Part 2. Risk Assessment

7. RISK ASSESSMENT METHODOLOGY

The risk assessments in this plan describe the risks associated with each identified hazard of concern. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
  - A summary of past events that have impacted the planning area
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity descriptions
  - Warning time likely to be available for response.
- **Determine exposure to each hazard**—Exposure was assessed by overlaying hazard maps with an inventory of structures, facilities, and systems to decide which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities**—Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as geographic information systems (GIS) and Hazus were used for this assessment for the dam failure, earthquake, and flood hazards. Outputs similar to those from Hazus were generated for other hazards, using data generated through GIS.

7.1 RISK ASSESSMENT TOOLS

7.1.1 Mapping

National, state, and local databases were reviewed to locate spatially based data relevant to this planning effort. Maps were produced using GIS software to show the spatial extent and location of hazards when such datasets were available. These maps are included in the hazard profile chapters of this document and the jurisdiction-specific annexes in Volume 2. Appendix C provides details on the mapping data sources and methodologies.

7.1.2 Modeling

Overview

FEMA developed the GIS-based software program Hazus (Hazards U.S.) to estimate losses caused by earthquakes, hurricanes, floods, and tsunamis. Hazus is used to support risk assessments, mitigation planning, and emergency planning and response. It provides a range of inventory data, (such as demographics, building stock, critical facilities, transportation and utility infrastructure) and multiple models to estimate losses from natural disasters. The program maps and calculates hazard data and damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates the review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

Hazus provides default data for inventory, vulnerability, and hazards; this default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. This data is derived from national databases and describes in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

7.2 RISK ASSESSMENT APPROACH

7.2.1 Hazard Profile Development

Hazard profiles were developed through web-based research and review of previous reports and plans, including community general plans and state and local hazard mitigation plans. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others.

7.2.2 Exposure and Vulnerability

Dam Failure, Earthquake, and Flood

Community exposure and vulnerability to the following hazards were evaluated using Hazus:

- **Dam Failure and Flood**—A Level 2 user-defined analysis was performed for general building stock and for community lifelines using the flood module. Current mapping for the planning area was used to delineate hazard areas for flood and dam failure and estimate potential losses. To estimate damage that would result from these inundation-based hazards, Hazus uses pre-defined relationships between water depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting inundation depth data and known property replacement cost values, dollar-value estimates of damage were generated.

- **Earthquake**—A Level 2 analysis was performed to assess earthquake risk and exposure for two scenario events and two probabilistic events:
  - A Magnitude-7.03 event on the Squaw Creek fault with an epicenter 36 miles north of Boise.
  - A Magnitude-6.81 event on the Big Flat Jakes Creek fault with an epicenter 45 miles north-northwest of Boise.
  - The standard Hazus 100- and 500-year probabilistic events.

Extreme Weather, Landslide, Volcano and Wildfire

Historical datasets were not adequate to model future losses for landslide, extreme weather, volcano and wildfire. However, areas and inventory susceptible to some of the hazards of concern were mapped by other means to evaluate exposure. A qualitative analysis was conducted for other hazards using the best available data and professional judgment.

Drought

The risk assessment methodologies used for this update focus on damage to structures. Because drought does not impact structures, the risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern.

7.3 SOURCES OF DATA USED IN MODELING AND EXPOSURE ANALYSIS

7.3.1 Building and Cost Data

Replacement cost is the cost to replace the entire structure with one of equal quality and utility. Replacement cost is based on industry-standard cost-estimation models published in the 2021 *RS Means Square Foot Costs*. It is calculated using the RS Means square foot cost for a structure, which is based on the Hazus occupancy class (i.e., multi-family residential or commercial retail trade), multiplied by the square footage of the structure from the tax assessor data. The construction class and number of stories for single-family residential structures also factor into determining the square foot costs.

Replacement cost values and detailed structure information derived from parcel and tax assessor data provided by Ada County were loaded into Hazus. When available, an updated inventory was used in place of the Hazus defaults for community lifelines.

7.3.2 Hazus Data Inputs

The following hazard datasets were used for the Hazus Level 2 analysis conducted for the risk assessment:

- **Flood**—The effective Digital Flood Insurance Rate Map (DFIRM) for the planning area was used to delineate flood hazard areas and estimate potential losses from the FEMA 1-percent-annual chance and 0.2-percent-annual-chance (100- and 500-year) flood events. Using the DFIRM floodplain boundaries and base flood elevation information and the best available digital elevation model data, flood depth grids were generated and integrated into the Hazus model.

- **Dam Failure**—Dam failure inundation area boundaries and depth grids data for Blacks Creek and Lucky Peak were provided by the Idaho Department of Water Resources and the U.S. Army Corps of Engineers, respectively. The individual dam depth grids were integrated into the Hazus model.
- **Earthquake**—Earthquake ShakeMaps and probabilistic data prepared by USGS were used for the analysis of this hazard. National Earthquake Hazard Reduction Program (NEHRP) soils and liquefaction maps for the Boise metro area, from the Idaho Geological Survey, were also integrated into the Hazus model.

7.3.3 Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Data sources for specific hazards were as follows:

- **Drought**—No GIS format drought hazard area datasets were identified for Ada County.
- **Extreme weather—**No GIS format extreme weather area datasets were identified for Ada County.
- **Landslide**—A dataset of steep slopes was generated using data from a combination of the Boise Foothills 1-foot digital elevation model and the U.S. Geological Survey (USGS) 10-meter digital elevation model. Two slope classifications were created: 15 to 30 percent; and greater than 30 percent. These two categories were used in the risk assessment.
- **Volcano**—No GIS format volcano hazard area datasets were identified for Ada County.
- **Wildfire**—Base hazard data from the 2016 Enhanced Wildfire Risk Map Project was provided by Ada County. High and moderate base hazard rating areas were used in the exposure analysis.

7.3.4 Data Source Summary

Table 7-1 summarizes the data sources used for the risk assessment for this plan.

7.4 LIMITATIONS

Loss estimates, exposure assessments and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic or economic parameter data
- The unique nature, geographic extent and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, Ada County and its planning partners will collect additional data to assist in estimating potential losses associated with other hazards.

Table 7-1. Hazus Model Data Documentation

Data	Source	Date	Format
Residential and commercial parcel characteristics	Ada County	2021	Digital
Condos	Ada County	2021	Digital (GIS)
Property parcels	Ada County	2021	Digital (GIS)
U.S. Building Footprints—Boise metro area	Microsoft	2019-20	Digital (GIS)
U.S. Building Footprints—Other areas	Microsoft	2012	Digital (GIS)
Building replacement (square foot) costs	RS Means	2021	Digital (pdf)
Lucky Peak Dam failure inundation area and depth grid	U.S. Army Corps of Engineers	2020	Digital (GIS)
Blacks Creek Dam failure inundation area and depth grid	Idaho Department of Water Resources	2020	Digital (GIS)
ShakeMap – Big Flat-Jakes Creek M6.81	USGS	2017	Digital (GIS)
ShakeMap – Squaw Creek M7.03	USGS	2017	Digital (GIS)
Probabilistic peak ground acceleration data	Hazus v5.1	2018	Digital (GIS)
Boise Metro Area NEHRP Site Class	Idaho Geological Survey	2011	Digital (GIS)
Boise Metro Area Liquefaction	Idaho Geological Survey	2011	Digital (GIS)
Digital Flood Insurance Rate Map—Ada County effective 6/19/2020 with latest Letter of Map Revision, effective date 10/14/2021	FEMA	2021	Digital (GIS)
Percent slope (generated from Boise Foothills 1-foot DEM and USGS 10-meter DEM)	2017 Ada County Hazard Mitigation Plan	2017	Digital (GIS)
Wildfire base hazard data (2016 Enhanced Wildfire Risk Map Project)	Ada County	2017	Digital (GIS)
USGS 10-meter DEM	U.S. Geological Survey	unknown	Digital (GIS)
USGS 2-meter DEM	U.S. Geological Survey	unknown	Digital (GIS)
2015 Boise Foothills DEM (1-foot)	Ada County	2015	Digital (GIS)
2020 Boise River DEM FCD10	Flood Control District #10	2020	Digital (GIS)
2015 Boise River DEM	Boise State University	2015	Digital (GIS)

8. CIVIL DISTURBANCE AND TERRORISM

8.1 GENERAL BACKGROUND

8.1.1 Description

Civil Disturbance

Civil disturbance can include acts of civil disobedience, such as demonstrations, riots, labor unrest, and rebellion often spontaneous, that involve large numbers of persons and are generally caused by political grievances, urban economic conflicts, or a decrease in the supply of essential goods and services. Civil disturbance is often a form of protest, arising from highly emotional social and economic issues.

Civil disturbance severity depends on the nature of the disturbance. The homicide of George Floyd on May 25, 2020, led to months of protests to address racism at all levels of society (Center for Disaster Philanthropy 2021). Between May 25 and Nov. 18, 2020, protests occurred in more than 4,446 cities worldwide, including in all states, territories and Washington, D.C., and internationally in more than 60 countries (Center for Disaster Philanthropy 2021). Throughout summer and fall 2020, there were also protests and rallies connected to the COVID-19 pandemic and the 2020 Presidential Election (Center for Disaster Philanthropy 2021). It is not possible to predict the potential severity of civil disturbance; however, it is necessary to think about the potential of such a disturbance. Incidents like these are less likely to occur in smaller cities.

Mob violence, such as riots, lynching, and vigilantism, is typically associated with disorder and lack of respect for the law on the part of masses of people who are uncontrolled, unorganized, angry, and emotional.

Terrorism

The Federal Bureau of Investigation (FBI) defines two types of terrorism (Federal Bureau of Investigation n.d.):

- International terrorism—Violent, criminal acts committed by individuals and/or groups who are inspired by, or associated with, designated foreign terrorist organizations or nations (state-sponsored). For example, an Uzbek national living in Boise was sentenced to 25 years in a federal prison for attempting to provide material support to a designated terrorist organization and possessing an unregistered destructive device (U.S. Immigration and Customs Enforcement 2016).
- Domestic terrorism—Violent, criminal acts committed by individuals and/or groups to further ideological goals stemming from domestic influences, such as those of a political, religious, social, racial, or environmental nature. For example, the January 6, 2021, storming of the U.S. Capitol building was described as an act of terrorism by the director of the FBI (Federal Bureau of Investigation 2021).

For a discussion of cyberterrorism, see Section 9.1.1.

8.1.2 Assessing Severity of the Hazard

Civil Disturbance

The following levels of severity can be associated with the civil disturbance hazard:

- A high hazard severity rating is assigned to an event where an emotionally charged and highly contentious business or police action engenders the outrage of a segment of the population. While the hazard severity is high, there is a moderate vulnerability in such an event and low probability. Therefore, a low risk rating is assigned to a high severity civil disturbance.
- A moderate hazard severity rating would be assigned to a localized event that resulted in damage to property, police action, or some physical harm to the people involved, either protesters or police. In that the vulnerability to such an event is moderate, the severity is moderate, and the probability is moderate, a moderate risk rating is assigned to a moderate civil disturbance event.
- A low hazard rating would be assigned to a localized event that resulted in minimal to no property damage, no police action (though potential police presence), and no physical harm to participants, bystanders, or police. While there may a high probability rating for such forms of civil disturbance, and while the vulnerability rating may be moderate, a low severity hazard would be given a low risk rating.

Such disturbances may originate from a political rally, a sport event celebration getting out of control, or demonstrations by environmental protestors. Dispatching police to control traffic corridors or intrusion on private property is considered a low severity civil disturbance. Disruption of businesses and potential property damage are assessed as a moderate civil disturbance. In these cases, police intervention would be required to restore order without employing chemical agents or physical force. A high civil disturbance would involve rioting, arson, looting, and assault, where aggressive police action (tear gas, curfews, and mass arrests) may be required.

Terrorism

The National Terrorism Advisory System issues alerts to communicate timely, detailed information about the risk of terrorism to the American public at any given time (U.S. Department of Homeland Security 2022).

8.1.3 Secondary Hazards

Civil Disturbance

The overall extent of secondary hazards will vary significantly based on the extent and nature of the civil unrest. Civil disturbances may lead to widespread urban fire, utility failure, transportation interruption, and environmental hazards. There is potential for a mass casualty incident to occur during the course of a civil disturbance event should rioters or protestors become violent and clash with law enforcement or opposing groups. The most significant secondary hazard associated with civil unrest is the interruption of continuity of government, which can also lead to several of the aforementioned secondary hazards.

Civil disturbances generally do not influence the initiation of natural hazards. However, humans could be the cause of a wildfire. During any natural hazard event, some homeowners worried about any ongoing civil disturbance may choose not to evacuate, causing first responders more danger when responding to the disaster.

Terrorism

Secondary hazards of terrorism can include falling debris, hazardous materials exposure, utility failure, or transportation interruption.

8.2 HAZARD PROFILE

8.2.1 Past Events

Civil Disturbance

The following episodes of civil disturbance occurred in Ada County over the past decade:

- **2011**—Occupy Boise, an episode of civil disturbance, launched from the Occupy movement that started with the Occupy Wall Street protest in New York City. Local officials expended time and resources planning for contingencies and dealing with permit issues. The protest against corporate entities for political reasons remained peaceful (Idaho Office of Emergency Management 2018).
- **February 3, 2014**—Gay-rights activists were arrested in Boise for a silent protest to draw attention to anti-discrimination legislation. The protestors blocked all entrances to the Senate chambers for more than two hours. Police took 43 people into custody after the demonstrators prevented lawmakers from getting past (Idaho Office of Emergency Management 2018).
- **March 4, 2014**—Twenty-three gay rights activists were arrested after they blocked the entrance to the governor's office inside the Idaho Statehouse. Four were charged with trespassing, 18 with unlawful assembly and one with resisting arrest (Idaho Office of Emergency Management 2018).
- **May and June 2020**—Protests and a vigil were attended by 5,000 to 6,000 people in response to the killing of George Floyd and other instances of police violence and racism toward African Americans nationwide. The protests did not lead to rioting, but U.S. Postal Service boxes were removed from areas near the State Capitol building as a precaution.
- **June 30, 2020**—During a protest at Boise City Hall, fights broke out between a small group of protesters from the organization Black Lives Matter Boise, who were scheduled to hold a "defund the police" rally, and a much larger group of counter protesters.
- **July 21, 2020**—A Black Lives Matter Boise group demonstrated in front of Boise City Hall. The event was met with counter protesters, but the police set up barriers before the event to manage the crowds (Idaho Press 2020).
- **March 6, 2021**—About 100 demonstrators burned masks outside the State Capitol in Boise as a statement against pandemic restrictions. No one was arrested, and the organizers had permits, but the rally was under review because an open fire is not allowed on State Capitol grounds (NBC News 2021).
- **March 15, 2022**—St. Luke's Boise Medical Center went on lockdown for about an hour after an activist urged supporters to go to the hospital to protest a child protection case.

Terrorism

In 2016, an Uzbek national living in Boise was sentenced for conspiring and attempting to provide material support to the Islamic Movement of Uzbekistan and procuring bomb-making materials in the interest of executing a terrorist attack. He was fined $250,000 and sentenced to 25 years in federal prison and three years of supervised release. He faces possible deportation after his sentence (U.S. Immigration and Customs Enforcement 2016).

8.2.2 Location

Civil Disturbance

Information is key for civil disturbances. There must be knowledge of who the demonstrators are, when, where, and why they are demonstrating, what their capabilities are, and what their possible course of action is. Because of their often spontaneous nature, it is difficult to identify specifics.

Government facilities, landmarks, prisons, and universities are common sites where crowds and mobs may gather. Correctional facilities, treatment units, and youth development centers, as well as local and private facilities throughout Idaho that may be targets for civil unrest. Civil disorder can erupt anywhere, but the most likely locations are those areas with large population groupings or gatherings. Civil disorder can also occur near where a "trigger event" occurred, as was the case in 2014 Ferguson, Missouri unrest.

The severity of a civil disturbance coincides with the level of public outrage. It can take the form of small gatherings or large groups blocking access to buildings or disrupting normal activities. Civil disturbances can be peaceful sit-ins or full scale riots (Idaho Office of Emergency Management 2018).

Terrorism

Terrorism can occur anywhere; however, targets are typically in urbanized areas where the attack will cause the most damage and fear.

8.2.3 Frequency

Civil Disturbance

It can be assumed that civil disturbances will occur in the future, but these events are difficult to predict. Some forms of civil disturbance are potentially anticipated. In the case of the race riots that erupted after legal verdicts, the ensuing civil disturbances could have been predicted.

Terrorism

While not historically as frequent as civil disturbances, it can be assumed that terrorism events will occur in the future. The frequency is difficult to predict.

8.2.4 Severity

Civil Disturbance

Civil disturbance severity depends on the nature of the disturbance. The protests after George Floyd's death took place in 140 U.S. cities; the arson, vandalism and looting that occurred will result in at least $1 billion to $2 billion of paid insurance claims—eclipsing the record set in Los Angeles in 1992 after the acquittal of the police officers who brutalized Rodney King (Kingston 2020).

Terrorism

The severity of an act of terrorism depends on whether the event is fully carried out or the instigators are apprehended before they can follow through with their plans.

8.2.5 Warning Time

Civil Disturbance

Because of their often spontaneous nature, it is difficult to identify specifics; however, information gathered in advance may warn officials and provide locations of future civil disturbances. Civil disturbances often occur with little to no warning; however, certain events may trigger riots. Planned demonstrations can turn into riots as a result of controversial court rulings, unfair working conditions, or general unrest. Riots can also be triggered as a result of favorable or unfavorable sports outcomes. Generally, there is a degree of warning time that a riot may occur; however, achieving certainty that an incident is imminent is not possible. Intelligence sharing with regards to crowd size and behavior, as well as known group presence, can assist authorities in determining the possibility of an organized nonviolent demonstration turning violent.

Terrorism

The National Terrorism Advisory System communicates information about terrorist threats. Bulletins are issued on the system's website regarding heightened threat environments across the United States, often in relation to public events such as the presidential inauguration, the anniversary of notable terrorist attacks, religious holidays and associated mass gatherings.

8.3 EXPOSURE AND VULNERABILITY

The entire county is vulnerable to the civil disturbance and terrorism hazard. However, government facilities, landmarks, and universities are common sites where crowds and mobs may gather. Facilities, such as homes, businesses, and other essential infrastructure, such as dams, utilities sites, and other public common areas are vulnerable to civil disturbance and terrorism. Civil violence and terrorism are most often directed at objects that reflect civil values—property, industry, and services.

The systems most likely impacted by civil disturbance include community systems, such as police, fire departments, and emergency medical teams. Straining such limited services, particularly in rural counties, could be disastrous. Transportation systems could be impacted if transit routes are blocked, such as major corridors through Ada County including Interstate 84 or Highway 55, or if the civil disturbance renders part of the city unsafe, like the Capitol building in Boise. Given its role as the state's capital and the high concentration of state buildings, the City of Boise is considered more vulnerable to this hazard than other areas of the county (State of Idaho Hazard Mitigation Plan 2018).

8.4 DEVELOPMENT TRENDS

Future population growth will impact the County's vulnerability to civil disturbance and terrorism. The population of Ada County is projected to increase by 37 percent between 2020 and 2040 (COMPASS 2021).

8.5 SCENARIO

A worst-case scenario for the civil disturbance and terrorism hazard would be a large protest event in the Capitol with a crowd numbering in the thousands, similar to the events in May/June 2020, with the added element of a terrorist attack targeting the mass gathering.

8.6 ISSUES

Much of Ada County is rural and not as impacted by issues concerning civil disturbance and terrorism. The issue in the population centers includes the lack of a civil disturbance policy.

9. CYBER DISRUPTION

9.1 GENERAL BACKGROUND

9.1.1 Description

Cyberattacks

A cyberattack is an intentional and malicious crime that compromises the digital infrastructure of a person or organization, often for financial or terror-related reasons. Such attacks vary in nature and are perpetrated using digital mediums or sometimes social engineering to target human operators. Generally, attacks last minutes to days, but large-scale events and their impacts can last much longer. As information technology continues to grow in capability and interconnectivity, cyberattacks become increasingly frequent and destructive. The FBI's *2020 Internet Crime Report* includes information from 791,790 complaints of suspected internet crime—an increase of more than 300,000 complaints from 2019—and reported losses exceeding $4.2 billion (FBI National Press Office 2021).

Cyberattacks can lead to loss of money, theft of personal information, and damage to personal reputation and safety. Cyber-threats differ by motive, attack type and perpetrator profile. Motives range from the pursuit of financial gain to political or social aims. Attack types include using viruses to erase entire systems, breaking into systems and altering files, using someone's personal computer to attack others, or stealing confidential information. Such threats having a wide range of effects on individuals, communities, and organizations.

Computer systems can experience a variety of cyberattacks, from blanket malware infection to targeted attacks on system capabilities. Cyberattacks seek to breach information technology security measures designed to protect an individual or organization. The initial attack is followed by more severe attacks for the purpose of causing harm, stealing data, or financial gain. Organizations are prone to different types of attacks that can be either automated or targeted in nature. Table 9-1 describes the most common cyberattack mechanisms faced by organizations today.

Cyberterrorism

Cyberterrorism is the use of computers and information, particularly over the Internet, to recruit others to an organization's cause, cause physical or financial harm, or cause a severe disruption of infrastructure service. Such disruptions can be driven by religious, political, or other motives. Like traditional terrorism tactics, cyberterrorism seeks to evoke very strong emotional reactions, but it does so through information technology rather than a physically violent or disruptive action.

Table 9-1. Common Mechanisms for Cyberattacks

Type	Description
Cross-Site Scripting	An attack that sends malicious scripts into content from reliable websites.
Denial of Service Attack	An attack that focuses on disrupting service to a network in which attackers send high volumes of data until the network becomes overloaded and can no longer function.
Internet of Things Attacks	Internet connectivity across commonly used devices presents a growing number of access points for attackers to exploit. The interconnectedness of things makes it possible for attackers to breach an entry point and use it as a gate to exploit other devices in the network.
Malware	“Malware” refers to various types of attacks, including spyware, viruses, and worms. Malware uses a vulnerability to breach a network when a user clicks a planted dangerous link or email attachment, which is used to install malicious software inside the system.
Man in the Middle	Man-in-the-middle attacks mirror victims and endpoints for online information exchange. In this type of attack, the attacker communicates with the victims, who believe they are interacting with a legitimate endpoint website. The attacker is also communicating with the actual endpoint website by impersonating the victim. As the process goes through, the attacker obtains entered and received information from both the victim and endpoint.
Password Attacks	Passwords are the most widespread method of authenticating access to a secure information system, making them an attractive target for cyber attackers. By accessing a person’s password, an attacker can gain entry to confidential or critical data and systems, including the ability to manipulate and control them.
Phishing	Malicious email messages that ask users to click a link or download a program. Phishing attacks may appear as legitimate emails from trusted third parties.
Rootkits	Rootkits are installed inside legitimate software, where they can gain remote control and administration-level access over a system. The attacker then uses the rootkit to steal passwords, keys, and credentials and retrieve critical data.
SQL Injection	This occurs when an attacker inserts malicious code into a server using server query language (SQL), forcing the server to deliver protected information. This type of attack usually involves submitting malicious code into an unprotected website comment or search box.
Zero-day Exploit	A zero-day exploit refers to exploiting a network vulnerability when it is new and recently announced—before a patch is released and/or implemented.

Source: (Datto 2022)

Cyberterrorism has three main types of objectives:

- **Organizational**—Cyberterrorism with an organizational objective includes specific functions outside of or in addition to a typical cyberattack. Terrorist groups today use the internet on a daily basis. This daily use may include recruitment, training, fundraising, communication, or planning. Organizational cyberterrorism can use platforms such as social media as a tool to spread a message beyond country borders and instigate physical forms of terrorism. Additionally, organizational goals may use systematic attacks as a tool for training new members of a faction in cyber-warfare.
- **Undermining**—Cyberterrorism with undermining as an objective seeks to hinder the normal functioning of computer systems, services, or websites. Such methods include defacing, denying, and exposing information. While undermining tactics are typically used due to high dependence on online structures to support vital operational functions, they typically do not result in grave consequences unless undertaken as part of a larger attack. Undermining attacks on computers include the following (Waldron 2011):
    - ➢ Directing conventional kinetic weapons against computer equipment, a computer facility, or transmission lines to create a physical attack that disrupts the reliability of equipment.
    - ➢ Using electromagnetic energy, most commonly in the form of an electromagnetic pulse, to create an electronic attack against computer equipment or data transmissions. By overheating circuitry or jamming communications, an electronic attack disrupts the reliability of equipment and the integrity of data.

- Using malicious code directed against computer processing code, instruction logic, or data. Malicious code is unwanted files or programs that can cause harm to a computer or compromise data stored on a computer (Cybersecurity & Infrastructure Security Agency 2019). This type of cyberattack can disrupt the reliability of equipment, the integrity of data, and the confidentiality of communications.

- **Destructive**—The destructive objective for cyberterrorism is what organizations fear most. Through the use of computer technology and the Internet, the terrorists seek to inflict destruction or damage on tangible property or assets, and even death or injury to individuals. There are no cases of pure cyberterrorism as of the date of this plan.

9.1.2 Secondary Hazards

Cyber disruptions can impact all human-caused hazards in numerous and unforeseen ways. Malicious software could harm critical infrastructure operations, including power systems. Cyber disruptions cannot directly influence natural hazards, but it is possible for related systems to be affected. For instance, any computerized systems that manage flood control systems could be impacted by a cyber-event, causing a flood event. Cyber disruptions could impact the environment in a number of ways, as affected systems could to stop functioning as intended.

Cyber disruption could also be caused by several other hazards. Earthquakes, flooding, and extreme weather such as severe storms can cause any number of cyber disruption issues through availability of the cyber network. If hardware, computer systems, networks, servers, and backups are damaged due to other hazards, it will cause a cyber disruption for that specific area damaged (State of Idaho Hazard Mitigation Plan 2018).

9.2 HAZARD PROFILE

9.2.1 Past Events

Ada County has been subject to cyberattacks in the past. In May 2019, both the FBI and the Department of Homeland Security were brought in to investigate a ransomware attack that shut down the computer systems of the Ada County Highway District for about 30 hours (Harding 2019). In August 2021, Idaho's governor announced the formation of a new task force to advance cybersecurity initiatives in Idaho (Lewis 2021).

9.2.2 Location

This hazard is not geography-based. Attacks can originate from any computer to affect any other computer in the world. If a system is connected to the Internet or operating on a wireless frequency, it is susceptible to exploitation. Targets of cyberattacks can be individual computers, networks, organizations, business sectors, or governments. Financial institutions and retailers are often targeted to extract personal and financial data that can be used to steal money from individuals and banks. The most affected sectors are finance, energy and utilities, and defense and aerospace, as well as communication, retail, and health care. Both public and private operations are threatened on a near-daily basis by the engineered cyberattacks developed to automatically seek technological vulnerabilities.

9.2.3 Frequency

Cyberattacks are experienced on a daily basis, often without being noticed. Up-to-date virus protection software used in public and private sectors prevents most cyberattacks from becoming successful. Programs that promote public education on virus protection are an effective way to mitigate cyber-threats. The COVID-19 pandemic resulted in a 600 percent increase in cybercrime, with much of the increase coming from phishing email schemes (Purplesec 2021).

9.2.4 Severity

There is no index for measuring the severity of a cyberattack. If it were measured as a country, then cybercrime—which is predicted to inflict damages totaling $6 trillion globally in 2021—would be the world's third-largest economy after the U.S. and China. Experts predict that global cybercrime costs will grow by 15 percent per year over the next five years, reaching $10.5 trillion annually by 2025—more profitable than the global trade of all major illegal drugs combined. This represents the greatest transfer of economic wealth in history, risks the incentives for innovation and investment, is exponentially larger than the damage inflicted from natural disasters in a year (Morgan 2020).

9.2.5 Warning Time

There is no warning time for cyberattacks. The top vector for spreading cyber-ransom threats is email.

9.3 EXPOSURE AND VULNERABILITY

The entire population of Ada County and all critical assets operated by a computer system are exposed to cyberattacks. Any areas where technological systems exist or are utilized are vulnerable to cyber disruption. This includes county and municipal buildings and infrastructure. All critical facilities operated by electricity and/or a computer system are vulnerable to cyberattacks. Cyberattacks may affect structures if any critical electronic systems suffer service disruption. For instance, a cyberattack may cripple the electronic system that controls a cooling system or pressure system within critical infrastructure. This may result in physical damage to the structure from components overheating, or an explosion if pressure relief systems are rendered inoperable. Such failures may not be immediately recognizable as cyberattacks, appearing at first to be attributable to mechanical malfunctions.

If an attack targets critical infrastructure (such as the power grid) impacting life support systems in a healthcare facility, the effects on life, health, and safety could be dire. Likewise, if a cyberattack affects the emergency response system, such as by rendering a 911 call center or the radio network inoperable, emergency services at the county and local level could be hindered, which may result in increased injury or loss of life during emergency situations. If a cyber-disruption impacts the power or utility grid, individuals with medical needs would be impacted the most. These populations are most vulnerable because many of the life-saving systems they rely on require power. Power redundancy is recommended for the essential and critical facilities that serve vulnerable populations.

Economic impacts can be far-reaching if a cyberattack is prolonged for a week or longer. Cyberattacks can have extensive fiscal impacts. Companies and government services can lose large sums of unrecoverable revenue from site downtime and possible compromise of sensitive confidential data. The average amount of money it takes to recover one record of data is $120, and the average medium size business recovery costs about $50,000. Cyber-incidents could result in the theft or modification of important data—including personal, agency, or corporate information—and the sabotage of critical processes, including the provision of basic services by government or private-sector entities.

Ada County will continue to be impacted by cyberattacks in the future. The nature of these attacks is projected to evolve in sophistication over time. The reality remains that many computers and networks in organizations of all sizes and industries around the U.S. will continue to suffer intrusion attempts on a daily basis from viruses and malware that are passed through websites and emails (State of Idaho Hazard Mitigation Plan 2018).

9.4 DEVELOPMENT TRENDS

Development trends across the county can greatly influence and impact future cyber events. As the population increases, the number of connected devices will increase, thus increasing the number of people potentially impacted.

9.5 SCENARIO

A worst-case scenario of cyber disruption would involve an interruption of all critical assets in the County. This would cripple functions in the County, including utilities, emergency services, communication, and vital records. Such an event could last for days or weeks and cost millions of dollars to remedy.

9.6 ISSUES

Issues relating to cyber disruption include the efforts of emergency management to keep up with the rapid advancements made by cyber criminals to hack and disable systems.

10. DAM/CANAL FAILURE

10.1 GENERAL BACKGROUND

10.1.1 Causes of Dam Failure

Partial or full failure of dams has the potential to cause massive destruction to the ecosystems and communities located downstream. Partial or full failure can occur as a result of one or a combination of the following reasons (Federal Emergency Management Agency 2016):

- Overtopping caused by floods that exceed the dam capacity (inadequate spillway capacity)
- Prolonged periods of rainfall and flooding
- Deliberate acts of sabotage (terrorism)
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate or negligent operation, maintenance, and upkeep
- Failure of upstream dams on the same waterway
- Earthquake (liquefaction/landslides).

Many dam failures in the United States have been secondary results of other disasters. The most common causes are earthquakes, landslides, extreme storms, equipment malfunction, structural damage, foundation failures, and sabotage. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

The potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367), which requires a periodic engineering analysis of every major dam in the country. The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public.

10.1.2 Irrigation Canals

Much of the arid land of Southwest Idaho was developed through reclamation projects of the early 1900s. These projects included dams to collect water and provide flood control and canals to deliver water to agricultural areas.

Many canals crisscross the state, but they are not generally perceived as flood hazards. New development has encroached on the canals and the areas around them. Numerous housing developments in Ada County lie below large-capacity canals. This proximity creates risk to life, safety and property. Because of widespread ownership issues (private canals, irrigation districts, etc.) data for canal failure events is not readily obtainable. The Silver Jackets technical advisory group has expressed strong interest in monitoring this issue and the Idaho Office of Emergency Management anticipates further discussions regarding this hazard.

10.1.3 Secondary Hazards

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

10.2 HAZARD PROFILE

10.2.1 Past Events

According to the 2018 State of Idaho Hazard Mitigation Plan, the following dam failures have historically occurred within the State Idaho, some of which impacted the planning area:

- **Ridenbaugh Canal Failure, 1973—**On May 26, 1973, a 30-foot wide break in the Ridenbaugh Canal flooded southeast Boise. Waist deep water flooded 15 homes and the Triangle dairy as water flowed from the breach toward the Boise River.
- **Teton Dam Failure, 1976—**On June 5, 1976, Teton Dam in Fremont County failed (see Figure 10-1). An estimated 80 billion gallons of water were released into the Upper Snake River Valley from the reservoir. Devastating flooding occurred in Wilford, Sugar City, Rexburg, and Roberts; additional significant flooding occurred in Idaho Falls and Blackfoot. At the time of its failure, Teton Dam was brand new, stood 305 feet high, with a crest length of 3,100 feet and a base width of 1,700 feet. The dam was a zoned earth-fill structure with a volume of 10 million cubic yards. The floodwaters threatened American Falls Dam downstream on the Snake River. Dam managers opened the outlet works on American Falls to empty the reservoir and to save American Falls Dam and the string of dams farther down the Snake River.
- **Oakley Dam, 1984—**Oakley Dam nearly overtopped; a canal was constructed to mitigate flooding.
- **Twin Falls County Dam, 1984—**Salmon Falls Creek release caused flooding.
- **Kirby Dam Failure, 1991—**In the summer of 1990, the old log crib structure of the Kirby Dam near Atlanta became unsound and was in jeopardy of failing. The possibility of failure was of special concern due to the large quantity of mine runoff and tailings that had collected behind the dam over the years. A strategy to stabilize the dam developed by the IDWR and the U.S. Forest Service was unsuccessful. On May 26, 1991, Kirby Dam collapsed, cutting off electrical power and blocking the primary access bridge to Atlanta. Sediments containing arsenic, mercury and cadmium were released into the Middle Fork of the Boise River.
- **Brown's Pond Dam, 2010—**Browns Pond Dam overtop and breach during rain on snow event; federal declaration DR-1927.

Figure 10-1. Teton Dam Failure, 1976

10.2.2 Location

Dams

According to Idaho's Dam Safety Program, there are 26 dams in Ada County that impound approximately 1.3 million acre-feet of water. These dams are listed in Table 10-1. Five are operated by federal agencies, and the rest are under the jurisdiction of the state.

Dam failure inundation mapping is not available for every dam in the County. The planning team secured inundation mapping from the Corps of Engineers for the Lucky Peak Reservoir and Blacks Creek Reservoir, which are the dams whose failure is most likely to have the largest impact on the planning area. This inundation area is the focus of the risk assessment for the dam failure hazard. It reflects the normal high pool and maximum inundation area associated with dam operations. Figure 10-2 and Figure 10-3 show the Lucky Peak Dam and Blacks Creek Dam inundation areas, respectively, as used for the risk assessment. The mapped inundation area within each municipality is listed in Table 10-2.

