by month shows in **Figure 3-52**.

Figure 3-52 Significant Fires by Month – Big Horn County 1980 to 2013



Sources: Big Horn County WRDS, HSIP Freedom

Figure 3-53 Significant Fires by Ignition Source – Big Horn County 1980 to 2013



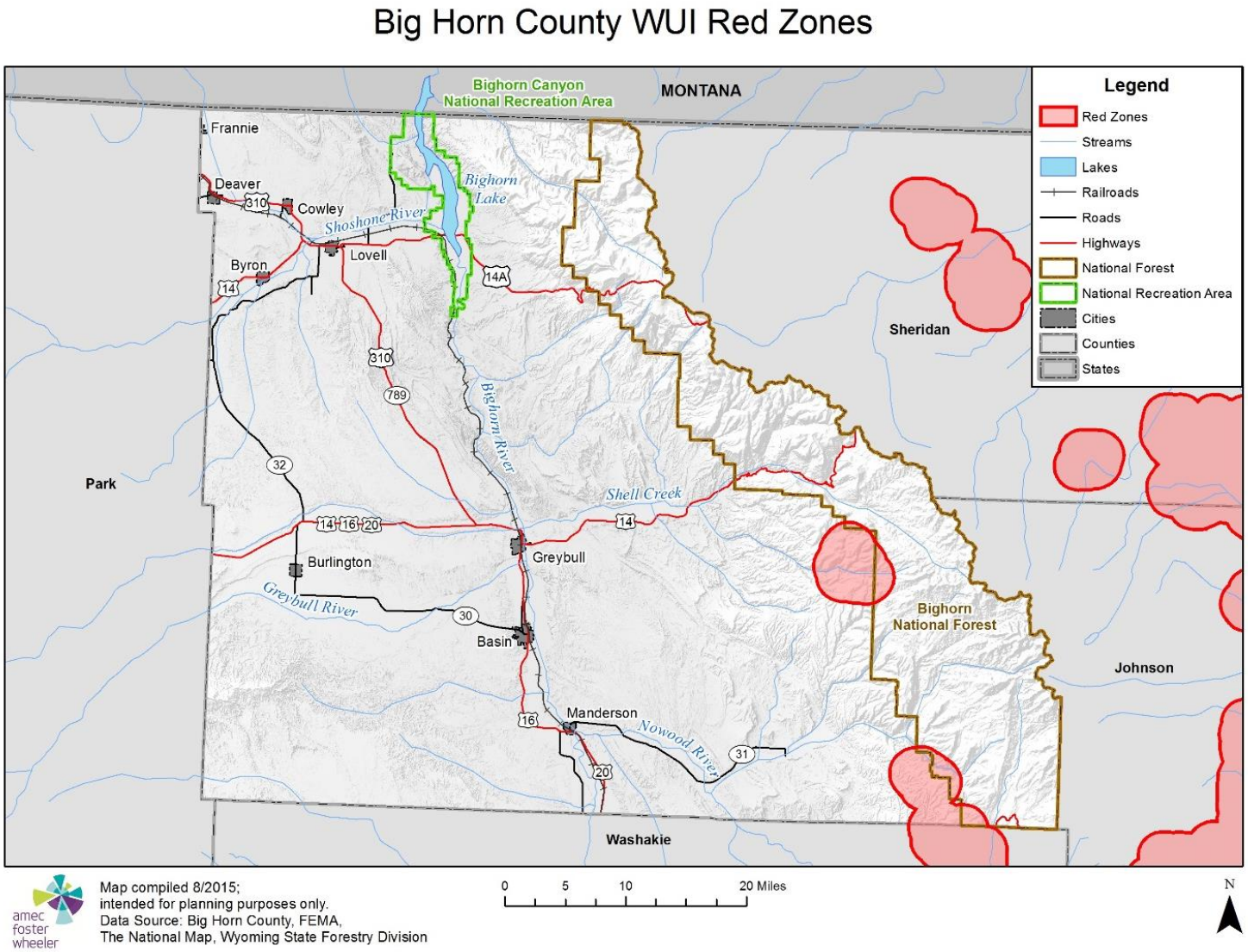
Sources: Big Horn County WRDS, HSIP Freedom

Additionally, wildfires in Big Horn County are more likely to be caused by humans, as 48% of the total fires in the county are attributable to non-natural causes (see **Figure 3-53**).

Vulnerability

Currently, the principal action plan for the State is 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 is a Risk, Hazard, and Value (RHV) map displaying areas of concern (Redzones) for catastrophic wildland fires (see **Figure 3-54**). 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 3-54 Big Horn County WUI Red Zones



The wildland and wildland-urban interface areas in Wyoming are of most concern and are shown on the previous page. As of 2015, there are limited areas of concern located in the rural areas at the base of the Bighorn National Forest in the southeastern part of the county.

In 2005, the county commissioned Technical Forestry Services (TFS) to develop the Big Horn County Mountain Community Wildfire Protection Plan (Big Horn Co. Mountain CWPP) to assess wildfire vulnerability in terms of structures, fuels, water supply, routes of travel and current fire protection. This plan was limited in scope as it only focused on mountain communities (second homes, cabins, lodges, private inholdings, etc.) located in the Big Horn National Forest. The analysis performed involved a matrix comparison of a number of factors including: fire hazard rating, fire occurrence rating (frequency interval), community layout hazard rating, structure ignitability hazard rating and fire risk rating value. Based on this analysis, the following mountain communities—none of which are incorporated--fell within the 'high' fire risk rating:

- Deer Haven (41 structures)
- Granite Creek (16 structures)
- Sitting Bull (6 structures)
- Porcupine (20 structures)
- Shell Falls (2 structures)
- Ranger Creek (30 structures)
- West Tensleep (10 structures)
- Medicine Mountain (1 structure)

Source: Big Horn County Mountain CWPP 2005

In addition to the potential wildfire hazard in the Big Horn Mountains, the county is threaded with river drainages, creek bottoms, and irrigation canals that are overgrown with invasive species (Russian olive and tamarisk) adding both downfall and live growth fire load. The Big Horn River, Greybull River, and Shoshone River, as well as secondary waterways, are densely overgrown with these trees. Many of these waterways flow through population centers within the county. Along these rivers lie the towns of Lovell, Greybull, Basin, and Manderson. The unincorporated town of Shell is also at risk. Scattered between the towns and on the lesser watersheds are a number of ranches and farms that could also be affected by the threat of wildfire. A wildfire event in almost any one of these drainages could threaten critical structures and prompt evacuations.

To address these risks, the 2005 CWPP was amended in 2010 (Big Horn County CWPP Addendum 2010) to add the watersheds outside the National Forest and to include the rest of the county (see **Figure 3-55**). The Addendum also addressed actions to be taken to lessen the impact of wildfire in the study areas.

The Addendum ranked the communities in Big Horn County based on the following methodology:

- **Low** if within the next 10 years there is a probability of a fire that will not exceed 99.9 acres

- **Moderate** if within the next 10 years there is a probability of a fire that will be larger than 99.9 acres but will not exceed 299.9 acres

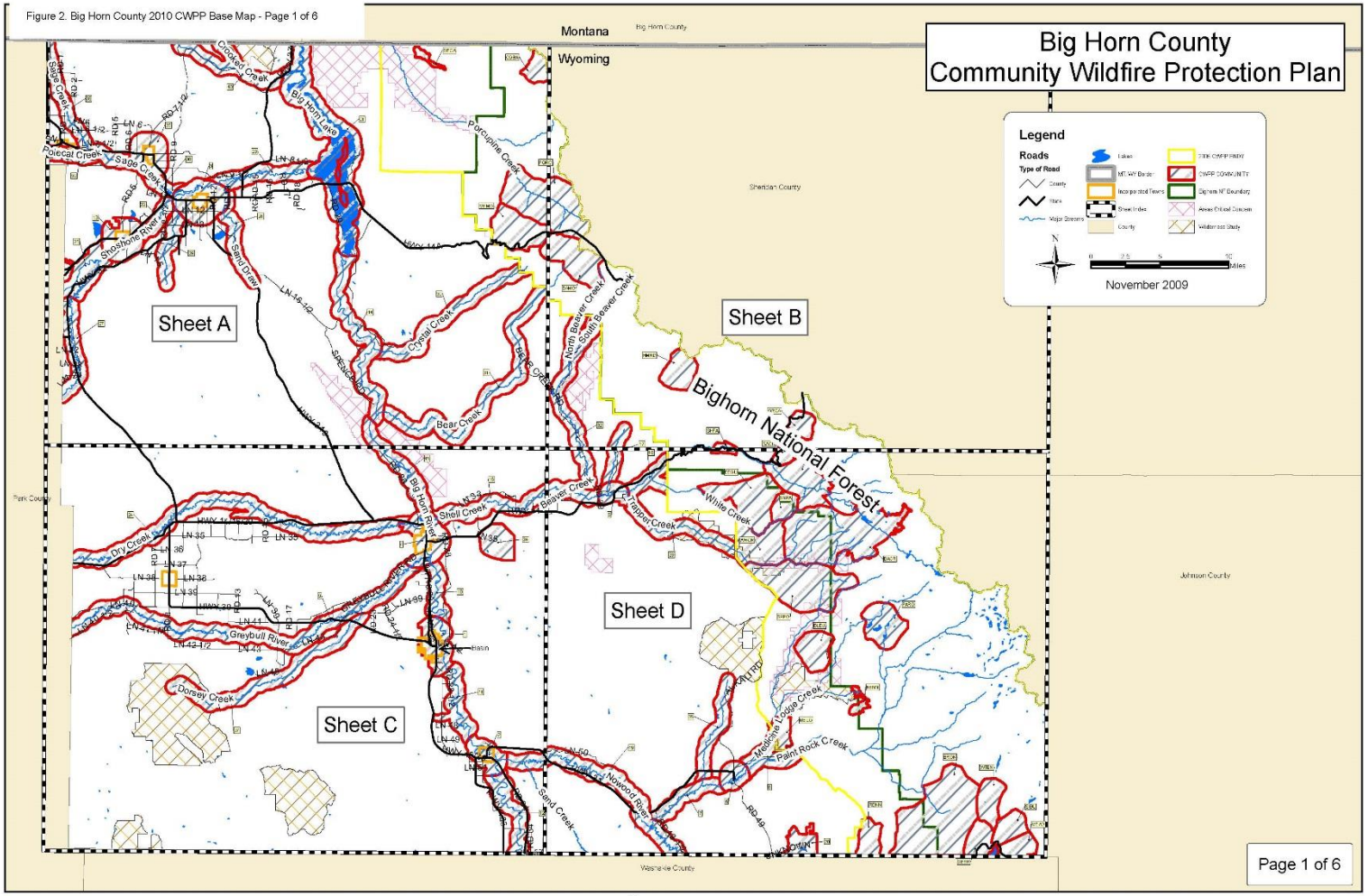
- **High** if within the next 10 years there is a probability of a fire that will be larger than 300 acres

The following communities received a **high** wildfire risk factor based on this methodology:

- Medicine Lodge Cr & Paintrock Cr (2005 CWPP boundary to Hyattville)
- Paintrock Creek (Hyattville to Nowood River confluence)
- Lovell (Town)
- Basin (Town)
- Manderson (Town)
- Greybull (Town)
- Shell (Town)
- Hyattville (Town)

Based on this analysis, there are approximately 33,379 acres in Big Horn County that have been rated as **high** wildfire risk.

