4.0 RISK ASSESSMENT AND VULNERABILITY ANALYSIS

Lewis and Clark County is exposed to many hazards both natural and man-made. A risk assessment and vulnerability analysis was completed to help identify where mitigation measures could reduce loss of life or damage to property in the county. The risk assessment completed for the PDM Plan update is more comprehensive than what was performed for the 2005 PDM Plan in that it calculates exposure for residential and commercial properties, critical facilities and vulnerable population to the various hazards and determines annual loss, as appropriate.

This section includes a description of the risk assessment methodology and a hazard profile for nine (9) hazards organized from high to low by rank: wildfire, earthquake, structure fire, flooding, hazardous material incidents, dam failure, severe summer weather, severe winter weather, and railroad accidents. The section is concluded with a risk assessment summary and discussion of the location of future development projects. Supporting documentation for the risk assessment is presented in **Appendix C**.

4.1 RISK ASSESSMENT METHODOLOGY

A risk assessment was conducted to address requirements of the DMA 2000 for evaluating the risk to Lewis and Clark County from natural hazards. DMA 2000 requires measuring potential losses to critical facilities and property by assessing the vulnerability of these facilities to natural hazards. In addition to the requirements of DMA 2000, the risk assessment approach taken in this study evaluated risks to vulnerable populations and also examined the risk presented by several man-made hazards. The goal of the risk assessment process is to determine which hazards present the greatest risk and what areas are the most vulnerable to hazards.

The risk assessment approach used for this Plan entailed using Geographic Information System (GIS) software and data to develop vulnerability models for people, structures, and critical facilities, and evaluating those vulnerabilities in relation to hazard profiles that model where hazards exist. This type of approach to risk assessment is dependent on the detail and accuracy of the data used during the analysis. Additionally, some types of hazards are extremely difficult to model. Data limitations are described in *Section 4.1.7*.

4.1.1 Critical Facilities and Building Stock

The Lewis and Clark City-County GIS Department and the City of East Helena provided the majority of the critical facility spatial data for the PDM analysis. Mapping of these facilities allowed for the comparison of their location to the hazard areas where such hazards are spatially recognized. Digital locations for critical facilities were not available for the 2005 PDM analysis. Construction type of critical facilities (e.g. steel, wood, masonry, etc.) has not been compiled and was therefore, not considered in the analysis. This data should be collected for future updates of this plan.

Infrastructure, including bridges, water and wastewater facilities, and communication sites had digital mapping and were therefore included in the PDM analysis. Bridge data was obtained from the Montana Natural Resource Information System (NRIS) Transportation GIS layer. Replacement values for critical facilities, as available from the jurisdiction's insurance companies, were used in the risk assessment (**Appendix C**). Bridge replacement values were extrapolated using unit costs for span length and width provided by the Lewis and Clark County Public Works Department. **Figure 3** presents bridge locations in Lewis and Clark County.

Building stock data was obtained from the Montana Department of Revenue's (MDOR) cadastral mapping program. This system spatially recognizes land parcels within the county with a distinction between residential and other properties. Appraised building values are available on the parcel level and were used to determine exposure. The "other" building type includes all properties not designated as residential and in this study and consists of commercial, agricultural and industrial properties. Data used for this analysis was from 2010.

Building exposure in the risk assessment is presented in accordance with distinct census reporting areas. Lewis and Clark County is located within four census divisions (Augusta, Helena, Lincoln, and Wolf Creek). The county also has nine census designated places (see **Table 3.5-2**) in addition to the two incorporated cities. A census-designated place (CDP) is a concentration of population identified by the U.S. Census Bureau for statistical purposes. CDPs are populated areas that lack separate municipal government, but which otherwise physically resemble incorporated places. **Figure 4** presents the census reporting areas used in the risk assessment.

4.1.2 Vulnerable Population

Data from the 2010 census was used in the analysis to determine vulnerable populations at risk in the hazard areas, as available. Census data was downloaded from the U. S. Census Bureau's website. Downloaded data included total population (by census block) and number of individuals under the age of 18 for the incorporated communities, the county, CDPs, and census divisions. Data for populations over the age of 65 and individuals living below the poverty level were not yet available for Census 2010; therefore, this information should be included in the 2016 PDM Plan update.

4.1.3 Hazard Identification

The 2005 PDM Plan identified seven hazards affecting Lewis and Clark County (flooding, earthquakes, hazardous materials, winter storms, summer storms, landslides, and wildfire); however, profiles were only provided for three (flooding, earthquakes, and wildfire). Hazards for the 2011 PDM update were identified by the Planning Team who reviewed a history of past events in the county that were compiled from: internet research, available GIS data, public meeting input, past disaster declarations, the 2005 PDM Plan and the State of Montana Multi-Hazard Mitigation Plan. Hazards included in the 2011 update

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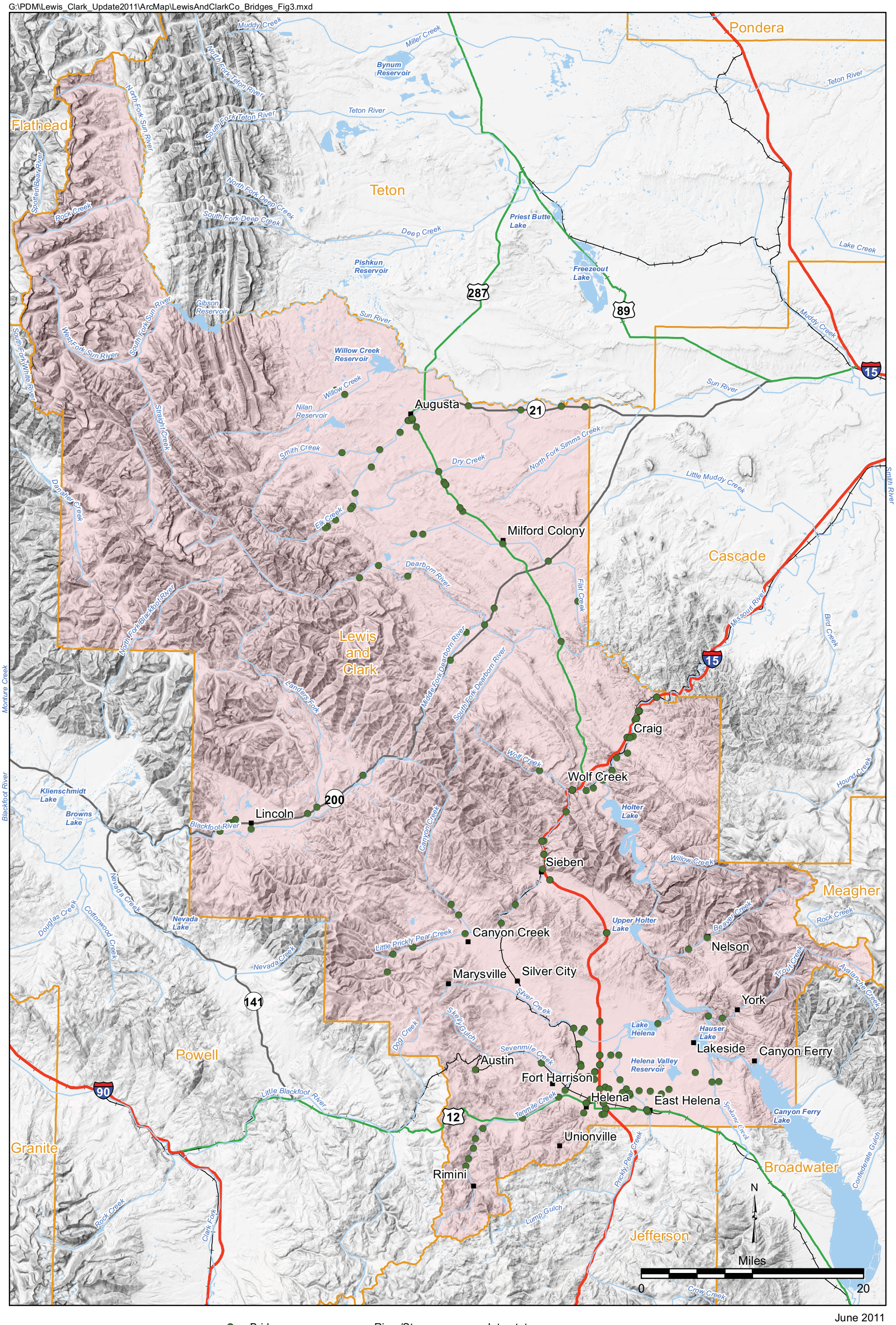


Bridges
Place Names
County Boundary
River/Stream
Lake/Reservoir
Interstate
U.S. Highway
Montana Highway
Rail

June 2011

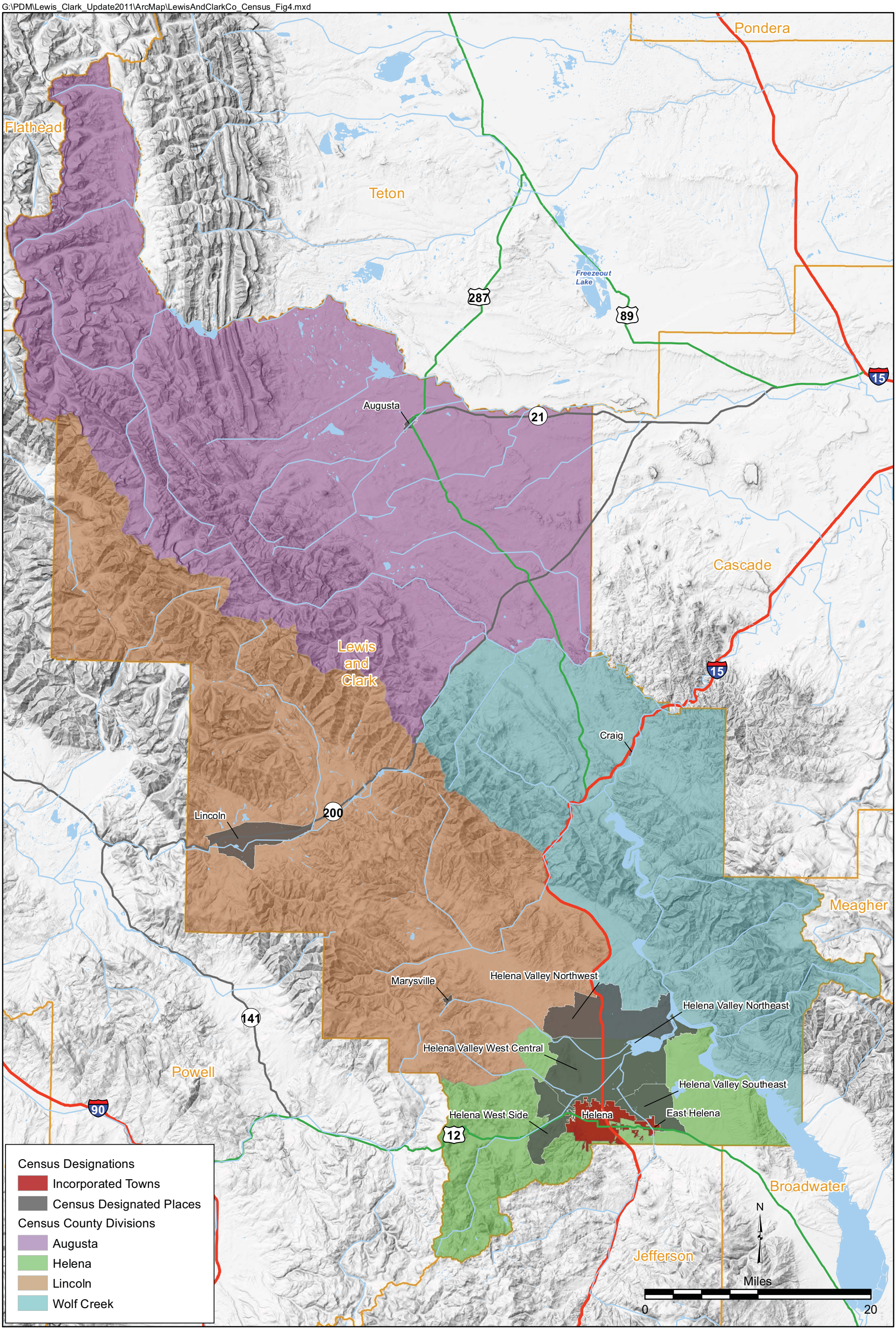
Figure 3

Bridge Inventory

Lewis and Clark County, Montana

Pre-Disaster Mitigation Plan

G:\PDM\Lewis_Clark_Update2011\ArcMap\LewisAndClarkCo_Census_Fig4.mxd



June 2011

River/Stream
Lake/Reservoir
County Boundary
Interstate
U.S. Highway
Montana Highway

Figure 4
Census Designations
Lewis and Clark County, Montana
Pre-Disaster Mitigation Plan

generally included those profiled in the 2005 PDM Plan with the addition of three hazards (dam failure, structure fire and railroad accidents). Hazards in the 2011 update were re-ranked using the Calculated Priority Ranking Index (CPRI) presented in Table 4.1.1 (see *Section 4.1.5*).

4.1.4 Hazard Profiles

Hazard profiles prepared for each of the identified hazards are presented within this section according to their county priority. The level of detail for each hazard is generally limited by the amount of data available.

Each hazard profile contains a description of the hazard and the history of occurrence, the vulnerability and area of impact, the probability and magnitude of future events, and an evaluation of how future development is being managed to reduce risk. The methodology used to analyze each of these topics is further described below.

Description and History

A number of databases were used to describe and compile the history of hazard events profiled in this plan. This data was supplemented by input from the public, local officials, newspaper accounts, and internet research. The two primary databases used included the National Climatic Data Center (NCDC) Storm Events Database and Spatial Hazard Events and Losses Database for the United States (SHELDUS).

The NCDC Storm Events database receives storm data from the National Weather Service. The NWS service receives their information from a variety of sources, including county, state and federal emergency management officials, local law enforcement officials, skywarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry and the general public. Storm data is an official publication of the National Oceanic and Atmospheric Administration (NOAA), which documents the occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce.

SHELDUS is a county-level hazard data set for the United States for 18 different natural hazard events types. For each event the database includes the date, location, property losses, crop losses, injuries, and fatalities that affected each county. The database includes every loss causing and/or deadly event between 1960 through 1975 and from 1995 onward. Between 1976 and 1995, SHELDUS reflects only events that caused at least one fatality or more than $50,000 in property or crop damages.