Table 10-1. Dams That Impact Ada County

Name	National ID #	County	Year Built	Dam Type	Purpose	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Downstream Hazard Potential
Anderson Ranch	ID00279	Elmore	1950	Earth	Multi-use	1350	456	503,500	High
Arrowrock	ID00280	Elmore	1915	Arch	Multi-use	1150	350	283,700	High
Barber	ID00207	Ada	1906	Timber	Multi-use	1225	26	200	High
Blacks Creek	ID00208	Ada	1915	Earth	Multi-use	1700	51.5	3,640	High
Boise Diversion	ID00281	Ada	1908	Gravity	Multi-use	500	57	1,200	High
C J Strike	ID00054	Elmore	1952	Earth	Hydro	3220	115	250,000	High
City of Kuna	ID00688	Ada	2001	Earth	Multi-use	940	18	15	Low
Cottonwood Creek Lower	ID00477	Ada	1961	Earth	Flood Control	1710	15	88	High
Cottonwood Creek Middle	ID00567	Ada	1961	Earth	Flood Control	1210	20	40	High
Cottonwood Creek Upper	ID00565	Ada	1961	Earth	Flood Control	840	18	17	High
Crane Creek Main Dam	ID00478	Ada	1998	Earth	Flood Control	204	64	56,800	Significant
Crane Gulch East Dam	ID00479	Ada	1998	Earth	Flood Control	316	60.4	28	Significant
Hidden Hollow Detention	ID00564	Ada	1997	Earth	Other	375	23	20	Low
Hidden Springs Cell 1A	ID00699	Ada	2007	Earth	Multi-use	--	26	9	Low
Hidden Springs Cell 3A	ID00695	Ada	2007	Earth	Multi-use	--	42.5	81.3	High
High Plains Estates	ID00691	Ada	2005	Erath	Multi-use	340	16	19	Significant
Hubbard	ID00376	Ada	1902	Earth	Irrigation	6000	23	4060	High
IDC-Effluent Storage	ID00490	Ada	1998	Earth	Irrigation	3125	23	105	Significant
Lucky Peak	ID00288	Ada	1954	Earth	Multi-use	2340	340	307,043	High
Micron Dam No 1	ID00415	Ada	1984	Earth	Multi-use	550	14	48	Low
Micron WWT Lagoon No 2	ID00561	Ada	1991	Earth	Other	1720	12	30	Significant
Micron WWT Lagoon No 3	ID00560	Ada	1997	Earth	Other	1540	13	30	Low
Orchard	ID00206	Ada	1902	Earth	Multi-use	2800	43	2,035	Significant
Stewart Gulch Main Fork	ID00480	Ada	1998	Earth	Flood Control	570	76.3	61	High
Swan Falls	ID00049	Ada	1901	Gravity	Hydro	1187	38	7,500	Significant
Terteling	ID00562	Ada	1973	Earth	Multi-use	1770	16	20	Low

Sources: (U.S. Army Corps of Engineers 2020), (Idaho Department of Water Resources 2022)

Table 10-2. Area Within the Mapped Inundation Area

	Area in Lucky Peak Dam Inundation Area (acres)	Area in Blacks Creek Dam Inundation Area (acres)
Boise	11,499	0
Eagle	6,290	0
Garden City	2,702	0
Kuna	0	0
Meridian	1	860
Star	3,222	0
Unincorporated	9,480	1,611
Total	**33,195**	**2,470**

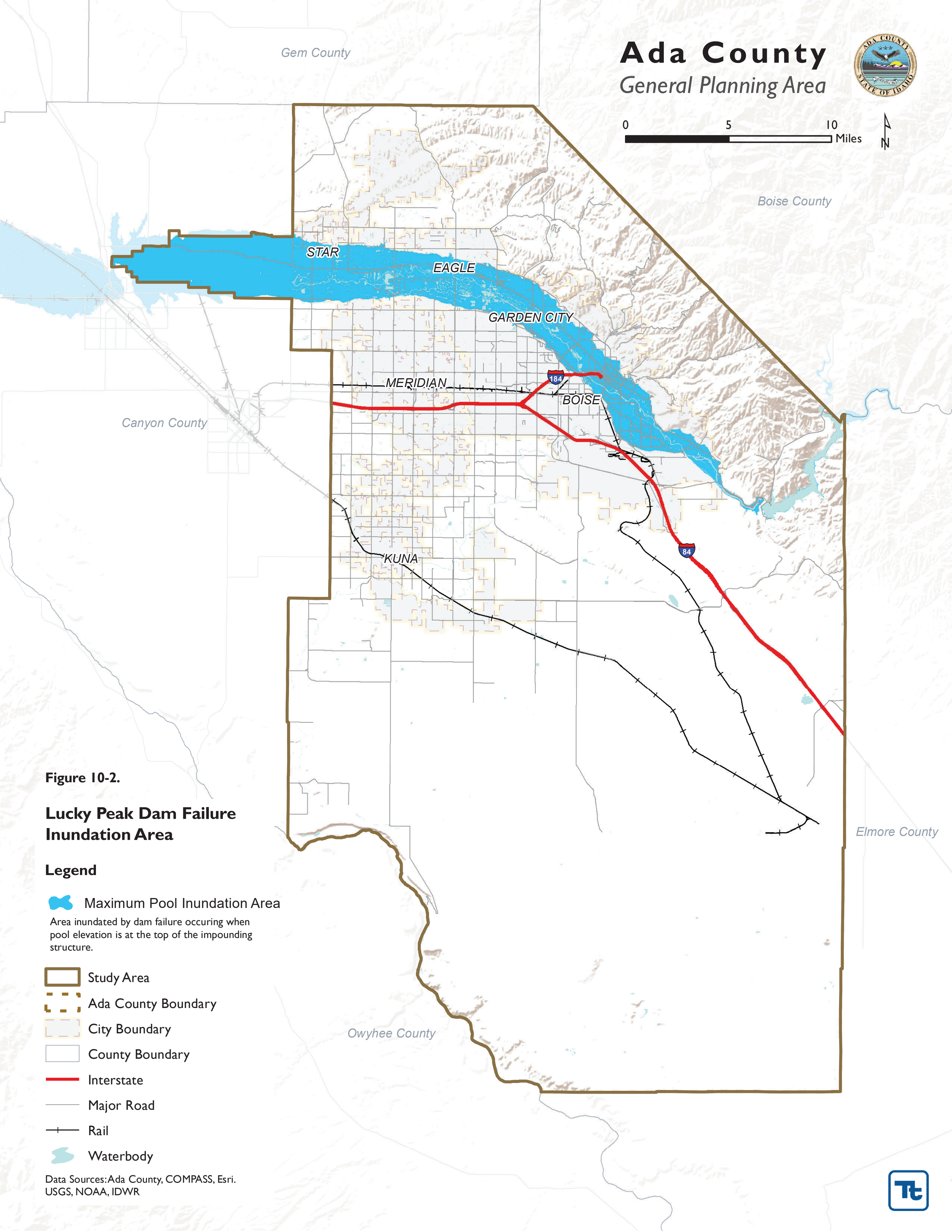


Figure 10-2.

Lucky Peak Dam Failure Inundation Area

Figure 10-3.

Blacks Creek Dam Failure Inundation Area

Legend

- Maximum Pool Inundation Area
  Area inundated by dam failure occuring when pool elevation is at the top of the impounding structure.
- Study Area
- Ada County Boundary
- City Boundary
- County Boundary
- Interstate
- Major Road
- Rail
- Waterbody

Data Sources: Ada County, COMPASS, Esri. USGS, NOAA, IDWR

Canals

With a water delivery system that includes over 400 miles of canals (see Figure 10-4), Ada County and the Boise area have the highest urban canal density in the United States. These canals are generally well-maintained by their owners/operators because it is their livelihood. However, these facilities can convey flows as high as 2,800 cubic feet per second (cfs), and they have not been evaluated according to engineering standards. The assessment of risk associated with canals is limited in this plan. Canal owners/operators were invited to participate in this plan update process but chose not to at this time. Future updates should continue to seek participation from these entities to better understand the risk posed by these facilities.

10.2.3 Frequency

Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides and excessive rainfall and snowmelt. There is a "residual risk" associated with dams. Residual risk is the risk that remains after safeguards have been implemented. For dams, the residual risk is associated with events beyond those that the facility was designed to withstand. However, the probability of any type of dam failure is low in today's regulatory and dam safety oversight environment.

10.2.4 Severity

The Idaho Dam Safety Program classifies dams and reservoirs in a three-tier hazard rating system based on the potential consequences to downstream life and property that would result from a failure of the dam and sudden release of water (Idaho Department of Water Resources 2021):

- **High Hazard**—A high-hazard rating does not indicate that a dam suffers from an increased risk of failure. This rating means that if failure were to occur, the resulting consequences likely would be a direct loss of human life and extensive property damage. All high-hazard dams must be properly designed, and at all times responsibly maintained and safely operated because the consequences of failure are so great. IDWR considers the inundation of residential structures with flood water from a dam break to a depth greater than or equal to 2 feet to be a sufficient reason for assigning to a dam a high-hazard rating. An up-to-date emergency action plan is a requirement for all owners of high hazard dams.
- **Significant Hazard**—Significant hazard dams are those whose failure would result in significant damage to developed downstream property and infrastructure or that may result in an indirect loss of human life. An example of the latter would be a scenario where a roadway is washed out and people are killed or injured in an automobile crash caused by the damaged pavement.
- **Low Hazard**—Low hazard dams typically are located in sparsely populated areas that would be largely unaffected by a dam breach. Although the dam and works may be totally destroyed, damage to downstream property would be restricted to undeveloped land, with minimal impact on infrastructure.

Table 10-3 shows the Corps of Engineers classification system for the hazard potential of dam failures. The Idaho and Corps of Engineers hazard rating systems are both based only on the potential consequences of a dam failure; neither system takes into account the probability of such failures.

10.2.5 Warning Time

Warning time for dam failure depends on the cause of the failure. In cases of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In cases of a structural failure due to earthquake, there may be no warning time.

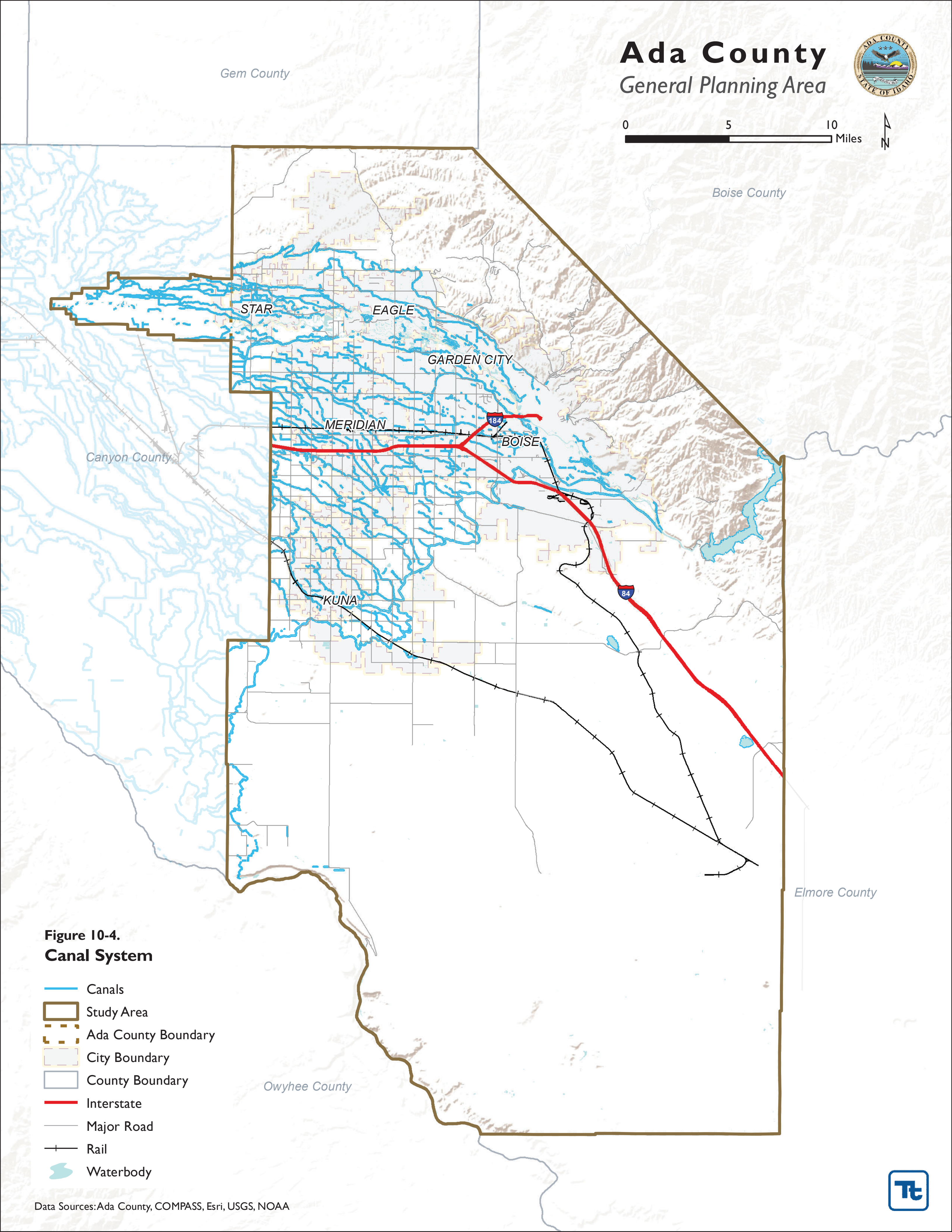


Figure 10-4.
Canal System

Table 10-3. Hazard Potential Classification

Hazard Category[a]	Direct Loss of Life[b]	Lifeline Losses[c]	Property Losses[d]	Environmental Losses[e]
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss of life potential based on inundation mapping of area downstream of the project. Analyses of loss of life potential should take into account the population at risk, time of flood wave travel, and warning time.
c. Indirect threats to life caused by the interruption of lifeline services due to project failure or operational disruption; for example, loss of critical medical facilities or access to them.
d. Damage to project facilities and downstream property and indirect impact due to loss of project services, such as impact due to loss of a dam and navigation pool, or impact due to loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: U.S. Army Corps of Engineers, 1995

A dam's structural type also affects warning time. Earthen dams do not tend to fail instantaneously. Once a breach is initiated, discharging water erodes the dam until either the reservoir water is depleted or the breach resists further erosion. Concrete dams also tend to begin with a partial breach, formed over a few minutes or a few hours (U. S. Army Corps of Engineers 2019). The approximate travel time for water released from Lucky Peak Dam to Capitol Boulevard Bridge in Boise is 2 hours (Ada County Emergency Management 2018). Flood warning and response procedures for all high water events, including imminent dam failure, are documented in the Ada County Flood Response Plan. The protocols are tied to emergency action plans for each dam.

10.3 EXPOSURE

The flood module of Hazus was used for a Level 2 assessment of dam failure. Where possible, the Hazus data was enhanced using GIS data from county, state and federal sources.

10.3.1 Population

All populations living in the mapped dam failure inundation zone would be exposed to the risk of a dam failure. Figure 10-5 and Figure 10-6 summarize the population living in the mapped dam-failure inundation areas for the Lucky Peak Dam and Blacks Creek Dam, respectively.

10.3.2 Property

The value of exposed buildings and contents in each jurisdiction is summarized in Figure 10-7 and Figure 10-8 for the Lucky Peak Dam and Blacks Creek Dam, respectively. Figure 10-9 summarizes the number of structures in the mapped Lucky Peak Dam inundation area by jurisdiction and occupancy class.

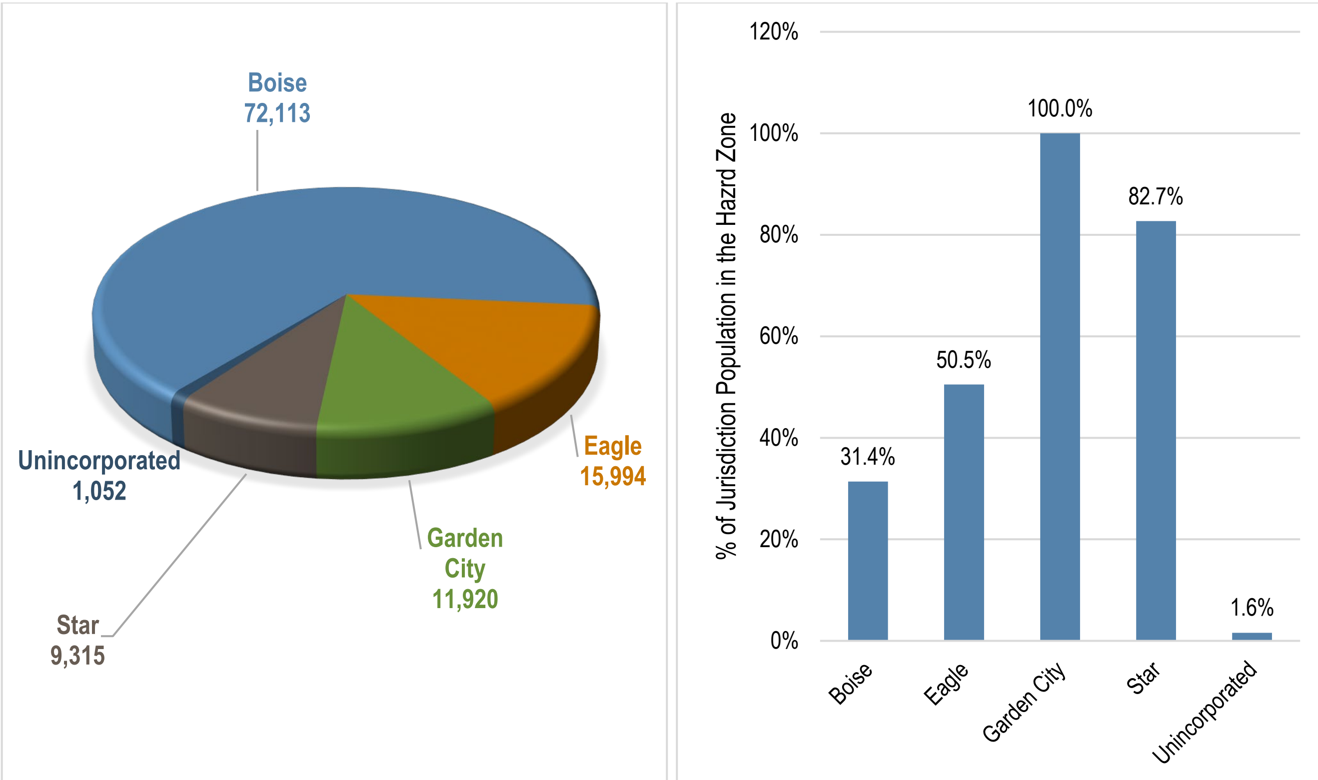


Figure 10-5. Population in the Lucky Peak Dam Failure Inundation Area

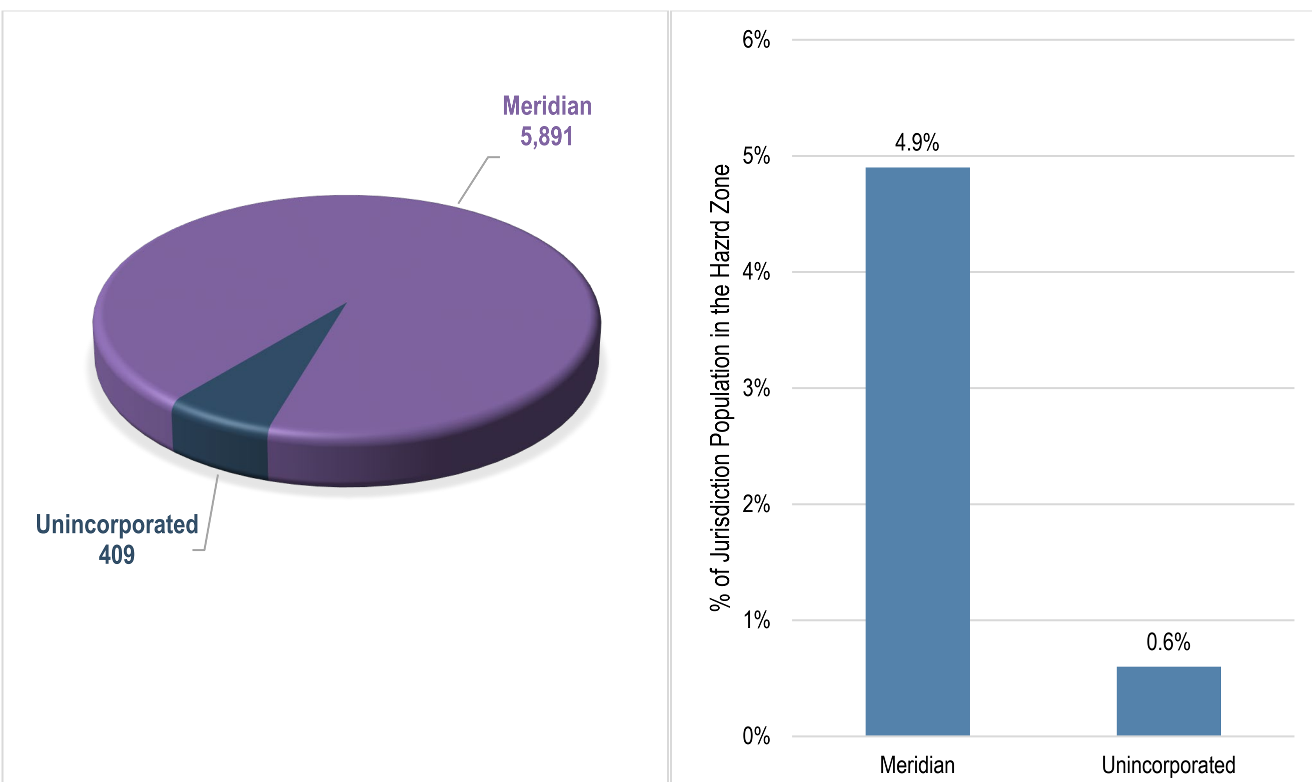


Figure 10-6. Population in the Blacks Creek Dam Failure Inundation Area

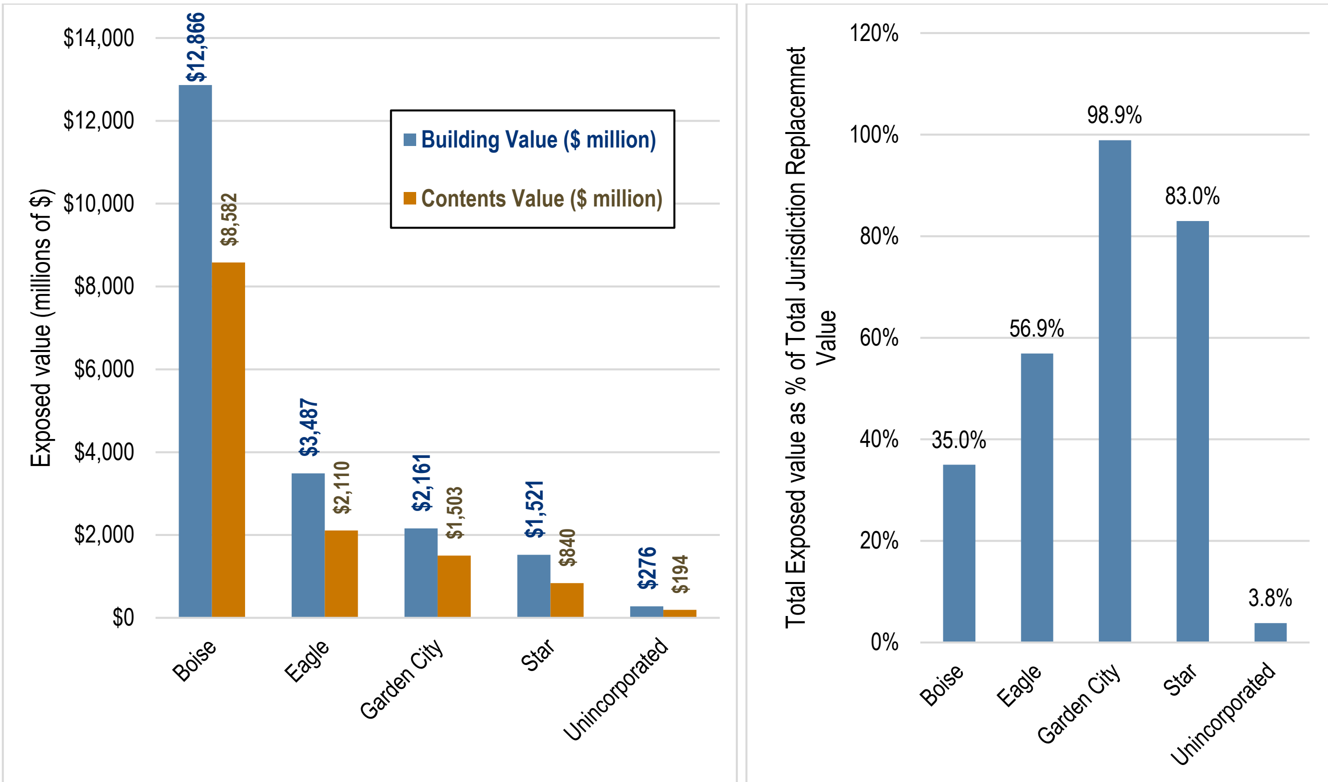


Figure 10-7. Value of Property in the Lucky Peak Dam Failure Inundation Area

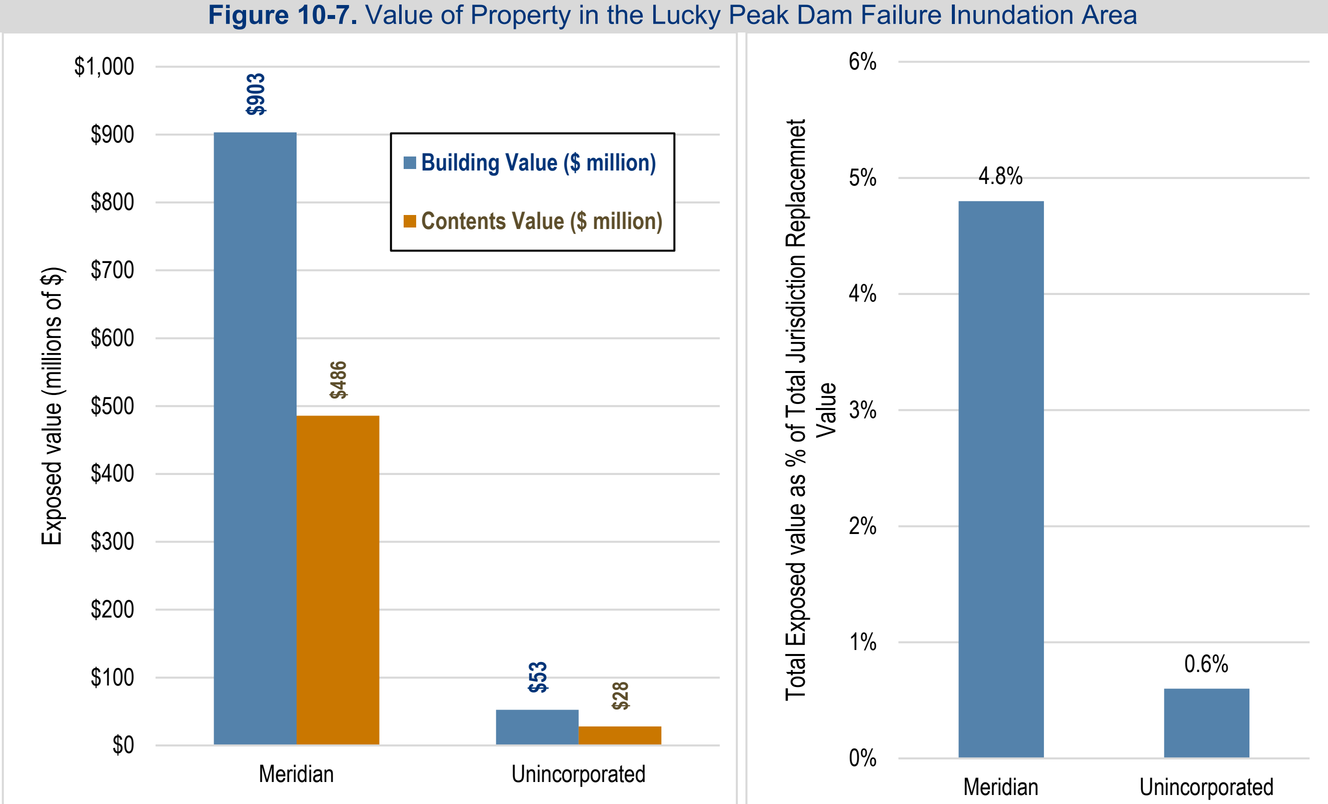


Figure 10-8. Value of Property in the Blacks Creek Dam Failure Inundation Area

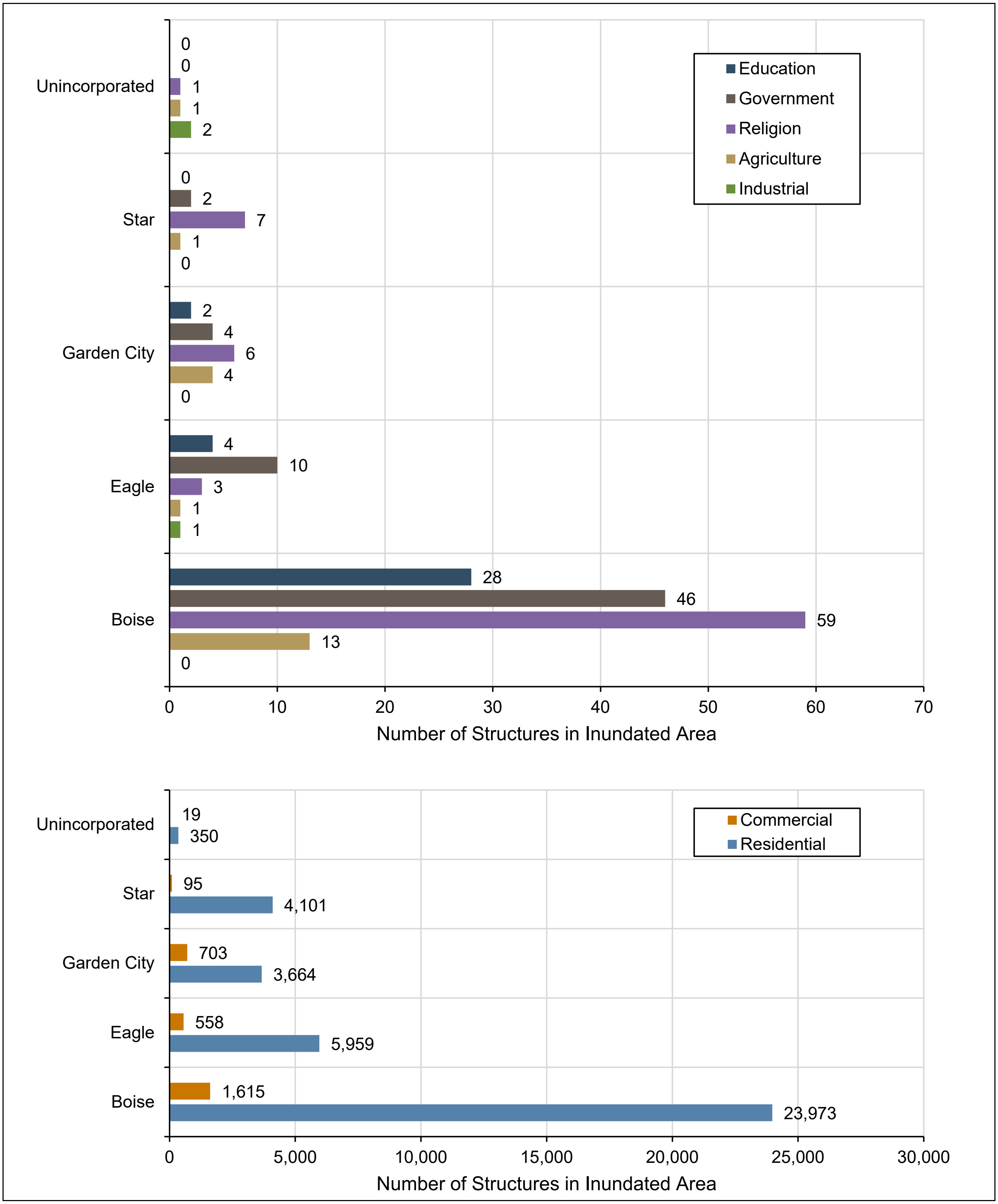


Figure 10-9. Number of Structures Within the Lucky Peak Dam Failure Inundation Area

For the Blacks Creek Dam, the mapped failure inundation area encompasses only the following numbers of structures:

- In unincorporated Ada County—2 agricultural, 2 commercial, 136 residential
- In Meridian—1 education, 1 religion, 8 commercial, 1,907 residential

10.3.3 Critical Facilities

GIS analysis determined that 702 of the planning area's critical facilities (33 percent of the planning area total) are in the mapped Lucky Peak Dam inundation area and 22 (1 percent) are in the mapped Blacks Creek Dam inundation area. Figure 10-10 summarizes critical facilities in the inundation area for the countywide planning area. Detailed results by jurisdiction are provided in Appendix D.