Figure 3-55 Big Horn County Communities Wildfire Hazard Risk



Source: Big Horn County CWPP Addendum 2010

Potential Losses

According to the 2010 Big Horn County Future Land Use (FLU) Plan, Big Horn County contains two of the top 20 locations in Wyoming for seasonal homes. One is Meadow Lark Lake area in the Big Horn Mountains. The second location is the unincorporated town of Hyattville, showing 32% of housing units as seasonal in 2000 Census figures. Inside the county boundaries, 220 cabins in 25 different community groups ranging from just south of the Montana state line to the whole length of the county to the Washakie County line, reside throughout the Big Horn Mountains *(Source: Big Horn County Mountain CCWP).*

The Big Horn County Assessor's Office was not able to provide values on these privately owned structures on federal land. While all those structures are vulnerable to wildfire and other hazards, it is not possible to assign potential estimates or figures on financial vulnerability of personal property until more data becomes available.

Building exposure value, or structures that have potential to be involved in a wildland fire, is used as an indicator of the amount of potential losses a county could experience in a fire event.

No estimates were provided in the Big Horn County CWPP 2005 or 2010 Addendum regarding vulnerability to economic or service loss as it might relate to total taxable value of the county's commercial forest land, timber losses, loss or non-use of public grazing lands, or identification and valuation of critical facilities or infrastructure.

See discussion in Hazard Identification section for estimates on potential building and content losses by community.

The 'Local Risk Assessment' conducted in the 2014 Wyoming Multi Hazard Mitigation Plan found Big Horn County to be at **medium-high** risk of losses based on population impacted, probability of occurrence within the county, property impacted, and risk perceived by each county relative to wildland fire hazards.

Future Development

Population growth and increased areas of wildland/urban interface are prompting policy makers, fire management organizations, and mapping technology to respond to the mounting need to mitigate wildfires to protect the residents and visitors of Wyoming. Any future development built in wildfire-prone areas should institute basic wildfire mitigation features, for example adequate access, water supply, and appropriate building materials, in order to protect lives and property.

The wildland/urban interface (WUI) is a very popular building location, as shown by national trends. More and more homes are being built in the interface. Regulating growth in these areas will be a delicate balance between protecting private property rights and promoting public safety. Should Big Horn County begin to experience this type of growth, local government may wish to consider regulation of subdivision entrance/exit roads and bridges for the safety of property owners and fire personnel, building considerations pertaining to land on slopes greater than 25% (in consideration of access for fire protection of structures), and water supply requirements set forth to include ponds, access by apparatus, pumps, and backup generators. Such standards serve to protect residents and property, as well as emergency services personnel.

Summary

Because of the large percentage of land under the management of the federal government within the county (almost 80%), a commitment toward risk reduction and mitigation efforts between all levels of government will be an important factor in protecting populations, infrastructure, agricultural grazing lands, and timber.

With the Big Horn County Community Wildfire Protection Plan (CWPP) in place, countywide vulnerability to wildfire should be reduced. It is incumbent upon local officials and residents alike to recognize that the Russian olive infestations are largely on private lands, as most privately owned lands and populations reside along the numerous waterways in the county. Through federal funding programs there is currently a very strong effort underway in the Big Horn Basin to eradicate the invasive growth of tamarisk and Russian Olive trees along natural and man-made (irrigation ditch) waterways. Although this will help the situation, reduction is a long process and will require many years to complete, adequate funding, and a strong commitment by the communities to maintain. From a county standpoint, and perhaps as an ultimately more sustainable approach, priorities similar to the NRCS in Russian Olive control may be more effective. That approach is to gain control and propagate re-vegetation at higher reaches of each waterway, working downstream to the Big Horn River as the primary goal. This is to try to mitigate the downstream spread of invasive species by seed migration (seeds are viable for three years).

Wyoming continues to be proactive and strategic in addressing wildfire mitigation projects. The Preservation and Enhancement Fund, state legislative funding utilized for fuels mitigation and road maintenance projects in a competitive process, has expended, on average, $99,000 annually over the past six (6) years for mitigation throughout the state, including Big Horn County. In addition, projects to mitigate wildfire hazards, specifically fuel removal, tree thinning, creation of wildfire defensible zones, and planting programs to spread fire resistant landscaping are occurring in 15 Wyoming counties, including Big Horn (Source: Wyoming Multi-Hazard Mitigation Plan 2014).

Loss Potential:	**Medium**
Population Impacted:	**Medium**
Probability:	**High**
Jurisdictions at Risk:	**All**

Severe Winter Weather

Narrative

Severe winter storms affect far more people in Wyoming than their summer counterparts, even though they are inherently less violent. This is because severe snowstorms are often 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. Temperatures down to twenty below zero can occur, and wind chills to 90 below zero have been documented. Poor visibility and huge snowdrifts are major hazards caused by blowing snow. These storms disrupt work, make travel difficult

or impossible, isolate communities, kill large numbers of livestock, and sometimes leave human fatalities in their wake. *(Source: Wyoming Multi-Hazard Mitigation Plan, 2014)*

Most of the data used to compile this hazard analysis comes from the National Climatic Data Center (NCDC). Six different storm types were reviewed for this data, as defined below:

Blizzard – A winter storm which produces the following conditions for 3 hours or longer: (1) Sustained winds or frequent gusts 30 knots (35 mph) or greater, and (2) falling and/or blowing snow reducing visibility frequently to less than ¼ mile, on a widespread or localized basis.

Winter Storm – A winter weather event which has more than one significant hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet and ice) and meets or exceeds locally/regionally defined 12 and/or 24 hour warning criteria for at least one of the precipitation elements, on a widespread or localized basis. Normally, a winter storm would pose a threat to life or property.

Winter Weather – A winter precipitation event that causes a death, injury, or a significant impact to commerce or transportation but does not meet locally/regionally defined warning criteria.

Ice Storm – An ice storm is a type of winter storm characterized by freezing rain, also known as a glaze event or, in some parts of the United States, as a silver thaw. The U.S. National Weather Service defines an ice storm as a storm which results in the accumulation of at least 0.25-inch (6.4 mm) of ice on exposed surfaces.

Heavy Snow - A Heavy snow event is defined by snowfall rates of 4 inches (10 cm) or more in 12 hours, or 6 inches (15 cm) or more in 24 hours.

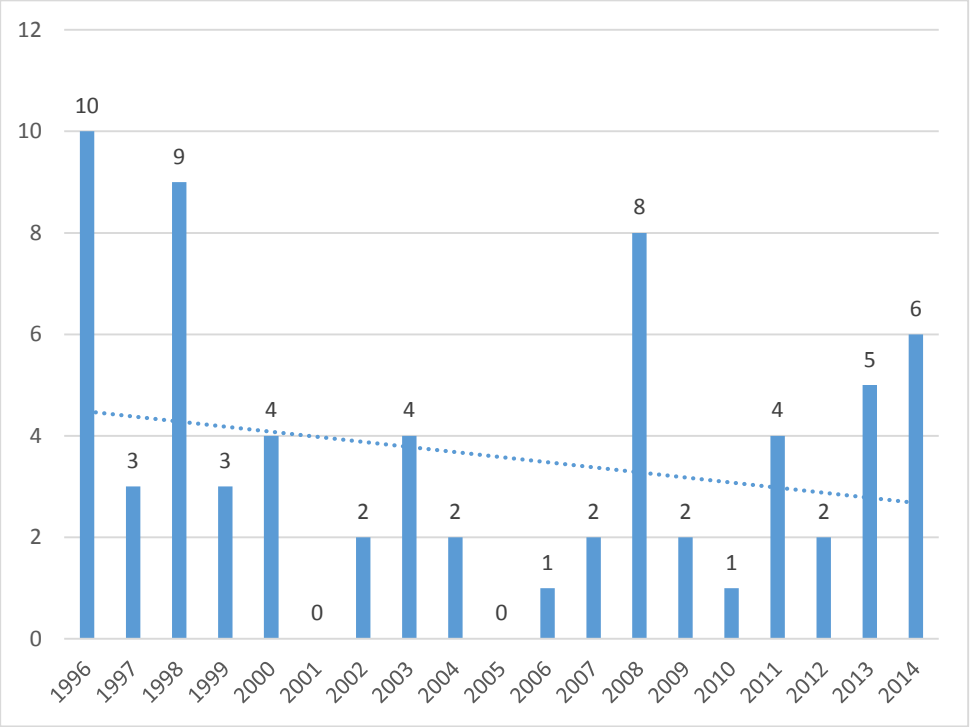
Extreme Cold/Windchill – Defined for northern American states as temperatures (with wind chill factor) at or below zero degrees Fahrenheit for 24 hours or longer.