Vulnerability and Area of Impact

Vulnerabilities are described in terms of exposure to critical facilities, structures, population, and socioeconomic values from the hazard. Hazard impact areas describe the geographic extent a hazard

can impact a jurisdiction and are uniquely defined on a hazard-by-hazard basis. Mapping of the hazards, where spatial differences exist, allows for hazard analysis by geographic location. Some hazards can have varying levels of risk based on location. Other hazards cover larger geographic areas and affect the area uniformly.

Probability and Magnitude

Probability of a hazard event occurring in the future was assessed based on hazard frequency over a 100 year period. Hazard frequency was based on the number of times the hazard event occurred divided by the period of record. If the hazard lacked a definitive historical record, the probability was assessed qualitatively based on regional history and other contributing factors. Probability was broken down as follows. In some cases a discrepancy existed between this probability ranking and the probability score determined by the PDM Planning Team using the Calculated Priority Ranking Index (see *Section 4.1.5*):

- Highly Likely – greater than 1 event per year (frequency greater than 1).
- Likely – less than 1 event per year but greater than 1 event every 10 years (frequency greater than 0.1 but less than 1).
- Possible – less than 1 event every 10 years but greater than 1 event every 100 years (frequency greater than 0. 01 but less than 0.1).
- Unlikely – less than 1 event every 100 years (frequency less than 0.01)

The magnitude or severity of potential hazard events was evaluated for each hazard. Magnitude is a measure of the strength of a hazard event and is usually determined using technical measures specific to the hazard. Magnitude was calculated for each hazard where property damage data was available. Magnitude is:

- (Property Damage / Number of Incidents) / $ of Building Stock Exposure = Magnitude expressed as a percentage.

Future Development

The impact to future development was assessed based on potential opportunities to limit or regulate development in hazardous areas such as building codes, zoning and subdivision regulations. The impacts were assessed through a narrative on how future development could be impacted by the hazard. Plans, ordinances and/or codes currently in place were identified that could be revised to better protect future development in the county from damage caused by natural and man-made hazards.

4.1.5 Hazard Ranking and Priorities

In ranking the hazards, the Planning Team completed a Calculated Priority Risk Index (CPRI) matrix for each hazard. The CPRI examines four criteria for each hazard (probability, magnitude/severity, warning time, and duration) and evaluates the risk index for each according to four levels, then applies a weighting factor (**Table 4.1-1**). The result is a score that has been used to rank the hazards. Each hazard profile presents its CPRI score with a cumulative score sheet included in **Appendix C**. **Table 4.1-2** presents the results of the CPRI scoring for all hazards.

TABLE 4.1-1
CALCULATED PRIORITY RISK INDEX

CPRI Category	Degree of Risk			Assigned Weighting Factor
	Level ID	Description	Index Value	
Probability	Unlikely	▪ Rare with no documented history of occurrences or events. ▪ Annual probability of less than 0.01.	1	45%
	Possibly	▪ Infrequent occurrences with at least one documented or anecdotal historic event. ▪ Annual probability that is between 0.1 and 0.01.	2	
	Likely	▪ Frequent occurrences with at least two or more documented historic events. ▪ Annual probability that is between 1 and 0.1.	3	
	Highly Likely	▪ Common events with a well documented history of occurrence. ▪ Annual probability that is greater than 1.	4	
Magnitude/ Severity	Negligible	▪ Negligible property damages (less than 5% of critical and non-critical facilities and infrastructure). ▪ Injuries or illnesses are treatable with first aid and there are no deaths. ▪ Negligible quality of life lost. ▪ Shut down of critical facilities for less than 24 hours.	1	30%
	Limited	▪ Slight property damages (greater than 5% and less than 25% of critical and non-critical facilities and infrastructure). ▪ Injuries or illnesses do not result in permanent disability and there are no deaths. ▪ Moderate quality of life lost. ▪ Shut down of critical facilities for more than 1 day and less than 1 week.	2	
	Critical	▪ Moderate property damages (greater than 25% and less than 50% of critical and non-critical facilities and infrastructure). ▪ Injuries or illnesses result in permanent disability and at least one death. ▪ Shut down of critical facilities for more than 1 week and less than 1 month.	3	
	Catastrophic	▪ Severe property damages (greater than 50% of critical and non-critical facilities and infrastructure). ▪ Injuries or illnesses result in permanent disability and multiple deaths. ▪ Shut down of critical facilities for more than 1 month.	4	
Warning Time	Less than 6 hours	Self explanatory.	4	15%
	6 to 12 hours	Self explanatory.	3	
	12 to 24 hours	Self explanatory.	2	
	More than 24 hours	Self explanatory.	1	
Duration	Less than 6 hours	Self explanatory.	1	10%
	Less than 24 hours	Self explanatory.	2	
	Less than one week	Self explanatory.	3	
	More than one week	Self explanatory.	4	

TABLE 4.1-2
CALCULATED PRIORITY RANKING INDEX SUMMARY

Hazard	Probability	Magnitude and/or Severity	Warning Time	Duration	CPRI Score
Wildfires	Highly likely	Critical	< 6 hours	< 1 week	3.60
Earthquake	Likely	Catastrophic	< 6 hours	> 1 week	3.55
Structure Fire	Highly likely	Critical	< 6 hours	< 6 hours	3.40
Highway Accidents	Highly likely	Critical	< 6 hours	< 6 hours	3.40
Hazardous Material Incidents	Likely	Critical	< 6 hours	> 24 hours	3.05
Railroad Accidents	Likely	Critical	< 6 hours	< 24 hours	3.05
Dam Failure	Possible	Catastrophic	< 6 hours	< 1 week	3.00
Aircraft Accidents	Likely	Critical	< 6 hours	< 6 hours	2.95
Severe Summer Weather	Highly likely	Limited	6 - 12 hours	< 6 hours	2.95
Severe Winter Weather	Highly likely	Limited	> 24 hours	< 1 week	2.85
Avalanche	Likely	Critical	12 - 24 hours	< 6 hours	2.65
Drought	Likely	Limited	> 24 hours	> 1 week	2.50
Terrorism/Violence	Possible	Critical	< 6 hours	< 6 hours	2.50
Flooding/Flash Flood	Likely	Limited	> 24 hours	< 1 week	2.40
Communicable Disease/ Pandemic	Possible	Critical	> 24 hours	> 1 week	2.35
Volcanic Ash	Possible	Limited	> 24 hours	< 1 week	1.95
Landslide/Mudslide	Possible	Limited	12 - 24 hours	< 6 hours	1.90
Tornado	Possible	Negligible	< 6 hours	< 6 hours	1.90

The Calculated Priority Risk Index scoring method has a range from 0 to 4. "0" being the least hazardous and "4" being the most hazardous situation.

The Planning Team determined that four hazards should be de-emphasized in the PDM Plan for the reasons cited below:

- Communicable Disease/Pandemic – Hazard is addressed by other programs at the county, state and federal level.
- Drought – Hazard is addressed by programs on the state and federal level.
- Terrorism/Violence – Hazard is addressed by programs on the state and federal level.
- Highway Accidents – Hazard is addressed by other programs at the state and federal level.

These hazards will not be further addressed in this Plan.

The Planning Team also determined that the CPRI ranking did not accurately reflect the county's priorities; therefore, the prioritized list of hazards for Lewis and Clark County is shown below. This is the order the hazard profiles appear in subsequent sections of the plan.

1 – Wildfire (Plan Section 4.2)
2 – Earthquake (Plan Section 4.3)
3 – Structure Fire (Plan Section 4.4)
4 – Flooding (Plan Section 4.5)
5 – Hazardous Material Incidents (Plan Section 4.6)
6 – Dam Failure (Plan Section 4.7)
7 – Severe Summer Weather (Plan Section 4.8)
8 – Severe Winter Weather (Plan Section 4.9)
9 – Avalanche
1**0 – Railroad Accidents** (Plan Section 4.10)
11 – Aircraft Accidents
12 – Volcanic Ash
13 – Landslides/Unstable Slopes
14 – Tornadoes

The avalanche, aircraft accident, volcanic ash, landslide/unstable slope, and tornado hazards were considered lower priority. Hazard profiles for these hazards are included in **Appendix C**, rather than in the body of the PDM Plan.

4.1.6 Assessing Vulnerability – Estimating Potential Losses

The methodology used in the vulnerability analysis presents a quantitative assessment of the building stock, population, and critical facility exposure to the individual hazards. Building stock data, available from the Montana Department of Revenue's (MDOR) cadastral mapping program was used in the analysis. This data spatially recognizes land parcels along with the appraised value of building stock; residential and "other" properties. Using GIS, hazard risk areas were intersected with the building stock data to identify the number of structures and exposure due to each hazard. Using GIS, hazard risk areas were also intersected with critical facility data to determine the number and exposure of critical facilities to each hazard. Various infrastructure (e.g. water systems, wastewater systems) were analyzed as part of the critical facility vulnerability analysis. A separate analysis was completed for the county's bridges.

Population exposure was computed using data from the 2010 census and the percentage of the census blocks located in each hazard area. Population exposure is reported according to total population living in the hazard area and a subset of this data, individuals under the age of 18 years. Using GIS, total population for the census blocks was intersected with the hazard maps to determine the population at risk. It should be noted that there are some inherent inaccuracies using this approach. Using a percentage of census block population to compute the number of individuals living in the hazard area may include more persons than actually reside in the hazard area where census blocks are large.

For hazards that are uniform across the jurisdiction (i.e. severe summer weather, structure fires, and severe winter weather) the methodology presented below was used to determine annualized property loss.

- Exposure x Frequency x Magnitude

Where:

- Exposure = building stock, vulnerable population, bridges, or critical facilities at risk
- Frequency = annual number of events determined by calculating the number of hazard events / period of record
- Magnitude = percent of damage expected calculated by: (property damage/# incidents)/ building stock or critical facility exposure

For hazards that are not uniform across the jurisdiction and instead occur in specific geographic areas (e.g. flooding, wildfire, hazardous material incidents, dam failure, etc.) the exposure of the hazard area was used in the loss estimation calculations.

For hazards without property damage magnitude could not be calculated and therefore, only the exposure of the building stock or population was computed. Annualized loss estimates cannot be calculated without property damage using this approach.

4.1.7 Data Limitations

Risk assessment results are only a general representation of potential vulnerabilities and there are many inherent inaccuracies with the risk assessment methodology used. Output is only as good as the data sources used and Lewis and Clark County may wish to consider alternate data for future PDM Plan updates.

The remainder of this section presents hazard profiles organized by county priority followed by a risk assessment summary. Loss estimates, where applicable, are summarized at the end of this section.

4.2 WILDFIRE

CPRI SCORE = 3.6

Description and History

A wildfire is an unplanned fire, a term which includes grass fires, forest fires and scrub fires, both man-caused or natural in origin. Severe wildfire conditions have historically represented a threat of potential destruction within the region. Negative impacts of wildfire include loss of life, property and resource damage or destruction, severe emotional crisis, widespread economic impact, disrupted and fiscally impacted government services, and environmental degradation.

Wildfire risk is the potential for a wildfire to adversely affect things that residents value- lives, homes, or ecological functions and attributes. Wildfire risk in a particular area is a combination of the chance that a wildfire will start in or reach that area and the potential loss of human values if it does. Human activities, weather patterns, wildfire fuels, values potentially threatened by fire, and the availability (or lack) of resources to suppress a fire all contribute to wildfire risk. Summer in Lewis and Clark County typically brings the fire season, the result of low rainfall, high temperatures, low humidity, and thunderstorms. However, major wildfires can occur at any time of the year. Varied topography, semi-arid climate, and numerous human-related sources of ignition make this possible.

Montana and other western states are experiencing forest health challenges primarily due to drought, insects, unusually warm temperatures, and past fire suppression activities. Various bark beetles including the mountain pine beetle and spruce bud worm are attacking large stands of trees. Because winter is no longer cold enough and long enough to keep these beetles in check, they survive to deplete the tree of nourishment and moisture throughout the year. Affected trees usually die within 2 to 3 years. Historically, the forests were open growth stands and resembled park like forests that could resist small ground fires that cleaned the forested areas of young trees and underbrush. Today, many of these older trees are no longer on the landscape. In the absence of fire, young trees crowd the understory, often out-competing the larger trees for available water. The result is a forest that is highly vulnerable to drought stress, insect and disease infestation and large stand-replacing fires. In Lewis and Clark County, bark beetle damage has become much more noticeable since the 2005 PDM Plan was completed. The number of stands infested by mountain pine beetle has increased each year as beetles have moved up the drainages.

In the past 25 years, Lewis and Clark County has witnessed a number of wildfires that have destroyed property and affected wildlife habitat, scenic resources, and air quality. **Table 4.2-1** presents the fires over 100 acres in the county since 1980, their size, and source of ignition. The most dramatic of these fires were in the North Hills (1984), and Squaw Gulch (1988), followed by a number of large fires in the area during the summer of 2000 (e.g., Canyon Ferry Complex fires). In 2003, two major fires threatened the area around Lincoln (the Snow-Talon and Moose Wasson complexes).

TABLE 4.2-1
FIRES OVER 100 ACRES IN LEWIS AND CLARK COUNTY, 1980-2010

Date	Name	Size in Acres	Cause	Date	Name	Size in	Cause
1984	North Hills	26,950	Human	1999	Little Hellgate	200	Human
1984	Timber Hill	600	Lightning	1999	Hauser Dam	220	Human
1984	Little Sheep Cr.	275	Human	2000	Wolf Creek	389	Human
1985	Baking Powder	160	Lightning	2000	Reef	100	Human
1988	Roberts Mt.	550	Not reported	2000	Indian Trail	389	Not reported
1988	Holter Lake	468	Human	2000	Bucksnort	15,311	Human
1988	Canyon Creek	45,700	Lightning	2000	Cave Gulch	30,000	Human
1988	Squaw Gulch	129	Human	2002	Rock Creek	104	Not reported
1990	Beartooth	32,968	Human	2003	Flat Creek #2	377	Lightning
1991	Holter Lake	125	Human	2003	Snowbank	37,405	Lightning
1992	Spokane Creek	166	Not reported	2003	Talon	500	Lightning
1992	Dearborn River	175	Not reported	2003	Lincoln	3,279	Not reported
1992	Gobblers Knob	760	Not reported	2006	Juedeman	176	Not reported
1993	Lyons Creek	135	Human	2007	Little Wolf	548	Not reported
1995	Sentinel Ranch	198	Human	2007	Fort Harrison	732	Not reported
1995	Foster Gulch	100	Human	2007	Novak	1,527	Not reported
1996	Electric Mt.	320	Lightning	2007	Meriwether	17,375	Not reported
1996	Ostrich	175	Lightning	2009	Noble	130	Not reported
1996	Exit. 216	110	Lightning	2009	Indian Trail	4,409	Not reported
1996	Timber Man	110	Lightning	2009	Copper Creek	109	Not reported
1997	Willow Creek	1,940	Human	2010	North Lyon	104	Not reported
1998	Copper Creek	110	Human	2010	North Fork	210	Not reported
1998	Spring	200	Not reported				

Source: CWPP, 2005; DNRC, 2011

The summer of 2000 was a devastating fire season in Montana. In the Helena area alone, fire suppression agencies averaged more than 150 wildland fire responses for the year, including lengthy involvement with huge blazes such as the Bucksnort (9,300 acres) and Cave Gulch (29,270 acres) fires.