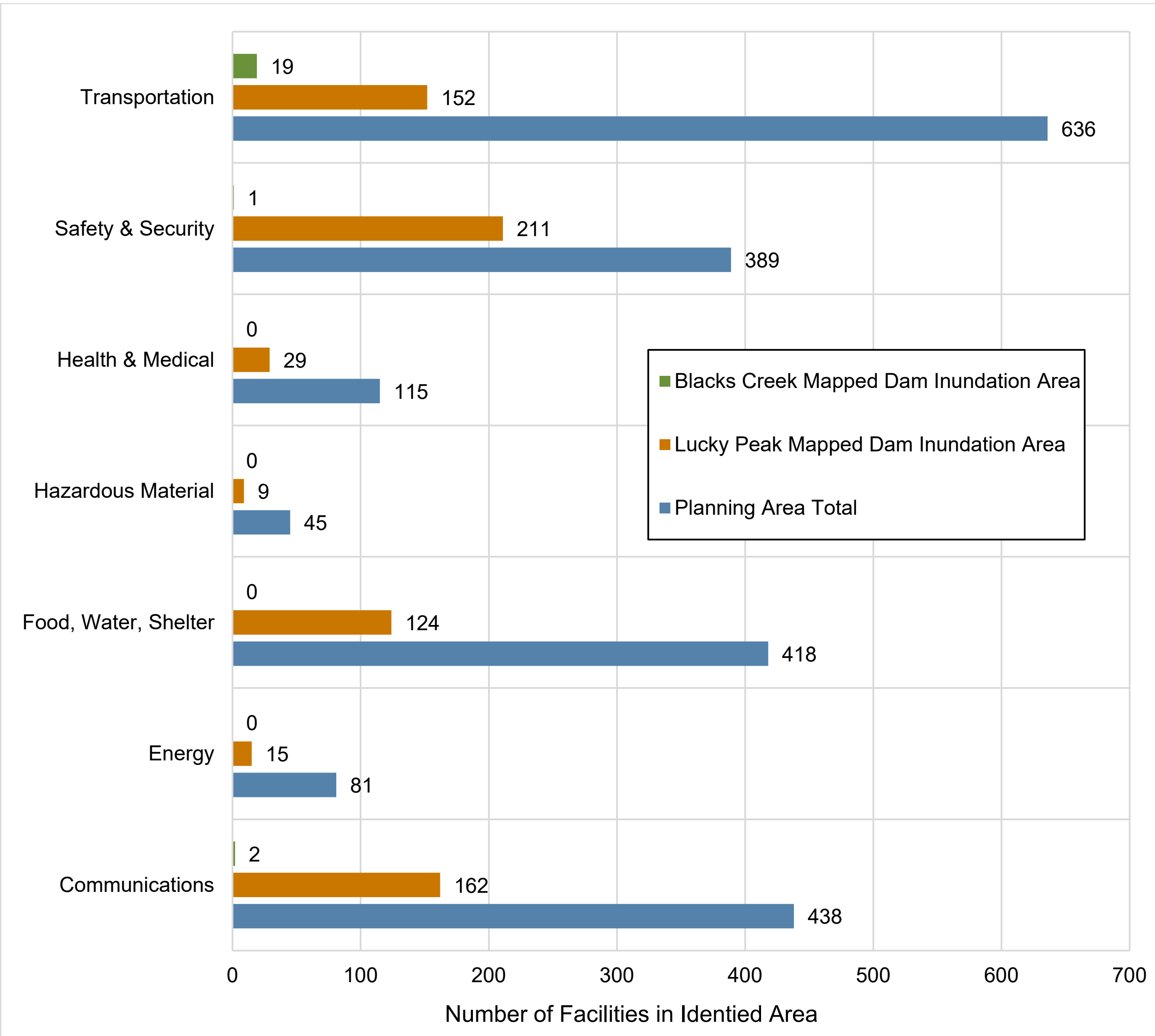


Figure 10-10. Critical Facilities in Dam Failure Inundation Zones and Countywide

10.3.4 Environment

Reservoirs held behind dams affect many ecological aspects of a river. River topography and dynamics depend on a wide range of flows, but rivers below dams often experience long periods of very stable flow conditions or saw-tooth flow patterns caused by releases followed by no releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of riverbeds and banks.

The environment would be exposed to a number of risks in the event of dam failure. The inundation could introduce many foreign elements into local waterways. This could result in destruction of downstream habitat and could have detrimental effects on many species of animals, especially endangered species such as salmon.

10.4 VULNERABILITY

The vulnerability of people, property, and critical facilities was evaluated for the combined dam inundation area. Detailed results by jurisdiction are included in Appendix D.

10.4.1 Population

Impacts on persons and households for the combined dam inundation area are estimated through the Level 2 Hazus analysis. Table 10-4 summarizes the results. Vulnerable populations include the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television, radio emergency warning system, siren, or cell phone alert.

Table 10-4. Estimated Dam Failure Impacts on Population

	Number of Displaced Residents	Number of Residents Requiring Short-Term Shelter
Lucky Peak Dam Failure Inundation Area		
Boise	66,414	2,577
Eagle	12,642	547
Garden City	11,701	487
Kuna	0	0
Meridian	0	0
Star	9,065	285
Unincorporated	580	38
Total	**100,402**	**3,933**
Blacks Creek Dam Failure Inundation Area		
Boise	0	0
Eagle	0	0
Garden City	0	0
Kuna	0	0
Meridian	2,302	161
Star	0	0
Unincorporated	68	7
Total	**2,370**	**168**

10.4.2 Property

Figure 10-11 and Figure 10-12 summarize the Level 2 Hazus for property damage from the dam failure hazard for the Lucky Peak Dam and Blacks Creek Dam, respectively.

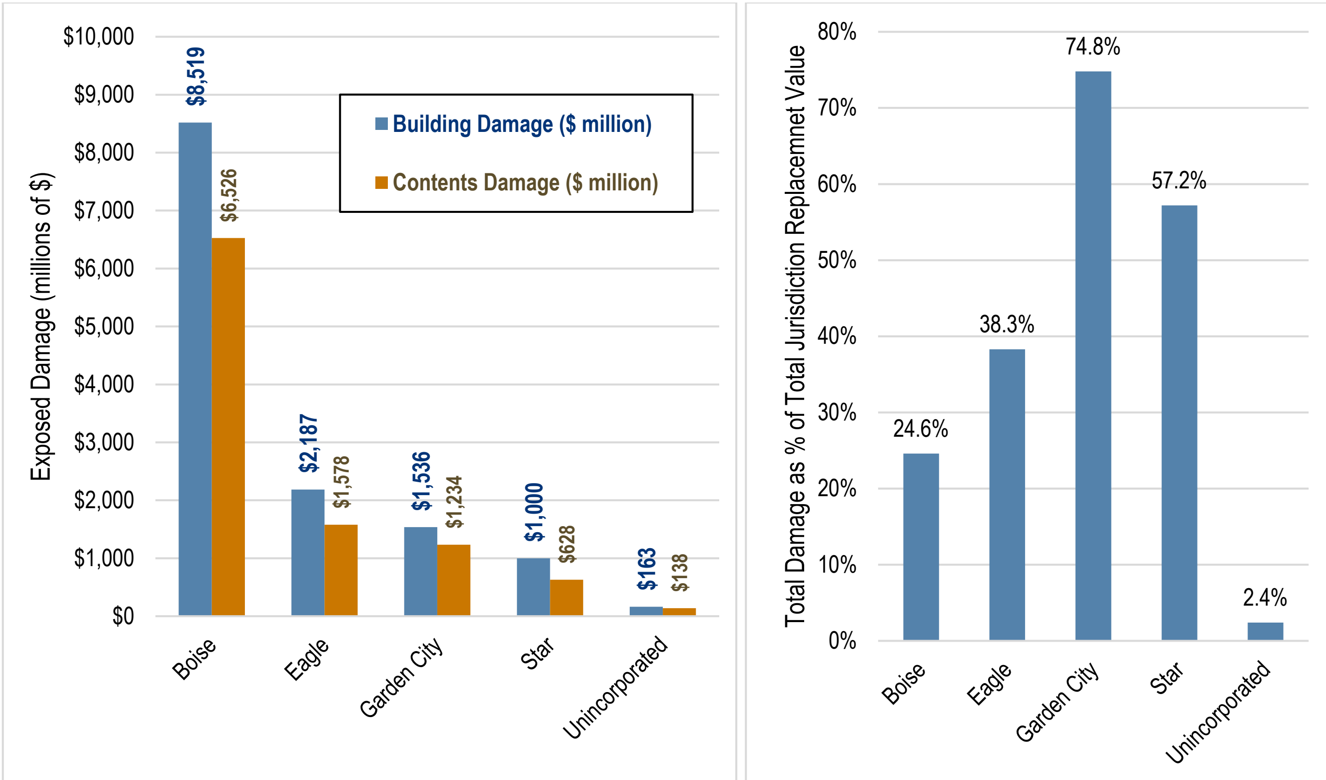


Figure 10-11. Estimated Damage to Property in the Lucky Peak Dam Failure Inundation Area

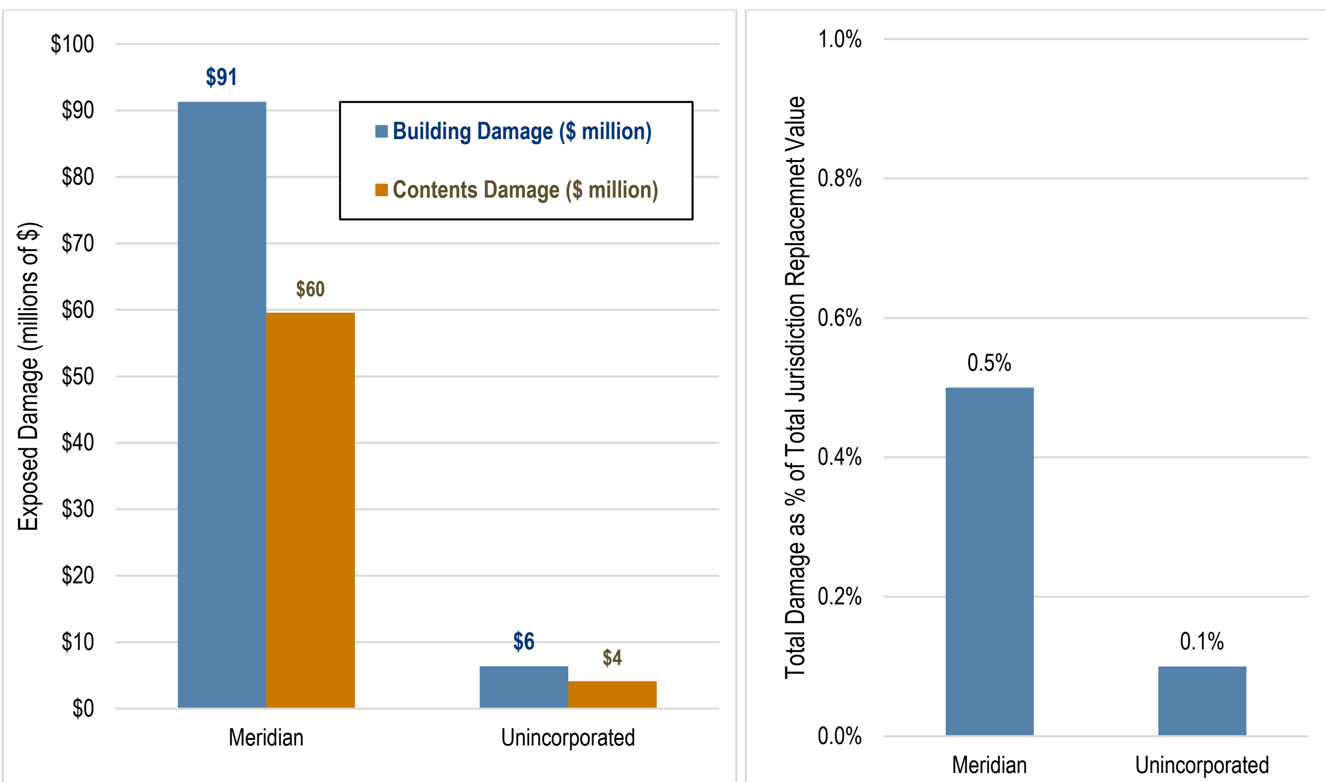


Figure 10-12. Estimated Damage to Property in the Blacks Creek Dam Failure Inundation Area

10.4.3 Critical Facilities

Hazus estimated damage to critical facilities in the dam failure inundation zones is summarized in Figure 10-13 and Figure 10-14.

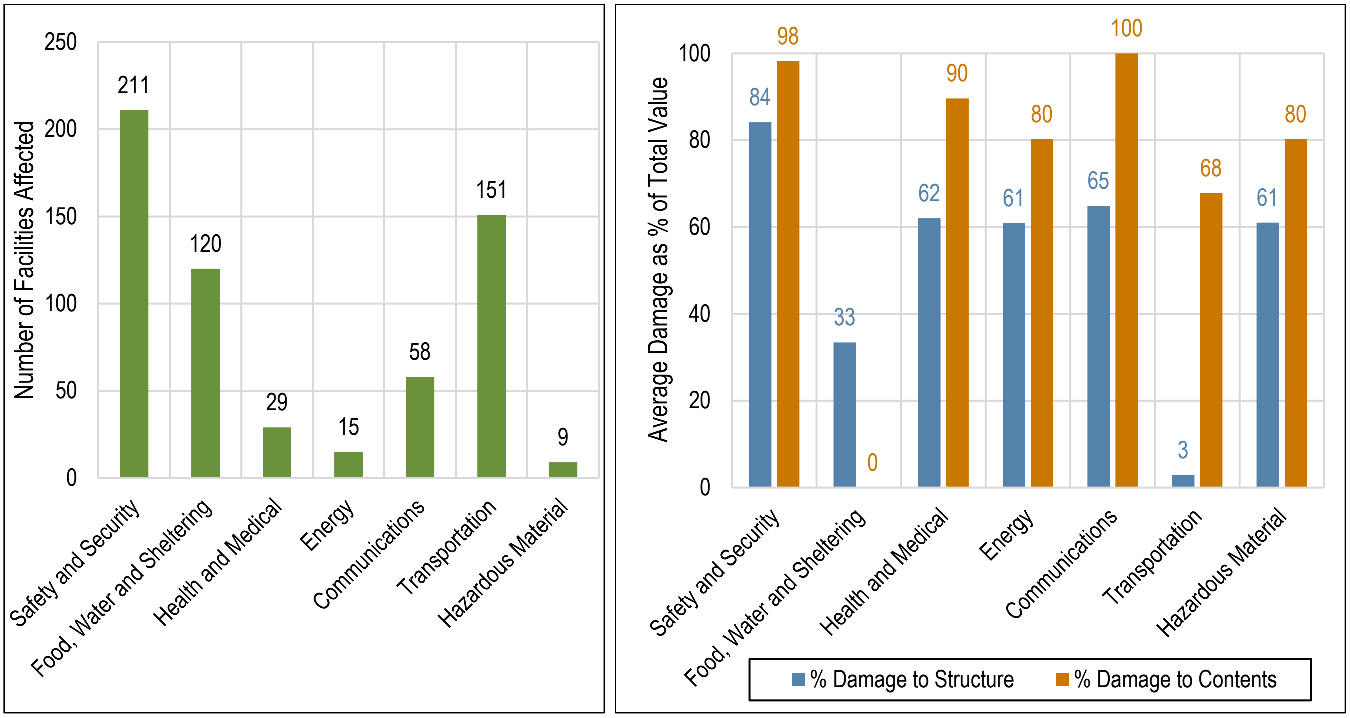


Figure 10-13. Estimated Damage to Critical Facilities from Lucky Peak Dam Failure

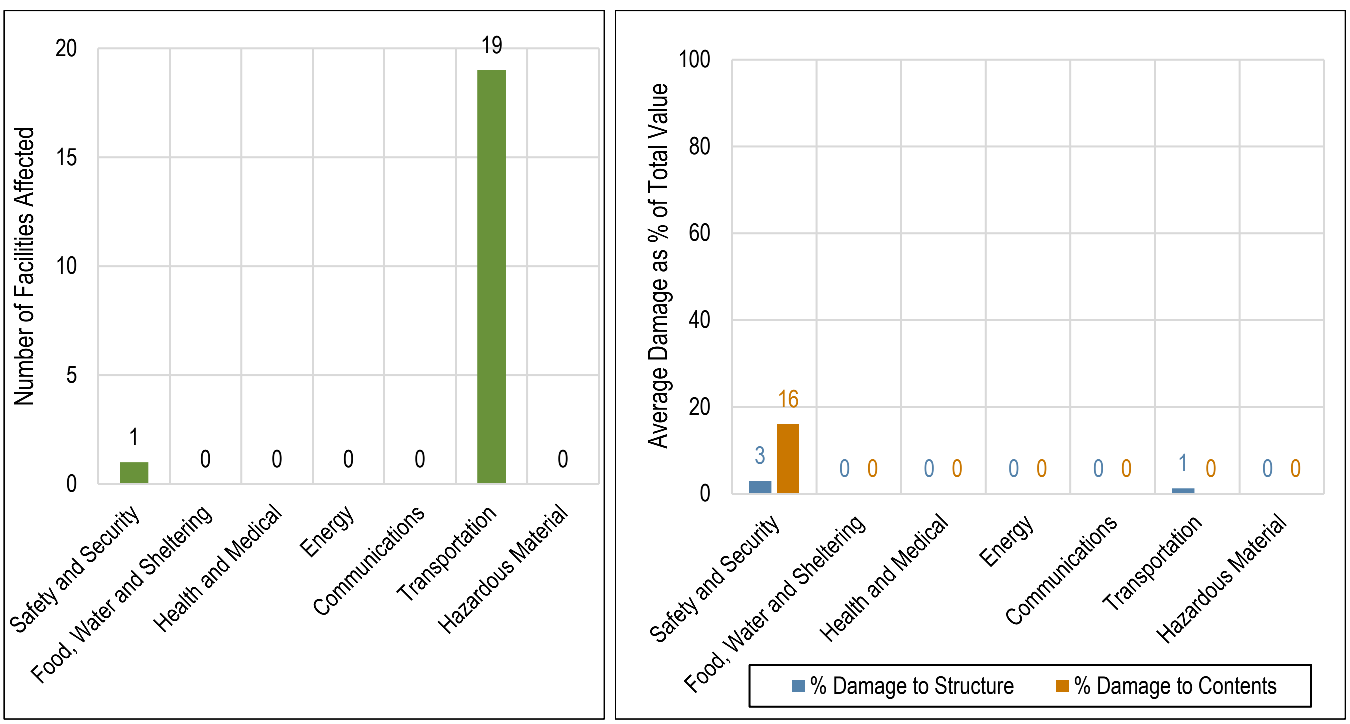


Figure 10-14. Estimated Damage to Critical Facilities from Blacks Creek Dam Failure

10.4.4 Environment

The environment would be vulnerable to a number of risks in the event of dam failure. The inundation could introduce foreign elements into local waterways, resulting in destruction of downstream habitat and detrimental effects on many species of animals, especially endangered species such as coho salmon. The extent of the vulnerability of the environment is the same as the exposure of the environment.

10.5 DEVELOPMENT TRENDS

The value of planning area properties exposed to the dam failure hazard has increased by 0.56 percent ($132.3 million) since the last hazard mitigation plan update in 2017. This increase in risk exposure can be attributed to the wide extent of the dam failure hazard and a countywide population growth of 13.6 percent in the same period (see Section 4.5.1).

While dam and canal failures are not generally hazards addressed in comprehensive plans, the risk assessment in this plan creates an opportunity for Ada County and its planning partners to consider the inclusion of dam/canal hazards in their comprehensive plans. The municipal planning partners have established comprehensive policies regarding sound land use in identified flood hazard areas. Most of the areas vulnerable to the greatest impacts from dam failure intersect the mapped flood hazard areas. Flood-related policies in the comprehensive plans will help to reduce the risk associated with the dam failure hazard for all future development in the planning area. Future updates to comprehensive plans in the planning area may provide enhancements to floodplain management policies considering the potential impacts from dam or canal failures.

10.6 SCENARIO

An earthquake in the region could lead to liquefaction of soils around a dam. This could occur without warning during any time of the day. A human-caused failure such as a terrorist attack also could trigger a catastrophic failure of a dam.

While the probability of dam failure is very low, the probability of flooding associated with changes to dam operational parameters in response to future climate conditions is higher. Dam designs and operations are developed based on hydrographs from historical records. If these hydrographs experience significant changes over time due to the impacts of future climate conditions, dam design and operations may no longer be valid for the changed condition. This could have significant impacts on dams that provide flood control. Specified release rates and impound thresholds may have to be changed. This would result in increased discharges downstream of these facilities, increasing the probability and severity of flooding.

10.7 ISSUES

Flooding as a result of a dam or canal failure would significantly impact properties and populations in the inundation zones. There is often limited warning time for such failures. These events are frequently associated with other natural hazard events such as earthquakes, landslides or extreme weather, which limits their predictability and compounds the hazard. Important issues associated with dam and canal failure hazards include the following:

- The true level of risk associated with canals in the planning area is not known. The lack of regulatory oversight of these facilities results in a void in the level of available information that can be used to assess risk and vulnerability.
- Owners of canals need to be educated on the benefits of participation in hazard mitigation planning. Their lack of participation in these planning efforts creates a gap in the coverage of these plans.
- Federally regulated dams have an adequate level of oversight and sophistication in the development of emergency action plans for public notification in the unlikely event of failure. However, the protocol for notification of downstream citizens of imminent failure needs to be tied to local emergency response planning.
- Mapping for federally regulated dams is already required and available; however, mapping for non-federally regulated dams that estimates inundation depths is needed to better assess the risk associated with dam failure from these facilities.
- Most dam failure mapping required at federal levels requires determination of the probable maximum flood. While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. For non-federally regulated dams, mapping of dam failure scenarios that are less extreme than the probable maximum flood but have a higher probability of occurrence can be valuable to emergency managers and community officials downstream of these facilities. This type of mapping can illustrate areas potentially impacted by more frequent events to support emergency response and preparedness.
- The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.
- A buildable-lands analysis that looks at vacant lands and their designated land use would be a valuable tool in helping decision-makers make wise decisions about future development.
- The risk analysis for Blacks Creek Dam is likely overstated due to the approximate methods that were used to generate the inundation mapping. To better understand the true risk from this facility, more detailed mapping and analysis is needed.

11. DROUGHT

11.1 GENERAL BACKGROUND

Drought is a significant decrease in water supply relative to what is needed to sufficiently meet typical demand in each location. It is a normal phase in the climactic cycle of most geographical regions, originating from a deficiency of precipitation over an extended period, usually a season or more. This leads to a water shortage for some activity, group, or environmental sector.

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered to be long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought.

Drought in Idaho is generally associated with a sustained period of low winter snowfall. Such periods result from a temporary change in the large-scale weather patterns in the western United States. Limited snowpacks result in reduced stream flows and groundwater recharge.

Water supply is controlled not only by precipitation, but also by other factors, including evaporation (which is increased by higher than normal heat and winds), transpiration (the use of water by plants), and human use. Idaho's system of reservoirs and natural storage can buffer the effects of minor events over a few years, but a series of dry winters (or an especially pronounced single low snowfall year) will result in a water shortage. Extended periods of above-average temperatures during spring and summer can increase the impacts of low snowpacks.

11.1.1 Types of Drought

Drought is generally defined based on four ways of measuring it (National Integrated Drought Information Center n.d.):

- **Meteorological drought**—When dry weather patterns dominate an area
- **Agricultural drought**—When crops become affected by drought
- **Hydrological drought**—When low water supply becomes evident in the water system
- **Socioeconomic drought**—When the supply and demand of various commodities is affected by drought
- **Ecological drought**—When natural ecosystems are affected by drought

11.1.2 Monitoring and Rating Drought

National Oceanic and Atmospheric Administration Drought Indices

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure the impacts and severity of meteorological, agricultural, and hydrological drought and to map their extent and locations:

- The ***Crop Moisture Index*** measures short-term drought weekly to assess impacts on agriculture.
- The ***Palmer Z Index*** measures short-term drought on a monthly scale.
- The ***Palmer Drought Severity Index*** is based on long-term weather patterns. The intensity of drought in a given month is dependent on current weather plus the cumulative patterns of previous months. Weather patterns can change quickly, and the Palmer Drought Severity Index can respond fairly rapidly.
- The ***Palmer Hydrological Drought Index*** quantifies hydrological effects (reservoir levels, groundwater levels, etc.), which take longer to develop and last longer. This index responds more slowly to changing conditions than the Palmer Drought Index.
- The ***Standardized Precipitation Index*** considers only precipitation. A value of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The Standardized Precipitation Index is computed for time scales ranging from one month to 24 months.

Each of these indices is meaningful for different sectors of society and the economy. For example an urbanized areas that uses water from reservoirs would be sensitive to hydrological drought characterized by the Palmer Hydrological Drought Index, while unirrigated grazing land would be sensitive to meteorological drought characterized by the Crop Moisture Index. Maps of these indices show drought conditions nationwide at a given point in time. They are not necessarily indicators of any given area's long-term susceptibility to drought. Recent examples of these maps are shown on Figure 11-1.

U.S. Drought Monitor

The U.S. Drought Monitor (USDM) is a map that is updated weekly to show the location and intensity of drought across the country. The USDM uses a five-category system (U.S. Drought Monitor 2022):

- D0—Abnormally Dry
  - Short-term dryness slowing planting, growth of crops
  - Some lingering water deficits
  - Pastures or crops not fully recovered
- D1—Moderate Drought
  - Some damage to crops, pastures
  - Some water shortages developing
  - Voluntary water-use restrictions requested
- D2—Severe Drought
  - Crop or pasture loss likely
  - Water shortages common
  - Water restrictions imposed

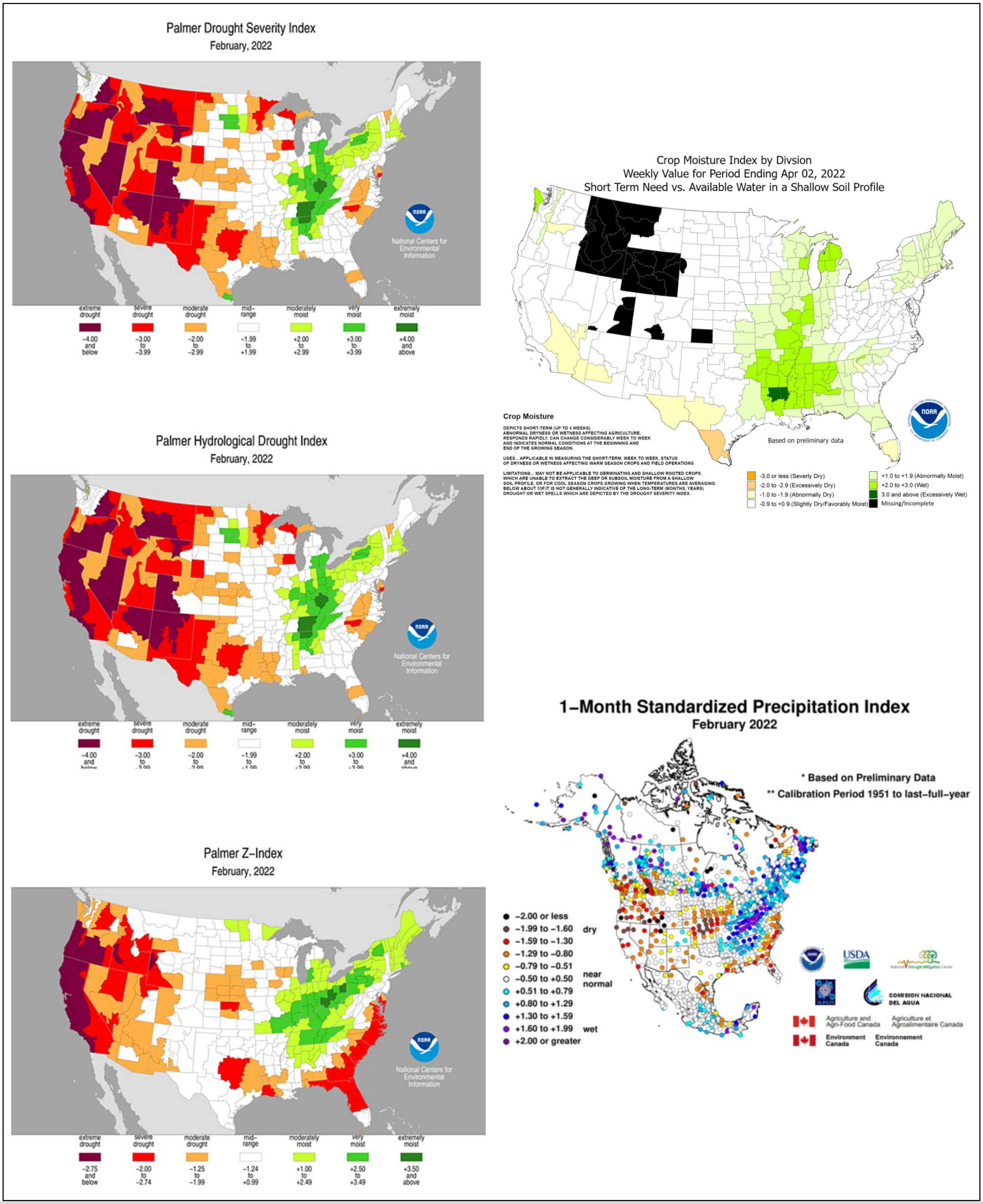


Figure 11-1. Example Drought Index Maps (for February and April 2022)

- D3—Extreme Drought
  - Major crop/pasture losses
  - Widespread water shortages or restrictions
- D4—Exceptional Drought
  - Exceptional and widespread crop/pasture losses
  - Shortages of water creating water emergencies

The USDM categories show experts' assessments of conditions related to drought. These experts check variables including temperature, soil moisture, stream flow, water levels in reservoirs and lakes, snow cover, and meltwater runoff. They also check whether areas are showing drought impacts such as water shortages and business interruptions. Associated statistics show what proportion of various geographic areas are in each category of dryness or drought, and how many people are affected. U.S. Drought Monitor data go back to 2000.

11.1.3 Drought Impacts

Drought can have a widespread impact on the environment and the economy, although it typically does not result in loss of life or damage to structures, as do other natural disasters. The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- **Economic Impacts**—These impacts of drought cost people (or businesses) money. Farmers' crops are destroyed; low water supply necessitates spending on irrigation or drilling of new wells; water-related businesses (such as sales of boats and fishing equipment) may experience reduced revenue; power shutoffs may occur.
- **Environmental Impacts**—Plants and animals depend on water. When a drought occurs, their food supply can shrink, and their habitat can be damaged. Drought also has the potential to increase the risk of wildfire.
- **Social Impacts**—Social impacts include public safety, health, power failures, conflicts between people when there is not enough water to go around, and changes in lifestyle.

The demand that society places on water systems and supplies—such as expanding populations, irrigation, and environmental needs—contributes to drought impacts. Drought can lead to difficult decisions regarding the allocation of water, as well as stringent water use restrictions, water quality problems, and inadequate water supplies for fire suppression. There are also issues such as growing conflicts between agricultural uses of surface water and in-stream uses, surface water and groundwater interrelationships, and the effects of growing water demand on uses of water.

Vulnerability of an activity to drought depends on its water demand and the water supplies available to meet the demand. The impacts of drought vary between sectors of the community in both timing and severity:

- **Water supply—**The water supply sector encompasses urban and rural drinking water systems that are affected when a drought depletes ground water supplies due to reduced recharge from rainfall.
- **Power supply—**Production of all types of energy requires water. Because the energy sector is dependent on water availability, drought can severely impact energy systems.
- **Agriculture and commerce—**The agriculture and commerce sector includes the reduction of crop yield and livestock sizes due to insufficient water supply for crop irrigation and maintenance of ground cover for grazing.

- **Environment, public health, and safety—**The environmental, public health, and safety sector is affected by wildfires, which are detrimental to the forest ecosystem and hazardous to the public. It also experiences the impacts of desiccating streams, such as the reduction of in-stream habitats for native species.

11.1.4 Secondary Hazards

The secondary hazard most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the drought continues.

11.2 HAZARD PROFILE

11.2.1 Past Events

According to the Idaho State Hazard Mitigation Plan, Ada County has been impacted by drought conditions five times since 1977. The U.S. Department of Agriculture (USDA) issued drought declarations for Ada County in eight of the past 10 years (see Table 11-1). The most prolonged drought in Idaho was during the 1930s. For most of the state, this drought lasted for 11 years (1929-41) despite greater than average stream flows in 1932 and 1938.

Table 11-1. Historical Droughts in Ada County

Year	USDA Drought Declaration(s)	State Drought Emergency Declaration	Part of Federal Disaster Declaration?
2001	Unknown	Yes	No
2005	Unknown	Yes	No
2013	Yes	No	No
2014	Yes	No	No
2015	Yes	No	No
2016	Yes	No	No
2018	Yes	No	No
2019	Yes	No	No
2021	Yes	No	No
2022	Yes	No	No

Sources: (Idaho Department of Water Resources 2021), (FEMA 2022), (State of Idaho Hazard Mitigation Plan 2018)

Of all the statewide drought emergency declarations, only one was also a federal disaster: 1977, the worst single year on record. This event was part of a more widespread water shortage faced by the United States. In Idaho, a lack of winter snowfall resulted in the lowest runoff on record at most gages in the state. Ski resorts were closed for much of the ski season. Irrigation ditches were closed well before the end of the growing season, and crop yields were below normal. Domestic wells in the Big and Little Wood River basins became dry early in April 1977, and many shallow wells in six western Idaho counties became dry in June. Ada County was not included in this drought declaration.

11.2.2 Location

Drought can have the broadest effect of all of Idaho's hazards, sometimes affecting all regions of the state simultaneously. Although deaths and injuries are rarely direct results, drought can have significant impacts on the economic, environmental, and social well-being of the state. Idaho's arid climate predisposes it to periodic drought. Some areas of the state, however, have a greater potential for drought than others. The Idaho Department of Water Resources reports that, based on analyses of historical stream flow records, southeastern Idaho and the upper portions of the Snake River Plain appear to have the highest probability for persistent, severe stream flow deficits.

11.2.3 Frequency

Drought has a high probability of occurrence in the planning area. From January 2000 to April 12, 2022, some part of Ada County experienced a USDM rating of D1 or higher in 655 out of 1,163 weeks (see Figure 11-2). Ada County has also been included in USDA drought disaster declarations eight times since 2012. Historical drought data for the planning area indicate there have been four significant multi-year droughts in the last 40 years (1981 to 2021), amounting to a severe drought every 10 to 11 years on average.

Source: (U.S. Drought Monitor 2022)

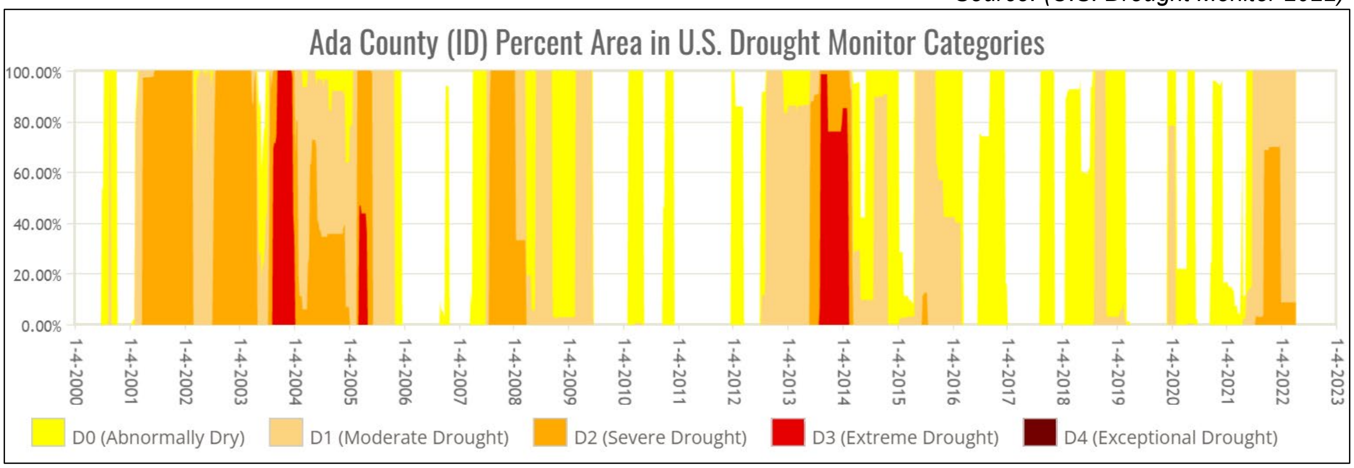


Figure 11-2. Percent of Ada County Affected by Each USDM Rating, 2000 – 2022

11.2.4 Severity

The severity of a drought depends on many factors. Driving factors are the amount and timing of precipitation, duration of below average rainfall, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts.