Past Occurrences

When they do occur, winter storms usually cover a significant part of the state and as such are difficult to describe on a single county basis.

Historically, most reported impacts in Big Horn County during severe winter weather involved sub-zero temperatures and blowing snow, causing dangerous drifting and icy roads. County and municipal emergency responders and local hospitals in Big Horn County have found winter storms can critically impede emergency response, stretch local resources, and endanger responders. This is due to the county's shared jurisdictional highway responsibility with the Bighorn National Forest and the frequency of transportation related incidents as result of a winter storm. See **Figure 3-56** for a timeline of winter storm events in Big Horn County.

Figure 3-56 Severe Winter Weather Events by Year, Big Horn County 1996 to 2014



Summary: National Climatic Data Center (NCDC)

On September 20th, 2004 a passenger bus overturned on Hwy. 14, between Burgess Junction and Greybull, as a result of treacherous winter driving conditions in the Big Horn Mountains. The bus was carrying 43 passengers from Belgium, Australia, and Germany. Thirty-eight of the passengers went to South Big Horn Medical Center and were then sent on to hospitals in Worland, Powell, and Billings. The last passengers reached the hospital six hours from the time of the accident. Resources were stretched, communications were hampered, and roads were dangerous.

On May 7th, 2007 the Wyoming Highway Patrol, Basin Police, Big Horn County Search and Rescue, Greybull Police Department, and the Big Horn County Sheriff's Department coordinated a rescue response to a location on U.S. Hwy 14 on Granite Pass, approximately two miles north of non-operating Antelope Butte Ski Area in the Bighorn National Forest. The storm resulted in vehicles being pushed off the road and stranded motorists. Law enforcement officials described conditions as "zero visibility with 30 to 40 mile per hour crosswinds." The Basin PD used all-terrain vehicles to fight five-foot drifts and rescue people. Some motorists were stranded in vehicles for as long as six hours, including small children and elderly. Thirty-two people were brought off the mountain. Fourteen cars and six semi-trucks were left stranded until the next day.

Table 3-32 on the following page displays summary information regarding major winter weather impacting the region or the county since 1978. See **Appendix X** for a complete list of winter storm events.

Table 3-35 Summary of Winter Weather Events and Impacts,. Big Horn County 1978 to 2015.

Total Number of Events	Total Injuries	Total Fatalities	Total Damage (Property and Agriculture)
74	**26**	**3**	**$4,010,223**

Sources: The National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center (NCDC) and SHELDUS

Impacts

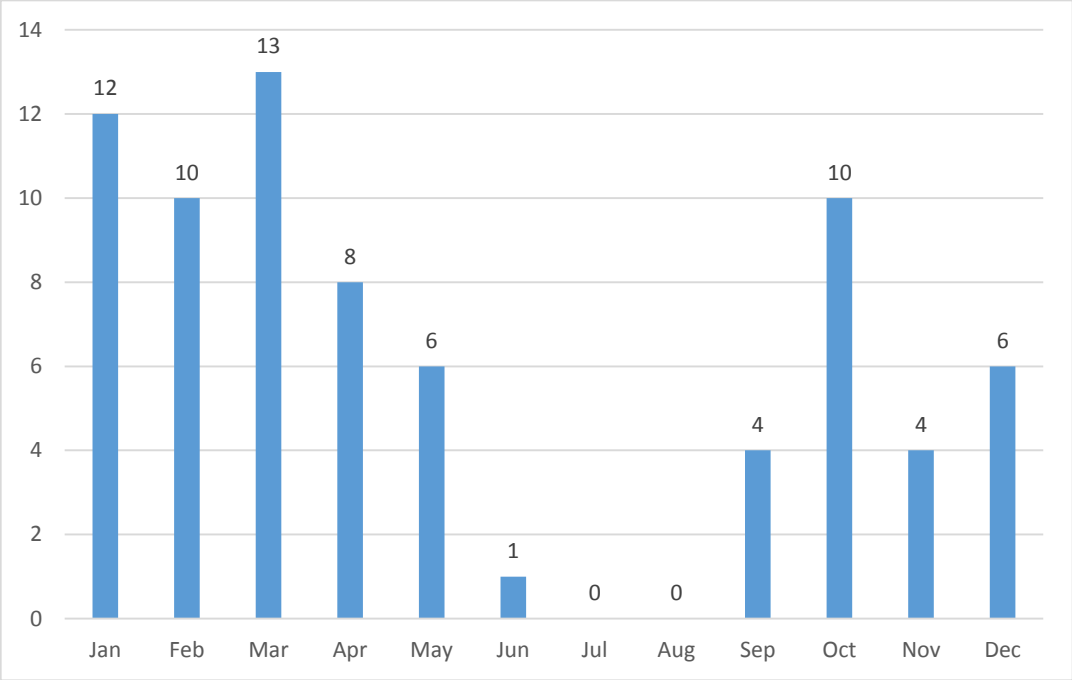
Impacts from severe winter weather include the following:

- Injury/loss of life
- Loss of utilities (gas, electric, water, wastewater, etc.)
- Business interruption
- Food shortages
- Medication shortages
- Transportation interruption
- Loss of emergency response access
- Stranded people (mine workers, locals, travelers)
- Increased risks to emergency responders
- Injuries associated with loss of utilities
- Loss of livestock
- Property loss and damage (vehicles)
- Damage to vegetation

Frequency

Data for severe winter weather in Big Horn County began to be recorded in 1996 at the National Climactic Data Center (NCDC). Since 1996, severe weather events in the county show a slight decline over this 18-year period with a current (2014) average of about three events per year.

Figure 3-57 Severe Winter Weather Events by Month, Big Horn County 1978 to 2015

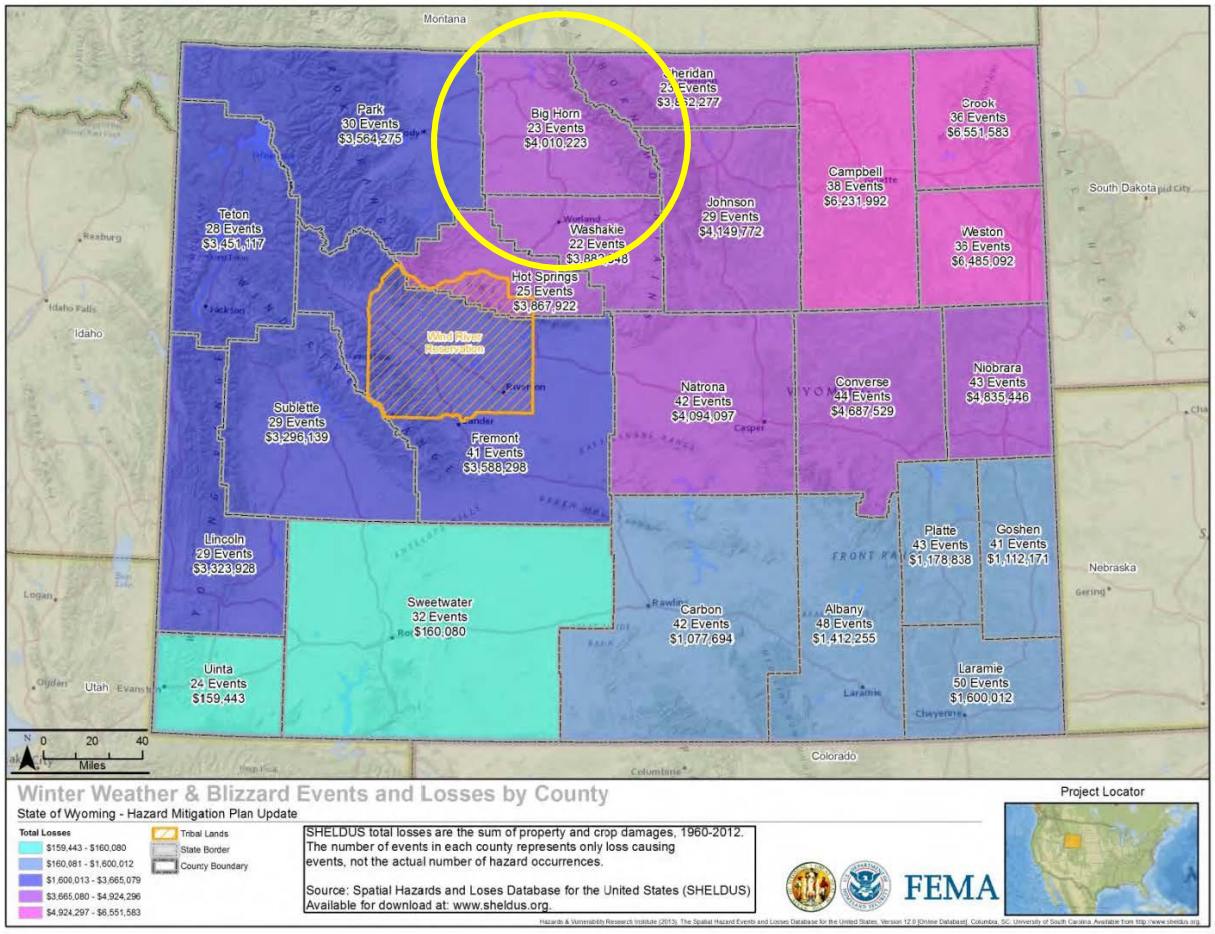


Sources: National Oceanic and Atmospheric Administration and the National Climatic Data Center

Vulnerability

According to the Spatial Hazards and Losses Database for the United States (SHELDUS) and the 2014 Wyoming Hazard Mitigation Plan, Big Horn County has suffered 23 damage causing winter weather events between 1960 and 2012, and a cumulative $4,010,223 in damage as a result of these events ($174,000/storm average).

Figure 3-58 Winter Weather Events and Losses, Wyoming 1960-2012. Big Horn County in Circle.