Several wildland fires during the summer of 2007 threatened Helena's urban areas. The 2007 fires, including the Fort Harrison artillery range fire in July and the Orofino Gulch and Spring Meadow Lake fires in September, spread—or had the potential to spread—into the Wildland Urban Interface (WUI), threatening many homes and prompting evacuation orders. The increase in wildland fires near population centers over the past decade has increased the level of awareness and the need for mitigation in the WUI setting.

Wildfire disasters were declared in Lewis and Clark County by the Governor in 2000 (Canyon Ferry Fires) and in 2003 (Lincoln Fires). The 2007 (Country Club Fire) received a Presidential disaster declaration. State-wide wildfire disasters (including Lewis and Clark County) were declared in 1979, 1988, 1991, 1992, 1996, 1998, 1999 and 2003 (DMA, 2011). According to the Montana State Hazard Mitigation Plan (2010), Lewis and Clark County is third in the state for having the greatest losses from wildfire. A description of a wildland fire that occurred in Lewis and Clark County is presented below.

Canyon Creek Fire - The 1988 Canyon Creek fire that affected the Augusta area of Lewis and Clark County is one of the most historically significant wildfires in Montana. The fire started June 26, 1988, near Canyon Creek in the Scapegoat Wilderness west of the Continental Divide. The fire was declared a prescribed wilderness fire rather than a suppression fire, and allowed to burn. On July 22, almost a month after its start, the fire made a 10,000-acre run to the east. On August 9th, fanned by 30-mph winds, the fire broke across the Continental Divide in the Dearborn River area, increasing in size to 33,000 acres. On August 29-30, the fire jumped to 51,200 acres. In early September, the fire went out of control. Over a 16 hour period, the wind-fanned fire raced across 117,000 acres. In one five-hour stretch, it traveled 21 miles. Flame lengths reached more than 200 feet into the sky. The 25,000-foot smoke plume, which had been vertical, suddenly collapsed to the ground as the jet stream was pushing the fire east toward Augusta.

The fire burned 247,000 acres in the Lolo, Lewis and Clark and Helena National Forests, destroying six cabins, 100 cattle, 40,000 acres of pasture, 200 miles of fence and 1,500 tons of hay. A rancher living four miles west of Augusta had the second biggest loss from the fire. He lost his great-grandmother's homestead, a barn, the blacksmith shop, 26 head of cattle, 36 calves and 3.5 million board feet of timber being actively logged at the time. The fire stopped five miles short of Augusta after running out of fuel on the prairie. Evacuation plans had been prepared. Fire lines had been dug around the town. *Source: Western Institute for Study of the Environment News, 3 Sep 2008.*

Fighting wildland fires in Lewis and Clark County is primarily the responsibility of the U.S. Forest Service (USFS) and the Montana Department of Natural Resources and Conservation (DNRC). Additionally, local volunteer fire districts provide vital support. The Tri-County FireSafe Working Group, USFS, and DNRC have been instrumental in maximizing the efficiency of local fire districts in response to wildfires.

Vulnerability and Area of Impact

Problems with wildfire occur when combined with the human environment. People and structures near wildfires are threatened unless adequately protected through evacuation or mitigation. Most structures are flammable, and therefore, are threatened when wildfire approaches. In addition, a significant loss of life could occur to residents, firefighters, and others who are in the wildfire area and do not evacuate. Infrastructure such as electric transmission lines, fuel tanks, and radio transmission towers are not often equipped to withstand the heat from a wildfire. Timber resources, animal habitats, and waterways can all be damaged leading to negative economic and environmental impacts.

Since the mid-1960s, and particularly in the last 20 years, people have subdivided and developed wildlands throughout the county for residential, recreational, and commercial uses. Development has created many communities mixed with wildland vegetation, otherwise known as a Wildland Urban Interface (WUI). The WUI is defined as the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. A WUI exists

anywhere that structures are located close to natural vegetation and where a fire can spread from vegetation to structures, or vice versa. A WUI can vary from a large housing development adjacent to natural vegetation to a structure or structures surrounded by vegetation. Throughout the country in the 1990s, the number of structures destroyed by wildfire increased six times over the previous decade's total, as increasing numbers of people moved to fire-prone areas.

The Tri-County FireSafe Working Group has been important in establishing areas within Lewis and Clark County subject to wildfire risk. A recent mapping effort was completed to assess the wildland fuel hazard risk within the county. High fire hazard areas exist in several places including the South Hills, the Scratchgravel Hills, the North Hills, and the Spokane Hills. The Ten Mile watershed, one of the areas providing municipal water to the City of Helena, is affected by the current pine beetle infestation which has created a dangerous fuel load. Steeper slopes and the WUI tend to be located along the southern and southwestern boundaries of the City of Helena. The city's southern edge often contains steeper slopes as it extends into the adjacent forested mountains to the south and west, increasing the danger from wildfire. Burning embers from a South Hills wildfire could travel as far north as Broadway under average wind conditions. The city of East Helena is generally at a low risk from wildfire. **Figure 5** presents a wildfire risk map showing the WUI and critical facilities in Lewis and Clark County.

Lewis and Clark County, as part of a collaborative effort along with Jefferson and Broadwater Counties, completed a *Regional Community Wildfire Protection Plan*. The Lincoln Rural Fire District has a *Fire Risk Management Strategy Community Protection Pla*n (2005). These documents are presented in **Appendix E**. Mitigation projects identified in these plans are incorporated herein by reference.

Probability and Hazard Magnitude

DNRC has collected data on structure loss from wildfires since 2003. In addition, Lewis and Clark County DES has records of structure loss from the wildfires of 2000. These sources indicate that in the past 10 years, wildfire has claimed 3 commercial buildings, 10 residential structures and 23 outbuildings in Lewis and Clark County. **Table 4.4-2** presents details on these structure losses including the approximate dollar loss adjusted for inflation.

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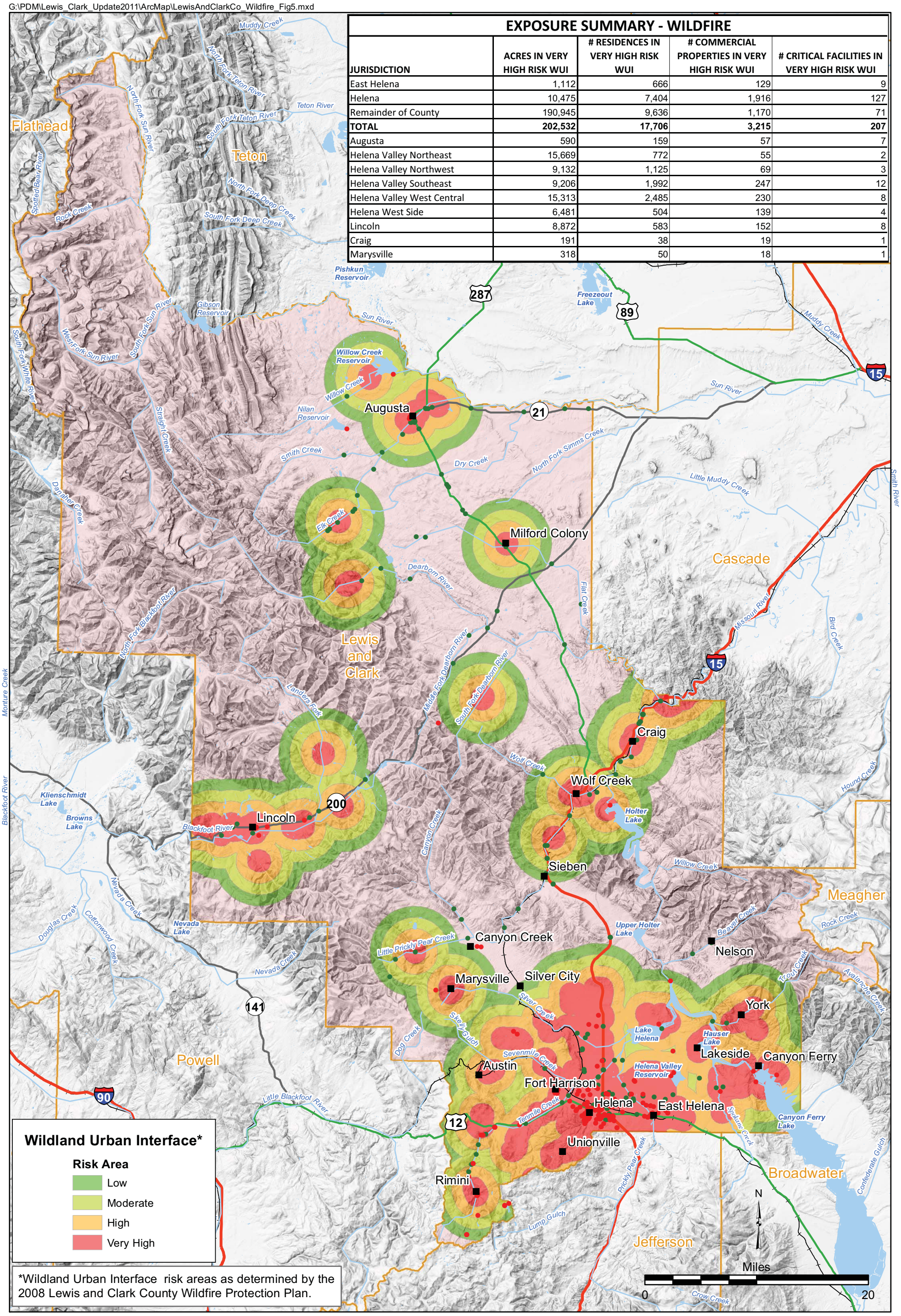
EXPOSURE SUMMARY - WILDFIRE

JURISDICTION	ACRES IN VERY HIGH RISK WUI	# RESIDENCES IN VERY HIGH RISK WUI	# COMMERCIAL PROPERTIES IN VERY HIGH RISK WUI	# CRITICAL FACILITIES IN VERY HIGH RISK WUI
East Helena	1,112	666	129	9
Helena	10,475	7,404	1,916	127
Remainder of County	190,945	9,636	1,170	71
TOTAL	**202,532**	**17,706**	**3,215**	**207**
Augusta	590	159	57	7
Helena Valley Northeast	15,669	772	55	2
Helena Valley Northwest	9,132	1,125	69	3
Helena Valley Southeast	9,206	1,992	247	12
Helena Valley West Central	15,313	2,485	230	8
Helena West Side	6,481	504	139	4
Lincoln	8,872	583	152	8
Craig	191	38	19	1
Marysville	318	50	18	1



Critical Facilities
Bridges
Place Names
River/Stream
Lake/Reservoir
County Boundary
Interstate
U.S. Highway
Montana Highway
Rail

June 2011

Figure 5

Wildfire Risk

Lewis and Clark County, Montana

Pre-Disaster Mitigation Plan

TABLE 4.2-2
STRUCTURE LOSS FROM WILDFIRE IN LEWIS AND CLARK COUNTY, 1980-2010

Date	Name of Fire	# Commercial Structures	Adjusted Value to 2011 Dollars	# Residential Structures	Adjusted Value to 2011 Dollars	# Outbuildings	Adjusted Value to 2011 Dollars
2000	Various	0	0	6*	$774,738	-	-
8/12/2003	Cottonwood	0	0	0	0	7	$7,000
6/20/2004	Across the River	1	352,150	0	0	0	0
9/17/2004	Rocky Road	0	0	0	0	1	$1,000
10/10/2004	Spring Creek	0	0	0	0	1	$1,000
11/13/2004	Accristo Road	0	0	1	$129,123	0	0
4/29/2006	Coulter Hill	0	0	0	0	2	$2,000
5/31/2006	Smoking John	0	0	0	0	1	$1,000
6/6/2007	Mary's Meadow	1	352,150	0	0	0	0
9/16/2007	Country Club	0	0	2	$258,246	8	$8,000
8/16/2008	Dearborn	0	0	1	$129,123	3	$3,000
4/22/2009	Gates of the Mtns.	1	352,150	0	0	0	0
TOTAL		3	1,056,450	10	$1,291,230	23	$23,000

Sources: Fire Data (DNRC, 2011); * Paul Spengler, LCC DES Coordinator, personal communication; Median Value of Residential Property (US Census, 2000); Assumed $1,000 value for average outbuilding; Value for commercial building derived from HAZUS-MH for small (5,000 sf) warehouse.

Table 4.2-3 presents the wildfire events in Lewis and Clark County with reported property damages from the SHELDUS database and Presidential disaster declarations. Property damages from the Spring Meadow Fire have been estimated at the minimum damage level for a Presidential disaster.

TABLE 4.2-3
LEWIS AND CLARK COUNTY WILDFIRE EVENTS WITH DAMAGES

Date	Injuries	Fatalities	Property Damage	Crop Damage	Remarks
8/19/1984	0	0.11	$555,556	$0	Lightning/Fire
8/1/1994	0	0	$5,000,000	$0	Wildfire
9/1/1994	0	0	$5,000,000	$500,000	Forest Fires
7/23/2000	2	0	$2,500,000	$0	Wild/Forest Fire
8/1/2000	2	0	$2,500,000	$0	Wild/Forest Fire
9/17/2007	0	0	$1,000,000	$0	Presidential Disaster
TOTAL	**4**	**0.11**	**$16,555,556**	**$500,000**	

Source: SHELDUS, 2010 (adjusted to 2010 dollars); DES, 2011

Note: Often casualties and damage information are listed without sufficient spatial reference. In order to assign the damage amount to a specific county, the fatalities, injuries and dollar losses were divided by the number of counties affected from this event.