U.S. Drought Monitor Ratings

Ada County has a history of severe droughts. As shown in Figure 11-2, at least part of the county has experienced severe (D2) or extreme (D3) droughts more than once since 2000.

Drought Impact Reporter

The National Drought Mitigation Center developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. Information comes from a variety of sources: on-line, drought-related news stories and scientific publications, members of the public who visit the website and submit a drought-related impact for their region, members of the media, and staff of government agencies. The database is being populated beginning with the most recent impacts and working backward in time.

The Drought Impact Reporter indicates 111 impacts from drought that specifically affected Ada County from January 2011 through March 2022 (National Drought Mitigation Center 2022). The following are the reported numbers of Ada County impacts by category (some incidents are assigned to more than one impact category):

- Agriculture—64
- Business & Industry—4
- Fire—17
- Plants and Wildlife—32
- Relief, Response & Restrictions—62
- Society & Public Health—9
- Tourism & Recreation—9
- Water Supply and Quality—56

11.2.5 Warning Time

Predicting drought depends on the ability to forecast precipitation and temperature. Only generalized warning can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions. Determination of when drought begins is based on impacts on water users and assessments of available water supply, including water stored in reservoirs or groundwater basins. Different water agencies have different criteria for defining drought. Some issue drought watch or drought warning announcements.

It is difficult to predict how long a drought will last. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale.

11.3 EXPOSURE

All people, property and environments in the Ada County planning area would be exposed to some degree to the impacts of moderate to extreme drought conditions.

11.4 VULNERABILITY

11.4.1 Population

The entire population of the county is vulnerable to drought events. Drought can affect people’s health and safety, including health problems related to low water flows, poor water quality, or dust. Other possible impacts include recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and hygiene; compromised food and nutrition; and increased incidence of illness and disease (Centers for Disease Control and Prevention 2020).

The planning partnership has the ability to minimize any impacts on residents and water consumers in the county should several consecutive dry years occur. This would be accomplished through proactive water conservation and identification and utilization of alternative water supplies. No significant life or health impacts are anticipated as a result of drought within the planning area.

11.4.2 Property

No structures will be directly affected by drought conditions, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Droughts can also have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

11.4.3 Critical Facilities

Critical facilities as defined for this plan will continue to be operational during a drought. The risk to the critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

11.4.4 Environment

Groundwater and Streams

Drought generally does not affect groundwater sources as quickly as surface water supplies, but groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams, especially during the summer when there is little or no precipitation. Reduced groundwater levels mean that even less water will enter streams when stream flows are lowest. Where stream flows are reduced, development that relies on surface water may seek to establish new groundwater wells, which could further increase groundwater depletion.

Other Potential Losses

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects. The following are potential impacts of drought:

- Wildlife habitat may be degraded through the loss of wetlands, lakes and vegetation. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity.
- Drought conditions greatly increase the likelihood of wildfires, a major threat to timber resources, structures, and other property.
- Water shortages and severe drought conditions would have a significant impact on Native American tribes’ way of life in fishing and farming subsistence.

- Scenic resources in the county are vulnerable to the increased likelihood of wildfires associated with droughts.
- Drying up or dying off of forests could reduce ecological and eco-tourist values.
- Shortage of water supply can have significant economic impacts.
- Drought conditions often are associated with harmful algal blooms—specifically cyanobacteria that can cause severe illness and death in mammals.

11.4.5 Economic Impact

Drought causes the most significant economic impacts on industries that use water or depend on water for their business, most notably agriculture and related sectors (forestry, fisheries, and waterborne activities), power plants (including geothermal power production), and oil refineries. In addition to losses in yields in crop and livestock production, drought is associated with increased insect infestations, plant diseases, and wind erosion. Drought can lead to other losses because so many sectors are affected—losses that include reduced income for farmers and reduced business for retailers and others who provide goods and services to farmers. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue. Prices for food, energy, and other products may also increase as supplies decrease.

11.5 DEVELOPMENT TRENDS

Because all of the planning area is exposed to the drought hazard, the increase in exposed population and property since the last hazard mitigation plan update is equal to the countywide trends since then: a 13.6 percent increase in population, a 19.4 percent increase in number of general building stock structures, and a 46.7 percent increase in assessed property value. However, since droughts typically do not cause physical harm to people or structures, there would be no increase in vulnerability to drought from this increased exposure.

The principal resource impacted by drought conditions is water. The Ada County 2025 Comprehensive Plan has established goals and policies to preserve and protect groundwater and surface waters. These goals and policies equip the county to deal with the impacts of future droughts on future development.

11.6 SCENARIO

An extreme multiyear drought could impact the region. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out throughout Ada County, increasing the need for water. Surrounding communities, also in drought conditions, could increase their demand for water supplies relied upon by the planning partnership, causing social and political conflicts. If such conditions persisted for several years, the economy of Ada County could experience setbacks, especially in water dependent industries.

11.7 ISSUES

The planning team has identified the following drought-related issues:

- Identification and development of alternative water supplies
- Utilization of groundwater recharge techniques to stabilize the groundwater supply

- The probability of increased drought frequencies and durations due to future climate conditions
- The promotion of active water conservation even during non-drought periods.
- Public education on water conservation.

12. EARTHQUAKE

12.1 GENERAL BACKGROUND

An earthquake is the vibration of the earth's surface that follows a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of segments of the crust or by a volcanic eruption. Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake along the surface and through the earth at varying speeds, depending on the material through which they move.

12.1.1 Earthquake Location

The location of an earthquake is commonly described by its focal depth and the geographic position of its epicenter. The focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates (the focus or hypocenter). The epicenter of an earthquake is the point on the Earth's surface directly above the hypocenter.

12.1.2 Earthquake Geology

Faults

Earthquakes tend to occur along faults, which are zones of weakness in the earth's crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur. In fact, relieving stress along one part of a fault may increase stress in another part.

Small, local faults produce lower magnitude quakes, but ground shaking can be strong and damage can be significant in areas close to the fault. In contrast, large regional faults can generate earthquakes of great magnitudes but, because of their distance and depth, they may result in only moderate shaking in an area.

Faults are more likely to have future earthquakes on them if they have more rapid rates of movement, have had recent earthquakes along them, experience greater total displacements, and are aligned so that movement can relieve the accumulating tectonic stresses. Geologists classify faults by their relative hazards. "Active" faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). "Potentially active" faults are those that displaced layers of rock from the Quaternary period (the last 1,800,000 years).

Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault. Most of the seismic hazards are associated with well-known active faults. However, inactive faults or concealed faults (referred to as “blind-thrust” faults), where no displacements have been recorded, also have the potential to reactivate or experience displacement along a branch sometime in the future.

Horizontal Extension

Most earthquakes occur at the boundaries of Earth’s tectonic plates. Idaho is not on a plate boundary, but many faults in the state have produced large earthquakes. Tectonic forces in the western part of the North American plate combine with high heat from the underlying mantel to stretch the crust in a northeast-southwest direction. In response, the rigid crust breaks and shifts along faults, and the fault movement produces earthquakes. Stretching, or horizontal extension, of the crust produces a type of dipping fault called a “normal” fault (Figure 12-1).

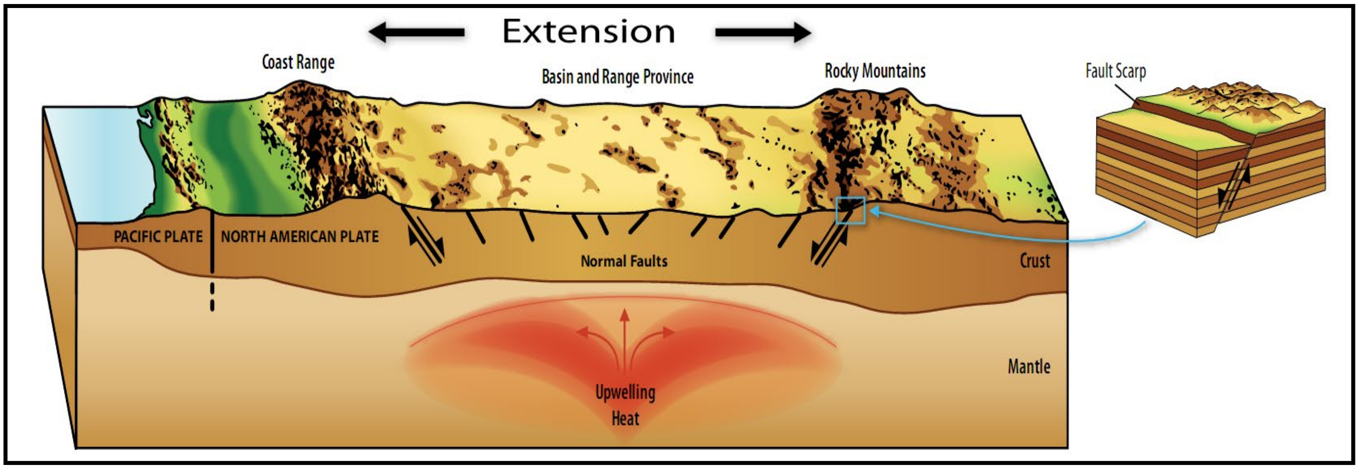


Figure 12-1. Horizontal Extension Creates Normal Faults

The movement of normal faults is characterized by the crust above the fault plane moving down relative to the crust below the fault plane. This up/down movement differs from movement on strike-slip faults like the San Andreas Fault in California, where the crust on one side of the fault slides horizontally past the crust on the other side. Earthquakes in Idaho can be generated by movement on a variety of types of faults, but the faults that are considered capable of generating large surface-faulting earthquakes are mainly normal faults.

Seismic Conditions in Idaho

Most earthquakes in Idaho occur along a belt of seismicity called the Intermountain Seismic Belt that extends from the northwest corner of Montana, along the Idaho-Wyoming border, through Utah, and into southern Nevada. Along most of its length, the Intermountain Seismic Belt straddles the boundary between the Basin and Range Province to the west and more stable parts of North America to the east.

The eastern Snake River Plain formed as the North American continent passed over a “hotspot” of hot rock rising from the earth’s mantle. This plume is called the “Yellowstone hotspot” because it is presently located in the Yellowstone National Park area. Beginning along the Oregon-Nevada-Idaho border about 14.5 million years ago and continuing as recently as 600,000 years ago in Yellowstone, the hotspot melted crustal rocks passing over it, creating huge volumes of magma that erupted to form explosive calderas. These calderas are progressively younger to the northeast because of the continuous movement of the North American continent over the hotspot.

In an area around the eastern Snake River Plain, the Yellowstone hotspot has interacted with the Basin and Range Province to create a pattern of earthquakes and mountain building called the Yellowstone Tectonic Parabola Figure 12-2). A major branch of the Intermountain Seismic Belt extends from the Yellowstone area westward across central Idaho. This zone includes at least eight major active faults and has been the site of numerous earthquake swarms and seismic events, including the two largest historic earthquakes in the Intermountain West.

The pattern of earthquake activity in eastern and central Idaho seems to be related to interactions between the Yellowstone hotspot and the Basin and Range Province to the west. Geologists divide the region into five tectonic belts based on historical earthquake activity and the age and amount of movement on prehistoric faults. Within the Snake River Plain, earthquake activity is very low. Earthquake activity increases and faults become younger away from the Plain, culminating in a band of active faults that forms the tectonic parabola on the east.

12.1.3 Earthquake Classifications

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as magnitude; or by the impact on people and structures, measured as intensity.

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. It is commonly expressed by ratings on the moment magnitude scale (M_W). Most people have heard about the Richter scale, but the moment magnitude scale is a more accurate measure of magnitude (U.S. Geological Survey 2021). It is based on the product of the distance a fault moved and the force required to move it.

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. Magnitude is commonly expressed by ratings on the moment magnitude scale (M_W), the most common scale used today (U.S. Geological Survey 2021). This scale is based on the total moment release of the earthquake (the product of the distance a fault moved and the force required to move it). The scale is as follows:

- Great—$M_W > 8$
- Major—$M_W = 7.0 – 7.9$
- Strong—$M_W = 6.0 – 6.9$
- Moderate—$M_W = 5.0 – 5.9$
- Light—$M_W = 4.0 – 4.9$
- Minor—$M_W = 3.0 – 3.9$
- Micro—$M_W < 3$

Intensity

The most used intensity scale is the modified Mercalli intensity scale. Ratings of the scale as well as the perceived shaking and damage potential for structures are shown in Table 12-1.

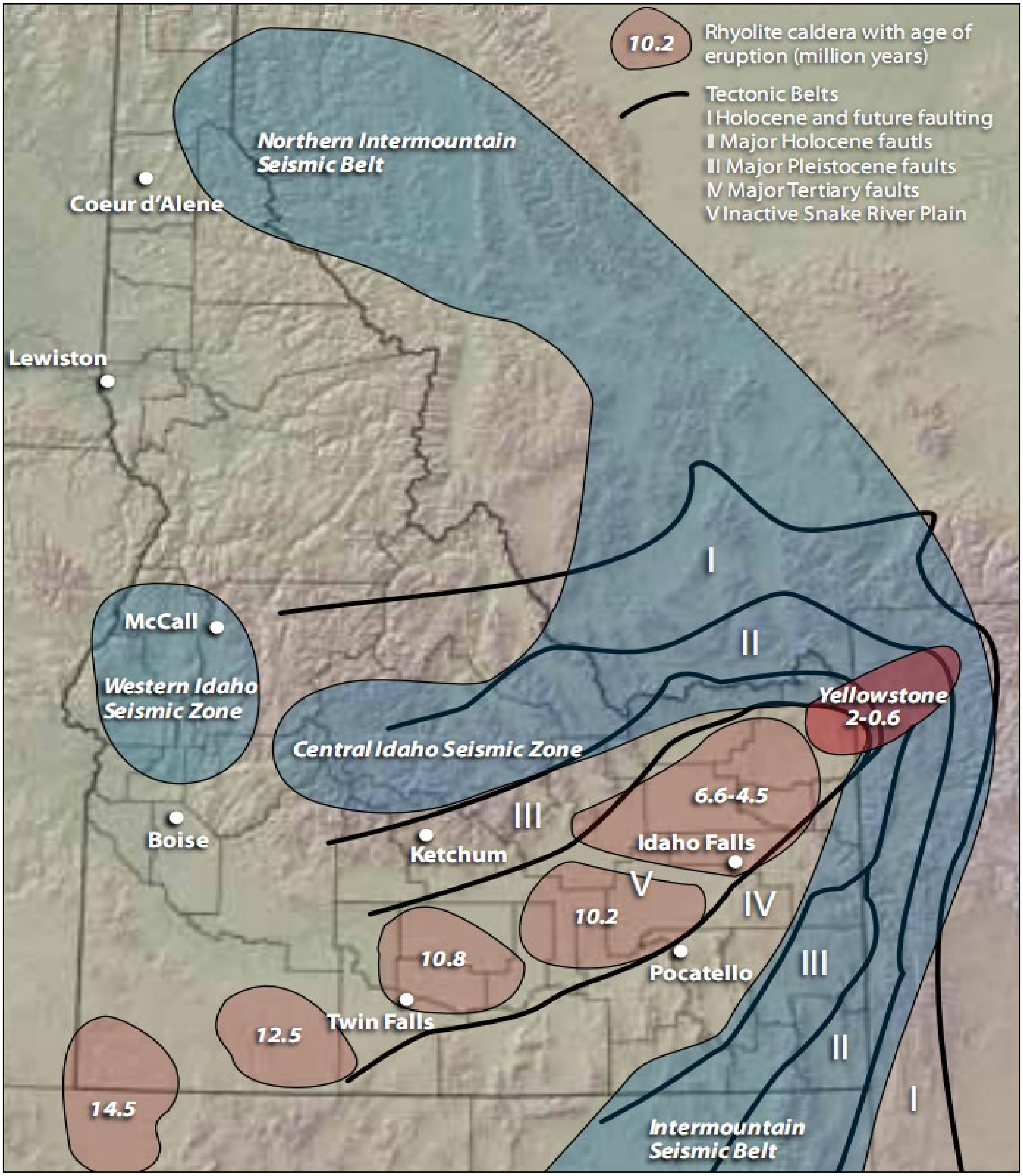


Figure 12-2. Volcanic and Tectonic Features of the Yellowstone-Snake River Plain System

Table 12-1. Mercalli Scale and Peak Ground Acceleration Comparison

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17% - 1.4%
IV	Light	None	None	1.4% - 3.9%
V	Moderate	Very Light	Light	3.9% - 9.2%
VI	Strong	Light	Moderate	9.2% - 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% - 34%
VIII	Severe	Moderate/Heavy	Heavy	34% - 65%
IX	Violent	Heavy	Very Heavy	65% - 124%
X – XII	Extreme	Very Heavy	Very Heavy	>124%

a. PGA = peak ground acceleration. Measured in percent of g, where g is the acceleration of gravity
Sources: (U.S. Geological Survey 2021); (U.S. Geological Survey 2011)

The modified Mercalli intensity scale is generally represented visually using shake maps, which show the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A shake map shows the variation of ground shaking in a region immediately following significant earthquakes (for technical information about shake maps see (U.S. Geological Survey 2021)).

12.1.4 Ground Motion

Earthquake hazard assessment is based on expected ground motion. During an earthquake when the ground is shaking, it also experiences acceleration. The peak acceleration is the largest increase in velocity recorded by a particular station during an earthquake. Estimates are developed of the annual probability that certain ground motion accelerations will be exceeded; the annual probabilities can then be summed over a time period of interest.

The most commonly mapped ground motion parameters are horizontal and vertical peak ground accelerations (PGA) for a given soil type. PGA is a measure of how hard the earth shakes, or accelerates, in a given geographic area. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. PGA is measured in g (the acceleration due to gravity) or expressed as a percent acceleration force of gravity (%g). These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 12-1 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

12.1.5 USGS Earthquake Mapping Programs

National Seismic Hazard Map

National maps of earthquake shaking hazards provide information for creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities and land use planning. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes (Brown et al., 2001). The USGS updated the National Seismic Hazard Maps in 2018. New seismic, geologic, and geodetic information on earthquake rates and associated ground shaking were incorporated into these revised maps. The 2018 map, shown in Figure 12-3, represents the best available data as determined by the USGS.

Source: (U.S. Geological Survey 2021)

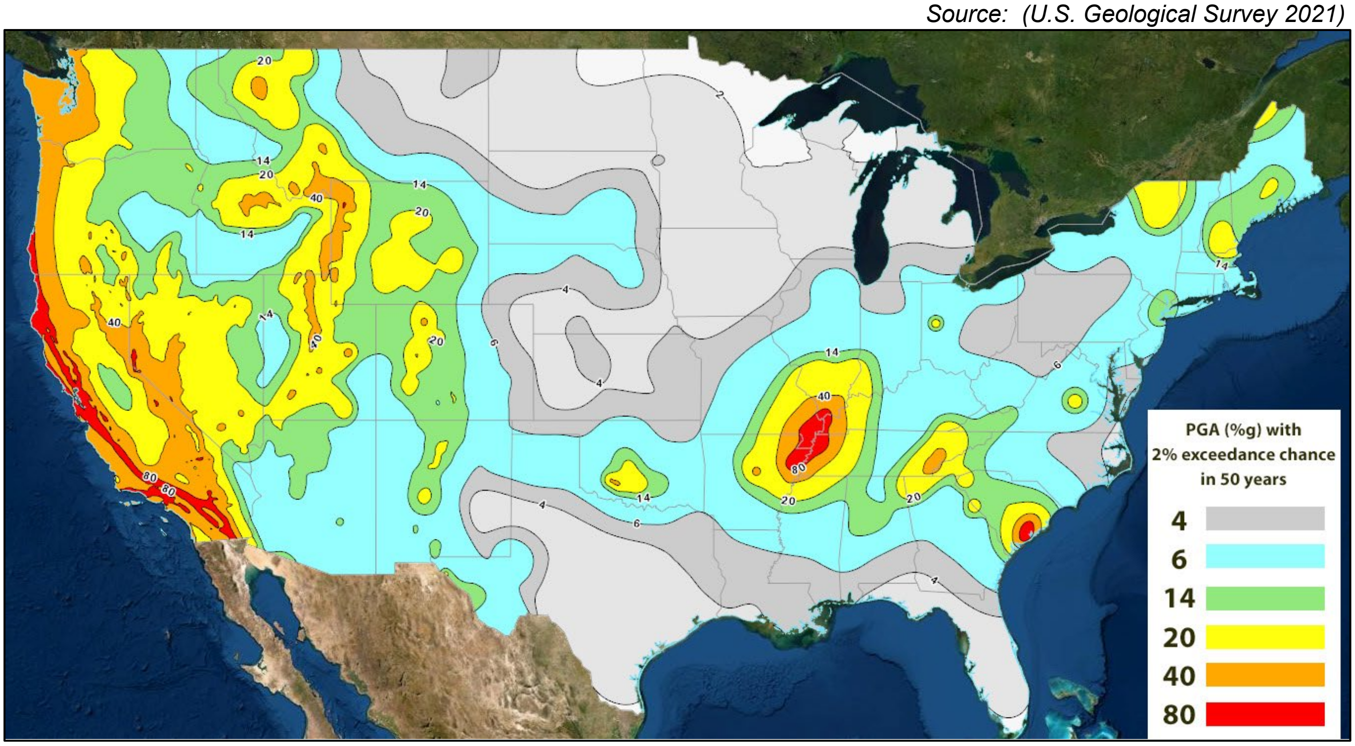


Figure 12-3. Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years

ShakeMaps

The USGS Earthquake Hazards Program produces maps called ShakeMaps that map ground motion and shaking intensity following significant earthquakes. ShakeMaps focus on the ground shaking caused by the earthquake, rather than on characteristics of the earthquake source, such as magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth’s crust.

A ShakeMap shows the extent and variation of ground shaking immediately across the surrounding region following significant earthquakes. Such mapping is derived from peak ground motion amplitudes recorded on seismic sensors, with interpolation where data are lacking based on estimated amplitudes. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. In addition to the maps of recorded events, the USGS creates the following:

- Scenario ShakeMaps of hypothetical earthquakes of an assumed magnitude on known faults
- Probabilistic ShakeMaps, based on predicted shaking from all possible earthquakes over a 10,000-year period. In a probabilistic map, information from millions of scenario maps is combined to make a forecast for the future. The maps indicate the ground motion at any given point that has a given probability of being exceeded in a given timeframe, such as a 100-year (1-percent-annual chance) event.

12.1.6 Liquefaction and Soil Types

Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people.

The National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. The maps classify soils as follows (Federal Emergency Management Agency 2022a):

- Type A—Hard rock (igneous rock).
- Type B—Rock (volcanic rock).
- Type C—Very dense soil and soft rock (sandstone).
- Type D—Stiff soil (mud).
- Type E—Soft soil (artificial fill).
- Type F—Soils requiring site-specific evaluations.

The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. In general, these areas are also most susceptible to liquefaction.

12.1.7 Secondary Hazards

The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris as the shocks shake buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides or releases of hazardous material, compounding their disastrous effects.

12.2 HAZARD PROFILE

12.2.1 Past Events

The historical record demonstrates that earthquakes can occur throughout Idaho. Most earthquakes felt by Idaho residents have occurred within the Yellowstone Tectonic Parabola. Notable exceptions include large earthquakes in northern Nevada, eastern Washington and western Montana. The 2008 magnitude-6.0 Wells, Nevada earthquake was felt by thousands in Boise, Twin Falls and Pocatello. Because large earthquakes are felt over hundreds of miles, the locations of some early events not recorded by seismographs are uncertain. Table 12-2 lists past seismic events felt in Idaho.

Table 12-2. Historical Earthquakes 5.0+ Strongly Felt in Idaho

Year	Magnitude	Location	Description
1872	7.4	Lake Chelan, WA	Largest quake in Washington State; felt strongly in north Idaho.
1884	6.0	Bear Lake Valley	The earthquake damaged houses considerably in Paris, Idaho.
1905	6.0	SW Idaho or NE NV	Considerable damage at Shoshone, Idaho.
1913	5.0	Adams County	Broke windows and dishes.
1914	6.0	UT-ID State Line	Intensity VII; between Ogden, Utah and Montpelier, Idaho.
1915	7.75	Pleasant valley, NV	Considerable damage in southwest Idaho a hundred miles from epicenter.
1916	6.0	North of Boise	Boise residents rushed into the street; chimneys fell.
1918	5.0	North Idaho	Widely felt near Sandpoint.
1925	6.6	SW Montana	Felt throughout Idaho.
1927	5.0	Connor Creek	On Idaho-Oregon border west of Cascade.
1934	6.6	Hansel valley, UT	Largest Utah event on record; 20 miles south of Idaho border. 2 fatalities.
1935	6.25	Helena, MT	Extensive damage. Multiple large events throughout Idaho. 4 fatalities.
1936	6.4	Walla Walla, WA	Damaging earthquake; widely felt in Idaho.
1942	5.0	Sandpoint area	Cracked plaster; rock fall onto railroad tracks.
1944	6.0	Central Idaho	Knocked people to ground in Custer County.
1945	6.0	Central Idaho	Epicenter near Clayton. Slight damage in Idaho City and Weiser.
1947	6.25	Southwest Montana	Epicenter in Gravelly range, 10 miles north of Idaho border.
1947	5.0	Central Idaho	Several large cracks formed in a well-constructed brick building.
1959	7.3	Hebgen Lake, MT	Major event, extensive fault scarps. 20 miles from Idaho. 29 fatalities.
1960	5.0	Soda Springs	Foundations and plaster cracked.
1962	5.7	Cache Valley	Heavily damaged older buildings.
1963	5.0	Clayton	Plaster cracked and windows broken.
1969	5.0	Ketchum	Cement floors cracked.
1975	6.1	NW Yellowstone	Widely felt in Yellowstone region.
1975	6.1	Pocatello Valley	Some 520 homes damaged in Ridgedale and Malad City.
1983	6.9	Borah Peak	Major event, 21 mile surface scarp, 11 buildings destroyed, 2 fatalities.
1984	5.0	Challis	Largest of many Borah Peak aftershocks.
1994	5.9	Draney Peak	Remote area on Wyoming border. One injury from falling flower pot.
1999	5.3	Lima, MT	In Red Rock valley just north of Idaho border.
2005	5.6	Dillon, MT	Felt across Idaho.
2008	6.0	Wells, NV	Felt strongly throughout southern Idaho.
2014	7.4	Near Challis, ID	Sequence of earthquakes about 15 miles northwest of a portion of the Lost River Fault.
2015	5	Near Challis, ID	Tremors were felt across Idaho, from McCall to the Treasure Valley.
2017	5.8	Near Lincoln, MT	No damage or injuries.
2017	5.3	Near Soda Springs, ID	Moderate shaking in southeast Idaho. No reports of damage or death.
2017	5.0	Near Georgetown, ID	Aftershock of the magnitude 5.3 earthquake near Soda Springs.
2020	6.5	Stanley, ID	No injuries and only minor damage reported.

Sources: (State of Idaho Hazard Mitigation Plan 2018); (U.S. Geological Survey 2022)

12.2.2 Location

Faults

Ada County is situated near two fault zones: the western Idaho fault system and Owyhee Mountains fault system. The Squaw Creek, Big Flat and Jake Creek faults are active structures near Emmett, about 25 miles north of Boise. The most important of these, the Squaw Creek fault, has geologic evidence for movement as recently as 7,600 years ago. About 57 miles southeast of Boise and 13 miles from Grand View is the Water Tank fault. Recently discovered in 1997, this fault was active as recently as 3,000 years ago. Other faults present in and around Ada County do not appear to be active.

NEHRP Soils

NEHRP soil types define locations that will be significantly impacted by an earthquake. NEHRP soils data is available for a portion of the Ada County planning area, as shown in Figure 12-4. In general, areas with NEHRP Soils D, E and F are also susceptible to liquefaction.

Liquefaction Zones

Liquefaction mapping is available for the same portion of the Ada County planning area as the NEHRP soil mapping, as shown in Figure 12-5.

12.2.3 Frequency

Thousands of earthquakes have been recorded in Idaho. Table 12-3 summarizes statistics for the past three years. The 3,501 events in that period represent an average of 1,167 per year. This average includes the many aftershocks that occur after large earthquakes. The number of small earthquakes (magnitude less than 3) is greatly under-reported in Idaho because of limited seismic monitoring.

Table 12-3. Idaho Earthquake Statistics 2019-2021

	Number of Events		Number of Events
Magnitude 2-3	3,053	**Magnitude 5-6**	0
Magnitude 3-4	418	**Magnitude 6-7**	1
Magnitude 4-5	29	**Total**	**3,501**

Source: (Volcano Discovery 2022)

Seismologists use a historical distribution of extreme values to estimate the probability of shaking at or above a given intensity over a 50-year year exposure time. Using this methodology, Idaho Geological Survey has estimated the maximum shaking on unstable sites within 300 miles of Boise as follows:

- A >50-percent chance of a midrange intensity event (VI or greater) in any 50-year period.
- A 33-percent chance of intensity VII in any 50-year period.
- An 18-percent chance of intensity VIII in any 50-year period
- A 10-percent chance of intensity IX in any 50-year period

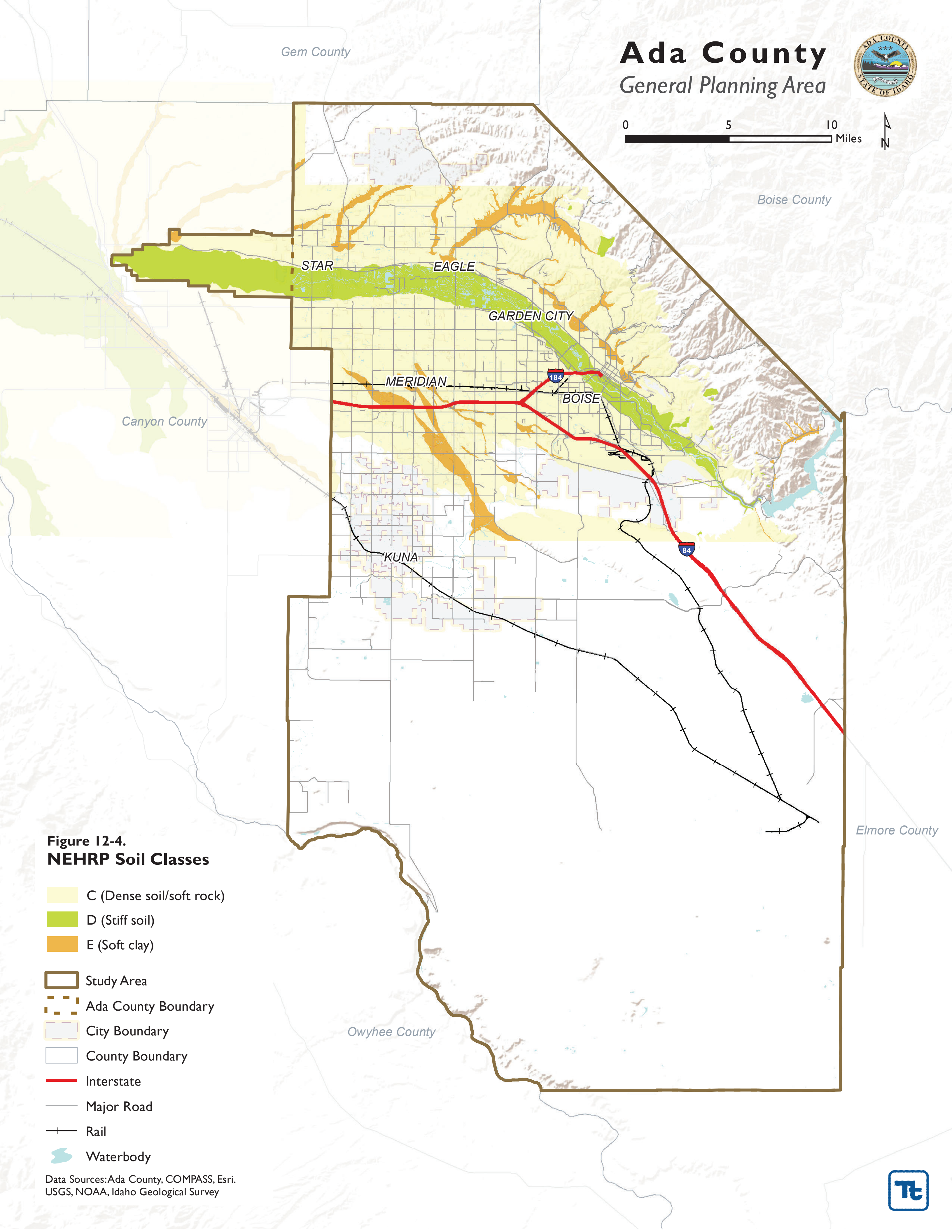


Figure 12-4.
NEHRP Soil Classes

C (Dense soil/soft rock)
D (Stiff soil)
E (Soft clay)
Study Area
Ada County Boundary
City Boundary
County Boundary
Interstate
Major Road
Rail
Waterbody

Data Sources: Ada County, COMPASS, Esri. USGS, NOAA, Idaho Geological Survey

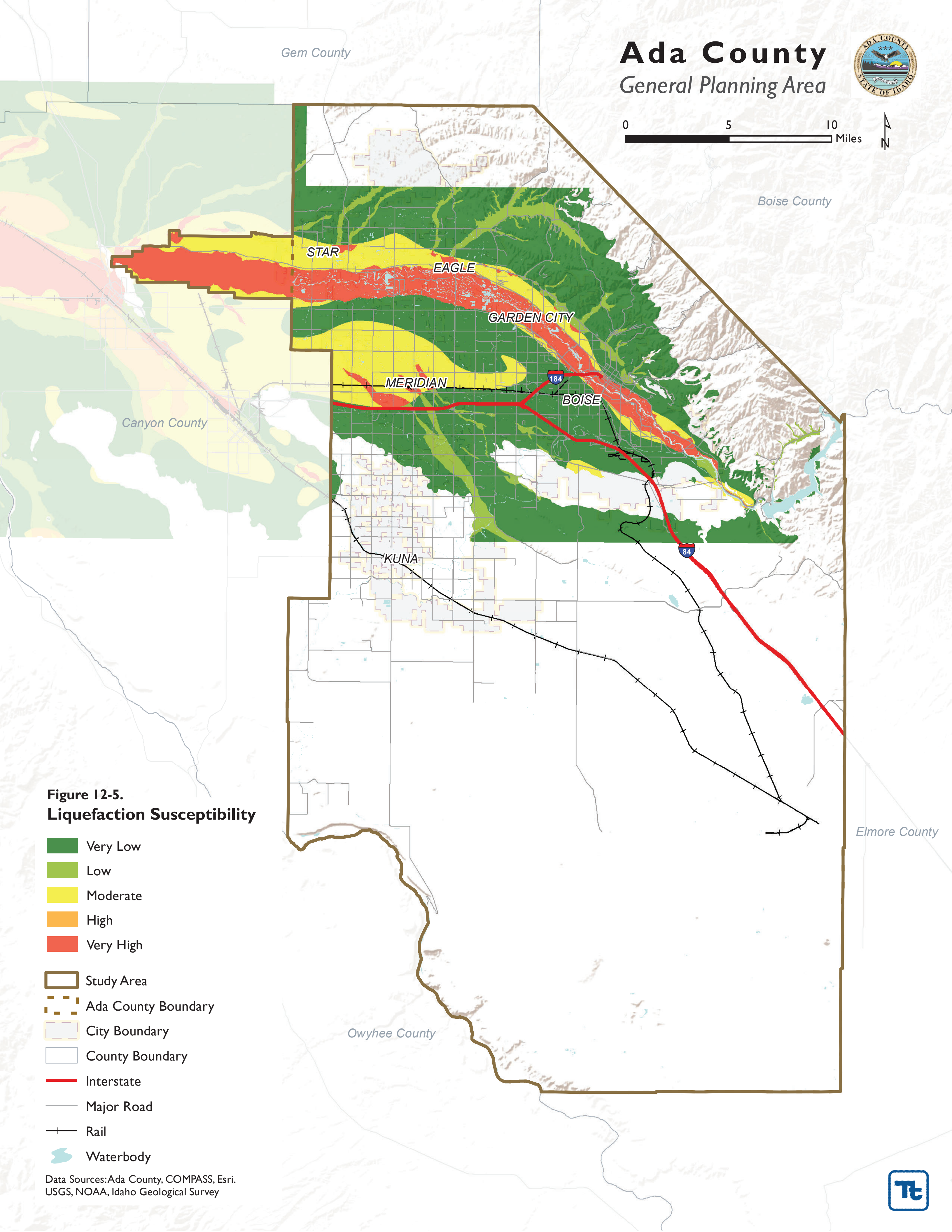


Figure 12-5.
Liquefaction Susceptibility

12.2.4 Severity

The severity of an earthquake can be expressed in terms of intensity or magnitude (see Section 12.1.3). It is directly correlated to the stability of the ground close to the event's epicenter. The difference in severity between intensity ranges can be immense. A poorly built structure on a stable site is far more likely to survive a large earthquake than a well-built structure on an unstable site. Thorough geotechnical site evaluations should be the rule of thumb for new construction in the planning area until creditable soils mapping becomes available.