Source: Wyoming Multi Hazard Mitigation Plan, 2014

While severe weather can occur throughout winter months in Big Horn County, the major snow storms hit with greatest frequency in the early fall or during the spring in March, April and May. These springtime snowstorms are particularly destructive for ranchers when they coincide with calving and lambing seasons. Livestock losses are non-insurable.

The long-term financial impact to a jurisdiction's economic base due to this type of hazard is hard to quantify, and can carry over for many years. Based on historic SHELDUS data, Big Horn County can expect a damaging winter weather event approximately once every 2.2 years with an average damage total of $174,000. It is important to note that the actual impacts might be much greater than this number suggests, because of the effects on transportation and tourism, and because of loss of life and injuries (SHELDUS only reports insured losses).

At times when the lower elevations of the county remain comparatively unaffected during a winter event, response to transportation accidents and search and rescue operations within county boundaries extend well up into the Big Horn Mountains and are part of jurisdictional responsibilities. In addition to

stockmen, populations at most risk may be seasonal hunters and the growing number of snowmobile enthusiasts that lodge and recreate during the winter months throughout the Bighorn Mountains.

Better tracking and communication technology, including satellite, wireless internet, and cell communication has improved the way communities and emergency services obtain and share information. Towns and communities located throughout Big Horn County adequately cope with the types of severe winter weather that the county is susceptible to. Public utilities serving the area cite power outages of very short duration and significantly limited incidence of problems. *(Source: Big Horn Rural Electric Cooperative, Business Office)*

Future Development

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.

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. According to the U.S. Census Bureau, Big Horn County grew 2.2% in the years between 2010 and 2014 (a net gain of 262 residents) a nominal number considering the more rapid growth in other parts of Wyoming.

Summary

Severe winter weather may occur at any time in Big Horn County. Based on historic recurrence, Big Horn County can expect about three winter storm events per year with a very severe (damaging) winter storm once every two to three years. Losses have been historically low, with damage recorded primarily as agricultural.

Loss Potential:	**Low**
Population Impacted:	**Low**
Probability:	**High**
Jurisdictions at Risk:	**All**

Chapter 4 HAZARD MITIGATION GOALS AND PROJECTS

How the goals and projects were developed

This plan contains ten goals to help protect people and property in Big Horn County from natural and human-caused disasters. The Towns of Basin, Burlington, Byron, Cowley, Deaver, Frannie, Greybull, Lovell, and Manderson, and Big Horn County each have their own individual goal. Projects to address a range of hazards are listed under each of the goal statements. This allows each jurisdiction and the public to easily see and track the projects that will protect their citizens and property, and for which the jurisdiction will take the lead.

A total of xx mitigation projects were identified as follows;

- Projects from the 2010 plan were reviewed for status and carried forward as appropriate,
- Big Horn County Emergency Management suggested project ideas,
- The contractor reviewed other local plans and brought forward needs and projects in those plans that related to hazard mitigation,
- Town/County staff suggested project ideas,
- The mayors for each community identified projects for their jurisdictions,
- The public was queried for project ideas.

The mayors for each community prioritized their own projects. The contractor did a preliminary prioritization of the county's projects. This was subsequently validated by the county commissioners. The project list was finalized and incorporated into the draft plan, then presented at a public meeting concurrent with the county commissioners' regular meeting in Basin when the draft was made available for public comment.

Project Costs

Costs for mitigation actions will fall within three ranges low (L), medium (M), or high (H.)

- Low Cost Projects: from $0 to $5,000
- Medium Cost Projects: from $5,001 to $50,000
- High Cost Projects: Over $50,000

Project Priorities

Priority rankings of High, Medium, or Low were assigned. Generally, the jurisdictions will initiate and depending on the complexity, try to accomplish the High priority projects within two years, the time frame for Medium priority projects will be three to four years, and Low priority projects will be accomplished by the five-year anniversary of this plan--if feasible. Projects will be undertaken by the local jurisdictions dependent on the availability of resources—funding, staff, and/or technical expertise.

Projects were ranked informally by the mayors for their own towns, and by the contractor using the following criteria for the county.

- Level of risk to life and property posed by hazard which project addresses,
- Reasonableness of project and extent to which it provides a long-term solution,

- Potential consequences of not implementing,
- Support from the elected officials, and
- Compatibility with other plans and policies.

The county commissioners, the mayors and elected bodies have the ability to adopt additional plans, policies, ordinances and regulations as needed within state statutes.

Abbreviations for priorities and project types are provided at the end of the project tables.

Project Types

A range of types of mitigation actions or projects were identified by the participants in the planning process. Examples of a range of types of projects from other counties were provided to the LEPC and mayors to illustrate a variety of project types and to stimulate ideas for each local jurisdiction. This was done to assist the elected officials, LEPC, and other participants in understanding the types of projects that could logically be included in a hazard mitigation plan.

Table 4-4-1: Project Types by Goal/Jurisdiction

Goal	Project Types
Goal One—Big Horn County	Education and Awareness, Emergency Services, Natural Resource Protection, Prevention, Property Protection, Structural
Goal Two—Basin	Emergency Services, Prevention, Property Protection
Goal Four—Burlington	Coordination, Prevention, Property Protection
Goal Three—Byron	Coordination, Education and Awareness, Natural Resource Protection, Prevention, Structural
Goal Five—Cowley	Emergency Response, Prevention, Property Protection, Structural
Goal Six—Deaver	Coordination, Education and Awareness, Emergency Response, Natural Resource Protection, Prevention, Property Protection
Goal Seven—Frannie	Education and Awareness, Emergency Response, Prevention, Structural
Goal Eight—Greybull	Natural Resource Protection, Prevention, Property Protection, Structural
Goal Nine—Lovell	Prevention, Structural
Goal Ten--Manderson	Education and Awareness, Prevention, Property Protection

GOAL ONE: Mitigate natural and human caused hazards to reduce the potential for property loss or damage, injury and loss of life for Big Horn County.

Table 4-2 Goal One Projects: Big Horn County

#	Description	Benefits	Priority	Cost	Type	Hazard	Responsible agency for implementation, coord.
1.1	Conduct public education to increase cell # sign-ups in notification system	Improve notification. Prevent loss of life.	M	L	EA	All hazards	County Emergency Management
1.2	Upgrade communications system in Sheriff's Office	Better notification, better response. Prevent loss of lives.	H	H	C, EA	All hazards	County Commissioners, Sheriff
1.3	Purchase enterprise GIS system	Better mapping for planning and response	M	M	C, EA, P	All hazards	County Commissioners, Sheriff, Planner
1.4	Conduct an exercise focused on evacuation of people unable to self-evacuate	More proficient evacuation of UTSEs if needed				All hazards	County Emergency Management
1.5	Continue program to reduce non-native vegetation in the Big Horn River floodplain	Reduce potential for floods, property loss and damage, potential for fire	H	M	C, P, PP	Flood, Wildlife Fire	County Emergency Management, Sheriff, Responders
1.6	Work with state to refill County prevention position	Reduce potential for wildland fire,property loss	H	M	C, P, PP	Wildland Fire	County Commissioners, Fire Warden
1.7	Identify/construct facilities to house response equipment across the county	Protect equipment, maintain response capacity	H	M	C, P, PP	All hazards	County Emergency Management, Sheriff
1.8	Coordinate with churches to establish shelters	Prevent loss of life	M	L	C, P	All hazards	County Emergency Management, Red Cross
1.9	Develop briefing paper for elected officials on natural hazards in the county	Educate newly elected officials on hazards	L	L	C, P	All hazards	County Emergency Management

GOAL TWO: Mitigate natural and human-caused hazards to reduce the potential for property loss or damage, injury and loss of life for Town of Basin.

Table 4-3 Goal Two Projects: Town of Basin

	Description	Benefits	Priority	Cost	Type	Hazard	Responsible agency for implementation, coord.
2.1	Clear gulches of dead vegetation	Reduce fire danger, potential for property loss	L	L	P, PP	Fire	Town of Basin
2.2	Remove dead and dying tree limbs	Reduce potential for injury and damage from wind.	L	L	PP	Wind	Town of Basin
2.3	Equip and train for services needed	Provide response to emergencies as needed	L	M	ER	All hazards	Town of Basin

GOAL THREE: Mitigate natural and human-caused hazards to reduce the potential for property loss or damage, injury and loss of life for Town of Burlington.

Table 4-4 Goal Three Projects: Town of Burlington

#	Description	Benefits	Priority	Cost	Type	Hazard	Responsible agency for implementation, coord.
3.1	Work with County to fund shared GIS position	Better hazard mapping to prevent future vulnerability	H	M	C, P	All hazards	Town of Burlington
3.2	Clean-up of debris around town	Reduce potential for wind damage, injury and fire	H	L	P, PP	Wind, Fire	Town of Burlington
3.3	Mow/treat weeds within community	Reduce potential for wildland fire	H	M	P	Fire	Town of Burlington
3.4	Educate population on tornado shelter locations	Improve personal safety	H	L	P	Tornado, Wind	Town of Burlington

GOAL FOUR: Mitigate natural and human-caused hazards to reduce the potential for property loss or damage, injury and loss of life for Town of Byron.

Table 4-5 Goal Four Projects: Town of Byron

#	Description	Benefits	Priority	Cost	Type	Hazard	Responsible agency for implementation, coord.
4.1	Investigate feasibility of joining NFIP	Determine advisability of entering the NFIP.	M	L	C	Flood	Town of Byron
4.2	Investigate and install emergency alert system	Increase warning time, reduce impacts	H	M	ER	All hazards	Town of Byron
4.3	Send fall letter to prepare for cold weather travel	Reduce potential for accidents, injury loss of life	M	L	EA	Winter Weather	Town of Byron
4.4	Identify shelter location	Be prepared to offer shelter	H	L	ER	All hazards	Town of Byron
4.5	Identify/address potential lagoon discharge to river	Reduce potential for natural resource damage	H	M	NRP, P	Flood	Town of Byron

GOAL FIVE: Mitigate natural and human-caused hazards to reduce the potential for property loss or damage, injury and loss of life for Town of Cowley.