Wildfire does not present a uniform risk across Lewis and Clark County. **Figure 4** presents a wildfire risk map showing the WUI and the Lewis and Clark County critical facilities. The WUI layer used for this analysis consists of two input layers: WUI zones computed using GIS and USFS Region One Healthy Forest Restoration Act WUI. Wildland interface zones up to four miles from interface communities (areas where population density >= 250 people per square mile) were identified as important areas for reducing fuel hazards. A wildland urban interface zone mapping procedure was created based on

buffering interface communities by four miles. Each one mile buffer zone in the four mile area was assigned a WUI risk class of: 4 (very high) for the nearest, 3 (high) for the next, 2 (moderate) for the next, and 1 (low) for the farthest. Additional WUI areas were added from the USFS Healthy Forest Restoration Act WUI layer which was created using communities at risk, population density, and topography modeling. It is acknowledged that the WUI, as depicted on **Figure 4**, does not recognize the Canyon Creek area along the highway that includes the Flesher Acres developed areas. The WUI map will be revised for the 2016 PDM Plan Update and this area included in the wildfire analysis.

To complete the vulnerability analysis for this project, GIS was used to intersect the resulting WUI layer with both the critical facility and MDOR cadastral parcel datasets. Estimates of vulnerable population were calculated by determining the percent exposure in each census block for the hazard area. Exposure values are presented in **Table 4.2-4**. Annualized loss estimates calculated by applying frequency and magnitude to building stock exposure are presented on the Risk Assessment Summary tables in *Section 4.11* (**Tables 4.11-1 through 4.11-3**). Building exposure reflects only the monetary structure value and does not account for improvements or personal effects that may be lost to wildfire. The *Wildfire Section* in **Appendix C** presents supporting documentation from the risk assessment including a list of critical facilities in the very high, high, moderate, and low WUI risk zones.

GIS analysis of the wildfire risk to Lewis and Clark County indicates that over 202,532 acres are within the very high-risk WUI. According to the vulnerability analysis, 17,706 residences, 3,215 commercial, industrial and agricultural buildings, and 207 critical facilities are located in very high-risk WUI. Digital data on construction type for the facilities is not available but will be considered in future PDM updates.

The history of wildfires, the terrain, and recent insect infestations has prompted Lewis and Clark County to identify wildfire as a significant hazard. Smoke from fires both within and outside of the county can create poor air quality. Sensitive groups, such as the elderly and asthmatics, can be affected. Wildfires can also have a significant impact on the regional economy with the loss of timber, natural resources, recreational opportunities, or tourism. Although the primary concern is to structures and the interface residents, most of the costs associated with fires, come from firefighting efforts. As past events have also shown, infrastructure such as power transmission lines can also be threatened.

Wildfires generally occur more than once per year in Lewis and Clark County and therefore, the probability of future events is rated as “highly likely”.

Future Development

Wildfire disasters can be mitigated through comprehensive land use planning that includes housing development design, fuels management, and public education. Regulations and ordinances addressing these issues in future development can play a significant role to minimize the danger posed by fire to residents, homes, and firefighters.

The Lewis and Clark County Growth Policy (2004) acknowledges the wildfire risk in the county through the following policy statement on future development:

- Minimize exposure to WUI and all other fire hazards through proactive code enforcement, public education programs, use of modern fire prevention measures, and adequate emergency management preparation.

Appendix K of the Lewis and Clark County Subdivision Regulations address Fire Protection Standards. The regulations state: "A*ll subdivisions shall be planned, designed, constructed, and maintained to minimize the risk of fire and to permit effective and efficient response to and mitigation of emergency incidents in order to protect persons, property, and natural resource areas.* " The regulations also provide guidance on placing structures in such a manner so as to minimize the potential for flame spread and to permit efficient access for fire fighting equipment. **Appendix E** contains a copy of the Fire Protection Standards from the subdivision regulations.

The county's subdivision regulations (2010) also include design standards to ensure satisfactory building sites are provided as they relate to topography (**Appendix E**). Design standards state that *"All subdivisions must be designed to avoid or mitigate any significant adverse impacts on fire protection and structures are prohibited at the apex or head of draws in designated high fire hazard areas, or in severe fire hazard areas identified in the Growth Policy."*

The Helena Growth Policy (2011) also acknowledges wildfire risk within the city limits and has adopted the county's design for development in WUI areas. In response to public safety concerns, the City of Helena adopted an ordinance mandating Class 3 fire-retardant roofs and vent requirements for all new roofing projects throughout the city.

Completed and On-Going Wildfire Mitigation Projects

The Tri-County FireSafe Working Group is the clearinghouse for wildfire mitigation projects in Lewis and Clark, Jefferson, and Broadwater Counties. Membership includes individual citizens, local government, state and federal agencies, interested contractors, and fire suppression departments from the counties. The group meets on a monthly basis. Since it's initiation following the North Hill fire of 1984, this group has had the primary mission of fire prevention education and helping homeowners survive a wildland residential interface fire. Much of the group's efforts are directed toward educating homeowners about reducing and managing fuel buildup, building and maintaining adequate road systems, providing adequate water supplies, and the use of fire-resistant materials and designs for homes and outbuildings.

TABLE 4.2-4

LEWIS AND CLARK COUNTY VULNERABILITY ANALYSIS – WILDFIRE (VERY-HIGH RISK)

JURISDICTION	RESIDENTIAL BUILDING EXPOSURE $	# RESIDENCES AT RISK	COMMERCIAL , INDUSTRIAL & AGRIICULTURAL BUILDING EXPOSURE $	# COMMERCIAL, INDUSTRIAL & AGRICULTURAL BUILDINGS AT RISK	CRITICAL FACILITIES EXPOSURE RISK $	# CRITICAL FACILITIES AT RISK	BRIDGE EXPOSURE $	# BRIDGES AT RISK	POPULATION AT RISK	PERSONS UNDER 18 AT RISK
Incorporated Communities & County										
East Helena	$57,693,923	666	$30,011,517	129	$22,219,536	9	$245,052	3	1,984	455
Helena	$1,055,814,324	7,404	$973,513,449	1,916	$862,592,085	127	$5,299,406	16	28,190	5,656
Remainder of County	$1,233,951,621	9,636	$130,278,630	1,170	$73,423,956	71	$10,871,150	69	31,731	7,950
CENSUS Designated Places										
Augusta	$8,968,514	159	$3,841,341	57	$475,814	7	$243,008	4	309	41
Helena Valley Northeast	$128,959,303	772	$11,314,071	55	$4,847,680	2	$302,356	4	2,626	639
Helena Valley Northwest	$150,898,994	1,125	$6,767,457	69	$4,784,608	3	$251,152	1	3,482	995
Helena Valley Southeast	$224,499,940	1,992	$36,877,573	247	$40,680,422	12	$334,348	8	8,227	2,377
Helena Valley West Central	$328,129,527	2,485	$55,255,190	230	$10,279,697	8	$844,044	14	7,883	2,033
Helena West Side	$61,851,388	504	$24,344,329	139	$0	4	$172,364	2	1,626	345
Lincoln	$49,687,779	583	$12,973,885	152	$6,049,159	8	$388,300	6	1,009	165
Craig	$2,956,295	38	$1,126,892	19	$475,000	1	$0	0	43	2
Marysville	$4,207,687	50	$235,257	18	$175,000	1	$0	0	80	11
CENSUS County Divisions										
Augusta	$16,597,394	235	$4,829,713	73	$475,814	7	$707,508	13	643	104
Helena	$1,989,565,446	14,658	$1,102,014,304	2,735	$943,706,898	178	$8,207,418	56	53,771	12,233
Lincoln	$230,587,086	2,010	$20,416,471	281	$11,008,767	13	$423,656	7	5,533	1,358
Wolf Creek	$110,709,942	803	$6,543,108	126	$3,044,097	9	$7,077,026	12	1,958	366

The group undertook a project to map the fuel hazard risk in the interface areas of the counties it represents. When Lewis and Clark County received the FEMA "Project Impact" grant program this committee was well suited to be the "fire" committee. The group found that with the money available for hazard mitigation in general, and with the generous match provided by numerous members and landowners, it was able to step out of the role of talking about fire prevention and mitigation to a very proactive position of wildland fuel hazard reduction projects. The mapping project continues along with the education and awareness programs and fuel hazard reduction in the wildland urban interface.

With the FEMA Project Impact funding no longer available, the committee has been successful in receiving hazard mitigation grants through FEMA's PDMC Program for fuel hazard reduction on City of Helena open space land, and private lands in the Wolf Creek area. The group was successful in obtaining National Fire Plan (NFP) Grants in 2001, 2002, 2004, 2006, 2007, 2009, and 2010 to develop the program for individual defensible space projects, and develop projects for non-industrial private forest owners. The BLM is assisting the fuel hazard reduction program with Community Assistance Agreements (CAA) entered into during the fall of 2003. The agreements were renewed in 2009 and are pivotal to the group's continuation.

The number, scope, and types of projects continue to grow with available funding opportunities and experience levels of the parties involved. The program continues to provide defensible space around homes in the interface, but has undertaken subdivision-wide protection projects, and is expanding into projects with larger tract non-industrial private forest landowners and primary evacuation route fuels mitigation.

4.3 EARTHQUAKE

CPRI SCORE = 3.55

Description and History

An earthquake is ground shaking and radiated seismic energy caused most commonly by a sudden slip on a fault, volcanic or magmatic activity, or other sudden stress changes in the earth. An earthquake of magnitude 8 or larger on the Richter Scale is termed a great earthquake. Fortunately, Montana has not experienced a great earthquake in recorded history. A great earthquake is not likely to occur in Montana but a major earthquake (magnitude 7.0-7.9) occurred near Hebgen Lake in 1959 and dozens of active faults have generated magnitude 6.5-7.5 earthquakes during recent geologic time.

Earthquakes are measured by two variables, magnitude and intensity. The magnitude of an earthquake, as measured on the Richter scale, reflects the energy release of an earthquake. The intensity of an earthquake is gauged by the perceptions and reactions of observers as well as the types and amount of damage. The intensity of an earthquake is rated by the Modified Mercalli Scale. This scale ranks the intensity from I to XII. An earthquake rated as a I, would not be felt except by very few people under especially favorable circumstances. An intensity rating of XII on the other hand would result in total destruction. Lewis and Clark County is generally rated as having an intensity level of VIII. Damage is predicted to be slight in buildings designed specially for the earthquake spectral response accelerations as per International Building Code (IBC) and the American Society of Civil Engineers (ASCE) recommended provisions. Buildings not constructed to meet the current IBC would experience considerable damage with partial collapse.

Lewis and Clark County is located in a zone of earthquake activity known as the Intermountain seismic belt. The zone extends from northwest Montana southward to southern Utah. The map below shows the occurrence and magnitude of earthquakes within the northern portion of the Intermountain Seismic Belt. (Source: MBMG, 2010)

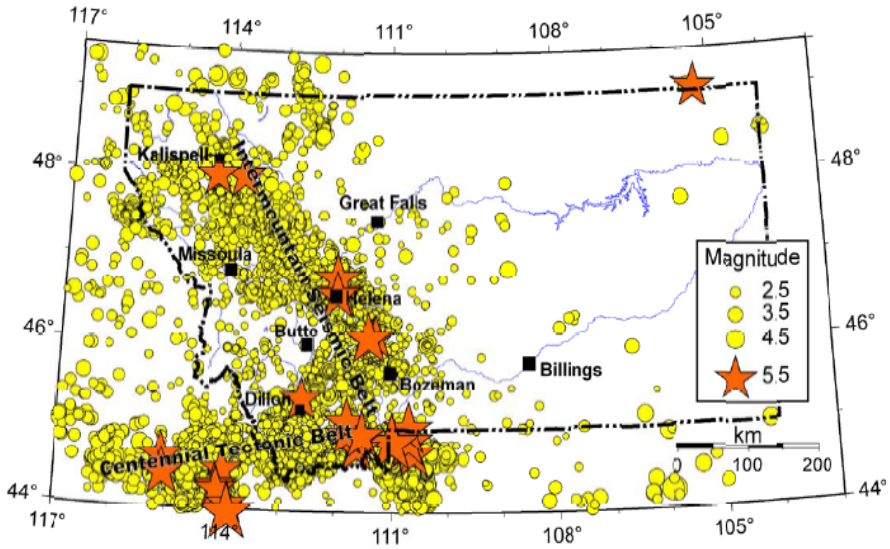


Table 4.3-1 shows the historic earthquakes in the region since 1900 with a magnitude of 5.5 or greater. Although one significant earthquake occurred in eastern Montana in 1909, the majority have occurred along the Intermountain Seismic Belt and Centennial Tectonic Belt in western Montana. Three earthquakes with magnitudes ranging from 6.3 to 5.9 occurred in Helena in 1935, as described below.

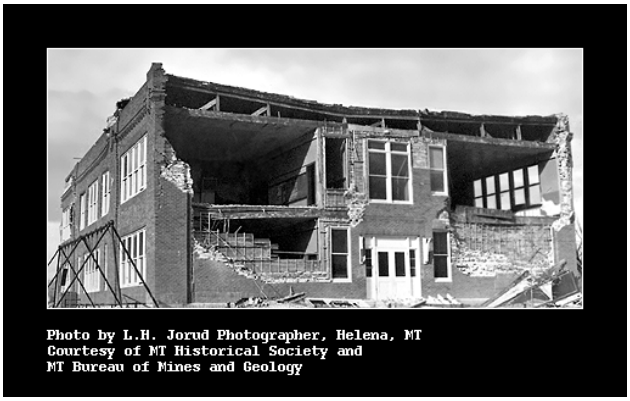
TABLE 4.3-1
HISTORIC EARTHQUAKES OF MONTANA AND SURROUNDING REGIONS WITH MAGNITUDES OF 5.5 OR GREATER SINCE 1900

Date	Magnitude	Approximate Location	Date	Magnitude	Approximate Location
05/16/1909	5.5	Northeast Montana	08/18/1959	6.0	Hebgen Lake
06/28/1925	6.6	Clarkston Valley (Three Forks)	08/18/1959	5.6	Hebgen Lake
02/16/1929	5.6	Clarkston Valley (Three Forks)	08/18/1959	6.3	Hebgen Lake
10/12/1935	**5.9**	**Helena**	08/19/1959	6.0	Hebgen Lake
10/18/1935	**6.3**	**Helena**	10/21/1964	5.6	Hebgen Lake
10/31/1935	**6.0**	**Helena**	06/30/1975	5.9	Yellowstone Park
07/12/1944	6.1	Central Idaho	12/08/1976	5.5	Yellowstone Park
02/14/1945	6.0	Central Idaho	10/28/1983	7.3	Challis, ID
09/23/1945	5.5	Flathead Valley	10/29/1983	5.5	Challis, ID
11/23/1947	6.1	Virginia City	10/29/1983	5.5	Challis, ID
04/01/1952	5.7	Swan Range	08/22/1984	5.6	Challis, ID
08/18/1959	7.5	Hebgen Lake	07/26/2005	5.6	Beaverhead County
08/18/1959	6.5	Hebgen Lake			

Source: Stickney and others, 2000

No federal or state disasters have been declared in Lewis and Clark County from an earthquake; the major earthquakes in the county all occurred before 1960.