The USGS creates ground motion maps based on current information about fault zones, showing the PGA that has a certain probability (2 percent or 10 percent) of being exceeded in a 50-year period. The PGA is measured in numbers of g's (the acceleration associated with gravity). Figure 12-6 shows the PGAs with a 2-percent exceedance chance in 50 years in southern Idaho. Ada County is in a medium-risk area.

Source: (U.S. Geological Survey 2014)

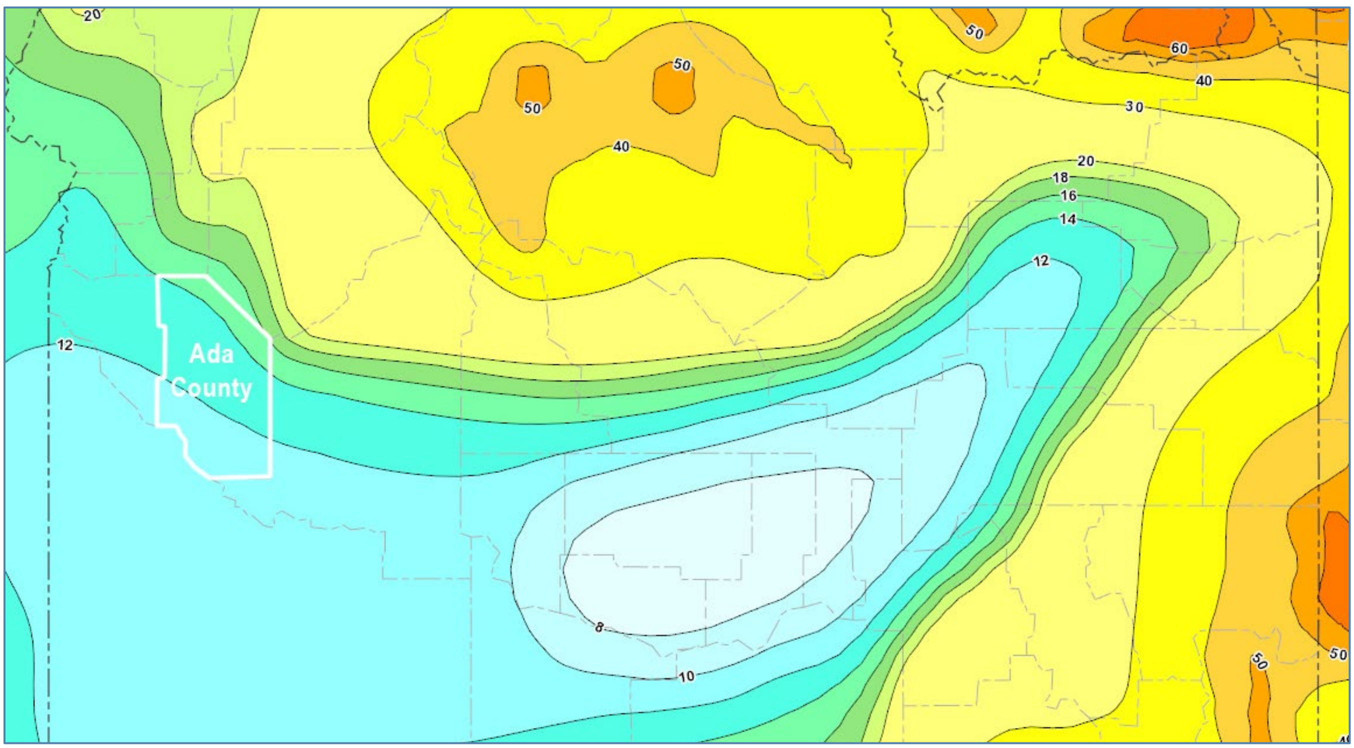


Figure 12-6. PGA (in %g) with 2-Percent Probability of Exceedance in 50 Years

12.2.5 Warning Time

Earthquakes can last from a few seconds to over five minutes. They may be one-time events or occur as a series of tremors over several days. There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short, but it could allow for someone to get under a desk, pause hazardous or high-risk work, or initiate protective automated systems in structures or critical infrastructure.

12.3 EXPOSURE

12.3.1 Population

The entire population of the planning area is potentially exposed to direct damage from earthquakes or indirect impacts such as business interruption, road closures, and loss of function of utilities.

12.3.2 Property

The Ada County Assessor reports 174,802 buildings in Ada County, with a total assessed value of $123 billion. Most of the buildings (94.8 percent) are residential. All buildings are considered to be exposed to the earthquake hazard.

12.3.3 Critical Facilities

Since the entire planning area has exposure to the earthquake hazard, all critical facilities components are considered to be exposed. The breakdown of the numbers and types of facilities is presented in Table 4-3. Critical facilities constructed on NEHRP Type D and E soils are particularly at risk from seismic events.

12.3.4 Environment

The entire planning area is exposed to the earthquake hazard, including all natural resources, habitat, and wildlife.

12.4 VULNERABILITY

Earthquake vulnerability data for the risk assessment was generated using a Hazus Level 2 (user-defined) analysis for the for the events listed in Table 12-4. The countywide analysis results are summarized in the sections below. Detailed results by jurisdiction can be found in Appendix D.

Table 12-4. Earthquakes Modeled for Risk Assessment

Event	Magnitude	Focal Depth	Epicenter Location	PGA
100-Year Probabilistic Earthquake	N/A	N/A	N/A	Figure 12-7
500-Year Probabilistic Earthquake	N/A	N/A	N/A	Figure 12-8
Squaw Creek Fault Scenario	7.03	9.0 km	44.146°N 116.238°W	Figure 12-9
Big Flat Jake Creek Scenario	6.81	9.0 km	44.259°N 116.347°W	Figure 12-10

12.4.1 Population

Estimated Impacts on Persons and Households

Hazus estimated impacts on persons and households in the planning area for the four selected earthquake scenarios as summarized in Table 12-5.

Ada County
General Planning Area

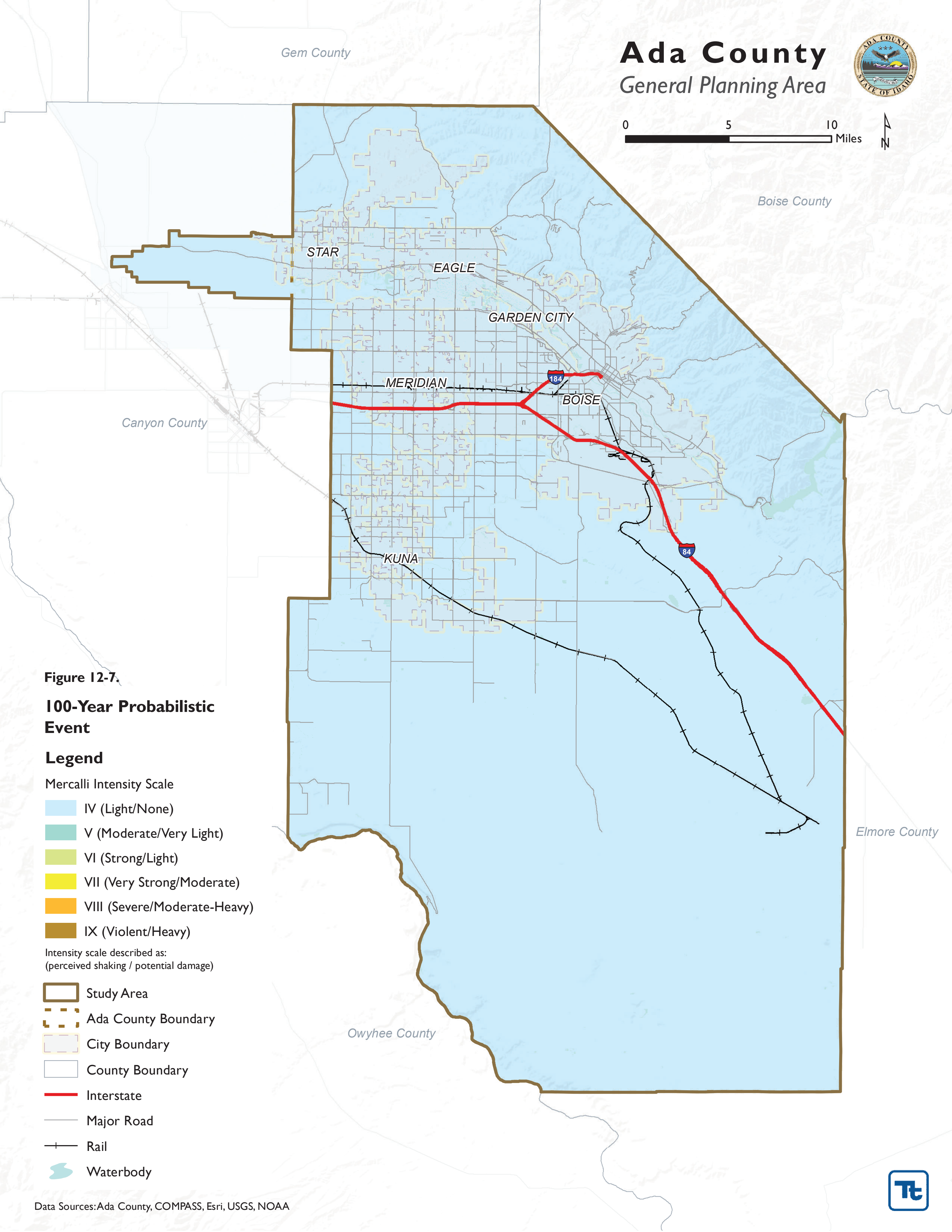


Figure 12-7.

100-Year Probabilistic Event

Legend

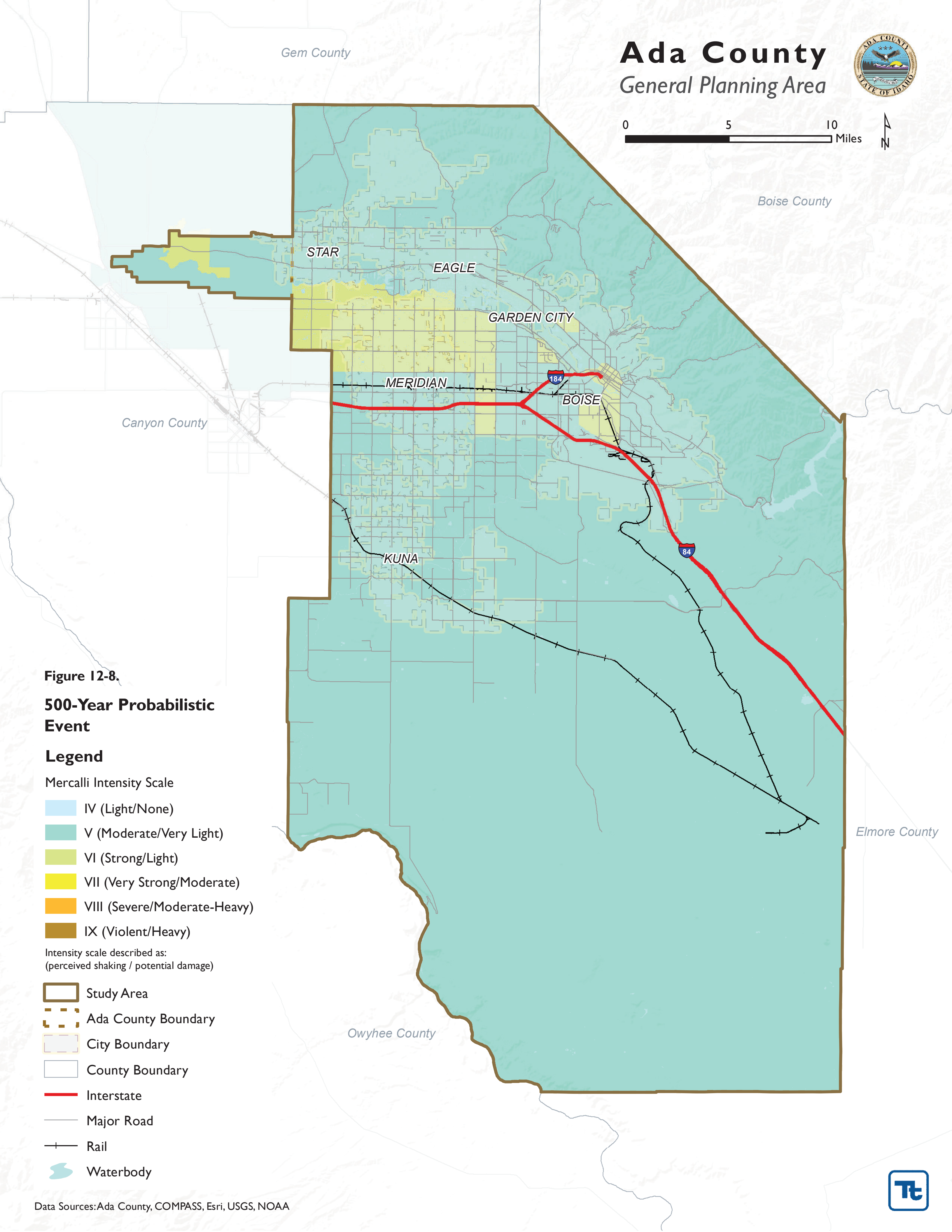
Mercalli Intensity Scale

- IV (Light/None)
- V (Moderate/Very Light)
- VI (Strong/Light)
- VII (Very Strong/Moderate)
- VIII (Severe/Moderate-Heavy)
- IX (Violent/Heavy)

Intensity scale described as:
(perceived shaking / potential damage)

- Study Area
- Ada County Boundary
- City Boundary
- County Boundary
- Interstate
- Major Road
- Rail
- Waterbody

Data Sources: Ada County, COMPASS, Esri, USGS, NOAA



Ada County
General Planning Area
0
5
10
Miles
N
Gem County
Boise County
Canyon County
Elmore County
Owyhee County
STAR
EAGLE
GARDEN CITY
MERIDIAN
BOISE
KUNA
184
84
Figure 12-8.
500-Year Probabilistic Event
Legend
Mercalli Intensity Scale
IV (Light/None)
V (Moderate/Very Light)
VI (Strong/Light)
VII (Very Strong/Moderate)
VIII (Severe/Moderate-Heavy)
IX (Violent/Heavy)
Intensity scale described as:
(perceived shaking / potential damage)
Study Area
Ada County Boundary
City Boundary
County Boundary
Interstate
Major Road
Rail
Waterbody
Data Sources: Ada County, COMPASS, Esri, USGS, NOAA

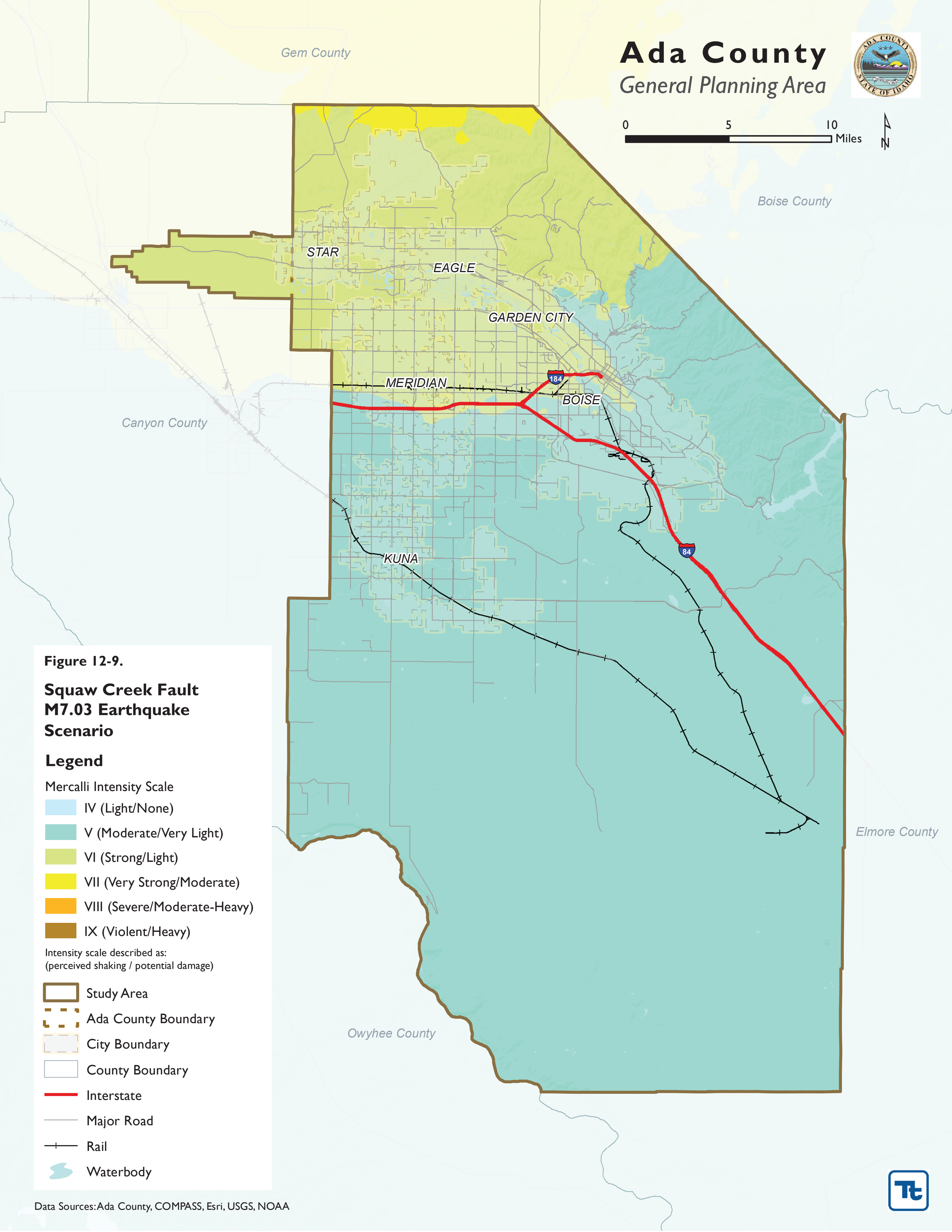


Figure 12-9.
Squaw Creek Fault M7.03 Earthquake Scenario

Ada County
General Planning Area

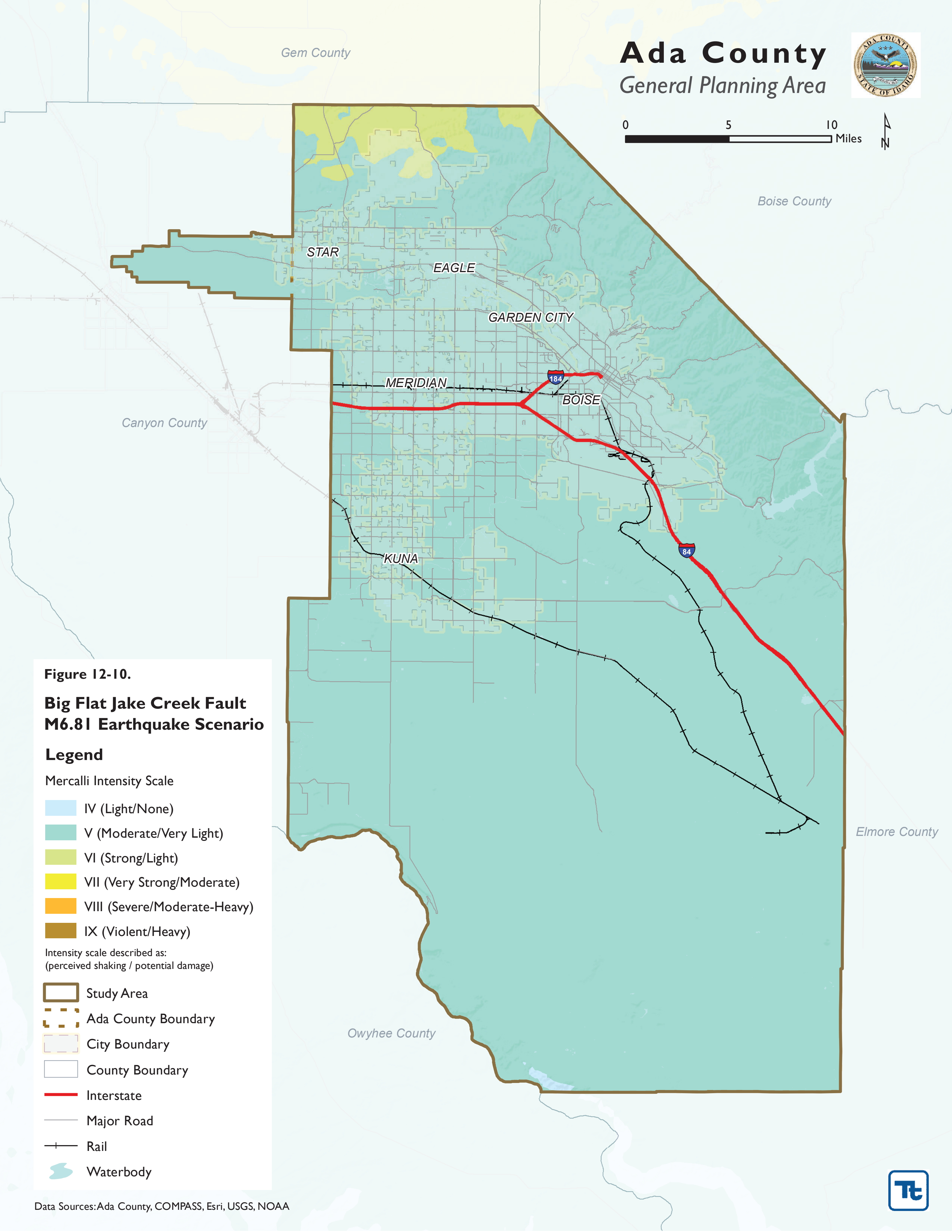


Figure 12-10.

Big Flat Jake Creek Fault M6.81 Earthquake Scenario

Legend

Mercalli Intensity Scale

- IV (Light/None)
- V (Moderate/Very Light)
- VI (Strong/Light)
- VII (Very Strong/Moderate)
- VIII (Severe/Moderate-Heavy)
- IX (Violent/Heavy)

Intensity scale described as:
(perceived shaking / potential damage)

- Study Area
- Ada County Boundary
- City Boundary
- County Boundary
- Interstate
- Major Road
- Rail
- Waterbody

Data Sources: Ada County, COMPASS, Esri, USGS, NOAA

Table 12-5. Estimated Earthquake Impact on Persons

Scenario	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
100-Year Earthquake	0	0
500-Year Earthquake	5	3
Squaw Creek Scenario	2	1
Big Flat Jake Creek Scenario	0	0

12.4.2 Property

Building Age

Building codes were not state-mandated in Idaho until 2008. However, the Ada County planning area has had a strong influence of building code enforcement as modern building codes have evolved nationally. Seismic code requirements have principally come from California, due to that state's immense seismic risk. The California State Building Code Council has identified significant milestones in building and seismic code requirements that can be used as a gauge of structural integrity of existing building stock. Using these time periods, the planning team used Hazus to identify the number of structures in the County by date of construction. Table 12-6 shows the results of this analysis.

Table 12-6. Age of Structures in Ada County

Time Period	Number of Current County Structures Built in Period	Significance of Time Frame
Pre-1933	5,717	Before 1933, there were no explicit earthquake requirements in building codes. State law did not require local governments to have building officials or issue building permits.
1933-1940	2,346	In 1940, the first strong motion recording was made.
1941-1960	13,336	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	16,642	In 1975, significant improvements were made to lateral force requirements.
1976-1994	37,816	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1995—present	98,945	Seismic code is currently enforced.
Total	**174,802**	

The number of structures does not reflect the number of total housing units, as many multi-family units and attached housing units are reported as one structure. Structures constructed after the Uniform Building Code was amended in 1994 to include seismic safety provisions account for 57 percent of the planning area's structures. Approximately 3 percent were built before 1933 when there were no building permits, inspections or seismic standards.

Loss Potential

Table 12-7 summarizes Hazus estimates of earthquake damage in the planning area for the modeled earthquake scenarios. Detailed results by jurisdiction are included in Appendix D. The debris estimates include only structural debris; they do not include additional debris that may accumulate, such as from trees. In addition, these estimates do not include losses that would occur from any fires stemming from an earthquake.

Table 12-7. Estimated Impact of Earthquake Scenario Events in the Planning Area

	Estimated Loss				Structural Debris (tons)
	Structural	Contents	Total	% of Total Planning Area Replacement Value	
100-Year Probabilistic Earthquake	$623,125	$543,636	$1,166,761	0%	1.81
500-Year Probabilistic Earthquake	$76,774,603	$52,067,050	$128,841,653	0.1%	27.28
Squaw Creek Fault Scenario	$555,907,389	$258,961,047	$814,868,435	0.7%	29.68
Big Flat Jake Creek Scenario	$76,293,829	$49,040,497	$125,334,326	0.1%	6.99

12.4.3 Critical Facilities

Level of Damage

Hazus classifies the vulnerability of critical facilities to earthquake as no damage, slight damage, moderate damage, extensive damage, or complete damage. Hazus was used to assign a category to each critical facility in the planning area for the assessed earthquake scenarios. shows the average probability of being damaged at a given level for all facilities in each critical facilities category is shown in Figure 12-11 through Figure 12-14

Time to Restore Critical Facilities to Functionality

Hazus estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, Hazus may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95 percent chance of being fully functional at Day 90. The analysis of critical facilities in the planning area was performed for the assessed earthquake scenarios. The results are summarized in Figure 12-15 through Figure 12-18. These figures show the average functionality for all critical facilities in each category.

12.4.4 Environment

Environmental problems as a result of an earthquake can be numerous. Secondary hazards will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly damage surrounding habitat. It is also possible for streams to be rerouted after an earthquake. Rerouting can change the water quality, possibly damaging habitat and feeding areas. Streams fed by groundwater wells can dry up because of changes in underlying geology.

12.5 DEVELOPMENT TRENDS

Because all of the planning area is exposed to the earthquake hazard, the increase in exposed population and property since the last hazard mitigation plan update is equal to the countywide trend over that time period: a 13.6-percent increase in population, a 19.4-percent increase in number of general building stock structures, and a 46.7-percent increase in assessed property value.

The entire planning area is under the influence of the International Building Code as mandated by the State of Idaho since 2008. This is a significant capability for the planning area in the management of seismic risk in future development. Strict adherence and enforcement of the seismic provisions of the International Building Code (IBC) will play a significant role in the management of seismic risk for new development in the future.

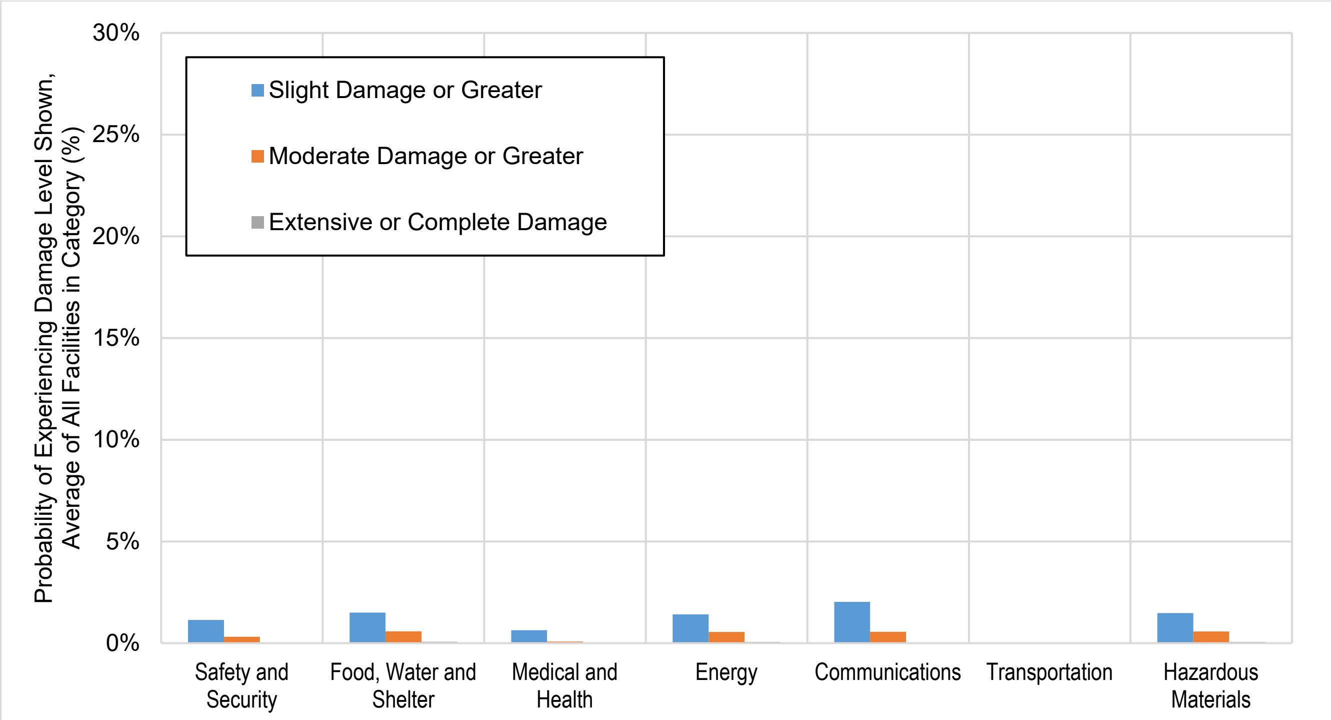


Figure 12-11. Critical Facility Damage Potential, 100-Year Probabilistic Earthquake

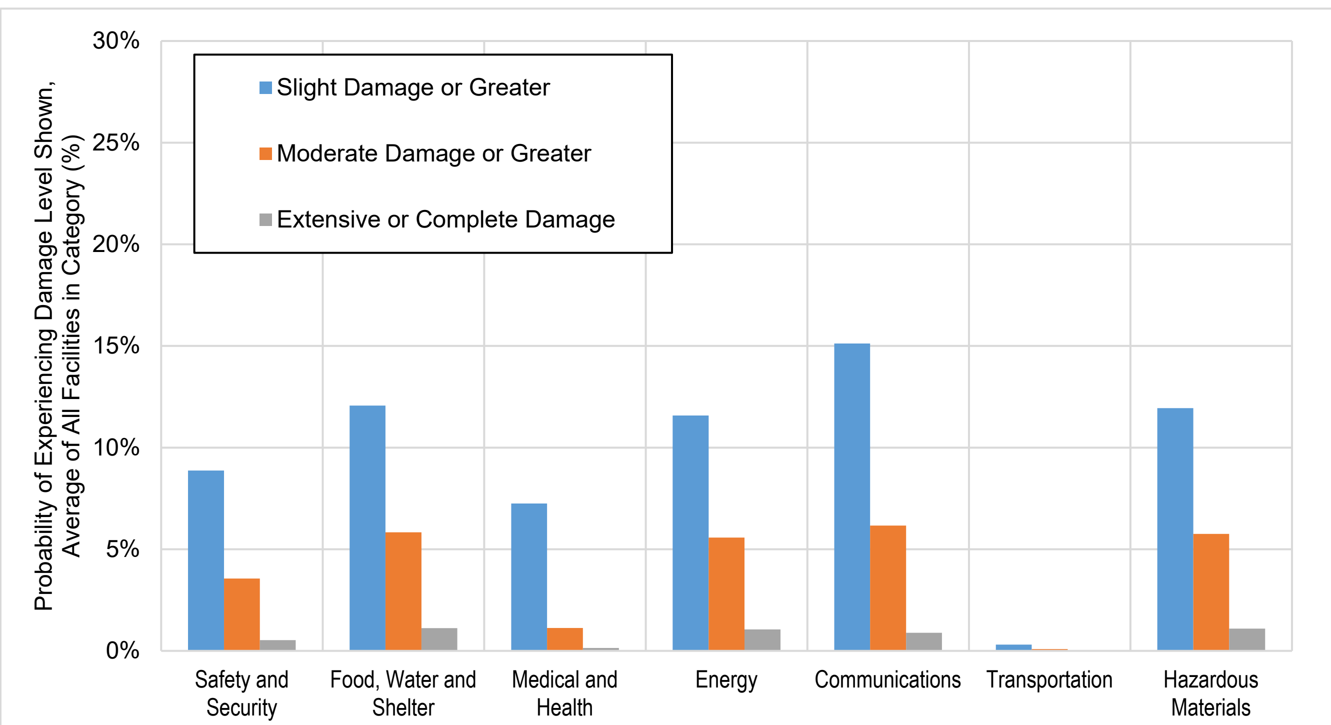


Figure 12-12. Critical Facility Damage Potential, 500-Year Probabilistic Earthquake