Table 4-6 Goal Five Projects: Town of Cowley

#	Description	Benefits	Priority	Cost	Type	Hazard	Responsible agency for implementation, coord.
5.1	Complete North drain install project	Reduce potential for flooding, property damage	H	M	P, PP	Flood	Town of Cowley
5.2	Reclaim three drains from old drainage district	Reduce potential for flooding, property damage	M	M	P, PP	Flood	Town of Cowley
5.3	Strengthen emergency response—recruit, update	Reduce potential for loss of life and property	M	M	ER	All hazards	Town of Cowley
5.4	Enhance shelter facility with power and better kitchen	Improve ability to shelter population	L	M	ER, S	All hazards	Town of Cowley

GOAL SIX: Mitigate natural and human-caused hazards to reduce the potential for property loss or damage, injury and loss of life for Town of Deaver.

Table 4-7 Goal Six Projects: Town of Deaver

#	Description	Benefits	Priority	Cost	Type	Hazard	Responsible agency for implementation, coord.
6.1	Identify, supply shelter	Provide safe space	H	L	ER	All hazards	Town of Deaver
6.2	Work with power company to ensure prompt response	Quick restoration of electricity	H	L	C	Lightning	Town of Deaver
6.3	Educate the public on travel during severe weather.	Prevent injury and loss of life	H	L	EA	All weather hazards	Town of Deaver
6.4	Update floodplain mapping	Prevent property damage	L	M	P, NRP, PP	Flood	Town of Deaver
6.5	Revisit participation in NFIP	Determine advisability of continuing participation.	L	L	C	Flood	Town of Deaver

GOAL SEVEN: Mitigate natural and human-caused hazards to reduce the potential for property loss or damage, injury and loss of life for Town of Frannie.

Table 4-8 Goal Seven Projects: Town of Frannie

#	Description	Benefits	Priority	Cost	Type	Hazard	Responsible agency for implementation, coord.
7.1	Do a mailing explaining the different siren tones	Increase warning time, reduce impacts	M	L	ER	All hazards	Town of Frannie
7.2	Use water bill to educate people about seasonal weather hazards	Reduce potential for accidents, injury and loss of life	H	L	EA	All weather hazards	Town of Frannie
7.3	Keep weeds and grasses sprayed and mowed	Reduce potential for wildland fire, loss of property	M	L	P	Fire	Town of Frannie
7.4	Address abandoned property	Reduce potential for injury and loss of life	H	L	P, S	Wind, Fire	Town of Frannie

GOAL EIGHT: Mitigate natural and human-caused hazards to reduce the potential for property loss or damage, injury and loss of life for Town of Greybull.

Table 4-9 Goal Eight Projects: Greybull

#	Description	Benefits	Priority	Cost	Type	Hazard	Responsible agency for implementation, coord.
8.1	Upgrade drainage infra.on 6th Street to prevent ponding	Reduce potential for flood damage	H	M	P, PP	Flood	Town of Greybull
8.2	Work with county to remove non-native vegetation in/along Big Horn River	Reduce potential for flood damage to property	M	M	NRP, P, PP	Flood, Fire	Town of Greybull
8.3	Promote domestic water conservation (per land plan)	Reduce drought impacts	M	L	NRP, P	Drought	Town of Greybull
8.4	Recertify Greybull levee	Protect town from flood	H	M	S, P, PP	Flood	Town of Greybull

GOAL NINE: Mitigate natural and human-caused hazards to reduce the potential for property loss or damage, injury and loss of life for Town of Lovell.

Table 4-10 Goal Nine Projects: Town of Lovell

#	Description	Benefits	Priority	Cost	Type	Hazard	Responsible agency for implementation, coord.
9.1	Address Road 12 drain issue	Reduce basement flooding	M	M	S, P	Flood	Town of Lovell
9.2	Research and implement warning/notification system	Increase warning time, reduce impacts	L	M	P	All hazards	Town of Lovell
9.3	Continue effort to shore up sewer lagoon	Prevent contamination of river	M	M	S	Flood	Town of Lovell

GOAL TEN: Mitigate natural and human-caused hazards to reduce the potential for property loss or damage, injury and loss of life for Town of Manderson.

Table 4-11 Goal Ten Projects: Town of Manderson

#	Description	Benefits	Priority	Cost	Type	Hazard	Responsible agency for implementation, coord.
10.1	Educate residents about benefits of flood insurance	Enhanced protection and recovery from flooding	H	L	EA	Flood	Town of Manderson
10.2	Evaluate and address town drainage issues	Prevent flood damage	H	M	P, PP	Flood	Town of Manderson
10.3	Use water bills to remind people to prepare for severe weather	Reduce chance of injury and death from severe weather	M	L	EA	All Weather Hazards	Town of Manderson
10.4	Check into obtaining warning/notification software	Increase warning time, reduce impacts	M	M	EA, P	All	Town of Manderson

Abbreviations used in table

Project Types

- Coordination
- EA: Education and Awareness
- ER: Emergency Response
- NRP: Natural Resource Protection
- P: Prevention
- PP: Property Protection
- S: Structural

Priorities

H: High
M: Medium
L: Low

Hazards

- A: Avalanche
- B: Blizzards and Winter Storms
- D: Dam Failure
- E: Earthquake
- F: Flood
- H: Hail
- Ha: Hazmat
- L: Landslide
- Li: Lightning
- T: Terrorism
- To: Tornado
- W: Wildland Fire

Action Plan

The above projects will be worked on pending adequate resources (personnel and funding.) Some of the projects are ongoing or already underway—for example treatment of Russian Olive in floodplain areas. Other projects will be selected based on priority, availability of resources, timeliness, and the opportunity to complete.

The initial priorities assigned with this update are expected to shift somewhat over the course of the five-year planning period based on the needs of the individual jurisdictions and resources available to them and perhaps in response to a significant disaster or new hazard.

For projects not requiring outside expertise or funding and located exclusively within one local jurisdiction, the Town or County may select and proceed with projects they wish to complete.

As described in Chapter 5, the County Emergency Management Coordinator will place the PDM Plan on the LEPC agenda once annually. Each of the signatories to the plan has the opportunity—and does have--representation on the LEPC. The Coordinator and LEPC will discuss the list of projects in the plan to see if any changes in overall priorities are desired. The discussion will include any direction or emphases from the local governing bodies, WOHS, or FEMA; incidents which have occurred during the previous year that could affect mitigation project priorities; and local resources and funding available to accomplish projects. The County Commissioners may direct, or the LEPC may hold a vote, if and when they wish to pursue grant funds for work on mitigation projects.

Use of Cost-Benefit Analysis

In cases where grants are being sought, the applicant will complete a cost/benefit analysis before submitting any funding requests.

The county can also make available information regarding the STAPLEE method for evaluating and prioritizing mitigation actions. The method looks at social, technical, administrative, political, legal, economic, and environmental aspects of projects to weigh pros and cons of implementing specific projects. Information on this analysis method can be found in FEMA's Developing the Mitigation Plan (FEMA 386-3).

The jurisdictions applying for funds will need to consider compatibility with goals and objectives in the state's plan, compatibility with goals in this plan, impacts of the project on other jurisdictions, costs and benefits, funding priorities, and compatibility with other plans and programs--when selecting projects to implement.

Existing Authorities, Policies, Programs and Resources for Implementation

Projects in this plan will be accomplished in one of three ways; under county leadership either by the Emergency Management Coordinator, or volunteers (firefighters, emergency medical personnel, and elected officials); by Town personnel, or through contractors funded by grants.

The Emergency Management Department currently has one fulltime coordinator which is vacant as of the publication of this draft plan. Big Horn County Commissioners have advertised and intend to fill the position immediately.

Communities in Wyoming do have statutory authority to engage in planning. Big Horn County does have a planner on staff who coordinates with the communities within limited available resources. However, the communities in Big Horn County are small in population and have not retained professional planning staff. Some communities do have land use plans and zoning—prepared by contracted planners. Because populations have remained relatively stable over time, planning for new development has not received been a priority. Local elected officials are ultimately responsible for public health and safety in their communities and due to lack of staff, they have largely assumed this responsibility by virtue of their elected positions.

Chapter 5 PLAN MONITORING, MAINTENANCE, REVISION AND COORDINATION

Responsible Parties

The Big Horn County Commissioners in cooperation with the Mayors of the Towns of Basin, Burlington, Byron, Cowley, Deaver, Frannie, Greybull, Lovell, and Manderson are responsible for ensuring that the PDM Plan is kept current. With adoption of the plan, the responsible officials designate the Big Horn County Emergency Management Coordinator—with the assistance of the Local Emergency Planning Committee—as the lead in accomplishing the on-going responsibilities.

Plan Monitoring and Evaluation

There are two types of plan monitoring and evaluation; effectiveness and implementation. Effectiveness monitoring looks at whether the plan has addressed needed items. Implementation monitoring looks at whether projects in the plan are being undertaken and completed. The county's Emergency Management Coordinator with the help of the LEPC will ask the following questions to evaluate the effectiveness and implementation of the plan.

- Have any potential hazards developed that were not addressed in the plan?
- Have any natural disasters occurred that were not addressed in the plan?
- Has any unanticipated development occurred that is vulnerable to hazards?
- Are there any additional mitigation ideas that need to be incorporated?
- Have projects been initiated and/or completed?
- What are the barriers to completing projects identified in the plan?

Each spring following the year of adoption of this plan, the LEPC will meet to ask and answer the questions listed above. The discussion will be documented so that when the plan is revised, the findings of the monitoring can be incorporated into the revision. The Big Horn County Emergency Management Coordinator will request that the LEPC Chairman place these items on the LEPC agenda for this purpose.

Plan Update Review Triggers

Any of the following three situations could trigger a review and update of the plan.

- Occurrence of a major natural disaster in or near Big Horn County,
- Passage of five years, or
- Change in state or federal regulations which must be complied with.