Helena Earthquakes – Starting with a small tremor on October 3, the City of Helena suffered through a devastating series of several hundred earthquake shocks in the month of October, 1935, including one major earthquake with multiple aftershocks with magnitudes of 5.9, 6.3, and 6.0 on October 12th, 18th, and 31st. Although no surface ruptures occurred during this earthquake sequence, shaking from the earthquakes damaged more than half of Helena's buildings. The epicenters of the 1935 earthquake series is not precisely known, but were probably located about 3.7 to 14 miles north of the city, possibly along the Prickly Pear fault zone (Qamar and Stickney, 1983) and the Helena Valley fault (Doser, 1989). The following description of the earthquake is from the National Information Service for Earthquake Engineering (NISEE, 1998).



Bryant Elementary School suffered increasing damage in the series of 1935 earthquakes which began October 12th. Until reconstruction was completed, its 276 students attended school in the basement of Central School.
Source: Utah NEHRP, 2004

Damage in Helena included collapsed chimneys, fallen parapets, gables, and end walls, shattered walls parallel to interior framing, with partial or total collapse of structures as the ultimate end. Most buildings with unreinforced masonry-bearing walls were severely damaged by the earthquake and month long barrage of aftershocks. The worst wreckage occurred in structures on the softer alluvial soil toward the valley, notably the new High School (Helena Middle School) and Bryant Elementary School. Four people were killed and property damage exceeded $4 million ($60.7 million in adjusted dollars).

Recent Seismic Activity - On January 16, 2011, the National Earthquake Information Center reported that a magnitude 3.8 earthquake occurred in Lewis and Clark County. The epicenter was about 20 miles northwest of Helena. No damage was reported.

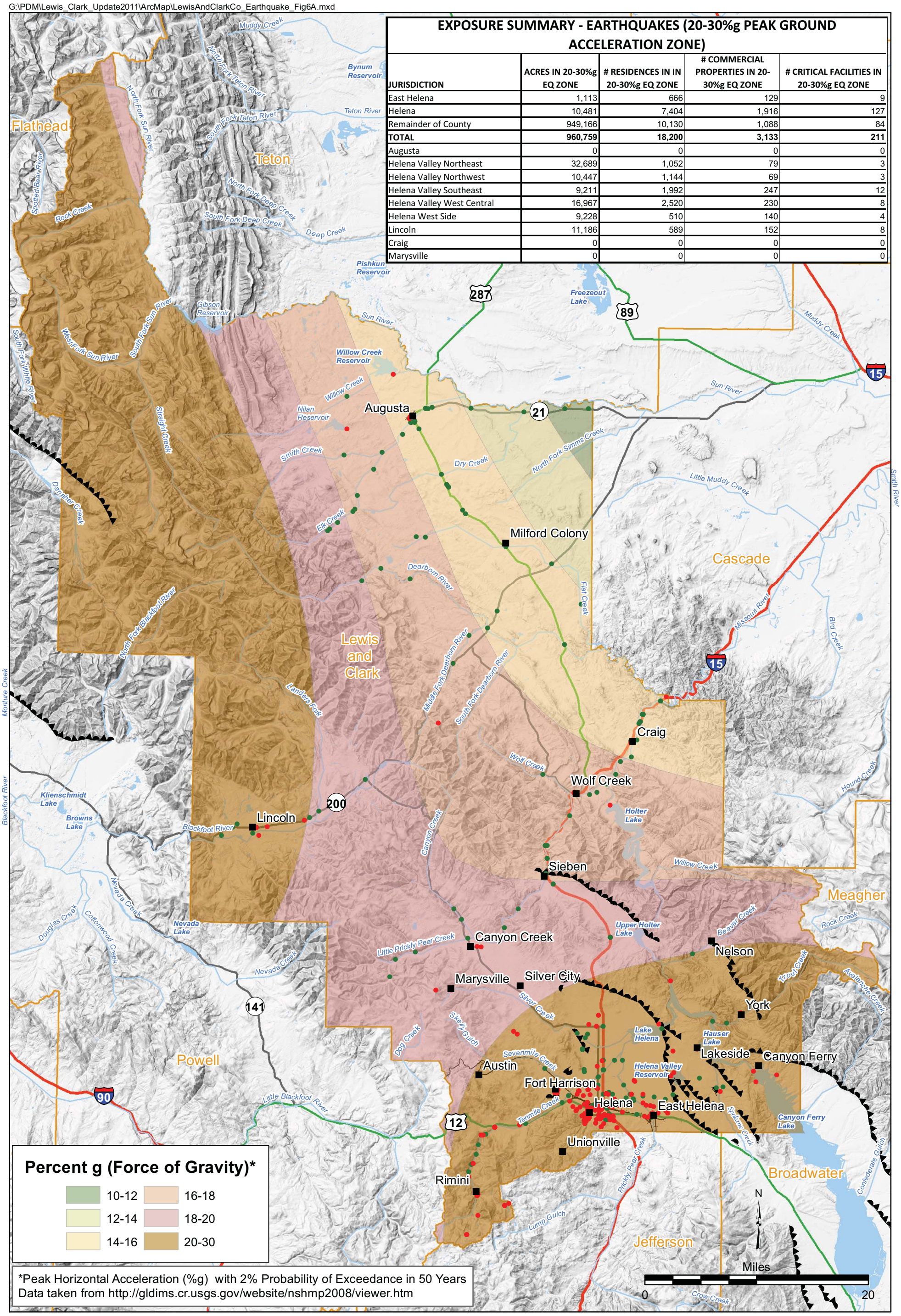
Vulnerability and Area of Impact

The Helena Valley was the site of Montana's second largest earthquake (in 1935) and, according to the U.S. Geological Survey (USGS), has a high potential for additional severe earthquakes. Geologic investigations by the Montana Bureau of Mines and Geology (MBMG) in 1981 and 1988 indicated that a probable earthquake of magnitude 7.5 on the Richter Scale could occur, subjecting the Helena Valley to severe ground shaking and liquefaction. A 1993 study by the MBMG and Montana State University further evaluated the risk for liquefaction and mapped the areas of the Helena Valley where the soil has the potential to liquefy in the event of an earthquake, as shown in **Figure 6B**. Soil liquefaction describes a phenomenon whereby a saturated soil substantially loses strength and stiffness in response to an applied stress, usually earthquake shaking or other sudden change in stress condition, causing it to behave like a liquid.

Other valleys within Lewis and Clark County may also be susceptible to liquefaction including the Silver Creek and Blackfoot River Valley. Conditions needed to create a liquefaction hazard include partially consolidated sediments (alluvial deposits that contain sand and silt) that are saturated with groundwater.

Numerous active fault lines have been identified throughout Lewis and Clark County. Other faults may exist but their locations are speculative at this time. Most earthquakes in Montana cannot be correlated to specific faults visible at the surface, except for those with magnitudes over 7.0. Small to moderate magnitude earthquakes occur at depths of three to 10 miles below the surface on small, discontinuous faults. **Figures 6A and 6B** indicate the general location of potentially active faults.

G:\PDM\Lewis_Clark_Update2011\ArcMap\LewisAndClarkCo_Earthquake_Fig6A.mxd



*Peak Horizontal Acceleration (%g) with 2% Probability of Exceedance in 50 Years
Data taken from http://gldims.cr.usgs.gov/website/nshmp2008/viewer.htm

EXPOSURE SUMMARY - EARTHQUAKES (20-30%g PEAK GROUND ACCELERATION ZONE)

JURISDICTION	ACRES IN 20-30%g EQ ZONE	# RESIDENCES IN IN 20-30%g EQ ZONE	# COMMERCIAL PROPERTIES IN 20-30%g EQ ZONE	# CRITICAL FACILITIES IN 20-30%g EQ ZONE
East Helena	1,113	666	129	9
Helena	10,481	7,404	1,916	127
Remainder of County	949,166	10,130	1,088	84
TOTAL	**960,759**	**18,200**	**3,133**	**211**
Augusta	0	0	0	0
Helena Valley Northeast	32,689	1,052	79	3
Helena Valley Northwest	10,447	1,144	69	3
Helena Valley Southeast	9,211	1,992	247	12
Helena Valley West Central	16,967	2,520	230	8
Helena West Side	9,228	510	140	4
Lincoln	11,186	589	152	8
Craig	0	0	0	0
Marysville	0	0	0	0

Critical Facilities
Bridges
Place Names
County Boundary
Quaternary Faults
River/Stream
Lake/Reservoir
Interstate
U.S. Highway
Montana Highway

June 2011

Figure 6A

Earthquake Risk - Intensity of Ground Shaking

Lewis and Clark County, Montana

Pre-Disaster Mitigation Plan

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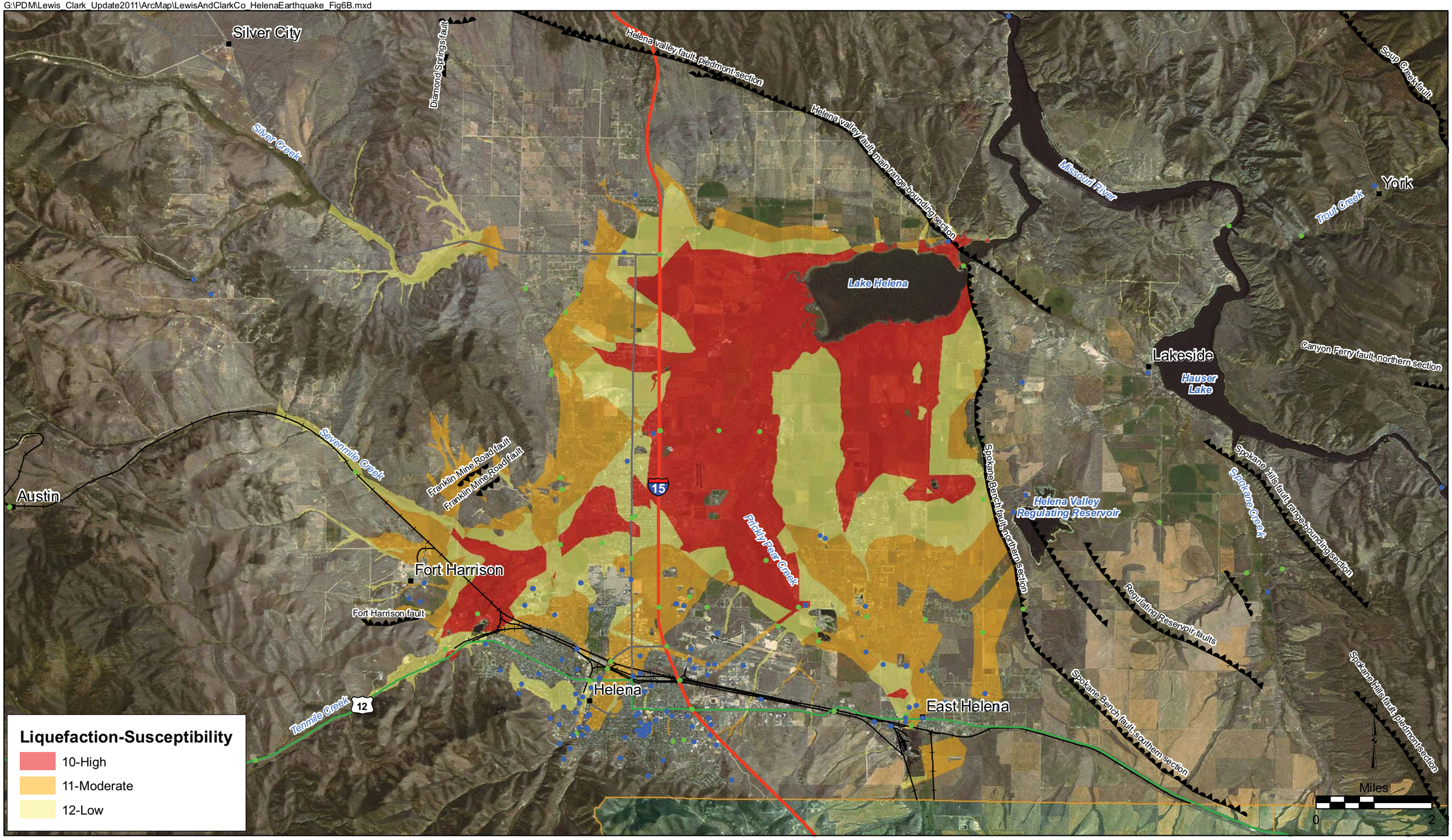


Critical Facilities
Bridges
Place Names
QuaternaryFaults
County Boundary
Interstate
U.S. Highway
Montana Highway
Railroad

*Quaternary Faults obtained from USGS: http//earthquake.usgs.gov/regional/qfaults/.

June 2011

Figure 6B

Helena Earthquake Risk

Lewis and Clark County, Montana

Pre-Disaster Mitigation Plan

The USGS's National Seismic Hazard Mapping Project has created peak ground acceleration maps. The maps show the strength of seismic shaking that has a 2 percent probability of being exceeded in a 50-year period. The strength of the shaking is measured as a percent of the acceleration of gravity (%g). **Figure 6A** shows peak ground acceleration zones and the location of Lewis and Clark County's critical facilities.

Peak ground acceleration increases across the county from the northeast to the southwest and south indicating that portions of Lewis and Clark County (including Helena, East Helena, and Lincoln) would experience seismic shaking between 20 and 30%g; enough to damage older unreinforced masonry buildings. According to Qamar (2008), at 9.2%g the earthquake is felt by all with many frightened. Some heavy furniture is moved with a few instances of fallen plaster. Damage is considered slight. At 18%g, damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly-built or badly designed structures. Some chimneys may be broken, and the shaking is noticed by people driving cars. At 34%g, damage is slight in specially designed structures, considerable in ordinary substantial buildings with partial collapse, and great in poorly built structures. Chimneys and walls may fall and heavy furniture is overturned.

Many structures, including critical facilities within Lewis and Clark County, have not been seismically assessed. According to 2000 census data, over 50 percent of residences were constructed prior to 1976. Many of the existing homes, businesses, and critical facilities may not be constructed to withstand seismic shaking.