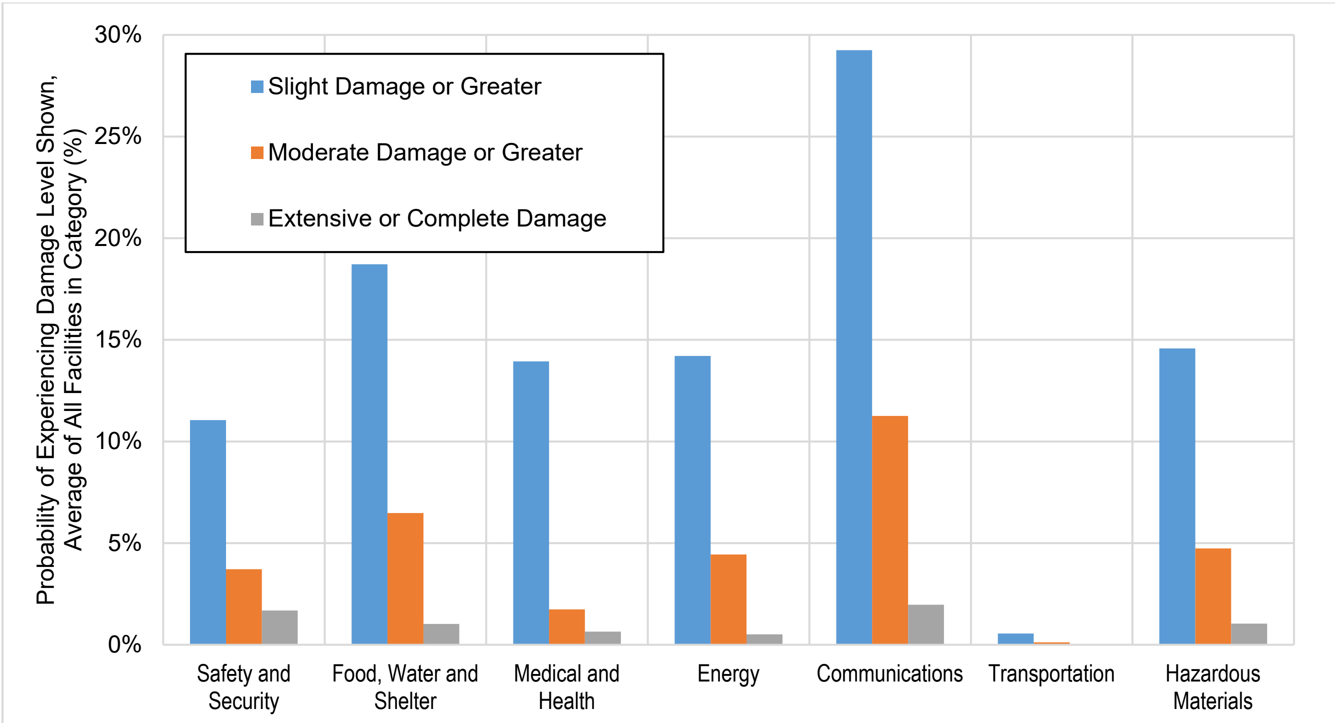


Figure 12-13. Critical Facility Damage Potential, Squaw Creek Fault Scenario

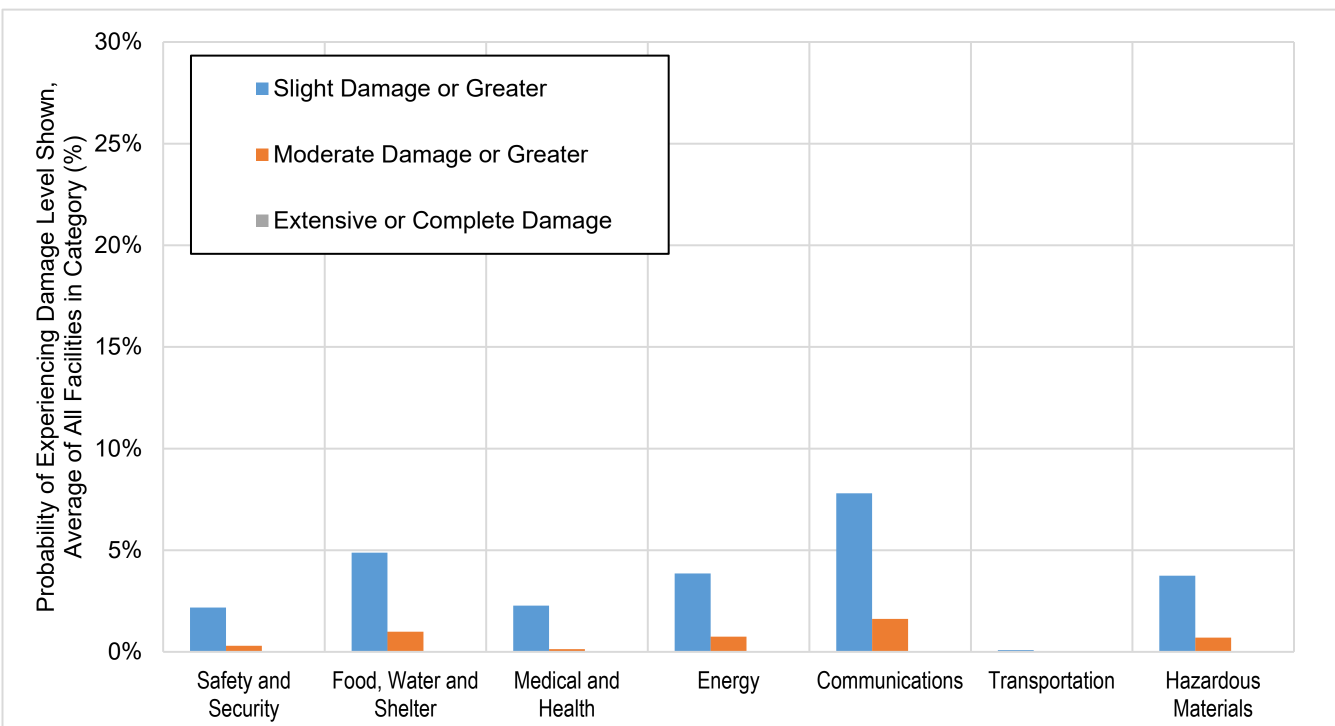


Figure 12-14. Critical Facility Damage Potential, Big Flat Jake Creek Fault Scenario

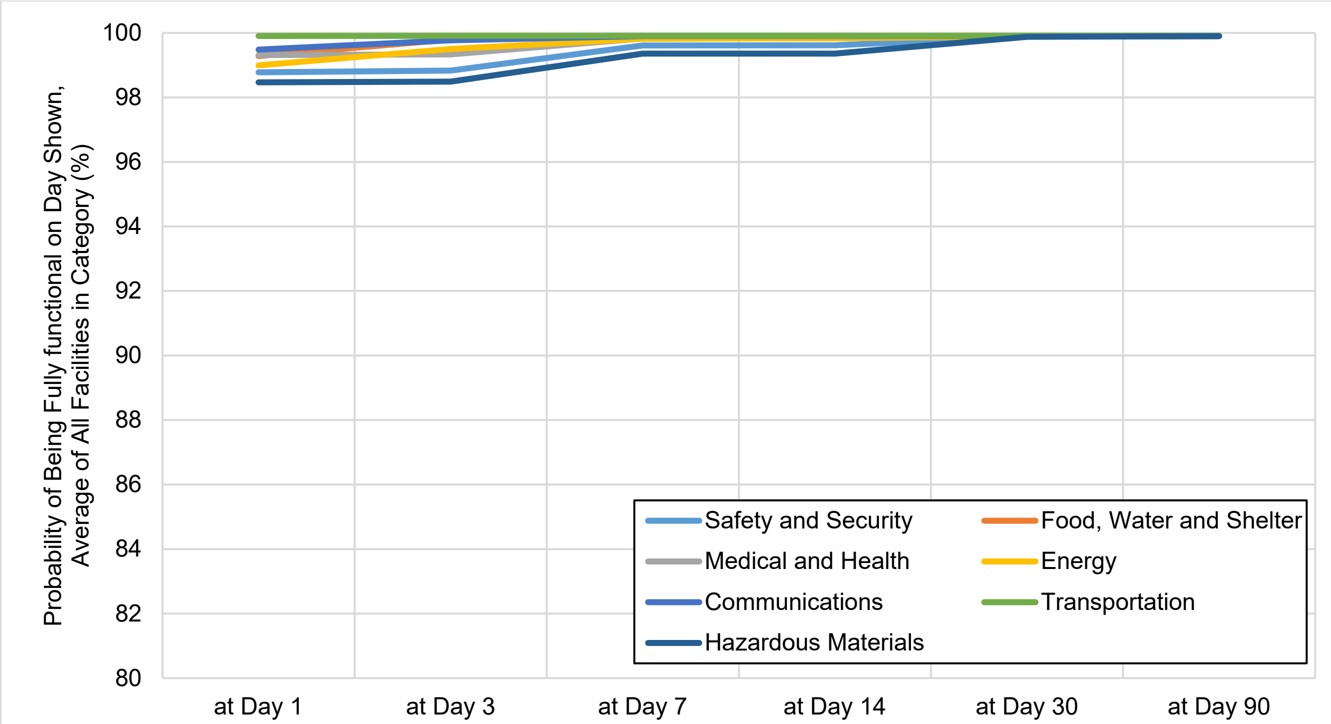


Figure 12-15. Critical Facility Functionality, 100-Year Probabilistic Earthquake

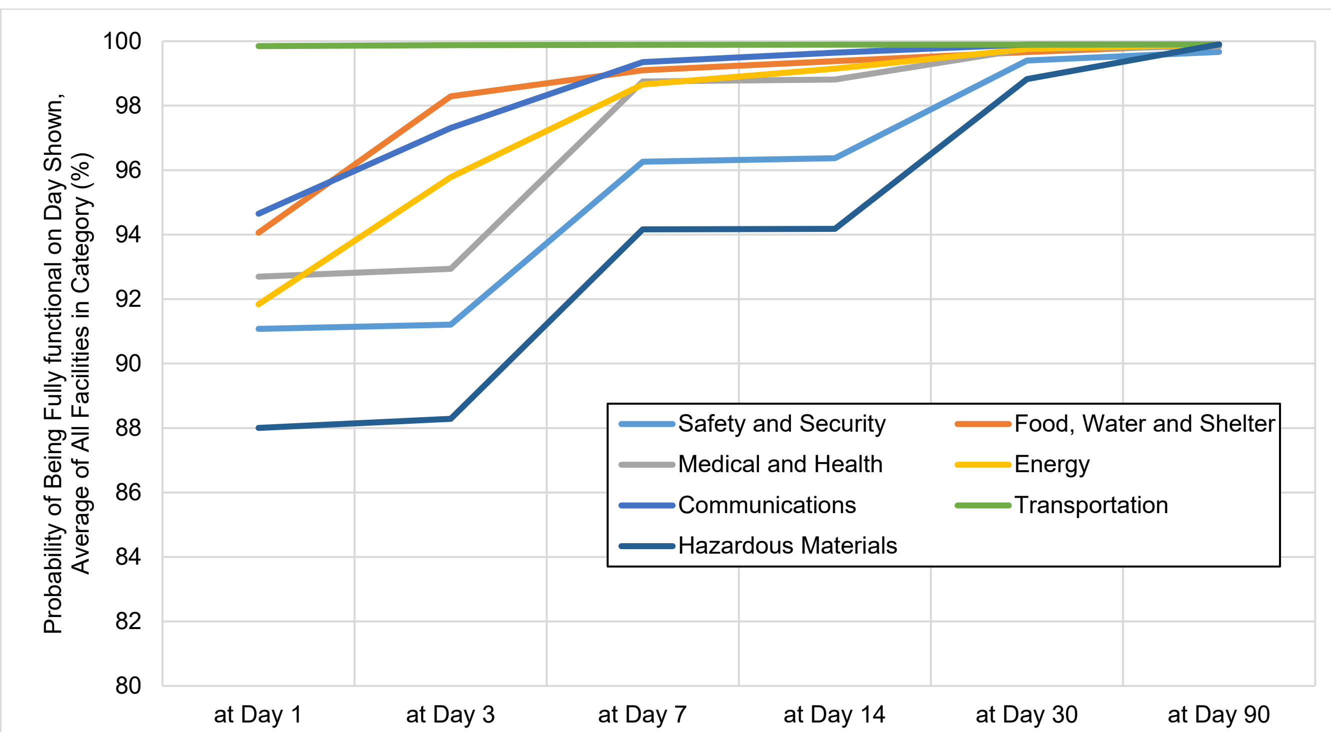


Figure 12-16. Critical Facility Functionality, 500-Year Probabilistic Earthquake

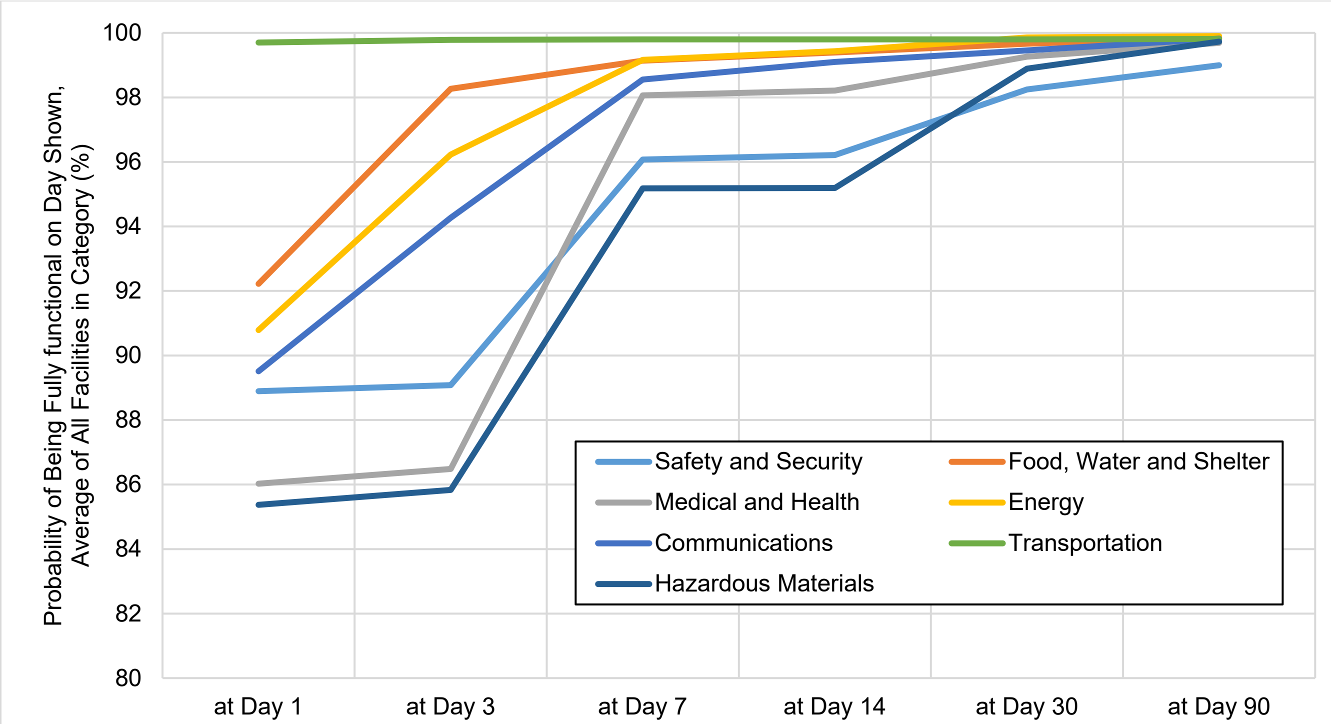


Figure 12-17. Critical Facility Functionality, Squaw Creek Fault Scenario

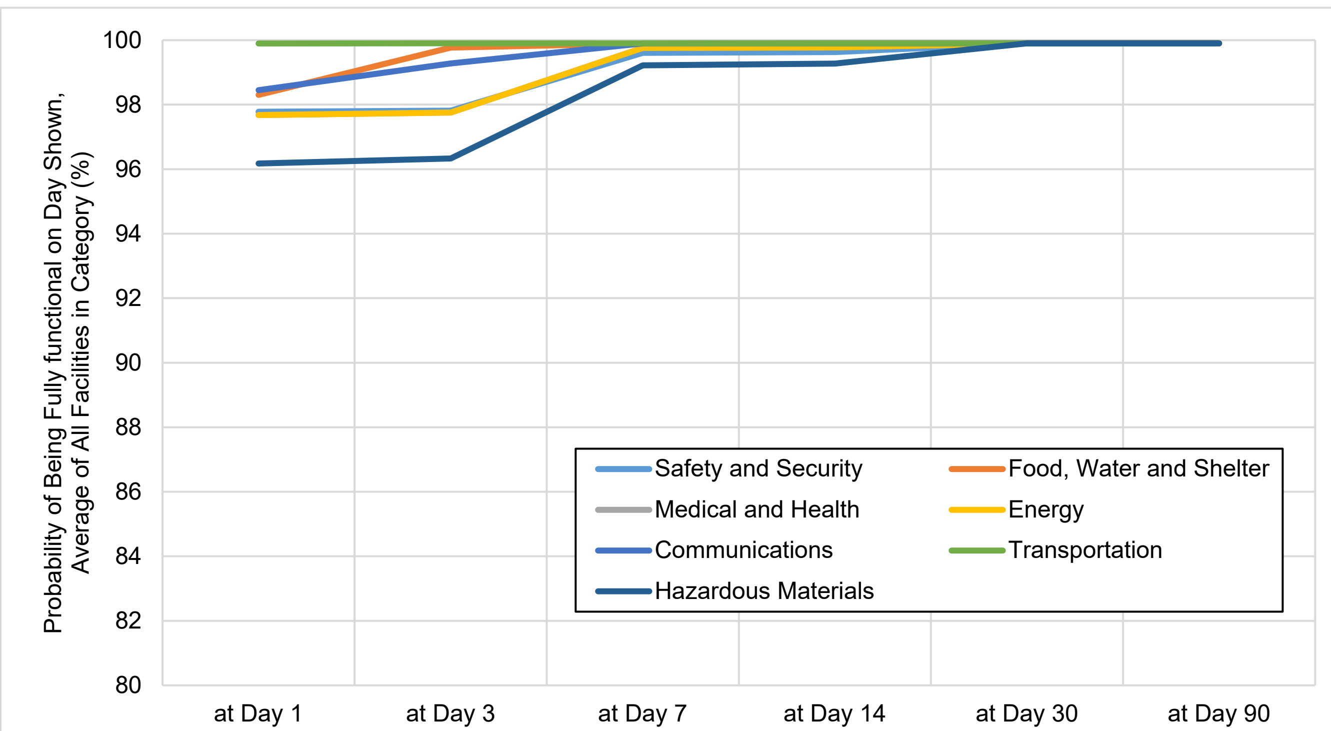


Figure 12-18. Critical Facility Functionality, Big Flat Jake Creek Fault Scenario

12.6 SCENARIO

Any seismic activity of 6.0 or greater on faults within the planning area would have significant impacts throughout Ada County. The seismic event likely to have the largest impact is a 7.1 magnitude or greater event on the Squaw Creek fault. Potential warning systems could give 40 seconds' notice that a major earthquake is about to occur; this would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to massive structural failure of property on unstable soils. With the abundance of imported fill used to elevate building pads for homes in the Boise River floodplain, liquefaction impacts in these areas could be widespread. Un-engineered canal embankments would likely fail, representing a loss of critical infrastructure. The structural integrity of Lucky Peak Dam could be jeopardized as well. These events could cause secondary hazards, including landslides and mudslides. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts or gravelly soils.

12.7 ISSUES

Important issues associated with an earthquake include but are not limited to the following:

- NEHRP soils mapping is not available for the entire planning area. Acquiring this data in areas it does not currently exist would enhance the accuracy of future risk assessments for the planning area.
- Shake maps should be developed for the Squaw Creek and Water Tank fault scenarios.
- Approximately 22 percent of the planning area's building stock was built prior to 1975, when seismic provisions became uniformly applied through building codes.
- Critical facility owners should be encouraged to create or enhance Continuity of Operations Plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- The County has over 400 miles of canals that were not constructed to engineering standards. The structural integrity of these facilities as it pertains to seismic impacts is not known.
- Earthquakes could trigger other natural hazard events such as dam failures and landslides, which could severely impact the county.
- Dam failure warning and evacuation plans and procedures should be updated to reflect the earthquake risk associated with a large number of earthen dams in the planning area.
- Hazard mitigation plan survey results indicate that the public does not perceive a significant seismic risk in the planning area.
- Unreinforced masonry structures in the planning area are particularly vulnerable to the earthquake hazard.
- It is difficult to develop seismic retrofit projects that are cost-effective for FEMA hazard mitigation grant programs, due to the lack of state and federal risk data to support FEMA benefit-cost methodologies.

13. EXTREME WEATHER

13.1 GENERAL BACKGROUND

Extreme weather refers to unusual weather events at the extremes of the historical distribution for a given area. It involves any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, damaging winds, tornadoes, extreme temperatures, and severe winter weather.

13.1.1 Thunderstorms, Lightning and Hail

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as "severe" when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado. Approximately 10 percent of the 100,000 thunderstorms that occur nationally every year are classified as severe (NOAA n.d.).

Storm Development

Three factors cause thunderstorms to form: moisture, rising unstable air (air that keeps rising when disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air) it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool and it condenses into a cloud.

The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves heard as thunder.

Storm Types

There are four types of thunderstorms:

- **Single-Cell Thunderstorms—**Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief extreme weather event. When this happens, it is called a pulse severe storm.

- **Multi-Cell Cluster Storm—**A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods and weak tornadoes. Each cell in a multi-cell cluster lasts only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.
- **Multi-Cell Squall Line—**A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf-ball size, heavy rainfall, and weak tornadoes, in addition to strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line to produce a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.
- **Super-Cell Storm—**A super-cell is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 miles per hour. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell (called a mesocyclone when visible on radar) helps the super-cell to produce extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 miles an hour or more, and strong to violent tornadoes.

Lightning

Lightning is an electrical discharge between positive and negative regions of a thunderstorm. A lightning flash is composed of a series of strokes, with an average of about four. The average duration of each stroke is about 30 microseconds. Lightning occurs in all thunderstorms. There are two main types of lightning: intra-cloud lightning and cloud-to-ground lightning (National Oceanic and Atmospheric Administration n.d.).

Lightning is one of the more dangerous weather hazards in the United States. Each year, lightning is responsible for deaths, injuries, and millions of dollars in property damage, including damage to buildings, communications systems, power lines, and electrical systems. Lightning also causes forest and brush fires and deaths and injuries to livestock and other animals. According to the National Lightning Safety Institute, property damage, increased operating costs, production delays, and lost revenue from lightning and secondary effects exceed $8-10 billion per year (National Lightning Safety Institute 2014). Impacts can be direct or indirect. People or objects can be directly struck, or damage can occur indirectly when the current passes through or near it.

Intra-cloud lightning is the most common type of discharge, but cloud-to-ground lightning is the most damaging and dangerous. Most flashes originate near the lower-negative charge center and deliver negative charge to earth. However, many flashes carry positive charge to earth, often during the dissipating stage of a thunderstorm's life. Positive flashes are more common as a percentage of total ground strikes during the winter. Positive lightning frequently strikes away from the rain core. It can strike as far as 5 or 10 miles from the storm in areas that people do not consider to be a threat. Positive lightning also has a longer duration, so fires are more easily ignited.

Using a network of lightning detection systems, the United States monitors an average of 25 million strokes of lightning from the cloud-to-ground every year. Statistics compiled by the National Oceanic and Atmospheric Administration between 1959 and 1994 indicate that most lightning incidents occur in June, July and August and during the afternoon between 2 and 6 p.m.

Hail

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. Super-cooled water may accumulate on frozen particles near the back-side of a storm as they are pushed forward across and above the updraft by the prevailing winds near the top of the storm. Eventually, the hailstones encounter downdraft air and fall to the ground.

Hailstones grow two ways: by wet growth or dry growth. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super cold. When the tiny piece of ice collides with a super-cooled drop, the water does not freeze on the ice immediately. Instead, liquid water spreads across tumbling hailstones and slowly freezes. Since the process is slow, air bubbles can escape, resulting in a layer of clear ice. Dry growth hailstones grow when the air temperature is well below freezing and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are “frozen” in place, leaving cloudy ice.

Hailstones can have layers like an onion if they travel up and down in an updraft, or they can have few or no layers if they are “balanced” in an updraft. Hailstones can begin to melt and then re-freeze together, forming large and very irregularly shaped hail.

13.1.2 Damaging Winds

Damaging winds are classified as those exceeding 58 mph. Damage from such winds accounts for half of all extreme weather reports in the lower 48 states. Straight-line wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. Isolated wind events in mountainous regions have more localized effects (State of Idaho Hazard Mitigation Plan 2018). There are seven types of damaging winds:

- **Straight-line winds—**Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdrafts—**A small-scale column of air that rapidly sinks toward the ground.
- **Downbursts—**A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- **Microbursts—**A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- **Gust front—**A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.
- **Derecho—**A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word “derecho” is of Spanish origin and means “straight ahead.” Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.

- **Bow Echo—**A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

Windstorms can result in collapsed or damaged buildings, damaged or blocked roads and bridges, damaged traffic signals, streetlights and parks, and other damage. They can also cause direct losses to buildings, people, and vital equipment. There are direct consequences to the local economy resulting from windstorms related to both physical damage and interrupted services.

Wind pressure can create a direct and frontal assault on a structure, pushing walls, doors, and windows inward. Conversely, passing currents can create lift and suction forces that act to pull building components and surfaces outward. As positive and negative forces impact a building's doors, windows and walls, the result can be roof or building component failures and considerable structural damage. The effects of winds are magnified in the upper levels of multi-story structures.

Debris carried along by extreme winds can contribute directly to loss of life and indirectly to the failure of protective building envelopes. Falling trees and branches can damage buildings, power lines, and other property and infrastructure. Tree limbs breaking in winds of only 45 mph can be thrown over 75 feet, so overhead power lines can be damaged even in relatively minor windstorm events. During wet winters, saturated soils cause trees to become less stable and more vulnerable to uprooting from high winds. Utility lines brought down by summer thunderstorms have also been known to cause fires, which start in dry roadside vegetation. Electric power lines falling down to the pavement create the possibility of lethal electric shock.

Downed trees and power lines, and damaged property also can be major hindrances to emergency response and disaster recovery. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. Industry and commerce can suffer losses from interruptions in electric service and from extended road closures.

13.1.3 Extreme Temperatures

Excessive Heat Events

Extreme heat is defined as summertime temperatures that are much hotter and/or humid than average. Because some places are hotter than others, this depends on what is considered average for a particular location. Humid conditions can make it seem hotter than it really is (Centers for Disease Control and Prevention 2017). Excessive heat claims over 100 lives each year in the United State. In a 30-year record of weather fatalities across the nation (1990-2019), excessive heat claimed more lives each year than floods, lightning, tornadoes, and hurricanes (Erdman 2021).

Heat Index

Extreme heat events are often a result of more than ambient air temperature. Heat index tables (see Figure 13-1) are commonly used to provide information about how hot it feels based on several meteorological conditions. Heat index values are for shady, light wind conditions; exposure to full sunshine can increase heat index values by up to 15°F. Strong winds with very hot, dry air also can be extremely hazardous (National Weather Service n.d.).

Source: (National Weather Service n.d.)

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution Extreme Caution Danger Extreme Danger

Figure 13-1. Heat Index Chart

Heat Islands

Extreme heat events may be exacerbated in urban areas, where reduced air flow, reduced vegetation and increased generation of waste heat can contribute to temperatures that are several degrees higher than in surrounding rural or less urbanized areas. When urban buildings, roads and other infrastructure replace open land and vegetation, surfaces that were once permeable and moist become impermeable and dry. These changes cause urban areas to become warmer than the surrounding areas, serving as contiguous regions of higher temperatures. This phenomenon is known as urban heat island effect. Heat islands can affect communities by increasing peak summer energy demand, air pollution, greenhouse gas emissions, and heat-related illness and death (Environmental Protection Agency 2022).

Extreme Cold and Wind Chill

Weather that constitutes extreme cold varies across different parts of the U.S. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered extreme cold (Centers for Disease Control and Prevention n.d.). Extreme cold can often accompany severe winter storms. Wind can exacerbate the effects of cold temperatures by carrying heat away from the body more quickly, thus making it feel colder than is indicated by the temperature. This phenomenon is known as wind chill. Wind chill is the temperature that your body feels when the air temperature is combined with wind speed. Figure 13-2 shows the value of wind chill based on ambient temperature and wind speed.

Source: (National Weather Service n.d.)

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

Figure 13-2. Wind Chill Chart

13.1.4 Severe Winter Weather

Blizzards and Snowstorms

The National Weather Service defines a winter storm as having significant snowfall, ice and/or freezing rain; the quantity of precipitation varies by elevation. Heavy snowfall is 4 inches or more in a 12-hour period, or 6 inches or more in a 24-hour period in non-mountainous areas; and 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period in mountainous areas. There are three key ingredients to a severe winter storm:

- Cold Air—Below-freezing temperatures in the clouds and near the ground are necessary to make snow and/or ice.
- Moisture—Moisture is required in order to form clouds and precipitation. Air blowing across a body of water, such as a large lake or the ocean, is a typical source of moisture.
- Lift—Lift is required in order to raise the moist air to form the clouds and cause precipitation. An example of lift is warm air colliding with cold air and being forced to rise over the cold dome. The boundary between the warm and cold air masses is called a front. Another example of lift is air flowing up a mountain side.

Areas most vulnerable to winter storms are those affected by convergence of dry, cold air from the interior of the North American continent and warm, moist air off the Pacific Ocean. When strong storms crossing the Pacific arrive at the coast, if the air is cold enough, snow falls. As the moisture rises into the mountains, heavy snow closes mountain passes and can cause avalanches. Cold air from the north has to filter through mountain canyons into basins and valleys to the south. If the cold air is deep enough, it can spill over a mountain ridge. As the air funnels through canyons and over ridges, wind speeds can reach 100 mph. High winds with snow results in a blizzard.

Ice Storms

The National Weather Service defines an ice storm as a storm that results in the accumulation of at least 0.25 inches of ice on exposed surfaces. Ice storms occur when rain falls from a warm, moist, layer of atmosphere into a below freezing, drier layer near the ground. The rain freezes on contact with the cold ground and exposed surfaces, causing damage to trees, utility wires, and structures (see Figure 13-3).

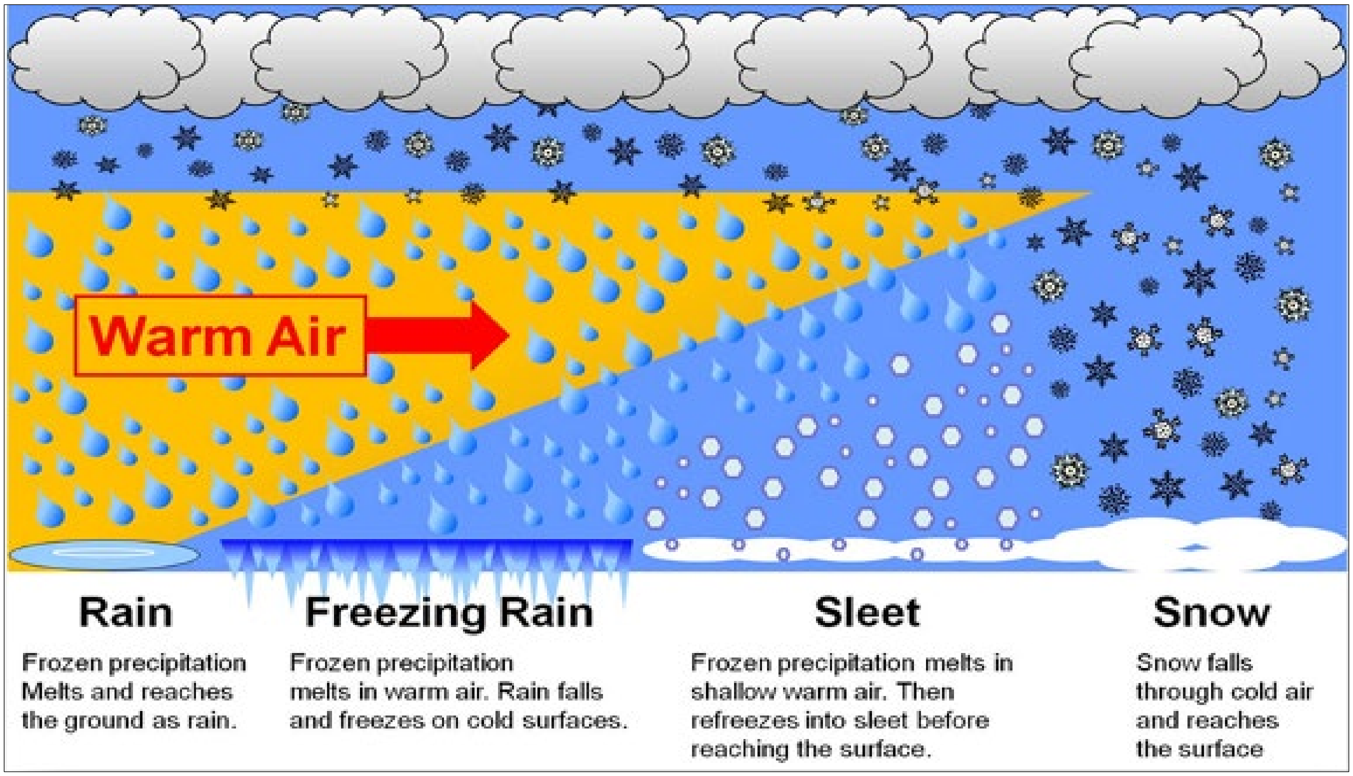


Figure 13-3. The Formation of Different Kinds of Precipitation

Ice accretion generally ranges from a trace to 1 inch. Accumulations between 1/4-inch and 1/2-inch can cause small branch and faulty limb breakage. Accumulations of 1/2-inch to 1 inch can cause significant breakage. Strong winds increase the potential for damage from ice accumulation.