Revision Procedures

Should a major natural disaster occur in Big Horn County, the LEPC shall meet following the disaster to determine whether a review of the PDM Plan is warranted. In the absence of a major natural disaster, the five-year review will take place during the six-month period preceding the FEMA approval anniversary date.

Following proper public notice, the Big Horn County Emergency Management Coordinator will request the LEPC Chairman to convene the LEPC and with their assistance and/or the assistance of the WOHS or a contractor as determined necessary, carry out the following tasks;

1. Review the Hazard Mitigation Plan Review Tool comments from WOHS and FEMA during their most recent review of the plan (2015.)

2. Examine and revise the risk assessment data as needed to ensure it is current.

3. Update the mitigation strategies to incorporate completion of actions and add any needed strategies or projects.

4. Identify problems that may be hindering or affecting implementation of the plan, and recommend actions for resolving those problems.

5. Recommend any necessary revisions to the PDM Plan.

6. Comply with all applicable regulations and statutes.

So that the public will have an opportunity to become involved in and comment on the revision, at least one public meeting will be scheduled in Basin, Greybull, or Lovell. This meeting may occur as a regularly-scheduled county commissioner meeting. The meeting will be publicized.

Forty-five days prior to the five-year anniversary date, a final draft of the revised plan will be submitted to the WOHS.

An annual review will be conducted by the Big Horn County Emergency Management Coordinator for the purpose of summarizing the status and effectiveness of the plan mitigation goals or strategies.

Incorporation into Other Plans

Local land use plans for those communities that have them were reviewed for the preparation of this PDM Plan update. The incorporated communities in Big Horn County are small and do not have professional planning resources. The plans that do exist were prepared by the use of contracted services.

The County has a planner and planning department. The county planner works with the communities as resources allow. The county planner and county sheriff (as the supervisor of the Emergency Management Coordinator) were heavily involved in the update of this plan. Additionally, one of the current county commissioners was previously the County Emergency Management Coordinator and is familiar with the contents of the PDM plan.

None of the communities indicated the intent to prepare a new plan or revise an existing plan during in the 5-year PDM planning horizon. However, if this changes, the county planner will be aware of such efforts and along with the County Emergency Management Coordinator can ensure that the contents of this plan are considered as appropriate in other planning efforts.

Opportunity for Continued Public Involvement

In addition to the procedures for including the public in the five-year updates described above, to ensure the public will have the opportunity to remain involved in the implementation and annual updates of the plan, the following will take place.

1) The Big Horn County Emergency Management Coordinator will provide a brief annual summary report to the county commissioners on what has been accomplished during the previous year and to receive guidance from the elected officials on their priorities for the coming year.

2) Each year following a spring LEPC meeting at which the status of the plan is reviewed, Emergency Management will make information available to the public on the accomplishments of the previous year and allow comment for any revisions.

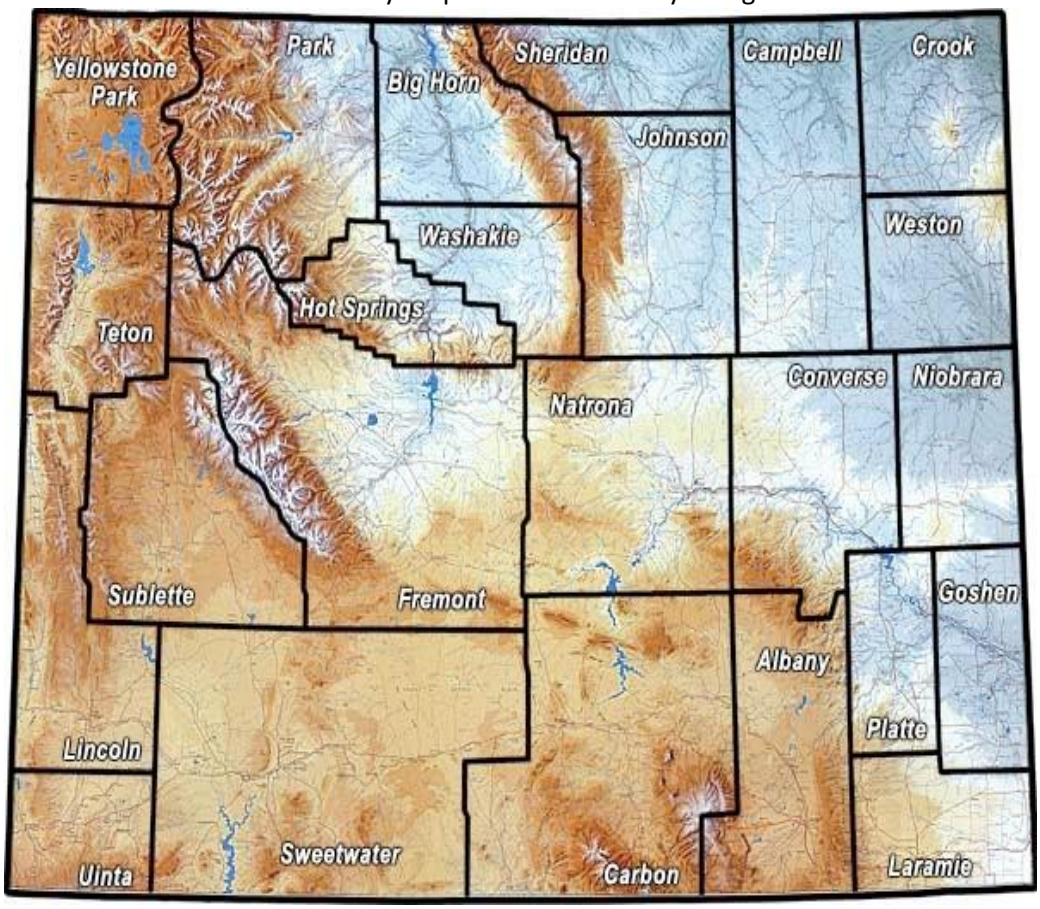
APPENDIX H: COUNTY PROFILE

GENERAL DESCRIPTION

To be able to fully analyze how physical hazards and threats relate to Big Horn County and the communities that lie within its external boundaries, it is important to understand the pertinent or unique facts regarding geographic, demographic, growth and economic features of the area.

The project area for this PDM Plan is Big Horn County, Wyoming and the incorporated cities and towns within its boundaries stipulated as Lovell, Greybull, Basin, Manderson, Burlington, Byron, Frannie, Deaver, and Cowley. The county is located in north central Wyoming, as pictured below in Figure 3.1, occupying 3,136 square miles. The State of Montana meets its northern boundary.

County Map of the State of Wyoming



Natural Features

Big Horn County is situated within the Big Horn Basin of Wyoming. Elevations in the county range from 3600 at basin floor, and soar to 13,187 feet above sea level at the top Cloud Peak in the Big Horn Mountain Range.

Mountains that surround this large regional basin create some formidable natural geographic barriers. The jurisdictional boundary of the county actually travels down the spine of the Big Horn Mountains on its eastern border. Between the mountains that ring the region, the landscape consists of acres of foothills, prairie, and desert badlands. The landscape is interspersed with thousands of irrigated agricultural acres fed by an intricate system of canals and irrigation ditches, with water supplied by various existing reservoirs and rivers that flow through the county.

Minerals & Natural Resource Development

Several different types of minerals are mined throughout the County. Most mines are surface mines. One known exception is the underground Rockwell Petroleum Mine located near Greybull. Extraction operations have the ability to move around the County according to need and supply. Bentonite processing plants proliferate throughout the jurisdiction. A gypsum plant operates southeast of Lovell.

The future of energy development in the County depends on both supply and demand, and given the extent of the federal land in the County--primarily Bureau of Land Management and National Forest--on federal policies.

Waterways

Big Horn County ranks sixth in number of irrigated acres, compared among the State's twenty-three counties. Water for agricultural use is vital to the County's economy and is contained and diverted from the Big Horn, Shoshone, Nowood, and Greybull Rivers, as well as smaller creeks such as Beaver Creek, east of the unincorporated town of Shell.

Big Horn River

The Wind River flows north from Fremont County and Boysen Dam, where it is renamed the Big Horn River continuing its path north through Big Horn County and into Montana. This primary waterway flows for approximately 60 miles through the county, paralleling major transportation route U.S. Hwy. 16-20 and 310.

Tributary - Nowood River

The Nowood River flows southeast across the southern boundary of the county (approx. 21 miles) until it reaches the Town of Manderson at the junction of U.S. 16/20, State 31 and 789. There it joins the Big Horn River's journey north to Montana and Yellowtail Dam.

Tributary - Greybull River

The Greybull River travels approximately 33 miles within county boundaries from the west county line to the Big Horn River. The source of the Greybull River is to the west of Big Horn County above the town of Meeteetse, situated in neighboring Park County. As the waterway wends its way to Meeteetse, it flows past the Upper and Lower Sunshine Reservoirs and is fed by water collected in the Sunshine Dams from snow melt and other smaller creeks and streams. Downstream, water is diverted from the Greybull River to fill

Roach Gulch Reservoir, to supply water for crops and livestock for the many farms and ranches existing in this portion of the Big Horn Basin. As the Greybull River continues its journey along the floor of the Big Horn Basin, it travels in close proximity to a portion of Wyoming County Road 40 and Highway 30, from west to east, until it makes its way into the Big Horn River directly above the Town of Greybull.

Tributary – Shoshone River

On the upper end of the county, the Shoshone River flows west to east from the Buffalo Bill Cody Dam located above Cody in neighboring Park County, eventually traveling near the town of Byron and just north of the Town of Lovell, and emptying into Big Horn Lake. It flows for a distance of approximately 24 miles through Big Horn County before emptying in Big Horn Lake.

Tributary – Shell Creek

Flowing west out of the Big Horn Mountains through the unincorporated town of Shell, Shell Creek is joined by Trapper and Beaver Creeks, as well as several others before joining the Greybull River several miles north of the city of Greybull.