In 2009 and 2010, the Montana Department of Administration received a FEMA grant to complete the *Critical Facility Seismic Evaluation and Hazard Reduction Project*, which evaluated state-owned buildings in areas of the state most vulnerable to earthquakes. Seismic building evaluations were performed on a number of facilities in Lewis and Clark County including the State Capitol Complex, Law Enforcement Academy, University of Montana-Helena campuses, and a Montana National Guard facility at Fort Harrison. Results of the assessment showed that the majority of the buildings were designed to withstand a typical earthquake but had non-structural deficiencies (HVAC systems and ceiling grids not adequately braced, etc.). A copy of the Inventory Report for this project is available at the Montana Department of Administration, Architecture and Engineering Office in Helena.

Probability and Hazard Magnitude

Earthquake damages can be hard to predict and assess without detailed structural information or a damage model. The FEMA Hazards of the United States – Multi-Hazard (HAZUS-MH) earthquake loss estimation methodology was used for the risk assessment. This is a software program that uses mathematical formulas and information about building stock, local geology and the location and size of potential earthquakes, economic data, and other information to estimate losses from a potential earthquake. The model earthquake used for analysis was a magnitude 6.3, shallow, crustal, extensional

earthquake that occurred on October 19, 1935 in the Helena area. A "Level 2" HAZUS analysis that required input of specific information about building characteristics was conducted for Lewis and Clark County's critical facilities. Estimated losses from the modeled earthquake for buildings with at least 30 percent damage are presented in **Table 4.3-2.** Documentation from the HAZUS-MH analysis is presented in **Appendix C.** It should be noted that St. Peter's Hospital and the Helena Regional Airport, as shown in Table 4.3-2, have had major additions that are designed to current codes.

To complete the vulnerability analysis for the earthquake hazard, GIS was used to intersect the USGS peak ground acceleration maps with both the critical facility and MDOR cadastral parcel datasets. Estimates of vulnerable population were calculated by determining the percent exposure in each census block for the hazard area. Exposure values are presented in **Table 4.3-3** and on the Risk Assessment Summary tables in *Section 4.11* (**Tables 4.11-1 through 4.11-3**). The *Earthquake Section* in **Appendix C** presents supporting documentation from the risk assessment.

GIS analysis of the earthquake risk to Lewis and Clark County indicates that over 960,759 acres are within the 20-30%g peak horizontal acceleration zone. According to the vulnerability analysis, 18,200 residences, 3,133 commercial, industrial and agricultural buildings, and 211 critical facilities are located in this zone. Digital data on construction type for the facilities is not available but will be considered in future PDM updates.

The MBMG searched their catalog for earthquakes within and immediately surrounding Lewis and Clark County in an attempt to calculate the return interval for earthquakes in the area. The catalog covers the period January 1, 1982 through February 14, 2011 (approximately 29 years) and revealed 4,657 earthquakes ranging in magnitude from 0.0 to 4.85. The analysis suggests that an earthquake of magnitude 5.0 might occur within or near Lewis and Clark County once in an 80-year period, and that a magnitude 6.0 earthquake might occur once in a 974-year period. These results represent minimum return times given the greater levels of historic seismicity (MBMG, 2011)

Hazard probability was assessed based on hazard frequency over a 10 year period. Since the earthquake hazard does not occur with an intensity to cause significant property damage or loss of life more than once every 10 years it was given an "possibly" probability rating. Using the CPRI, the PDM Planning Team scored the earthquake hazard as "likely" (Table 4.1.2).

TABLE 4.3-2
HAZUS EARTHQUAKE ANALYSIS RESULTS - MOST VULNERABLE BUILDINGS

Name	Address	Year Built	Area (sq ft)	Building Cost	Content Cost	Total Cost	Economic Loss	Percent Loss	Functionality				
									Day 1	Day 7	Day 14	Day 30	Day 90
Public Safety Bldg/Fire Station #2	2850 Skyway Dr	1990	8,600	$350,000	$0	$350,000	$166,355	48%	11.8%	28.7%	28.8%	61.5%	89.9%
Helena Regional Airport	2850 Skyway Dr.	1978	104,000	$20,000,000	$0	$20,000,000	$9,506,000	48%	11.8%	28.7%	28.8%	61.5%	89.9%
Helena Middle School	1025 N Rodney St	1935	197,914	$22,774,960	$3,422,640	$26,197,600	$12,383,000	47%	9.7%	22.9%	22.9%	52.3%	84.0%
Helena Fire Dept. Station 1	300 Neill Ave	1920		$6,786,683	$450,000	$7,236,683	$3,355,130	46%	12.4%	27.7%	27.7%	58.3%	88.1%
Capitol Building	1301 E 6th Ave	1889	187,773	$114,987,975	$7,844,879	$122,832,854	$56,916,700	46%	16.2%	26.9%	26.9%	56.8%	89.9%
LCC Health Dept	1930 Ninth Ave.	1975	14,719	$1,274,961	$49,776	$1,324,737	$610,171	46%	11.6%	28.4%	28.4%	61.1%	89.7%
Civic Center	Neill Ave @ Park	1920	78,525	$13,687,936	$1,332,525	$15,020,461	$6,763,210	45%	12.4%	27.7%	27.8%	58.3%	88.2%
LCC Courthouse	228 Broadway	1886	36,008	$6,296,523	$878,370	$7,174,893	$3,208,140	45%	11.5%	26.2%	26.2%	56.4%	87.0%
Dept. Environmental Quality	1100 N. Last Chance Gl	1920	56,251	$9,665,945	$1,617,894	$11,283,839	$4,864,770	43%	8.1%	23.7%	23.8%	59.8%	88.8%
Scott Hart Building	303 N. Roberts	1936	81,383	$13,836,676	$2,340,782	$16,177,458	$6,874,200	42%	16.1%	26.7%	26.7%	56.6%	89.8%
Helena Fire Dept. Station 2	650 N Hannaford St	1974	6,300	$1,510,934	$244,060	$1,754,994	$722,906	41%	11.6%	28.4%	28.4%	61.2%	89.7%
Central School	402 N Warren St	1915	36,260	$4,753,840	$692,640	$5,446,480	$2,124,440	39%	20.1%	32.0%	32.1%	62.6%	92.8%
Maintenance Shop Building.	2108 Custer Avenue	1960	1,176	$86,239	$20,322	$106,561	$41,281	39%	11.6%	28.3%	28.4%	61.1%	89.7%
Neighborhood Center	201 S. Main	1975	28,377	$1,625,714	$0	$1,625,714	$625,152	38%	18.5%	39.5%	39.5%	72.1%	94.7%
Records Management Building	1320 Bozeman Ave.	1960	29,600	$2,245,900	$301,900	$2,547,800	$963,671	38%	15.4%	33.2%	33.3%	68.0%	91.6%
Montana Dept. of Transportation	2701 Prospect Ave.	1978	189,821	$28,467,579	$5,459,803	$33,927,382	$12,826,900	38%	13.9%	30.8%	30.8%	65.4%	90.4%
Rossiter Elementary	1497 Sierra Road	1966	50,636	$5,354,960	$862,160	$6,217,120	$2,313,660	37%	14.7%	33.6%	33.7%	66.6%	92.5%
Aviation Support Facility	2800 Airport Rd.	1960	16,920	$2,318,378	$486,634	$2,805,012	$1,039,510	37%	14.1%	31.0%	31.1%	65.7%	90.5%
Walt Sullivan Building	1315 Lockey	1959	51,610	$9,129,719	$1,484,490	$10,614,209	$3,921,210	37%	15.3%	33.1%	33.2%	67.9%	91.5%
Shop-County Equipment	3402 Cooney Drive	1966	7,810	$634,024	$44,184	$678,207	$247,390	36%	18.0%	38.8%	38.8%	71.4%	94.5%
Secondary Digester & Control	2108 Custer Avenue	1975	9,600	$1,660,968	$530,349	$2,191,317	$795,072	36%	11.6%	28.3%	28.4%	61.1%	89.7%
Maintenance/Fire Station #1	2150 Airport Rd	1974	32,000	$4,000,000	$0	$4,000,000	$1,438,760	36%	17.8%	39.0%	39.1%	77.4%	97.6%
Public Works Office	3402 Cooney Drive		980	$39,366	$0	$39,366	$14,145	36%	20.9%	41.8%	41.9%	76.0%	94.8%
UM-Helena Donaldson Campus	1115 N. Roberts	1967	89,460	$16,488,160	$3,781,500	$20,269,660	$7,140,030	35%	15.1%	32.7%	32.8%	67.5%	91.4%
Hawthorne School	430 Madison Ave	1913	47,668	$3,533,920	$743,600	$4,277,520	$1,476,930	35%	22.7%	35.4%	35.4%	66.0%	94.2%
St Peters Hospital	2475 E. Broadway St	1967	420,000	$100,000,000	$40,000,000	$140,000,000	$45,092,000	32%	13.9%	30.7%	30.8%	65.4%	90.3%
Dept Public Health and Human	111 N. Sanders	1975	48,682	$8,659,994	$1,400,263	$10,060,257	$3,230,180	32%	11.3%	38.1%	38.2%	78.2%	93.8%
Bio-Solids Equipment Storage	2108 Custer Avenue	1982	3,960	$245,876	$39,281	$285,157	$88,395	31%	17.8%	39.0%	39.1%	77.4%	97.6%
Margaret Condon Building	5 S. Last Chance Gulch	1983	53,875	$9,685,853	$1,549,570	$11,235,423	$3,479,260	31%	20.9%	41.8%	41.9%	76.0%	94.8%
Interpretive Center	2108 Custer Avenue	1975	990	$137,936	$80,134	$218,070	$66,027	30%	11.6%	28.3%	28.4%	61.1%	89.7%
New Jail	242 Breckenridge	1985	36,052	$6,290,177	$1,540,057	$7,830,234	$2,313,340	30%	20.2%	40.7%	40.8%	75.1%	94.4%

TABLE 4.3-3

LEWIS AND CLARK COUNTY VULNERABILITY ANALYSIS – EARTHQUAKE (20-30 %g PEAK GROUND ACCELERATION)

JURISDICTION	RESIDENTIAL BUILDING EXPOSURE $	# RESIDENCES AT RISK	COMMERCIAL, INDUSTRIAL & AGRICULTURAL BUILDING EXPOSURE $	# COMMERCIAL, INDUSTRIAL & AGRICULTURAL BUILDINGS AT RISK	CRITICAL FACILITIES EXPOSURE RISK $	# CRITICAL FACILITIES AT RISK	BRIDGE EXPOSURE $	# BRIDGES AT RISK	POPULATION AT RISK	PERSONS UNDER 18 AT RISK
Incorporated Communities & County										
East Helena	$57,693,923	666	$30,011,517	129	$22,219,536	9	$245,052	3	1,984	455
Helena	$1,055,814,324	7,404	$973,513,449	1,916	$862,592,085	127	$5,299,406	16	28,190	5,656
Remainder of County	$1,350,996,743	10,130	$127,364,582	1,088	$141,323,223	84	$5,648,628	52	33,440	8,348
CENSUS Designated Places										
Augusta	$0	0	$0	0	0	0	$0	0	309	41
Helena Valley Northeast	$175,967,445	1,052	$14,167,115	79	$4,847,680	3	$476,356	6	2,995	734
Helena Valley Northwest	$155,538,705	1,144	$6,767,457	69	$4,784,608	3	$251,152	1	3,482	995
Helena Valley Southeast	$224,499,940	1,992	$36,877,573	247	$40,680,422	12	$334,348	8	8,227	2,377
Helena Valley West Central	$335,087,292	2,520	$55,255,190	230	$10,279,697	8	$844,044	14	7,883	2,033
Helena West Side	$62,825,691	510	$24,501,419	140	$0	4	$172,364	2	1,637	349
Lincoln	$49,797,130	589	$12,940,190	152	$6,049,159	8	$373,672	5	1,013	165
Craig	$0	0	$0	0	0	0	$0	0	43	2
Marysville	$0	0	$0	0	0	0	$0	0	80	11
CENSUS County Divisions										
Augusta	$365,909	6	$310,582	2	0	0	$0	0	858	146
Helena	$2,093,776,624	15,242	$1,105,790,899	2,761	$991,686,541	195	$10,671,070	64	54,314	12,404
Lincoln	$236,589,900	2,020	$20,286,231	269	$10,833,767	12	$373,672	5	5,929	1,436
Wolf Creek	$133,772,557	932	$4,501,836	101	$1,395,000	4	$148,344	2	2,513	473

Future Development

The cities of Helena and East Helena have adopted the 2009 International Building Code (IBC). Seismic provisions found in the IBC are what are required for new commercial construction. Compliance with the IBC is enforced through the building permit system, which means new buildings will better withstand earthquakes and the accompanying liquefaction hazard.

The IBC does not cover single-family residences. The State of Montana has adopted the International Residential Code (IRC), 2006 edition for one and two family residences and townhouses. Local jurisdictions (cities, counties and towns) can elect to become certified to take on enforcement of single-family residences. The cities of Helena and East Helena are certified to enforce these building codes.

Lewis and Clark County does not have a building department and therefore, has no seismic provisions for development outside the Helena and East Helena city limits. The City of Helena's Growth Policy has a development constraints map that addresses faults and liquefaction potential which includes the Helena Valley.

Completed/Ongoing Mitigation Projects

The following projects are either on-going or have been completed in Lewis and Clark County to mitigate the earthquake hazard:

- Encourage schools and city/county buildings to have earthquake drills.
- Promote earthquake awareness every October.
- Install 3-mil window film on windows of schools to prevent shattering.

In addition, a FEMA grant allowed the Montana Department of Administration to complete a seismic study of state-owned critical facilities in Lewis and Clark County. The results of this study will be used to prioritize long-term maintenance funds for structural and non-structural retrofits and to support future grant applications.

4.4 STRUCTURE FIRE

CPRI SCORE = 3.4

Description and History

Structure fires are usually individual disasters and not community-wide; however, the potential exists for widespread structure fires that displace several businesses or families. Urban blocks, commercial structures, and apartment buildings are especially vulnerable. Statistics from the structure fires in Lewis and Clark County over the past 10 years are presented in **Table 4.4-1.**

TABLE 4.4-1
LEWIS AND CLARK COUNTY STRUCTURE FIRE STATISTICS; 1/2001-12/2010

Property Type	Fires	Fire Fighter Deaths	Fire Fighter Injuries	Civilian Deaths	Civilian Injuries	Property Loss
Residential	264	0	1	2	6	$1,807,400
Commercial	29	0	0	0	0	$91,100
Industrial	46	0	0	0	0	$451,970
TOTAL	339	0	1	2	6	$2,350,470

Sources: State Fire Marshal, 2011

According the East Helena Growth Policy, East Helena suffered a catastrophic fire in 1919, which destroyed the town's business district and many homes. Further information on this fire was not available to include in this plan.