13.1.5 Tornado

A tornado is a violently rotating column of air extending between, and in contact with, a cloud and the surface of the earth. Tornadoes are often (but not always) visible as a funnel cloud. On a local-scale, tornadoes are the most intense of all atmospheric circulations, with wind that can reach speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long. Tornadoes can occur throughout the year at any time of day but are most frequent in the spring during the late afternoon. As shown in Figure 13-4, Idaho has a relatively low risk of tornadoes compared to states in the Midwestern and Southern U.S. Washington has experienced tornadoes on occasion. Some have produced significant damage, injury or death. Washington's tornadoes can be formed in association with large Pacific storms arriving from the west. Most of them, however, are caused by intense local thunderstorms. These storms also produce lightning, hail and heavy rain, and are more common during the warm season from April to October.

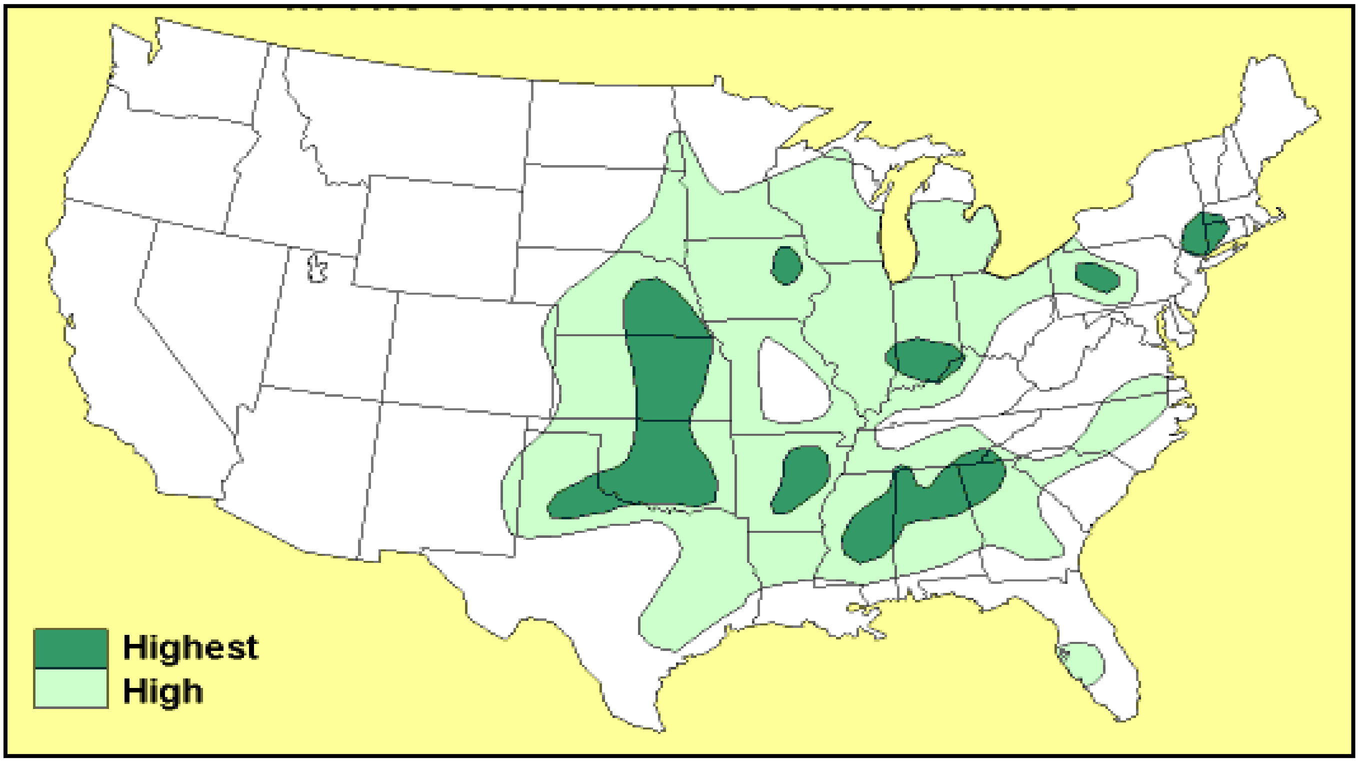


Figure 13-4. Tornado Risk Areas in the United States

13.1.6 Secondary Hazards

The most significant secondary hazards associated with severe local storms are floods, falling and downed trees, landslides and downed power lines. Rapidly melting snow combined with heavy rain can overwhelm both natural and man-made drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails.

13.2 HAZARD PROFILE

13.2.1 Past Events

Table 13-1 summarizes extreme weather events in Ada County since 1970 that caused property damage or injury, as recorded by the National Oceanic and Atmospheric Administration (NOAA).

13.2.2 Location

Extreme weather events have the potential to happen anywhere in the planning area. Communities in low-lying areas next to streams or lakes are more susceptible to flooding. Wind events are most damaging to areas that are heavily wooded.

Table 13-1. Extreme Weather Events Impacting Planning Area Since 1970

Date	Type	Deaths or Injuries	Property Damage
6/22/2021	Thunderstorm Wind	0	Reports of damage, but not quantified.
Hot and dry conditions were ideal for thunderstorm microburst outflow propagation across Southeast Oregon and Southwest Idaho. Severe gusts were reported with reports of damage throughout the area.			
5/01/2021	Thunderstorm Wind	0	Numerous reports of damage, but not quantified.
A low pressure system moved through the Intermountain West, producing thunderstorms with severe winds, dust storms and small hail. The automated surface observing system at Boise measured a 62 mph wind gust and numerous incidents of damage were reported.			
5/30/2020	Thunderstorm Wind	0	Downed trees and fences
Severe thunderstorms developed across parts of South Central Idaho and the West Central Mountains ahead of a strong cold front.			
4/30/2020	Thunderstorm Wind	0	Wind damage across the Treasure Valley
A strong low pressure system swept across the Pacific Northwest initiating severe convection across parts of Southwest Idaho.			
10/19/2019	Thunderstorm Wind	2	House fire, downed power lines and fences, car damage
A strong low pressure system and a fast moving cold front caused severe thunderstorms across the Treasure and Magic valleys. The Boise Fire Department reported a lightning strike on a house 2 miles east of Boise. Two injuries were reported.			
9/05/2019	Thunderstorm Wind	0	Trees downed, school campus and home damage
Numerous trees were knocked down during a microburst from Broadway Avenue to Apple Street, especially near Timberline High School, in Southeast Boise. Extensive damage to the high school campus was surveyed by National Weather Service (NWS) employees, including trees knocked down onto houses in the vicinity. The peak thunderstorm wind was estimated at 80 mph.			
8/30/2017	Thunderstorm Wind	0	Downed branches and power outages
Monsoon moisture combined with unstable conditions associated with an approaching trough and afternoon heating produced strong to severe thunderstorms across parts of Southwest Idaho. Multiple damage reports were received in Southeast Boise, with large trees and branches down including power outages.			
6/04/2017	Thunderstorm Wind	0	Downed trees
An upper level trough and a strong cold front moved through the Intermountain west producing severe thunderstorms including damaging winds. Trees down from Eagle to Boise and throughout the Treasure Valley.			
8/10/2015	Thunderstorm Wind	0	Unknown damage
Monsoon moisture moved northward out of Arizona creating conditions for severe convection over Southwest Idaho. A 61 mph wind gust was recorded at the Boise Automated Surface Observing System and numerous reports of damage were received by the NWS.			
3/17/2014	Thunderstorm Wind	0	Unknown damage and power outages
A powerful cold front raced through Southwest and South Central Idaho on the 17th with numerous reports of damage and power outages. Numerous reports of power outages reported by Idaho Power.			
9/5/2013	Hail	0	None reported
A strong upper level jet moving through the area brought severe thunderstorms to parts of Southeast Oregon and Southwest Idaho. Spotters in Meridian and Eagle reported large hail up to an inch and a half across the area.			
3/6/2013	Thunderstorm Wind	0	Bleacher and fence damage
A trough rotating around a large, cold, upper level low swept across Southwest Idaho. Strong to severe thunderstorms developed along the associated front bringing damaging winds and hail up to three quarters of an inch to the area. A NWS storm survey estimated a 60 to 65 mph wind gust destroyed an announcer's booth at the Meridian Lions Club rodeo grounds. Four sets of unsecured grandstand bleachers were flipped upside down and rolled over a fence into the middle of the rodeo grounds.			
2/06/2013	Fog/Freezing Rain	1 injury	None reported
Dense fog and a brief period of freezing rain in the Treasure Valley of Southwest Idaho caused numerous accidents throughout the area. Numerous reports of slide offs, roll overs and crashes due to dense fog and freezing rain in the area.			
8/06/2012	Thunderstorm Wind	0	Tree and fence damage
Thunderstorms developed across the Intermountain West on the 6th leading to wind damage in parts of Ada County in Southwest Idaho. Thunderstorms that moved across Ada County caused damage around the Boise area, including tree tops torn off, a large tree snapped at its base, and residential fences blown down.			

Date	Type	Deaths or Injuries	Property Damage
4/24/2012	Hail	0	Wind damage
A line of severe thunderstorms moved through parts of Southwest Idaho on the 24th producing large hail and damaging winds. A trained spotter reported half dollar size hail and wind gusts to 75 mph.			
1/18/2012	Heavy Snow	0	None reported
A major winter storm slammed into the Pacific Northwest and spread heavy snow across parts of Eastern Oregon and Southwest Idaho Impacts were felt in the Boise metro area and along the Interstate 84 corridor. In the mountains, 2 to 3 feet of snow fell over a four day period. 4 to 8 inches of new snow were reported by various sources in the Treasure Valley and 9 inches at Mountain Home.			
4/25/2011	Thunderstorm Wind	0	Wind damage
A strong cold front produced high winds and isolated severe convection leading to significant wind damage to locations in the Treasure Valley of Southwest Idaho on the 25th. KTVB reported wind damage near Rocky Mountain High School in Meridian and around the Kuna area. Hail was covering the ground in the affected areas.			
8/21/2010	Thunderstorm Wind	70 injuries	$10,000
A dry cold front moving across Eastern Oregon and Idaho set off a series of mainly dry thunderstorms generating severe outflow winds in the Treasure Valley, including Boise, and the Snake River plain throughout the evening of the 21st. Minor injuries were reported from the Western Idaho Fair as a result of temporary structures collapsing.			
6/4/2010	Thunderstorm Wind	0	$10,000
The Boise Automated Surface Observing Systems measured a wind gust of 59 mph and NWS employees reported downed trees and fences in Southeast Boise along Surprise Valley Way. Ada County Emergency Manager reported power lines down in Southwest Boise and trees and traffic lights down in Garden City.			
3/29/2009	High Wind	0	$100,000
The automated surface observing system at Boise recorded a peak gust of 53 mph and over $100,000 in damage was sustained in the north end of Boise. Mountain Home had winds of 40 to 50 mph for most of the day.			
6/29/2006	Thunderstorm Wind	0	$5,000
Very moist air mass combined with a well-defined vortices center and maximum day time heating to produce widespread pulse thunderstorms yielding numerous reports of nickel size hail and wind damage including downed trees and power lines			
1/30/2004	Thunderstorm Wind	0	$15,000
During the morning of January 30, a fast moving cold front produced several severe thunderstorms, very strong (in excess of 60 mph) winds and snow showers as it moved eastward across Eastern Oregon and Southwestern Idaho. Fairly large trees were blown down in Payette in Payette County and in Nampa in Canyon County. There were also reports of trees down in Baker and Malheur counties in Oregon. Power was briefly knocked out in northern Owyhee County as the line of thunderstorms moved across the county..			
5/8-9/2002	Extreme Cold/Wind Chill	0	Crop damage
Most observation sites recorded low temperatures in the mid to upper 20s. The hard freeze damaged fruit and field crops.			
8/3/2000	Tornado	0	Uprooted trees, minor home damage
A series of thunderstorms moved though the Treasure Valley with four confirmed tornadoes in Ada county. One tornado touched down near Hidden Springs, with damage limited to two large trees being uprooted. The path of the tornado was 10 yards wide and less than one-tenth of a mile in length. Another touched down near the intersection of Lake Hazel Road and 5 Mile Road. Damage was confined to one home where a flag pole was bent in half and a 2x4 was imbedded in the outer wall of the home.			
2/2/1999	Winter Storm	0	100+ auto accidents, major traffic disruptions
During the day on February 2, a winter storm snarled traffic in the Treasure Valley and brought local heavy snow to the Lower Treasure Valley and the Boise Mountains. In the Upper Treasure Valley, 3 to 4 inches of snow fell and caused major traffic disruptions. Over 100 auto accidents were reported around Boise.			
1/16/1999	Thunderstorm Wind	0	$5,000
During the morning of January 16 a line of strong rain showers and ice pellet showers produced severe wind gusts near Boise. A spotter reported the roof of a small barn was blown off and a tree was uprooted. A second spotter reported a small outbuilding was blown 50 yards and power lines were downed.			
9/7/1998	Thunderstorm Wind	0	$20,000
Scattered thunderstorms produced heavy rains and isolated wet microbursts in the Boise area. Numerous reports of street flooding were received from around the city. Lightning caused a structure fire in Boise while about 3000 people were without power due to trees falling on power lines. At Shadow Valley on the outskirts of Boise, winds ripped two sections of roof off of an elementary school.			

Date	Type	Deaths or Injuries	Property Damage
9/7/1998	Lightning	0	$10,000
Scattered thunderstorms produced heavy rains and isolated wet microbursts in the Boise area. Numerous reports of street flooding were received from around the city. Lightning caused a structure fire in Boise while about 3000 people were without power due to trees falling on power lines. At Shadow Valley on the outskirts of Boise, winds ripped two sections of roof off of an elementary school.			
9/6/1998	Thunderstorm Wind	0	$8,000
During the evening of September 6th scattered thunderstorms moved through the Treasure Valley and Boise Mountains with heavy rain and isolated wet microbursts. In and around Boise numerous reports of street flooding were received while in Boise County a number of small mud slides covered the road between Garden Valley and Lowman. Winds gusted to an estimated 60 to 70 mph at the NWS office in Boise, while numerous reports of trees down were received from around the city. Winds toppled a tree onto a car and caused scattered power outages			
4/23/1998	Thunderstorm/ Wind/Hail	0	$20,000
A severe thunderstorm caused damage from Owyhee Count through the Boise area and into the Boise Mountains. As the storm crossed into Ada County numerous reports of large hail up to golf ball size were received along with damaging winds up to 59 mph. Many trees were blown down and a greenhouse sustained heavy damage from large hail. Windblown debris smashed a car window. A wind gust of 74 mph was reported south of Idaho City.			
3/4/1998	Winter Storm	0	20 to 30 minor traffic accidents
A local snow shower produced 3 inches of accumulation over southeast Boise. Twenty to thirty minor traffic accidents disrupted traffic on area roadways.			
9/17/1997	High Wind	0	$2,000
A strong wind gust toppled a 30-foot tall masonry wall at a Boise construction site.			
7/31/1997	Lightning	0	One house burned down, fire damage to a restaurant
During the afternoon of July 31, a thunderstorm formed over the Owyhee Mountains of southwest Idaho and moved into the Boise area. Lightning from this storm triggered a 530-acre range fire in Owyhee County and sparked a fire that burned a house down east of Boise. Winds from this storm peeled off shingles and damaged siding on a house in southeast Boise and short circuited an electric sign, causing a fire that damaged a restaurant in Boise.			
4/20/1997	Tornado	0	Six homes and surroundings suffered damage
A strong cold front across Southern Idaho spawned a short lived weak tornado. The tornado moved through a subdivision on the outskirts of Boise. Six houses suffered roof damage, fences were torn up and a trampoline was hurled 5 city blocks.			
9/3/1995	Lightning	0	$50,000
In Gooding, high winds uprooted trees, downed power lines, and damaged several structures in the area. A thunderstorm that moved through the Boise area produced lightning igniting a house on fire. This storm also produced high winds downing power lines causing several power outages throughout the Treasure Valley.			
7/28/1995	Lightning	2	$50,000
Thunderstorm in the Kuna area of Ada County caused 2 fatalities and approximately $5,000 in property damage			
8/15/1993	Lightning	0	$50,000
A lightning bolt did extensive damage to a home in Eagle, 10 miles northwest of Boise. The bolt punctured a hole in the roof, then traveled around the inside of the house damaging walls and knocking electrical outlets and telephones out of the walls. The bolt finally grounded on a telephone utility box and completely destroyed it.			
5/20/1993	Lightning	0	$5,000
Lightning from a morning thunderstorm struck two trees sending bark into two windows of a house. The two windows were shattered, and one tree was split.			
3/21/1984	Tornado	0	$25,000
A small tornado, associated with a fast moving cold front, passed through a farm east of Kuna. A grain bin, as well as a two-story wood framed shed, and the roof of an adjacent storage area were damaged.			
10/26/1984	Tornado	0	$25,000
An F1 tornado was reported in Ada County causing approximately $25,000 in Property damage.			

13.2.3 Frequency

Table 13-2 summarizes search results from the National Center for Environmental Information Storm Events Database for Ada County over the 20-year period from 2001 through 2021. Based on these results, damaging wind, severe winter weather, and thunderstorm, lightning and hail events are likely to happen every year, tornado events once every 10 years, and extreme temperature events once every 20 years.

Table 13-2. Ada County Extreme Weather Events, January 2001 - December 2021

Event Types Included[a]	Total Number of Events	Number of Days with: Event	Event and Death or Injury	Event and Property Damage	Average Years Between Days with Event
Thunderstorms, Lightning and Hail					
Hail, Heavy Rain, Lightning, Thunderstorm Wind	51	51	3	1	<1
Damaging Winds					
High Wind, Strong Wind, Thunderstorm Wind	57	57	3	2	<1
Extreme Temperatures					
Extreme Cold/Wind Chill	1	2	0	0	20
Severe Winter Weather					
Dense Fog, Heavy Snow	24	38	0	0	<1
Tornado					
Funnel Cloud	2	2	0	0	10

a. Event types are the categories available for search in the National Center for Environmental Information Storm Events Database
Source: National Center for Environmental Information Storm Events Database

13.2.4 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but can occur. Roads may become impassable due to flooding, downed trees or a landslide. Power lines may be downed due to high winds or ice accumulation, and services such as water or phone may not be able to operate without power. Physical damage to homes and facilities can be caused by wind or accumulation of snow or ice. Even a small accumulation of snow can cause havoc on transportation systems due to a lack of snow clearing equipment and experienced drivers and the hilly terrain.

Lightning severity is typically assessed based on property damage and life safety (injuries and fatalities). Lightning can cause severe damage and injury. The number of reported injuries from lightning is likely to be low. County infrastructure losses can be up to thousands of dollars each year.

Windstorms can be a frequent problem in the planning area and have been known to cause damage to utilities. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher. Lower wind speeds typical in the lower valleys are still high enough to knock down trees and power lines and cause other property damage. Mountainous sections of the county experience much higher winds under more varied conditions.

Ice storms accompanied by high winds can have especially destructive impacts, especially on trees, power lines, and utility services. While sleet and hail can create hazards for motorists when they accumulate, freezing rain can cause the most dangerous conditions in the planning area. Ice buildup can bring down trees, communication towers and wires, creating hazards for property owners, motorists and pedestrians. Rain can fall on frozen streets, cars, and other sub-freezing surfaces, creating dangerous conditions.

The severity of an extreme heat event depends on the number of consecutive days it lasts. Urban heat island effect can exacerbate the severity of an extreme heat event. Impacts of an extreme heat event may include increased energy consumption, elevated emissions of air pollutants and greenhouse gases, compromised human health and comfort, and impaired water quality. Extreme heat can also impact infrastructure by warping bridges, causing roads to buckle, and melting runways (National Weather Service n.d.).

Tornadoes are potentially the most dangerous of local storms, but they are not common in the planning area. If a major tornado were to strike within the populated areas of the county, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings could be damaged or destroyed.

13.2.5 Warning Time

Meteorologists can often predict the likelihood of a severe storm. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time.

13.3 EXPOSURE

All people and property and the entire environment of the planning area is exposed to some degree to the extreme weather hazard.

13.4 VULNERABILITY

13.4.1 Population

Vulnerability by Type of Weather

Population vulnerabilities to specific types of extreme weather event are as follows:

- **Damaging Winds—**Debris carried by extreme winds and trees felled by gusty conditions can contribute directly to loss of life. Electric power lines falling down to the pavement create the possibility of lethal electric shock.
- **Extreme Temperatures—**Certain medical conditions, such as heat stroke, can be directly attributable to excessive heat, while others may be exacerbated by excessive heat, resulting in medical emergencies. Individuals who lack shelter and heating are particularly vulnerable to extreme cold and wind chill.
- **Severe Winter Weather—**Many of the deaths that result from severe winter weather are indirectly related to the actual weather event, including deaths resulting from traffic accidents on icy roads and heart attacks while shoveling snow. Icy road conditions that lead to major traffic accidents can make it difficult for emergency personnel to travel. This may pose a secondary threat to life if police, fire, and medical personnel cannot respond to calls. Homeless populations that lack adequate shelter are also vulnerable to severe winter weather events.

- **Thunderstorms—**Most injuries and deaths associated with lighting strikes occur when people are outdoors; however, almost one-third of lightning-related injuries occur indoors. Males are five times more likely than females to be struck by lighting and people between the ages of 15 and 34 account for 41 percent of all lightning strike victims (Centers for Disease Control and Prevention 2013).
- **Tornado—**All residents in the path of a tornado are vulnerable, especially if there is not adequate warning that tornado-causing conditions are likely.

13.4.2 Property

Loss estimations for the extreme weather hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 13-3 lists the loss estimates to the general building stock.

Table 13-3. Potential Damage to Buildings from Extreme Weather Hazard

City	Assessed Value	10% Damage	30% Damage	50% Damage
Boise	$61,280,836,767	$6,128,083,677	$18,384,251,030	$30,640,418,383
Eagle	$9,838,649,929	$983,864,993	$2,951,594,979	$4,919,324,964
Garden City	$3,705,101,875	$370,510,187	$1,111,530,562	$1,852,550,937
Kuna	$3,886,826,099	$388,682,610	$1,166,047,830	$1,943,413,050
Meridian	$28,959,315,273	$2,895,931,527	$8,687,794,582	$14,479,657,637
Star	$2,845,160,473	$284,516,047	$853,548,142	$1,422,580,237
Unincorporated	$12,472,792,807	$1,247,279,281	$3,741,837,842	$6,236,396,403
Total	**$122,988,683,223**	$12,298,868,322	$36,896,604,967	$61,494,341,611

It is estimated that 20 percent of residential structures in the planning area were built without the influence of a structure building code with provisions for wind loads. All of these buildings are considered to be exposed to the extreme weather hazard, but structures in poor condition or in particularly vulnerable locations may risk the most damage. Those in higher elevations and on ridges may be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse. The frequency and degree of damage will depend on specific locations.

13.4.3 Critical Facilities

Critical facilities exposed to floods are at risk from extreme weather with heavy rain or snowmelt. Critical facilities on higher ground may be exposed to wind damage, damage from falling trees, heavy snow and ice accumulation, tornadoes, lightning strikes and extreme temperatures. The sections below describe systems most commonly at risk.

Transportation Systems

High winds can cause significant damage to trees and power lines, disrupting ingress and egress on roads with obstructing debris. Landslides caused by heavy prolonged rains can block roads. Snowstorms significantly impact the transportation system and the availability of public safety services. Of particular concern are roads providing access to isolated areas and bridges, which tend to become icy before and after other areas are clear. Prolonged obstruction of major routes due to weather can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region.

Power and Communication Lines

Ice and severe windstorms can create serious impacts on power and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting both electricity and communication for households. They can also break as a result of falling trees. This can result in isolation.

Water and Sewer Lines

Severe local storms can cause water and sewer lines to freeze, which may crack pipes. This could result in a loss of potable water to households or exposed sewage causing public health hazards. However, extreme and prolonged freezing weather is required to cause underground pipes to crack, which is not likely to occur in Ada County. Above-ground pipes leading to and from individual homes are more likely vulnerabilities than large mainlines.

13.4.4 Environment

The environment is highly vulnerable to extreme weather. Natural habitats such as streams and trees exposed to the elements during a severe storm risk major damage and destruction. Prolonged rains can saturate soils and lead to slope failure. Flooding caused by extreme weather or snowmelt can produce river channel migration or damage riparian habitat. Storm surges can erode beachfront bluffs and redistribute sediment loads.

13.5 DEVELOPMENT TRENDS

Because all of the planning area is exposed to the extreme weather hazard, the increase in exposed population and property since the last hazard mitigation plan update is equal to the countywide trend over that time period: a 13.6-percent increase in population, a 19.4-percent increase in number of general building stock structures, and a 46.7-percent increase in assessed property value. However, since the majority of this growth was new development, the increase in vulnerability to extreme weather is considered to be minimal due to the influence of strong codes and code enforcement within the planning area.

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. All planning partners that have permit authority have adopted the International Building Code. This code is equipped to deal with the impacts of extreme weather events. Land use policies identified in comprehensive plans within the planning area also address many of the secondary impacts (flood and landslide) of the extreme weather hazard. With these tools, the planning partnership is well equipped to deal with future growth and the associated impacts of extreme weather.

13.6 SCENARIO

Severe local storms can occur frequently and impacts can be significant, particularly when secondary hazards of flood and landslide occur. A worst-case event would involve prolonged high winds during a winter storm accompanied by thunderstorms. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads, and landslides on steep slopes. Flooding and landslides could further obstruct roads and bridges, further isolating residents.

13.7 ISSUES

Important issues associated with extreme weather in the Ada County planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to extreme weather events such as windstorms.
- Redundancy of power supply throughout the planning area must be evaluated to better understand what areas may be vulnerable.
- The capacity for backup power generation is limited.
- The County has numerous isolated population centers.
- Public education on dealing with the impacts of extreme weather needs to continue so that residents can be better informed and prepared for extreme weather events.
- Debris management (downed trees, etc.) must be addressed, because debris can impact the severity of extreme weather events, requires coordination efforts, and may require additional funding.
- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to severe winter weather effects such as snow loads or high winds.
- Street tree management programs should be evaluated to help reduce impacts from tree-related damages.
- Priority snow removal routes should continue to be cleared first to ensure navigable routes through and between jurisdictions.

14. FLOOD

14.1 GENERAL BACKGROUND

14.1.1 Types of Flooding in the Planning Area

Three types of flooding primarily affect Ada County: riverine, stormwater runoff, and flash floods. The following subsections describe each type.

Riverine Floods

Riverine flooding is overbank flooding of rivers and streams. Natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers. Two types of flood hazards are generally associated with riverine flooding:

- **Inundation**—Inundation occurs when floodwater is present and debris flows through an area not normally covered by water. These events cause minor to severe damage, depending on velocity and depth of flows, duration of the flood event, quantity of logs and other debris carried by the flows, and amount and type of development and personal property along the floodwater's path.
- **Channel Migration—**Erosion of banks and soils worn away by flowing water, combined with sediment deposition, causes migration or lateral movement of a river channel across a floodplain. A channel can also abruptly change location (termed "avulsion"); a shift in channel location over a large distance can occur within as short a time as one flood event.

The frequency and severity of flooding for river systems are based on discharge probability. The discharge probability is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for different discharge levels and storm surge levels. These measurements reflect statistical averages only; it is possible for multiple floods with a low probability of occurrence (such as a 1-percent-annual-chance flood) to occur in a short time period. For riverine flooding, the same flood event can have flows at different points on a river that correspond to different probabilities of occurrence.

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas inundated by the 1-percent-annual-chance flood with flood depths of only 1 to 3 feet. These areas are generally flooded by low-velocity sheet flows of water.

Stormwater Runoff Floods

Stormwater flooding is a result of local drainage issues and high groundwater levels. Locally, heavy rain, especially during high lunar tide events, may induce flooding within areas other than delineated floodplains or along recognizable channels due to presence of storm system outfalls inadequate to provide gravity drainage into the adjacent body of water. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding problems. Flooding issues of this nature generally occur within areas with flat gradients, and generally increase with urbanization, which speeds accumulation of floodwaters because of impervious areas. Shallow street flooding can occur unless channels have been improved to account for increased flows.

Urban drainage flooding is caused by increased water runoff due to urban development and drainage systems. Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and within other urban areas. These systems utilize a closed conveyance system that channels water away from an urban area to surrounding streams, and bypasses natural processes of water filtration through the ground, containment, and evaporation of excess water. Because drainage systems reduce the amount of time surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development within that area.

Flash Floods

The National Weather Service defined a flash flood as follows (National Weather Service 2009):

> "a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within 6 hours of the causative event (e.g., intense rainfall, dam failure). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters"

Flash floods can tear out trees, undermine buildings and bridges, and scour new channels. In urban areas, flash flooding is an increasingly serious problem due to removal of vegetation and replacement of ground cover with impermeable surfaces such as roads, driveways, and parking lots. The greatest risk from flash floods is occurrence with little to no warning. Major factors in predicting potential damage are intensity and duration of rainfall, and steepness of watershed and streams.

14.1.2 FEMA Regulatory Flood Zones

FEMA defines flood hazard areas through statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Flood hazard areas are delineated on Digital Flood Insurance Rate Maps (DFIRMs), which are official maps of a community on which the Federal Insurance and Mitigation Administration has delineated both special flood hazard areas (SFHAs) and risk premium zones. DFIRMS identify the following:

- Locations of specific properties in relation to SFHAs
- Base flood (1-percent annual chance flood) elevations at specific sites
- Flood magnitudes in specific areas
- Regulatory floodways and floodplain boundaries (1-percent and 0.2-percent annual chance floodplain boundaries).

The SFHA is the land area covered by floodwaters of the base flood. In SFHAs, National Flood Insurance Program (NFIP) floodplain management regulations must be enforced and flood insurance is mandatory.

The NFIP defines the base flood elevation as the floodwater elevation during a base flood event (a flood that has a 1-percent chance of occurring in any given year). A structure within a 1-percent annual chance floodplain has a 26-percent chance of undergoing flood damage during the term of a 30-year mortgage. The 1-percent annual chance flood is a regulatory standard adopted by federal agencies and most states to administer floodplain management programs. The 1-percent annual chance flood is used by the NFIP as the basis for insurance requirements nationwide. DFIRMs also depict 0.2-percent annual chance flood designations (500-year events).

DFIRM, FIRMs, and other flood hazard information identify the expected spatial extent of flooding from a 1-percent or 0.2-percent annual chance event, defining specific areas as follows:

- **Zones A1-30 and AE—**SFHAs that are subject to inundation by the base flood, determined using detailed hydraulic analysis. Base flood elevations are shown within these zones.
- **Zone A (Also known as Unnumbered A-zones**)—SFHAs where no base flood elevations or depths are shown because detailed hydraulic analyses have not been performed.
- **Zone AO—**SFHAs subject to inundation by types of shallow flooding where average depths are between 1 and 3 feet. These are normally areas prone to shallow sheet flow flooding on sloping terrain.
- **Zone B and X (shaded)—**Zones where the land elevation as been determined to be above the base flood elevation, but below the 500-year flood elevation. These zones are not SFHAs.
- **Zones C and X (unshaded)—**Zones where the land elevation has been determined to be above both the base flood elevation and the 500-year flood elevation. These zones are not SFHAs.

14.1.3 Floodplains

A floodplain is the area adjacent to a river, creek, lake or the ocean that becomes inundated during a flood. Riverine floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon.

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, and/or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce and residential development.

Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

Floodplain Ecosystems and Beneficial Functions

Floodplains can support ecosystems that are rich in plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive, and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. This makes floodplains valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

Floodplains have many natural beneficial functions, and disruption of them can have long-term consequences for entire regions. Some well-known, water-related functions of floodplains (noted by FEMA) include:

- Natural flood and erosion control
- Provide flood storage and conveyance
- Reduce flood velocities
- Reduce flood peaks
- Reduce sedimentation
- Surface water quality maintenance
- Filter nutrients and impurities from runoff
- Process organic wastes
- Moderate temperatures of water
- Provide groundwater recharge
- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low surface flows

Areas in the floodplain that typically provide these natural functions are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species.

Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; riverine floodplain land is fertile and suitable for farming; transportation by water is easily accessible; land is flatter and easier to develop; and there is value placed in ocean views. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels or causing erosion of natural flood protection systems such as dunes. Flood potential can be increased in several ways: reducing a stream's capacity to contain flows; increasing flow rates or velocities downstream; and allowing waves to extend further inland. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

14.1.4 Secondary Hazards

The most problematic secondary hazard for riverine flooding is bank erosion, in some cases more harmful than actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour banks, edging properties closer to the floodplain or causing them to fall in. Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers, or storm sewers.

14.2 HAZARD PROFILE

Flooding in Ada County is typically caused by high-intensity, short-duration (1 to 3 hours) storms concentrated on a stream reach with already saturated soil. Flooding is predominantly confined within traditional riverine valleys. Locally, some natural or manmade levees separate channels from floodplains and cause independent overland flow paths. Occasionally, railroad, highway or canal embankments form barriers, resulting in ponding or diversion of flows. Some localized flooding not associated with stream overflow can occur where there are no drainage facilities to control flows or when runoff volumes exceed the design capacity of drainage facilities.

14.2.1 Principal Flooding Sources

The Boise River

The Boise River is about 200 miles long and flows generally east to west. The headwaters are in the Sawtooth Mountains and the mouth is near Parma, Idaho, where it empties into the Snake River. Principal tributaries of the Boise River are the North, Middle, and South Forks, and Mores Creek. Total drainage area of the Boise River is 4,134 square miles. Deep V-shaped valleys, steep slopes and narrow ridges characterize the watershed above Lucky Peak Dam. In the upper basin, elevation ranges from 3,000 to 10,600 feet. The watershed below Lucky Peak Dam is roughly 1,485 square miles and is composed of river bottoms, terraces, and low rolling to steep hills. The bottomland adjoining the main stream constitutes the floodplain and varies from 1 to 3 miles in width.

Water gradients on the Boise River vary from 150 feet per mile in the upper reaches of the watershed to 6 feet per mile in the lower Reaches from Barber Dam to the Ada-Canyon County border, the river has an average slope of 11.5 feet per mile. The natural runoff of the Boise River usually consists of low flows from late July through February, increasing flows during March, and high flows in April, May and June. Occasionally this pattern is interrupted by high flows of short duration in winter caused by rainstorms. The vast majority of the runoff is generated above Lucky Peak Dam. Average discharge near Boise is about 2,750 cubic feet per second (cfs) or 2 million acre-feet per year. The maximum recorded mean daily discharge was 35,500 cfs, on June 14, 1896.

The principal dams on the Boise River are Anderson Ranch, Arrowrock and Lucky Peak. These dams provide flood-control storage for 64 percent of the drainage area of the river. The dams have greatly reduced the magnitude and frequency of Boise River floods. In spite of the flood protection provided by the existing system, major floods still cannot be fully controlled. Boise River water levels reach bank-full stage (6,500 cfs at the Glenwood Bridge gage) virtually every year. However, the reservoirs provide enough regulation to generally allow for 24 to 72 hours' warning before cities along the Boise River in Ada County experience major flooding.