Climate

Because of the varied terrain and geology of Big Horn County the climate is diverse. According to the Wyoming Climate Atlas (2004), Big Horn County has averaged from 6-10 inches, all the way up to 81-90 inches of precipitation annually for the 30-year period 1971-2000. Western areas of the County see little precipitation while the crest of the Big Horn Range receives a great deal more precipitation much of it in the form of snow. Actual snow cover in lower elevations through the winter averages two inches, while the mountain elevations typically experience deep snow throughout the winter months.

Summer temperatures average 75 to 85 degrees during the day and 50 degrees at night across much of the County. Deep winter months average 15 to 25 degrees during the day and 5° F at night. Spring and fall months are generally moderate and pleasant. However, temperature extremes have been recorded as high as 112 degrees F in the summer to -43 degrees below during the winter. Humidity is low, making summer temperatures more tolerable and cold temperatures less penetrating. Mean average annual temperatures range from 20-25 degrees Fahrenheit high in the Big Horns to 40-45 degrees in the lower western areas of the County. (Wyoming Climate Atlas, 2004) High elevation lands are largely public and the population centers of the County lie in the drier, more moderate western areas.

Transportation & Infrastructure

Big Horn County is characterized by it distances, and the fact that nine incorporated town and four unincorporated towns are spread over the entire length and width. There are 70 miles from the southern-most town of Manderson to the northern-most town of Frannie. The County's width also spans just over 70 miles east to west from the top of Burgess Junction in the Big Horn Mountains, to the western most town of Burlington.

Highways

There are four primary transportation routes that cross Big Horn County. **US Highway 16-20** parallels the Big Horn River on the east and State Hwy. 433 on the west, then slicing south to north from Worland to Manderson and on through Basin and Greybull. **U.W. Hwy 310** begins at the intersection of Highway 16-20 five miles northwest of Greybull and travels through Lovell, Cowley, Deaver and Frannie into the State of Montana.

Country Road 40 is a secondary connecting route traveling east - west from the Park County, Meeteetsee area to just south of the Town of Burlington where it merges with State Hwy 30 traveling east into Basin.

U**.S. Alternate Route 14A** travels west and east from Yellowstone National Park and Cody through the town of Byron and Lovell and continuing east up into the Big Horn Mountains. This route parallels the Shoshone River through Lovell, until it terminates at Big Horn Lake east of Lovell. This route is closed in the winter months.

U.S. Primary 14 also travels west and east out of Cody, transecting **U.S. Hwy 1620** in the Town of Greybull and continuing east through Shell and up into the Big Horn Mountains. It eventually joins **Alternate 14** to become one transportation route at Burgess Junction. This route drops down the eastern slope of the Big Horn Mountains.

Railroad

The Burlington Northern/Santa Fe (BNSF) Railroad line generally follows **U.S. 310** and **U.S. 16-20**, ultimately traveling right next to the Big Horn River passing through the towns of Frannie, Deaver, Lovell, Greybull, Basin, and Manderson.

Air

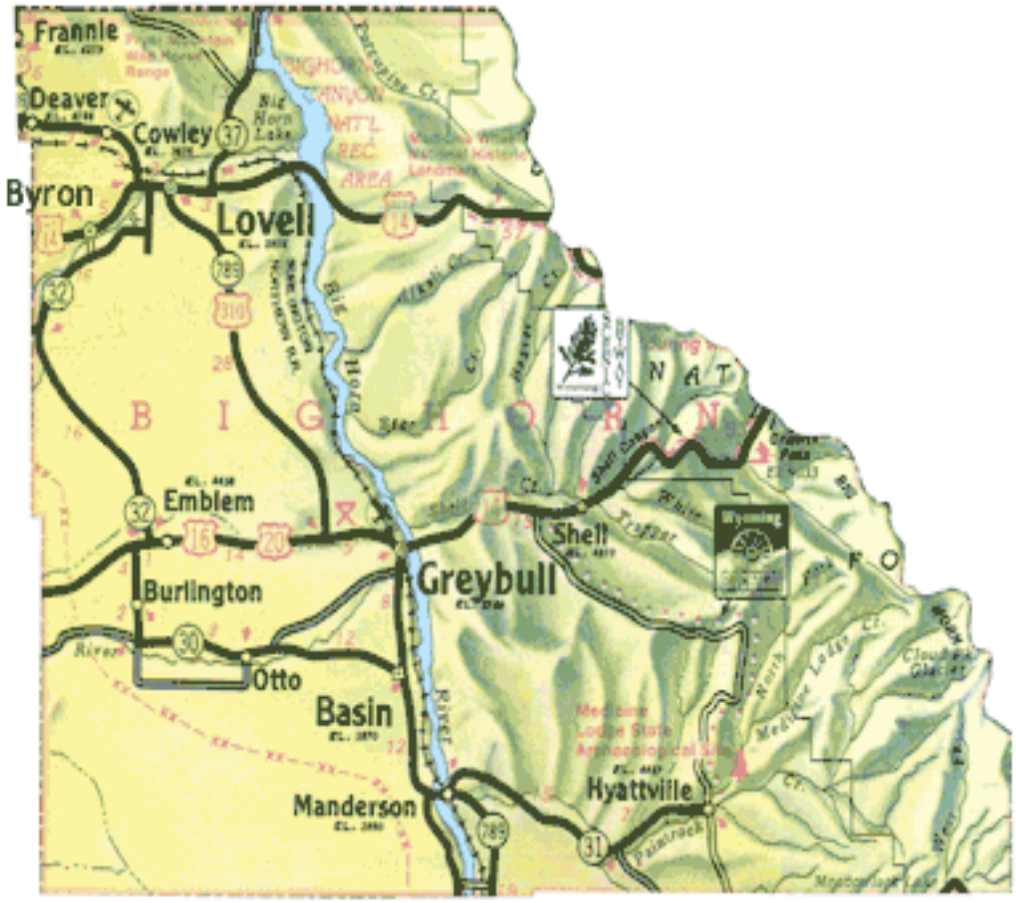
Big Horn County hosts two airports. South Big Horn County Airport located two miles northwest of Greybull has two asphalt runways; 100' wide and 6302' long and 75' wide by 3699' long. North Big Horn Airport is located two miles north of Cowley and also contains two runways. The first is asphalt, 75' wide by 5199' in length. The second is dirt, measuring 65' wide and 1856' long. Both airports have lights and basic services. These airports are used for general aviation. Additionally, several sod runways are scattered across the county. South Big Horn Hospital near Basin and North Big Horn Hospital in Lovell both have helispots. Commercial air service is located to the west in Cody, to the east in Sheridan, and to the north in Billings, MT.

Pipelines

A fourth mode of transportation must be considered as relevant in describing Big

Horn County transportation systems; that of pipeline transportation or carrier. There are at least five major buried eight to fourteen-inch pipe conveyances carrying natural gas, crude oil, and some H2S product across the county in various locations, as reported to local officials by 'the Pipeline Group." Pipelines may be found at very, very shallow depths due to wind and water erosion or other unspecified circumstances, or may be found buried up to 20-feet deep. Specified routes and locations of major industrial pipelines are not made public, but are known by the emergency management, fire, and law enforcement officials within the County.

Features of Big Horn County, Wyoming



Municipal Water Supplies

Much of Big Horn County is served by one of the several public drinking water systems. Each incorporated town and the unincorporated towns of Hyattville and Shell each have water systems. There are also several rural water systems that provide service to extensive unincorporated areas of the county. The four largest water systems are those served by the (1) Shoshone Municipal Pipeline, (2) South Big Horn County Water Supply (3) Northern Supply Pipeline, and (4) Cowley water supply. Three of four of these water supplies are derived from deep artesian wells of up to 5,000 feet deep, pumping as much as 1,000 gallons per minute. The Shoshone would be the exception and flows from the Buffalo Bill Reservoir located outside of Cody.

There are no water treatment plants located in Big Horn County, with chlorination regimes and testing protocols in place. The Northern Supply Pipeline and the South Big Horn County Water Supply derived from four different artesian wells, serve several counties and are managed by the Big Horn Regional

Joint Powers Board. The pipelines under the Big Horn Regional umbrella are sourced from the artesian wells in the Manderson area serve communities and residences in Washakie, Hot Springs, and Big Horn Counties. Redundancy and looping has been built into the system so that should one of the four wells be compromised, another part of the system can still supply the needs of users on the South Big Horn, Northern Supply, or Big Horn Regional systems.

Population

According to the U.S. Census Bureau, the estimated County population on July 1, 2014 was 11,930. The town of Basin is the county seat, with the two larger towns of Greybull and Lovell lying 8 and 35 miles north of Basin, respectively. These three cities are the primary population centers of the County. The estimated populations as of 2013 for the other incorporated cities and towns and their corresponding populations are presented below—taken from www.city-data.com. The Census Bureau does not estimate populations between the decennial censuses for small communities.

Population of Incorporated Municipalities

Community	2013 Estimated Population
Basin	1312
Burlington	316
Byron	615
Cowley	710
Deaver	180
Frannie	162
Greybull	1885
Lovell	2432
Manderson	188

Each of the above communities with the exception of Frannie and Deaver showed a slight population increase since the 2010 PDM plan. The population of Frannie has decreased slightly. The population of Deaver remained the same. Approximately 65% of the County's population resides in one of the incorporated communities.

The remainder of approximately 4,140 residents (or 35% of the County's population) is either scattered across the landscape of the County or reside in one of the four unincorporated towns of Hyattville, Shell, Otto, and Emblem. According to the Census Bureau's Quickfacts, Big Horn County has a population density of 3.7 persons per square mile. This contrasts with the national average of 87.4 persons per square mile.

Economy

In 2013, the three industrial sectors in Big Horn County with the largest earnings were Government, Farm, and Construction. Government had $86.1 million in earnings and provided 1,587 jobs—making it the most significant economic sector in the County by a large margin. The Farm sector had $26.1 million in earnings, and Construction produced $21.5 million in earnings. However, mining (including fossil fuels), rather than farming had the second highest number of jobs with 699. Construction, third in both earnings and number of jobs provided 462 jobs in 2013.