Fire protection services are provided by several entities in Lewis and Clark County. The City of Helena has a paid professional fire department that serves the municipal jurisdiction. The City of East Helena has a volunteer force that serves its jurisdiction. The remaining portions of the county are served by rural volunteer fire departments, including formal Fire Districts, Fire Service Areas, and Lewis and Clark County.

The Lewis and Clark County Rural Fire Council provides a focus for mutual-aid agreements that have been developed between participating fire protection entities. The agreements have proven essential to increasing the level of service provided to the constituents of the area. The mutual-aid structure provides for assistance among fire departments, thus expanding the equipment and personnel resources available to respond to an incident. This mechanism allows for increased utilization of the expensive capital equipment that is necessary for fire protection service and achieves a higher level of service in the county than could be achieved by any one fire protection entity.

Vulnerability and Area of Impact

Based on review of historic structure fire data and consultation with the State Fire Marshal, the entire project area has been classified with a uniform risk for structure fire since vulnerable structures are not restricted to a specific area within the county. Structure fires have resulted in well over $2.3 million dollars in structural losses over the past 10 years. Annualized loss estimates are presented in the Risk Assessment Summary Tables in *Section 4.11* (**Tables 4.11-1 through 4.11-3**). Supporting documentation is included in the Structure Fire section of **Appendix C**.

Probability and Hazard Magnitude

History has shown that structure fires are a serious concern in Lewis and Clark County. The losses, primarily covered by insurance, have not resulted in a Presidential Disaster Declaration, but have resulted in other negative impacts such as economic loss.

With 339 structure fires in the 10 period of record, the probability of this hazard occurring in the future is rated as “highly likely”.

Future Development

The cities of Helena and East Helena have adopted the International Fire Code. This is a comprehensive code which includes regulations governing the safeguarding of life and property from all types of fire and explosion hazards. Topics include general precautions against fire, emergency planning and preparedness, fire department access, fire hydrants, automatic sprinkler systems, fire alarm systems, hazardous materials storage and use, and fire safety requirements for new and existing buildings and premises. Lewis and Clark County has not adopted the International Fire Code because currently there is not county building department, which is a required element in implementing the code.

4.5 FLOODING

CPRI SCORE = 2.40

Description and History

A flood is a natural event for rivers and streams. Excess water from snowmelt and rainfall accumulates and overflows onto the banks and adjacent floodplains. Floodplains are lowlands, adjacent to rivers and lakes that are subject to recurring floods. A flash flood generally results from a torrential (short duration) rain or cloudburst on a relatively small drainage area. Ice jam flooding occurs when pieces of floating ice carried by the streams current accumulate at an obstruction to the stream. The water held back can cause flooding upstream, and if the obstruction suddenly breaks, flash flooding can then occur downstream as well.

Hundreds of floods occur each year, making it one of the most common hazards in all 50 states. Floods kill an average of 150 people a year nationwide. Most injuries and deaths occur when people are swept away by flood currents and most property damage results from inundation by sediment-laden water. Faster moving floodwater can wash buildings off their foundations and sweep vehicles downstream. Pipelines, bridges, and other infrastructure can be damaged when high water combines with flood debris. Basement flooding can cause extensive damage to the structure and systems of a building.

The National Weather Service provides short-term forecasts and warnings of hazardous weather to the public by producing regularly-scheduled severe weather outlooks and updates on various forms of hazardous weather including heavy rain and flooding. A "watch" is issued when conditions are favorable for severe weather in or near the watch area. A "warning" is issued when the severe weather event is imminent or occurring in the warned area. Warning and Advisory Criteria for flooding is presented below.

- *Flash Flood Warning:* Flooding is imminent, water levels rise rapidly with inundation occurring in less than 6 hours.
- *Flood Warning:* Flooding is expected to occur more than 6 hours after the causative event.

The peak of the flood season in Lewis and Clark County is during May and June, which usually are the wettest months of the year. Flooding has typically been caused by heavy rainfall combined with snowmelt. Major floods occurred in June 1975, May 1981, February 1996, and June 2011 when Presidential Disaster Declarations were granted. State-wide flood disasters were declared in 1978, 1981, 1984, 1986, 1997, 1998 and 2003 (DMA, 2011). Rapid snowmelt events in 1982, 1985, 1996, 2003 and 2007 caused flooding problems at various locations within Helena and East Helena. Major flooding occurred along the Blackfoot River in 1908, 1964, and 1975.

In the City of Helena, Dry Gulch and Last Chance Gulch have flooded in the past, although damage has generally been minor. The largest known floods on both drainages occurred in 1908 and 1915. Newspaper and eyewitness accounts of these two floods indicate that some structures were significantly damaged. Other known floods on Last Chance Gulch occurred during the late 1920s and early 1930s. Little damage was reported, but many merchants used sandbags to prevent basement flooding. All known floods in Helena resulted from heavy rainfall. Rainfall runoff from side streets has also contributed to the flooding on Last Chance Gulch.

Little is known about the magnitude of the 1908 flood, but photographs and newspaper accounts indicate that is was probably greater than a 100-year flood on Prickly Pear and Ten Mile Creeks. Records from the National Weather Service indicate that the 1908 flood had a similar precipitation pattern as the 1981 flood. The antecedent conditions were primed with over 6 inches of precipitation in May. The 1908 flood struck when an additional 4 inches of precipitation accumulated in three days in early June. The flood of 1908, covered several blocks in the center of East Helena, filled cellars with water, tore out bridges and floated houses off foundations

The 1964 flood was particularly severe on Elk Creek in Augusta. Most of the community was flooded, and agricultural damage upstream and downstream from Augusta was extensive. The 1964 flood was less than a 100-year flood on the Blackfoot River and Ten Mile, Prickly Pear, and Silver Creeks.

The 1975 flood caused substantial flooding on the Blackfoot River and Elk, Ten Mile, Silver and Prickly Pear Creeks. The greatest structural damage to buildings and residences occurred in the Helena Valley along Ten Mile Creek and in Augusta along Elk Creek. In both areas, basements and their contents in many homes were flooded and some foundations of buildings were damaged. Little structural damage occurred in East Helena due to judicious sandbagging efforts through the town. Flooding would have been much more extensive had the sandbagging either failed or not been adequate.

The 1981 flood was the result of a combination of snowmelt and heavy rainfall. Records from the National Weather Service indicate that 6 inches of precipitation fell in May 1981. Of that amount, 3.4 inches fell during the three days leading to the flood on May 21, 1981. This event was three times larger than the 1975 flood and created nearly three times as much damage.

The June 2011 flood was also the result of snowmelt and heavy rainfall and affected numerous areas throughout the county. At the time of this writing, this flood event was ongoing; therefore, further details will be presented in the 2016 PDM Plan update.

Vulnerability and Area of Impact

Figures 7A and 7B present the flood prone areas in Lewis and Clark County. The maps present data from the county's website which was developed by digitizing FEMA's flood insurance rate maps (FIRMs). The maps also include data from preliminary DFIRMs (digital flood insurance rate maps) that have been recently completed as part of FEMA's Map Modernization Program.

The primary sources of flooding in the City of Helena are two ephemeral streams draining the hills south of town. The thread of the old Dry Gulch channel now lies almost entirely in residential development, and Last Chance Gulch now forms the primary north-south street through the main business district. A 54-inch diameter storm sewer was constructed under Last Chance Gulch in the early 1900s; however, the storm sewer inlet capacity is considerably less than the calculated 100-year frequency flood discharge. The threat of flooding on Last Chance Gulch has been lessened substantially as a result of storm sewer construction, but it has not been completely eliminated.

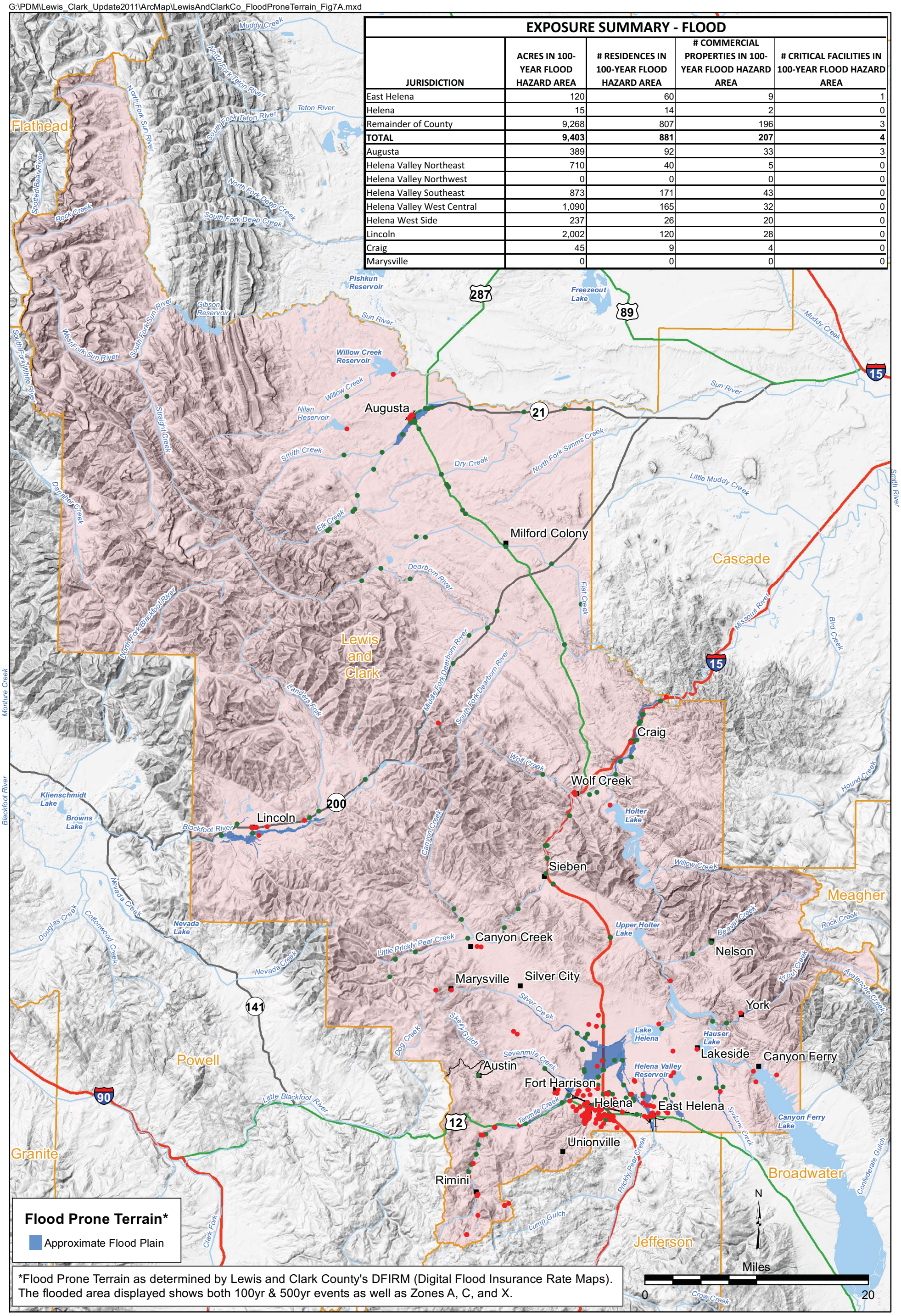
The main stream channels of Ten Mile and Prickly Pear Creeks are higher, in many places, than the adjoining valley land to the north and east. Thus, flood flows in excess of the main channel capacities cause shallow flooding over large areas far removed from the main channels. This shallow flooding problem is most severe along Ten Mile Creek, where flood flows leave the main channel near Green Meadow Drive. While some of this overflow moves along the overbanks, most of it flows out of the floodplain and moves generally northeasterly through heavily developed residential areas up to two miles from the main stream. Similar conditions prevail on Prickly Pear Creek just north of East Helena, where flood flows leave the main channel and move northward.

Flooding from Silver Creek is aggravated by the poorly defined channel that runs through the area. Therefore, flood flows of much less volume than the 100-year flood can spread over a large area along the creek. Floods have damaged structures and their contents on numerous occasions.

The City of East Helena and other portions of the East Helena area are located within 100-year and 500-year floodplains associated with Prickly Pear Creek and its overflow branches. Most of the Augusta townsite is located within the Elk Creek floodplain. A portion of the Wolf Creek townsite and many areas along the Missouri River are within a floodplain. No flood protection structures are in place on any of the flooding sources in Lewis and Clark County.

Due to the extensive damage caused by the June 2011 floods, the Lewis and Clark County Commissioners hired a consultant and held public meetings for Silver Creek, Ten Mile Creek, and Prickly Pear Creek flood victims to voice their concerns. Projects developed to mitigate the affects of flooding will be incorporated into this PDM Plan by addendum at a later date.

G:\PDM\Lewis_Clark_Update2011\ArcMap\LewisAndClarkCo_FloodProneTerrain_Fig7A.mxd



*Flood Prone Terrain as determined by Lewis and Clark County's DFIRM (Digital Flood Insurance Rate Maps). The flooded area displayed shows both 100yr & 500yr events as well as Zones A, C, and X.

EXPOSURE SUMMARY - FLOOD				
JURISDICTION	ACRES IN 100-YEAR FLOOD HAZARD AREA	# RESIDENCES IN 100-YEAR FLOOD HAZARD AREA	# COMMERCIAL PROPERTIES IN 100-YEAR FLOOD HAZARD AREA	# CRITICAL FACILITIES IN 100-YEAR FLOOD HAZARD AREA
East Helena	120	60	9	1
Helena	15	14	2	0
Remainder of County	9,268	807	196	3
TOTAL	**9,403**	**881**	**207**	**4**
Augusta	389	92	33	3
Helena Valley Northeast	710	40	5	0
Helena Valley Northwest	0	0	0	0
Helena Valley Southeast	873	171	43	0
Helena Valley West Central	1,090	165	32	0
Helena West Side	237	26	20	0
Lincoln	2,002	120	28	0
Craig	45	9	4	0
Marysville	0	0	0	0

Critical Facilities
Bridges
Place Names
River/Stream
Lake/Reservoir
County Boundary
Interstate
U.S. Highway
Montana Highway
Railroad

June 2011

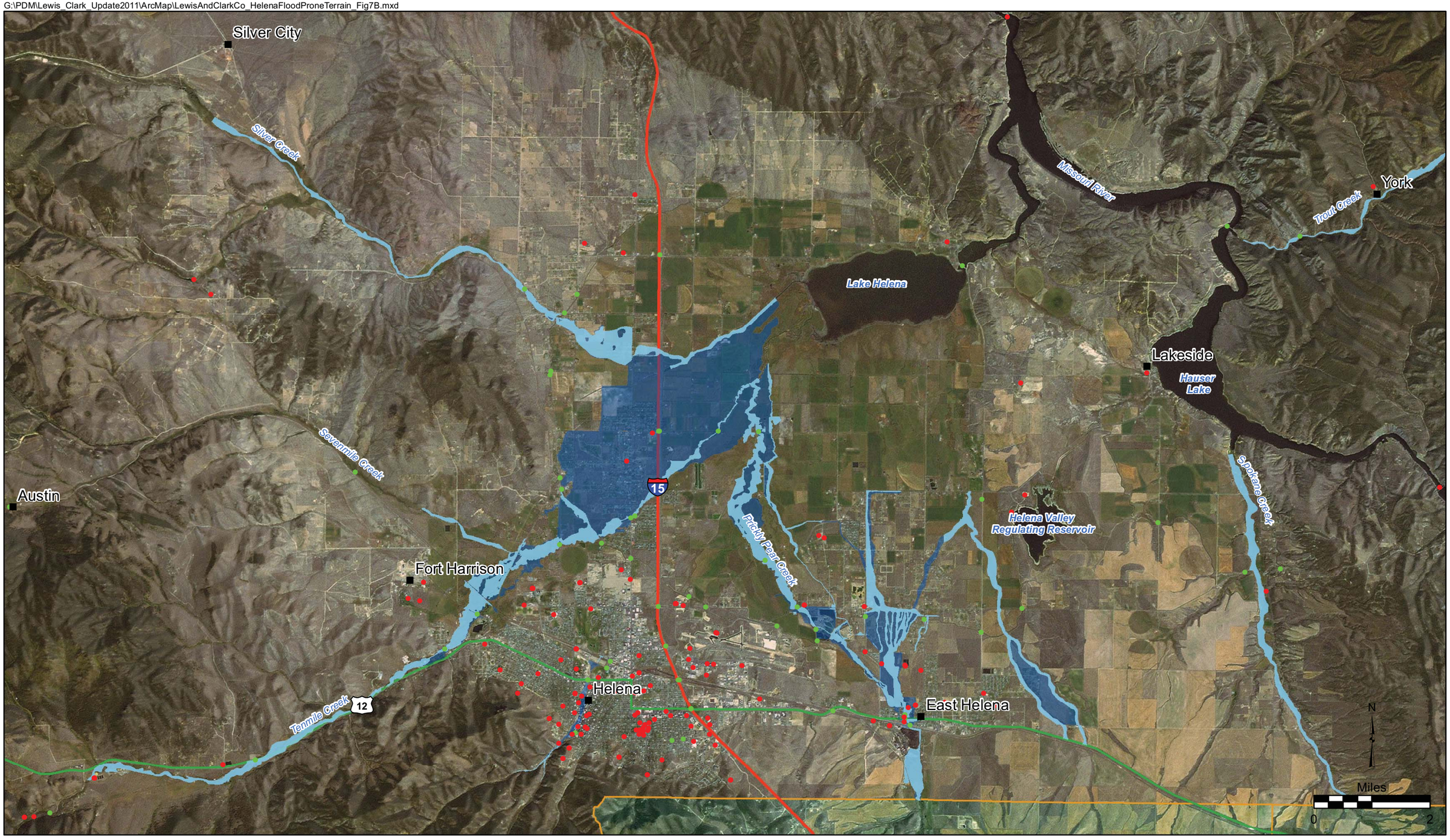
Figure 7A

Flood Prone Terrain

Lewis and Clark County, Montana

Pre-Disaster Mitigation Plan

G:\PDM\Lewis_Clark_Update2011\ArcMap\LewisAndClarkCo_HelenaFloodProneTerrain_Fig7B.mxd



Critical Facilities
Bridges
Place Names
100 yr Event
500 yr Event
County Boundary
Interstate
U.S. Highway
Montana Highway

*Flood Prone Terrain as determined by Lewis and Clark County's DFIRM (Digital Flood Insurance Rate Maps).

June 2011

Figure 7B

Helena Flood Prone Terrain

Lewis and Clark County, Montana

Pre-Disaster Mitigation Plan

There are 181 bridges in Lewis and Clark County (**Figure 3**). The majority are in fair to good condition. The Montana Department of Transportation (MDT) and the county maintain detailed bridge condition records, including maintenance recommendations. MDT lists bridges with scour potential from flooding and has identified the county-owned bridge over Elk Creek, 13 miles southwest of Augusta as being in need of repair.

The City of Helena's Stormwater Drainage Master Plan identifies four major stormwater drainage basins located in or immediately adjacent to the city: Davis Gulch, West Area, Bull Run, and Last Chance Gulch. Initial stormwater drainage evaluations indicated that urbanization within Helena resulted in a greater than seven-fold increase in the volume of stormwater runoff from its non-developed state. Increased volumes of stormwater runoff and construction across and within natural drainage paths result in localized flooding, causing structural damage, traffic disruption, pavement deterioration, and other adverse impacts.

Lincoln does not have a formal stormwater plan. Currently, stormwater runoff is a problem along Highway 200 through the Lincoln townsite. This area is predominantly commercial and as more businesses pave their parking areas the problem is exacerbated. Lincoln's stormwater problem is caused by a combination of factors: the lack of topographic relief causes ponding; Highway 200 construction has disrupted drainage patterns and increased elevation due to periodic resurfacing; and, more businesses are paving their parking areas adjacent to the Highway.

Floodplain and Floodway Management Ordinance

FEMA prepared detailed floodplain maps for Lewis and Clark County in 1981 and revised them in 1985. The 1985 revisions were updated on June 17, 2002 to incorporate new approximate flood hazard information for the Prickly Pear Creek Overflow. Lewis and Clark County has 30 floodplain maps for the Helena Valley along Spokane, Ten Mile, Prickly Pear and Silver Creeks, the Blackfoot River in Lincoln, Elk Creek in Augusta, Trout Creek near York and the Missouri River near Craig. Floodplain mapping is driven by development, a history of flooding and cost, which means that much of the county is not mapped. Unmapped areas may be prone to flooding that occurs in established floodplains. DFIRMs maps have been completed for various areas within Lewis and Clark County including a new floodplain map for the Silver Creek area and new 100-year floodplain zones around the N. Montana Ave./Crestwood Lane intersection and west of Interstate-15. The DFIRMs will be adopted by the county in June 2012.

The National Flood Insurance Program (NFIP) encourages local governments to adopt "sound" floodplain management programs to reduce private and public property losses due to floods. Lewis and Clark County and the Cities of Helena and East Helena are enrolled in the NFIP. **Table 4.5-1** presents statistics on flood insurance policies and losses.

TABLE 4.5-1 NATIONAL FLOOD INSURANCE PROGRAM STATISTICS				
Jurisdictions	**Policies in Force**	**Insurance in Force**	**Total Losses**	**Total Payments**
Lewis and Clark County	137	$23,181,000	23	$55,758
City of Helena	8	$1,994,600	16	$73,348
City of East Helena	22	$2,548,400	3	$14,454

Source: FEMA, 9/30/2010

There are no repetitive loss or severe repetitive loss properties in the county, Helena or East Helena.

The NFIP's Community Rating System (CRS) recognizes community efforts (beyond minimum standards) by reducing flood insurance premiums for the community's property owners. CRS discounts on flood insurance premiums range from 5 up to 45 percent. Those discounts provide an incentive for new flood protection activities that can help save lives and property in the event of a flood. To participate in the CRS, a community can choose to undertake some of the 18 public information and floodplain management activities. Based on the total number of points a community earns, the CRS assigns the jurisdiction to one of ten classes. The discount on flood insurance premiums is based on the assigned class. Lewis and Clark County currently participates in the CRS with a rating of 8. The Cities of Helena and East Helena do not currently participate in the CRS.

Probability and Magnitude

Past flood damage is difficult to document. County and city public works departments do not maintain records of infrastructure repair necessary due to flooding. As such, flood damage was compiled from SHELDUS, flood insurance studies, and Presidential Disaster Declarations. Flood listings, with associated property and crop damage, adjusted for inflations are presented in **Table 4.5-2.** Damages from the 2011 floods are not currently available and will be included in the 2016 PDM Plan update.

TABLE 4.5-2 LEWIS AND CLARK COUNTY FLOOD EVENTS WITH DAMAGES					
Date	**Injuries**	**Fatalities**	**Property Damage**	**Crop Damage**	**Remarks**
3/17/1969	0	0	$877	$0	Flooding
1975	-	-	$1,000,000	-	Presidential Disaster
7/3/1978	0	0	$0	$41,667	Flash Flood, Hail, Rain
1981	-	-	$1,000,000		Presidential Disaster
7/26/1989	0	0	$5,556	$56	Flooding
11/11/1989	0	0	$166,667	$0	Flood
1996	-	-	$1,000,000	-	Presidential Disaster
3/11/1996	0	0	$166,667	$0	Floods
8/5/1999	0	0	$4,000	$0	Floods
5/27/2001	0	0	$5,000	$0	Canyon Ferry Floods
3/12/2003	0	0	$750,000	$0	Floods
TOTAL	**0**	**0**	**$4,098,766**	**$41,722**	

Source: SHELDUS, 2010 (adjusted to 2009 dollars)

Lewis and Clark County maintains a GIS layer of flood-prone terrain (100-year floodplains and floodways) including data from the new DFIRMS. For the PDM vulnerability analysis, this GIS layer was intersected with MDOR parcel data and critical facility data to determine exposure of the building stock from flooding. The GIS layer of flood-prone areas was also intersected with census data and vulnerable populations were calculated based on the percentage of flood-prone areas in each census block. Annualized loss estimates for the county were calculated applying frequency and magnitude to building stock vulnerability, as presented in **Table 4.5-3**. **Figures 6A and 6B** present approximated 100-year flood zones and the distribution of critical facilities.

The GIS analysis indicates that 9,403 acres in Lewis and Clark County are located in the 100-year flood hazard area including 881 residences, 207 commercial, industrial and agricultural buildings, and 4 critical facilities. The Flood Section in **Appendix C** presents supporting documentation from the risk assessment.

Based on the frequency of past events, the probability of flooding in Lewis and Clark County is rated as "likely"; an event that may occur more than once per decade but not every year.

Future Development

Floodplain management regulations are presently in effect for parts of Lewis and Clark County and the Cities of Helena and East Helena. These regulations are administered by the Montana DNRC and basically preclude new structural development within areas classified as designated floodways under state law. The Lewis and Clark County Subdivision Regulations establish waterbody setbacks and buffer areas throughout the county. Building in the 100-year floodplain requires a permit that stipulates buildings to be elevated two feet above the base flood elevation with no basements. There are no restrictions for building in the 500-year floodplain.

The Helena Growth Policy has a development constraints map showing the 100- and 500-year floodplain locations along Ten Mile and Prickly Pear Creeks. Ten Mile Creek is located north and northwest of the City of Helena bordering an area that could be developed in the future. The floodplain along Prickly Pear Creek extends through East Helena and continues north and east of the airport, also an area where future development is likely. High groundwater and floodplains in the Augusta townsite present challenges for the town site's ability to expand.

Lewis and Clark County does not have a formal storm water management plan but is becoming an increasingly important issue as the population grows and commercial development expands. The City of Helena requires property owners with more than 5,000 square feet of impervious surface (roof tops, patios, decks and driveways) to address stormwater drainage on their property. Development may not allow more than the historic amount of stormwater to run off of the property, and it must be at a

TABLE 4.5-3

LEWIS AND CLARK COUNTY VULNERABILITY ANALYSIS – FLOODING (100-YEAR FLOOD)

JURISDICTION	RESIDENTIAL BUILDING EXPOSURE $	# RESIDENCES AT RISK	COMMERCIAL, INDUSTRIAL & AGRICULTURAL BUILDING EXPOSURE $	# COMMERCIAL, INDUSTRIAL & AGRICULTURAL PROPERTIES AT RISK	CRITICAL FACILITIES EXPOSURE RISK $	# CRITICAL FACILITIES AT RISK	BRIDGE EXPOSURE $	# BRIDGES AT RISK	POPULATION AT RISK	PERSONS UNDER 18 AT RISK
Incorporated Communities & County										
East Helena	$5,012,016	60	$3,861,424	9	$152,483	1	$245,052	3	242	41
Helena	$1,749,553	14	$117,900	2	$0	0	$0	0	923	54
Remainder of County	$87,224,898	807	$20,723,657	196	$401,890	3	$10,766,694	27	8,423	1,965
CENSUS Designated Places										
Augusta	$4,946,516	92	$2,299,801	33	$401,890	3	$243,008	4	225	27
Helena Valley Northeast	$5,958,079	40	$339,821	5	$0	0	$236,176	3	650	148
Helena Valley Northwest	$0	0	$0	0	$0	0	$0	0	0	0
Helena Valley Southeast	$16,896,876	171	$3,898,990	43	$0	0	$135,232	2	2,574	709
Helena Valley West Central	$19,493,222	165	$6,617,783	32	$0	0	$179,252	3	2,407	616
Helena West Side	$3,465,672	26	$10,587,681	20	$0	0	$0	0	399	84
Lincoln	$10,817,781	120	$896,463	28	$0	0	$134,112	1	545	84
Craig	$952,449	9	$95,847	4	$0	0	$0	0	2	0
Marysville	$0	0	$0	0	$0	0	$0	0	0	0
CENSUS County Divisions										
Augusta	$6,970,689	112	$2,387,054	36	$401,890	3	$451,484	8	308	31
Helena	$64,005,696	550	$20,126,525	118	$152,483	1	$926,164	12	8,259	1,881
Lincoln	$12,060,476	132	$1,120,152	32	$0	0	$134,112	1	724	121
Wolf Creek	$10,949,606	87	$1,069,250	21	$0	0	$9,499,986	9	297	27

controlled rate. Stormwater drainage may be accommodated in onsite detention ponds or may use the City's storm drainage system.

Completed Mitigation Projects

Flood projects completed since 2005 include: a new bridge in East Helena (Wylie Drive) and installation of larger culverts at several locations; revision to the 1985 flood plains in the Helena Valley; obtaining status as a NWS Storm Ready Community; and, enrollment in the NFIP Community Rating System.