From 1970 to 2013, the population increase in the County was 17%. During this same period, the number of jobs grew from 4,542 to 6,904--a 52% increase, while personal income grew from $215.5 million to $457 million--a 112% increase. Total personal income in the County in 2013 was $456,997,000. Of this total personal income, $258,430 was labor earnings and $198,567 was non-labor earnings. Non-labor earnings (43% of personal income in Big Horn County) include dividends, interest, and rent; age-related transfer payments, hardship-related transfer payments, and other transfer payments. (Source: Economic Profile System (EPS.) EPS compiles and analyzes publicly-available data from the U.S. Department of Commerce, Bureau of Economic Analysis, the Department of Labor, Bureau of Labor Statistics, and the U.S. Census Bureau.)

Big Horn County Income and Earnings

Per Capita Personal Income (2013)	$38,102
Average annual earnings per job (2013)	$42,540

Source: Headwaters Economics Socioeconomic Profile for Big Horn County, WY. August 11, 2015 (www.headwaterseconomics.org)

The total number of jobs in the County in 2013 was 6,904. This is an increase of 134 jobs for the period 2010-2013. Services related jobs made up 41.1% of the total number of jobs, Non-service related jobs made up 33.4% of all jobs, and Government jobs made up the remaining 23.0% of the number of jobs in Big Horn County.

The average annual unemployment rate for the County in 2014 was 4.7%. For the months in 2015 to date the rate has been at a high of 5.7% in March to a low of 3.7% in May. There is some seasonality to the unemployment picture in Big Horn County.

According to the 2012 Census of Agriculture conducted by the National Agricultural Statistic Service (NASS), Big Horn County contained 627 farms or ranches in 2012 compared to 621 in 2007. The average farm size in 2012 was 483 acres compared to the average farm size 705 acres in 2007. The amount of land in farms was 302,555 acres in 2012 and 438,003 in 2007. The average farm size and the number of acres in farms each decreased by 31% during this five-year period. So while the total number of farms in the county stayed relatively constant, both the average farm size and total acreage in farms decreased by approximately one third.

Crop sales of over $53 million exceeded livestock sales of just under $36 million. Livestock production numbers are made up primarily of cattle and calves, and sheep and lambs. The highest value crop production in 2012 in descending order was in hay, barley, dry beans, sugar beets, and corn. Big Horn County ranked seventh in the State of Wyoming in 2012 agricultural sales with a figure of $88,836,000. (USDA, NASS Census of Agriculture)

Land Use

The county is a rural public lands county, with seventy-seven percent (77%) of the acres owned and managed by the federal government. Bureau of Land Management (BLM) acres are found across the county and account for the largest holding. The Big Horn Mountains--largely National Forest--run north - south on the eastern side of the county. Big Horn Canyon National Recreational Area under the jurisdiction of the National Park Service, and Medicine Lodge State Park are also part of the county profile of public lands.

Surface Management	Acres	% of Total
Bureau of Land Management	1,160,612	57.2
National Forest	351,226	17.3
Private	383,614	18.9
State of Wyoming	83,055	4.1
National Park Service	26,725	1.3
Bureau of Reclamation	20,324	1.0
Department of Defense	3,542	0.2
Total	2,029,102	100

Bureau of Land Management (BLM) records/ Big Horn Co. FLU

Private lands are largely used for agricultural, residential, and industrial purposes.

Development Trends

The following information on development trends was obtained from the County Planner, the Mayors, and planning department records.

Mayors from each of the nine incorporated communities were asked to report on development within their communities at the July 16 Mayors' and Clerks' meeting held in Deaver. The following table summarizes their responses.

According to Big Horn County Planner, Joy Hill, there is not much development activity in the unincorporated areas of the county. Based on development permits, septic permits, floodplain development permits, subdivision applications, and change of address requests current activity is slightly less than average. Hill characterized the situation as "very stable." (phone interview on August 11, 2015)

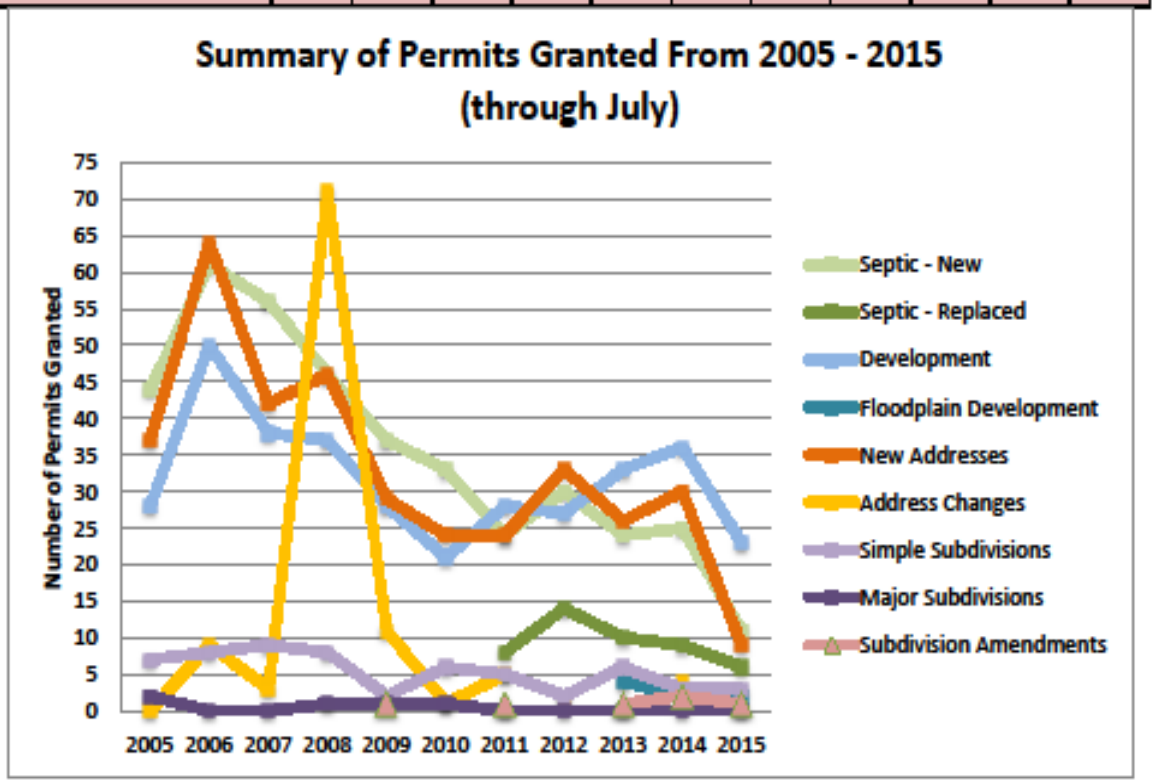
Development by Community

Community	Type	What	Where	When
Basin	Unknown			
Burlington	Residential-govt.	Husky Phase III Subdivision	In town	In progress
Byron	Unknown			
Cowley	Not present			
Deaver	Residential	Misc new home construction	In town	3/year
Deaver	Industrial	Manufacturing facility	Old school	Possible
Frannie	Industrial	Individual farm development	Outside town	In progress
Frannie	Government	Park development	In town	Soon
Frannie	Residential	Nuisance cleanup	In town	In progress
Greybull	Residential	Looking for development	E of town	5-10 years
Greybull	Commercial/Ind.	Developing business park	SE corner of town	Next 5 years
Greybull	Government	New Forest Service building	S of town	Completed
Lovell	Residential	Residential building	Clay Subdi.	In progress
Lovell	Residential-govt	Senior housing development	10th Street	Future
Lovell	Industrial	Factory improvements	Western Sugar	In progress
Lovell	Government	Replacing lift station	Sewer Lagoon	Fall 2015
Manderson	None	N/A	N/A	N/A

Source: Individual respective Mayors and Town Clerks, July 16, 2015

Building Permits 2005-2015

Permit Type	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Septic - New	44	61	56	46	37	33	24	30	24	25	11
Septic - Replaced							8	14	10	9	6
Development	28	50	38	37	28	21	28	27	33	36	23
Floodplain Development									4	2	2
New Addresses	37	64	42	46	29	24	24	33	26	30	9
Address Changes	0	9	3	71	11	1	5	2		4	
Simple Subdivisions	7	8	9	8	2	6	5	2	6	3	3
Major Subdivisions	2	0	0	1	1	1	0	0	0	0	0
Subdivision Amendments					1		1		1	2	1



Source: Big Horn County Planning Office

Land Use Plans

This 2010 Big Horn County Future Land Use (FLU) Plan is a comprehensive document about Big Horn County land use, including past and future development.

As stated in the FLU, it is anticipated that the county will have slow growth overall; that the growth will be uneven among the municipalities; and the unincorporated areas will see a major portion of the growth. In 2000, the unincorporated areas of the county accounted for 34% of all households in the county and that proportion was the same in 1990 as well. This percent remained quite stable in 2015. If the proportion of households in the unincorporated areas continues at 34% of all households in the county, by 2020 it would result in an additional 121 households under the moderate household projection scenario, 277 under the strong growth scenario, and 463 under the very strong scenario.

It is most likely that both Burlington and Cowley are planning on growth rates greater than the rest of the county. Growth often attracts growth, so the county can likely anticipate increased population (and related development) in unincorporated areas near growing municipalities. Please see the Review of Existing Plans section in Chapter 2 for remarks on how each of these plans may relate to the PDM Plan.

Big Horn River at Greybull

Conclusion

A broad description of topography, land use, growth trends, climate, local economy, populations, and infrastructure provides a foundation with which to consider the hazards to which Big Horn County may be vulnerable.

This Plan, particularly the Section 3 - Risk Assessment will outline each hazard in detail and how it may affect Big Horn County and the nine incorporated cities and towns within. Additional hazards may exist that were not apparent during the development process, and certainly, disasters can occur in unexpected ways.

Although any and all hazards cannot be fully mitigated, the intent of the Big Horn County PDM Plan is to help local government, public safety officials, and citizens better understand the various hazards as they truly exist.