The river's ability to carry a flood has been significantly reduced over time by siltation. Before the upstream dams regulated flows, spring runoff flushed and scoured the river channel. Since 1954, when Lucky Peak, the last of the three big dams, went into operation, the capacity of the river channel has gradually been reduced. A 1972 USGS study noted a considerable decrease in stream capacity at the gauging stations at Notus and Boise. At the same river stage, flows at Notus were 11,800 cfs in 1938 and 8,000 cfs in 1972. Flows at the same stage at Boise were 9,600 cfs in 1943 and 7,700 cfs in 1972. This is a reduction in carrying capacity of 32 percent at Notus and 20 percent in Boise. In the decades since that study, silt has continued to be deposited. With present channel capacity, there is not enough reservoir space in the system to fully regulate the standard flood. There is a 1 percent chance in any year of flows at Boise exceeding 16,600 cfs, and a 2 percent chance of flows exceeding 11,000 cfs.

Other factors that affect flooding on the Boise River are the construction and condition of levees, the proliferation of plant growth along the river, and the construction of structures in the floodway. With these changes, water levels that in the past were merely an inconvenience now can cause significant damage. When flood elevations for the 10 percent or 2 percent annual chance flood are only slightly less than for a 1 percent annual chance flood, debris blockages can cause 1 percent annual chance elevations during a 10 percent annual chance flood.

The Snake River

The Snake River forms part of the southern boundary of Ada County, running from Castle Butte in the east to Gaffey Butte in the west. The river flows through a deep canyon bordered by high, steep walls. The main threat of flooding on the Snake River is from ice jams. The potential for other types of flooding is limited since large dams control the river. There is very little development along this part of the Snake River. The main residential area is near Swan Falls Dam. Depending on the time of year, varying numbers of recreationists may be on the river.

Tributaries

The most hazardous streams in Ada County are the Boise River tributaries that have their headwaters in the Boise Foothills: Seaman Gulch, Pierce Gulch, Polecat Gulch, Stewart Gulch, Crane Creek, Hull’s Gulch, and Cottonwood Creek. These streams flow southwest and are dry most of the year. Only after periods of heavy rainfall or snowmelt do they have significant flows. The soil of these streams is almost entirely deep sandy loam, loam with areas of clay, or clay loam, and all are highly erodible. Vegetation in these gulches is sparse and consists mainly of sagebrush, bitterbrush and perennial grasses. Elevations range from about 2,800 feet at the Boise city limits to about 5,800 feet at the summit of Boise Ridge.

The danger on these streams is flash flooding. Cottonwood Creek is the largest of these drainages and carries the greatest threat for extensive flash flooding. The largest flood in recent history from these Foothills streams occurred August 20, 1959, when Cottonwood Creek flooded, inundating about 50 blocks in Boise and several hundred acres of farmland with water, rocks and mud.

Precipitation normally varies from 12 inches in Boise to about 22 inches at higher elevations. Both frontal storms and thunderstorms can be sufficiently heavy to cause flooding. The maximum recorded 24-hour rainfall in Boise is 2.7 inches. The maximum observed short-duration rainfall at the Boise weather station is 4.1 inches/hour. However, intensities as high as 7.5 inches/hour have been logged in southwestern Idaho and eastern Oregon. Peaks for both of these types of floods occur in a rather short time: from 15 minutes to several hours.

Two conditions may cause floods in the drainages on the Boise Front: the combination of a rainstorm with snowmelt on frozen ground in winter or early spring; high-intensity thunderstorms, in summer. Winter storm floods generally occur during January through March. Thunderstorms may occur at any time of the year, although they usually happen from March through September. Sandy soil and sparse vegetation combine to foster flash floods during intense thunderstorms. Floods from thunderstorms do not occur as frequently as those from general rain and snowmelt conditions, but are far more severe. The possibility for injury and death from flash floods is heightened because they are so uncommon that people do not recognize or accept the potential danger.

The onset of flooding in these gulches can range from extremely slow to very fast. This variability depends on the cause of flooding and other factors such as rainfall intensity, the areas receiving the rain, temperature, and the condition of the soil. Floods that occur quickly are usually caused by thunderstorms, while floods that occur more slowly are often the result of moderate but prolonged rainfall, snowmelt or a combination of both. In the case of intense rainfall immediately above developed areas, the onset of flooding may occur in a matter of minutes.

The lower portions of most of the gulches contain residential developments, including single-family homes, mobile home parks and apartment complexes. A large portion of the older residential district in the City of Boise is located within the floodplains of these gulches. Residential streets form the flood channel in several locations. A number of gulches and areas immediately below the gulches contain commercial and public facilities.

Between August 26 and September 2, 1996, 15,300 acres of the Boise City foothills were burned by the Eight Street wildfire. About 50 percent of the area in the Stewart Gulch and Cottonwood Creek watersheds was burned. Crane Gulch and Hulls Gulch watersheds were burned almost totally. The fire removed vegetation and hardened the soil. As a result, for several years the threat of flash flooding was significantly increased. Treatments applied in an effort to reduce the flood risk included contour felling of trees, tillage and aerial seeding, placing straw wattles, hand trenching, contour trenching, and straw bale check dams. Flood control structures were as follows:

- Enlarging the Cottonwood Creek Mountain Cove ponds to 150 acre-feet combined and re-channeling the flow through the Mountain Cove Road turn at the head of the flume, and constructing a wall along Reserve Street to direct the flow of water
- Constructing a 35-acre-foot upper catch basin and a 15-acre-foot lower catch basin on Hulls Gulch
- Constructing a 19-acre-foot dam on the Main Fork of Crane Gulch, and a 28-acre-foot dam on the East Fork of Crane Gulch
- Elevating sections of the Bogus Basin Road to act as a 61-acre-foot dam across Stewart Gulch.

Recent studies addressing flash floods have focused on these Boise gulches. However, long-term consideration of all drainages is necessary to avoid similar problems. Other streams in Ada County that may be subject to flooding are Big Gulch Creek, Black's Creek, Bryans Run Creek, Corder Creek, Council Spring Creek, Current Creek, Dry Creek, Eightmile Creek, Fivemile Creek, Highland Valley Gulch, Indian Creek, Little Gulch Creek, Maynard Gulch, Ninemile Creek, Rabbit Creek, Sand Creek, Sheep Creek, Spring Valley Creek, Tenmile Creek, Threemile Creek, Warm Spring Creek, and Willow Creek. The majority of these streams are dry most of the year.

Canals

There are more than two dozen canals in Ada County, extending over 400 miles. The canals draw water from the Boise River, generally from April through October. This is the time of year when canals present the greatest flood danger. There are several types of flood threats posed by canals. The first type is from a break or breach in the canal. This has the potential for significant flooding, especially if the canal is elevated or located on a hillside. Another possibility is be from an obstruction in a canal that causes water to overtop the canal bank. Other potential risks are vandalism, piping of water, gopher holes, etc. A break would pose the most serious problem.

Urban Flooding

Like many areas in the western U.S., Ada County has experienced rapid change due to urban development in once rural areas. Drainage facilities in these recently urbanized areas are a series of pipes, roadside ditches and channels. Urban flooding occurs when these conveyance systems lack the capacity to convey rainfall runoff to nearby creeks, streams and rivers. As drainage facilities are overwhelmed, roads and transportation corridors become conveyance facilities. The two key factors that contribute to urban flooding are rainfall intensity and duration. Topography, soil conditions, urbanization and groundcover also play an important role.

Urban floods can be a great disturbance of daily life in urban areas. Roads can be blocked and people may be unable to go to work or school. Economic damage can be high but the number of casualties is usually limited, because of the nature of the flood. On flat terrain, the flow speed is low and people can still drive through it. The water rises relatively slowly and usually does not reach life endangering depths.

14.2.2 Participation in Federal Flood Programs

National Flood Insurance Program

Ada County entered the NFIP on December 18, 1984. Structures permitted or built in the County after then are called "post-FIRM" structures and are eligible for reduced flood insurance rates, since they were constructed after regulations and codes were adopted to decrease vulnerability. Structures built before then are called "pre-FIRM" and are subject to higher rates because they may not meet code or may be located in hazardous areas. The effective date for the current countywide FIRM is June 2020. This map is a DFIRM (digital flood insurance rate map).

All incorporated cities in Ada County also participate in the NFIP. The county and cities are currently in good standing with the provisions of the NFIP. Compliance is monitored by FEMA regional staff and by the Idaho Department of Water Resources under a contract with FEMA. Maintaining compliance under the NFIP is an important component of flood risk reduction. All planning partners that participate in the NFIP have identified actions to maintain their good standing.

Table 14-1 lists flood insurance statistics that help identify vulnerability in Ada County. Seven communities in the planning area participate in the NFIP, with 2,152 flood insurance policies providing $656.8 million in insurance coverage. According to FEMA statistics, 121 flood insurance claims were paid between January 1, 1978, and March 31, 2022, for a total of $480,275 and an average of $3,969 per claim.

Table 14-1. Flood Insurance Statistics for Ada County

Jurisdiction	Date of Entry Initial FIRM Effective Date	# of Flood Insurance Policies as of 3/31/2022	Insurance In Force	Total Annual Premium	Claims, 11/1978 to 3/31/2022	Value of Claims paid, 11/1978 to 3/31/2022
Boise	4/17/1984	952	$276,871,100	$625,595	55	$102,909
Eagle	3/04/1980	316	$114,310,600	$212,357	15	$198,703
Garden City	5/15/1980	486	$149,003,700	$352,585	18	$44,557
Kuna	10/02/2003	2	$537,300	$1,633	0	$0
Meridian	9/27/1991	122	$33,269,900	$88,623	1	$0
Star	12/18/1984	89	$28,015,100	$57,541	0	$0
Unincorporated	12/18/1984	185	$54,770,300	$133,551	32	$134,106
Total		**2,152**	**$656,778,000**	**$1,471,885**	**121**	**$480,275**

The Community Rating System

Ada County and the cities of Boise, Eagle, Garden City and Meridian are currently participating in the CRS, as summarized in Table 14-2. Many of the mitigation actions identified this plan are creditable activities under the CRS program. Therefore successful implementation of this plan offers the potential for these communities to enhance their CRS classifications and for currently non-participating communities to join the program.

Table 14-2. CRS Community Status in Ada County

Community	NFIP Community #	CRS Entry Date	Current CRS Classification	Premium Discount, SFHA	Premium Discount, non-SFHA
Ada County	160001	10/1/1994	7	15%	5%
Boise	160002	10/1/1991	6	20%	10%
Eagle	160003	4/1/2000	6	20%	10%
Garden City	160004	10/1/1998	8	10%	5%
Meridian	**160180**	**5/1/2016**	8	**10%**	**5%**

14.2.3 Past Events

Ada County has a long and extensive history of flooding. The most common problem areas for flooding are the Boise River and the Boise Foothills streams. The greatest flood of known magnitude on the Boise River occurred on June 14, 1896. Peak flow was estimated at 35,500 cfs. The largest recent flood occurred in April 1943. Peak flow for this event was estimated at 21,000 cfs. Both of these events occurred prior to the river being regulated by Lucky Peak Dam. Table 14-3 shows flood events that have impacted the planning area since 1955.

Table 14-3. Ada County Flood Events

Date	Declaration #	Type of event
8/01/2021	N/A	Flash Flood
Multiple small rock slides and flooding in Southeast Boise.		
4/30/2020	N/A	Flash Flood
Streets were flooded due to heavy rain from thunderstorms and stranded cars, which led to road closures in Southeast Boise.		
4/01/2017 - 5/01/2017	DR 4342	Flood
Planned releases from Lucky Peak Reservoir for flood control in April ranged from 7,800 cfs to 8,900 cfs. The Boise River remained in flood all of May due to planned release from Lucky Peak dam. Regulated flows were above flood stage for 101 days, resulting in extensive damage to the Greenbelt and Nature Trail paths. Extensive flood fight efforts were undertaken in the Eagle Island area. On Eagle Island in the Riviera Estates area, several homes were surrounded by water and low lying roads were inundated. Flood fight efforts to mitigate a pit capture were undertaken along the Eagle Island south channel of the river. Large portions of Ann Morrison Park, Barber Park, and Marianne Williams Park were flooded. Residential streets were flooded in the Garden City Warehouse District and on Eagle Island. A major shift in the river channel occurred downstream of Eagle Island. Streets in the Stonebriar development downstream of the Highway 16 bridge were inundated. Severe bank erosion and large trees washed into the river caused problems at some bridges.		
3/06/2017	N/A	Planned Dam Release
The Army Corps of Engineers and Bureau of Reclamation increased regulated flows from Lucky Peak Reservoir, putting the Boise River in flood for the remainder of March. Flooding was expected to continue through late spring. Flood flows caused significant damage to the Greenbelt and Nature Trail paths along the river. Flood fight efforts focused on the Eagle Island area where severe bank erosion occurred and a pit capture threat existed. A HESCO barrier wall and extensive sandbagging occurred in the area to mitigate a pit capture.		
2/08/2017	N/A	Flood
Strong Southwesterly flow behind a warm front spread heavy rain across most of the intermountain west. Flooding occurred in most of South Central Idaho.		
7/08/2015	N/A	Flash Flood
Strong thunderstorms and heavy rain crossed parts of southwest Idaho. Heavy rain from slow moving thunderstorms caused flash flooding in downtown Boise and in the north and northwest parts of the city. Over an inch of rain fell in less than an hour in parts of Boise.		
5/01/2012	N/A	Planned Dam Release
Unusually high rainfall triggered a rapid snow melt. Peak inflow into the three-dam reservoir system was over 26,000 cfs. Flows peaked at 8100 cfs through town. The high flows also caused an overtopping of a canal head-gate and two riverbank breeches along the Little Pioneer Ditch. Uncontrolled flows into the irrigation canal caused flooding on agricultural lands and threatened numerous public rights of way in Star. Ada County Highway District took the lead and completed the bank repairs that resolved this issue.		

Date	Declaration #	Type of event
5/30/2011	N/A	Planned Dam Release
Due to capacity issues at Lucky Peak Dam, officials were forced to increase flow on the Boise River, causing the channel to go above flood stage during the day. The river crested at 10.03 feet around 3:00 p.m..		
5/20/2008	N/A	Flooding-Boise River
High flows on the Boise River forced Boise Parks & Recreation to close three sections of the Greenbelt. The walking-only pedestrian area was underwater from the Cottonwoods Apartments past River Run in southeast Boise. Two other areas were also closed: Broadway Avenue tunnel on the north side of the river and Loggers Creek footbridge from Leadville Avenue east to the Park Center Bridge.		
5/6/2006	N/A	Flooding-Kuna-Mora canal
A breach in the Kuna-Mora Canal flooded parts of a south Kuna subdivision and came close to compromising a sewage pump about 2.5 miles away. Thirty to forty homeowners reported flooding. The canal broke about one quarter south of King Road. It started as a six foot breach and quickly became a 40 foot breach.		
5/25/2006	N/A	Flooding-Boise River
High water levels along the Boise River created a breach in the riverbank near Eagle Island. About 8- 10 homes along Artesian and Trout Roads were affected. The State of Idaho repaired the breach. For the affected residents Ada County provided sandbags, portable toilets, sump pumps and diesel for tractors.		
5/11/2006	N/A	Flooding –Boise River
High flows on the Boise River eroded a bridge near Garden City and nearly caused it to collapse into the river.		
4/5/2006	N/A	Flooding-Tributaries
Flooding along Five mile Creek and Lake Patricia flooded two homes and threatened several others as well as a small, private dam, southeast of Boise. Ada County inmate crews assisted in sandbagging.		
7/7/2004	N/A	Urban Flooding
The Idaho State Capital building was inundated by a flash flood. The flood occurred in the basement, displacing about 20 workers. Repairs are estimated to be between $70,000 and $100,000.		
3/7/1999	N/A	Flooding-Boise River
High water levels released from Lucky Peak Reservoir caused flooding in low lying areas. Segments of the Greenbelt were closed and areas in southeast Boise near Logger's Creek and Cottonwood Apartments were flooded. Also a 200' section of riverbank near Eagle's Starwood subdivision collapsed.		
May/June 1998	N/A	Flooding-Boise/Snake
Two weeks of rain fell on a melting snowpack caused flooding along the Snake, Weiser, Payette and Boise Rivers for the second year in a row. A levee break near Eagle Island caused flooding of nearby homes.		
9/11/1997	N/A	Flash Flooding
Flash flooding from thunderstorms caused damage in the Boise Foothills. Cloudburst dropped 0.40" of rain in 9 minutes on the Foothills area burned by the 1996 Eighth Street Fire, flooding homes, Highlands Elementary School, and streets in the Crane Creek and Hulls Gulch areas. Floodwaters were contained in several holding ponds. 15 people were evacuated and sheltered at Les Bois Junior High.		
March/July 1997	DR 1177	Riverine Flooding
Rapid melt of a record snowmelt led to flooded rivers throughout southern Idaho. The Snake River Basin received significant snowfall during the winter of 1996-97, and in higher elevations the snow pack exceeded 250 percent of normal, causing above normal runoff during the spring melt.		
1/1/1997	DR 1154	Riverine Flooding
Warm temperatures combined with a rainfall 4-6 times normal caused snowmelt triggering floods, mudslides and avalanches in the Weiser, Payette and Salmon River drainages, damaging communities and infrastructure throughout Idaho. Increased flows in the Boise River to make room in reservoirs flooded homes and businesses along Eagle Island. A dike near South Eagle Road broke, flooding a road and surrounding fields. Parts of the Greenbelt along the Boise River were closed.		
May 1993	N/A	Flooding-Boise River
Boise River floodwaters soaked 10 Eagle homes, 1 woman drowned.		
February 1986	N/A	Flooding-Tributaries
Melting snow flooded North Boise from creeks in the Foothills. Streets in downtown Boise were closed to form a temporary diversion cancel to channel water from Cottonwood Creek to the Boise River. The canal carried an est. 800,000 gallons of water an hour		

Date	Declaration #	Type of event
June 1983	N/A	Flooding-Boise River
Snowmelt caused by high temperatures led to the raising of the Boise River to a peak runoff of 24,294 cfs. Flooding damaged the Greenbelt and river banks along Barber Park, Parkcenter, Garden City and Eagle Island. Homes along the river were flooded, and residents of Eagle Island used boats to travel. Cottonwood trees fell into the river, causing damming and further flooding. Municipal Park lost a chunk of land 300' long and 55' deep.		
February 1982	N/A	Flooding-Tributaries
Mudslides closed Hwy 55 three times in one month; erosion from floodwaters caused damage to numerous streets in the Foothills.		
1/5/1979	N/A	Flooding-Tributaries
In Boise, rain and melting snow caused flooding in North and West Boise from Foothills creeks. Over a dozen homes in the Highlands near Crane Creek were hardest hit, flooding basements, yards and streets despite sandbagging efforts. Flooding was also seen along Polecat Gulch, Stewart Gulch and Cottonwood Creek north of Boise, and Three mile, Five mile, Eight mile and Ten mile Creeks south of the airport, flooding homes, businesses and farmlands. Eckert Road bridge was closed.		
5/26/1973	N/A	Flooding-Canal
A 30' wide break in the Ridenbaugh Canal flooded the Triangle Dairy and 15 houses in southeast Boise with muddy, waist-deep water. The affected area was between Broadway/Linden/Leadville		
1/17/1971	N/A	Urban Flooding
Heavy rain and snow over four days caused flooding in southwest Idaho. Basements, yards and low-lying roads were flooded. In Orchard, 3 of 30 homes were evacuated by rowboat. Floodwaters covered approximately 160 acres in the town.		
1/22/1969	N/A	Flooding-tributaries
Crane Creek, Cottonwood Creek, and other drainages in the Foothills flooded, with the Cottonwood Creek flow being measured at 30 percent above normal. The Boise River reached 3,643 cfs, three times normal. Flooding was mostly confined to roads and yards in North Boise.		
5/22/1965	N/A	Flooding-Boise River
300 acres of farmland and several houses near Eagle Island were flooded by the Boise River when a levee broke.		
1/29/1965	N/A	Flooding-Tributaries
Flooding from Cottonwood and Dry Creeks, Crane, Stewart and Hulls Gulch. Damage mostly was for repair to bridges and cleanup.		
12/21/1964	N/A	Riverine Flooding
Warm weather combined with heavy rains and melting snow caused flooding along the Payette, Big Wood, Little Wood, Portneuf, Clearwater and Boise River drainages. Hwy 21 and 15, U.S. 95N and 30E were closed. Over 100 homes were damaged, numerous bridges were washed out, and thousands of acres of farmlands were flooded. Two deaths were attributed to the flood. A state of emergency was declared. Boise was isolated as surrounding roads and highways were closed, train and bus service cut off.		
2/1/1963	N/A	Flooding
In Ada County, Meridian streets and homes were flooded, farmland along Hwy 20-26 flooded. Canals in the area were running 3' above normal. Several highways were closed, bridges were washed away, and homes had basements and yards.		
9/22/1959	N/A	Flash Flooding
Heavy storms caused flooding along Cottonwood Creek and other Foothill drainages. The force of the water broke dikes across from the Armory on Reserve Street. Hwy 21 was closed because of debris flows. The area affected was mainly in the North End, from Fourth to Eighth Streets and Thatcher to Resseguie; also from Reserve Street to MK Plaza to Eighth Street. After these floods, several local and federal agencies cooperated in the "Boise Front Watershed Restoration Project" involving contour trenching, furrowing, seeding with trees and grasses and building protective fences, at a cost of approx. $165,000.		
8/20/1959	N/A	Cloudburst Floods
Severe thunderstorms in the northeast Boise Foothills were estimated to be a 50- to 100-year rainfall event; 0.30" of rain fell in 5 minutes at Deer Point. Earlier Lucky Peak fires had denuded the foothills of vegetation. Debris flows filled basements and yards in north and east Boise. Floodwaters were diverted along Broadway Avenue to the Boise River. Some 500 houses were damaged by mud; over 160 acres were covered by silt and debris. The agriculture area between Lucky Peak Dam and East Boise suffered extensive property, crop and livestock losses. The Boise police clubhouse on Mountain Cove Road was destroyed. The Idaho National Guard headquarters on Reserve Street was inundated.		

Date	Declaration #	Type of event
1/12/1958	N/A	Flash Flooding
A rainstorm that dumped over 2" of rain in Boise in a 12 hour period caused extensive flooding and heavy crop damage. Homes, roads and storm basins were flooded, several families were evacuated. The Boise Bench was hit hardest, with one family on Atlantic Street evacuated when their house was flooded with over a foot of water.		
2/25/1957	N/A	Flooding-tributaries
Parts of Eagle flooded by Dry Creek.		
8/1/1955	n/a	Flooding-Canals
200' section of the New York Canal broke 7 miles southeast of Boise and flooded 200-300 acres of farmland with water, mud and rock. A dozen homes near the break were flooded with 3' of water and families were evacuated.		

14.2.4 Location

Figure 14-1 shows the flood hazard areas from FEMA's 2020 DFIRM for Ada County, which was used to assess flood risk for this plan update. The mapped 1 percent annual chance and 0.2 percent annual chance flood hazard area within each municipality is listed in Table 14-4.

Table 14-4. Area Within the Mapped Flood Hazard Areas

	Area in Flood Zone (acres)	
	1% Annual Chance	0.2% Annual Chance
Boise	2,386	6,398
Eagle	2,640	4,046
Garden City	845	2,092
Kuna	420	420
Meridian	590	976
Star	728	1,205
Unincorporated	14,673	16,542
Total	**22,282**	**31,679**

14.2.5 Frequency

Ada County experiences episodes of river flooding almost every winter. Large floods that can cause property damage typically occur every three to seven years. Urban portions of the county annually experience nuisance flooding related to drainage issues.

14.2.6 Severity

Peak Flows

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges; Table 14-5 lists peak flows used by FEMA to map the floodplains of Ada County.

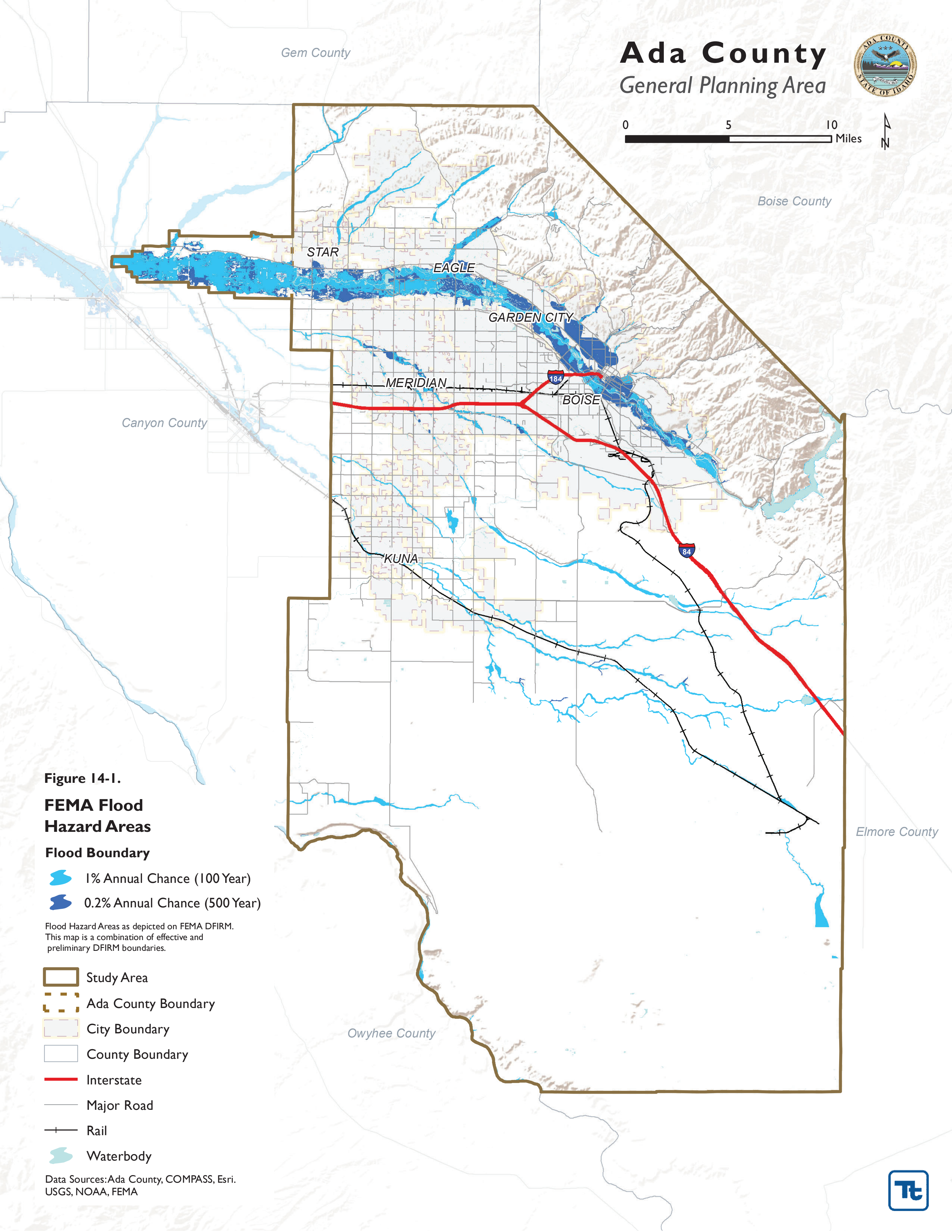


Figure 14-1.
FEMA Flood Hazard Areas

Table 14-5. Summary of Peak Discharges Within Ada County

Source/Location	Drainage Area (Square Miles)	Discharge (cubic feet/second)			
		10-Year	50-Year	100-Year	500-Year
Boise River					
At Lucky Peak Dam	2,650[a]	7,500[b]	11,000[b]	16,600[b]	34,800[b]
Boise River Side Channel					
At Park Center	N/A	N/A	N/A	675[c]	N/A
Cottonwood Gulch					
A mouth	16.5	242	1,450	3,650	25,500
Above Freestone Creek	11.7	192	1,016	2,688	19,282
Crane Gulch					
At mouth	7.8	154	376	1,030	8,428
Dry Creek					
At City of Eagle	67	610	2,700	4,000	13,200
Below Confluence with Spring Valley Creek	57.1	1,090	1,700	2,030	2,750
Above Confluence with Spring Valley Creek	37.8	791	1,200	1,410	1,950
Above Wooden Farm Bridge	34.5	695	1,090	1,280	1,770
Dry Creek below Current Creek Lane	33.5	674	1,060	1,240	1,710
Above split flow to Dry Creek Side Channel	--[d]	--[d]	--[d]	1,641	--[d]
5700 feet downstream of Cartwright Rd	--[d]	--[d]	--[d]	2,230	--[d]
Eightmile Creek					
At confluence with Fivemile Creek	16.7	330	525	590	850
At Cloverdale Road	--[d]	325	510	575	820
At Victory Road	13.4	275	390	425	580
Above New York Canal	9.9	300	700	950	1,800
Fivemile Creek					
Below Ninemile Creek	63	650	1,000	1,200	1,875
At Linder Road	--[c]	565	850	1,000	1,570
Below Eightmile Creek	52.5	530	780	900	1,375
Below Ridenbaugh Canal	--[c]	200	250	525	815
Above Ridenbaugh Canal	--[c]	345	440	525	815
Below Five Mile Road	--[c]	325	400	470	725
Below Threemile Creek	33	300	390	440	650
At Victory Road	--[c]	265	320	350	580
Below New York Canal	30.2	250	280	300	500
Above New York Canal	30.2	725	1,450	1,850	3,000
Highland Valley Gulch					
	2.5	150	940	1,250	2,100
Hulls Gulch					
At mouth	4.3	108	263	360	2,200
Maynard Gulch					
	2.3	150	830	1,100	1,850
Ninemile Creek					
At Tenmile Road	5.6	70	135	175	290
Above Linder Road	--[d]	50	95	120	200
At Meridian Road	--[d]	55	120	145	235

Source/Location	Drainage Area (Square Miles)	Discharge (cubic feet/second)			
		10-Year	50-Year	100-Year	500-Year
At Locust Grove Rd.	2.9	40	80	95	150
Pierce Gulch					
	2.0	140	760	1,100	1,700
Polecat Gulch					
	1.2	110	580	780	1,300
Seaman Gulch					
	1.8	140	760	1,100	1,700
South Channel Boise River Eagle Island					
	--c	--d	--d	4,900	14,000
South Channel Boise River Right Overbank					
	--c	--d	--d	3,250	4,000
Spring Valley Creek					
Below Brookside Lane	19.2	425	679	798	1,120
Stewart Gulch					
At mouth	9.1	169	538	1,494	11,794
Tenmile Creek					
At Roosevelt Road	10.0	215	415	510	820
At Tenmile Community Church	1.8	83	160	200	320
At Interstate 84	6.5	185	350	440	680
At Locust Grove Road	--d	170	320	400	620
At Amity Road	5.0	--c	--c	350	--c
At Eagle Road	3.4	--c	--c	275	--c
Warms Springs Creek					
	5.0	230	1,860	2,500	4,300

a. Drainage area above Lucky Peak Dam
b. Regulated Discharges
c. Data not available
d. Data not applicable

Repetitive Loss Areas

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses more than $1,000
- Two paid losses more than $1,000 within any rolling 10-year period
- Three or more paid losses that equal or exceed the current value of the insured property.

The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. Studies have found that many of these properties are outside any mapped 1 percent annual chance floodplain. The key identifiers for repetitive loss properties are the existence of NFIP insurance policies and claims paid by the policies.

Based on data provided by FEMA, there are two identified repetitive loss properties within the planning area as of March 14, 2022: one in the City of Garden City and one in the City of Eagle. Both are single-family residential.

FEMA further designates as severe repetitive loss any NFIP-insured single-family or multi-family residential building for which either of the following is true:

- The building has incurred flood-related damage for which four or more separate claims payments have been made, with the amount of each claim (including building and contents payments) exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000
- At least two separate claims payments (building payments only) have been made under NFIP coverage, with the cumulative amount of claims exceeding the market value of the building.

To qualify as a severe repetitive loss property, at least two of the claims must be within 10 years of each other, and claims made within 10 days of each other are counted as one claim. In determining severe repetitive loss status, FEMA considers the loss history since 1978, or from the building's construction if it was built after 1978, regardless of any changes in the ownership of the building.

FEMA-sponsored programs, such as the CRS, require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss.

14.2.7 Warning Time

Due to the extended pattern of weather conditions needed to cause serious flooding, warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding danger.

The Ada County Flood Response Plan documents flood response operations for the planning area. Since flows on the Boise River system are regulated by the Corps of Engineers, warning on this system is tied to water release rates set by the Corps. Each significant increase in release rates from Lucky Peak Dam requires notification to emergency managers by the Corps. These announcements usually occur well in advance (24 to 48 hours) of increased release rates.

The National Weather Service (NWS) uses a two-tiered warning system for flash flooding:

- A Flash Flood Watch covers a large area (a thousand square miles or greater, usually several counties) for up to 12 hours. A Flash Flood Watch is issued when conditions are favorable to produce flash flooding on the Boise Foothills within the next 12 hours.
- A Flash Flood Warning generally covers a very small area (a few square miles to several hundred square miles) for up to 6 hours. A flash flood warning for the Boise Foothills is issued under the following conditions:
  - Rainfall in the Boise Foothills is occurring or is imminent and is falling at a rate that could cause flash flooding.
  - Heavy rainfall is falling on snowpack and flash flooding is occurring or imminent.
  - Flash flooding is occurring and has been confirmed by stream flow gauges, NWS spotters, emergency responders or citizens.

There is no warning system for flooding from canal breaches or failures. Warning for failures of these systems will occur likely well after the event has begun.

14.2.8 Natural and Beneficial Floodplain Functions

What Are Beneficial Floodplain Functions?

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Riparian areas—the zones along the edge of a river or stream that are influenced by or are an influence upon the water body—generally have a greater diversity and structure of vegetation than upland areas. Shelter, space, food and water available in these areas determine the health of wildlife populations. Riparian communities are of special importance for many animals since water supply is a major limiting factor to the animals' population. Animals depend upon a supply of water for their existence.

The Boise River Enhancement Plan

The Boise River Enhancement Plan is a community-generated plan to improve Boise River water quality, aquatic and riparian habitat, and stream channel function from Lucky Peak Dam to the Snake River. It provides an overview of the current health of the river and identifies how, what and where enhancement can be achieved to bring the most effective benefits to the river (Boise River Enhancement Network 2015).

14.3 EXPOSURE

A Level 2 Hazus analysis was used to assess exposure to flooding in the planning area. Where possible, the Hazus default data was enhanced using local GIS data from county, state and federal sources.

14.3.1 Population

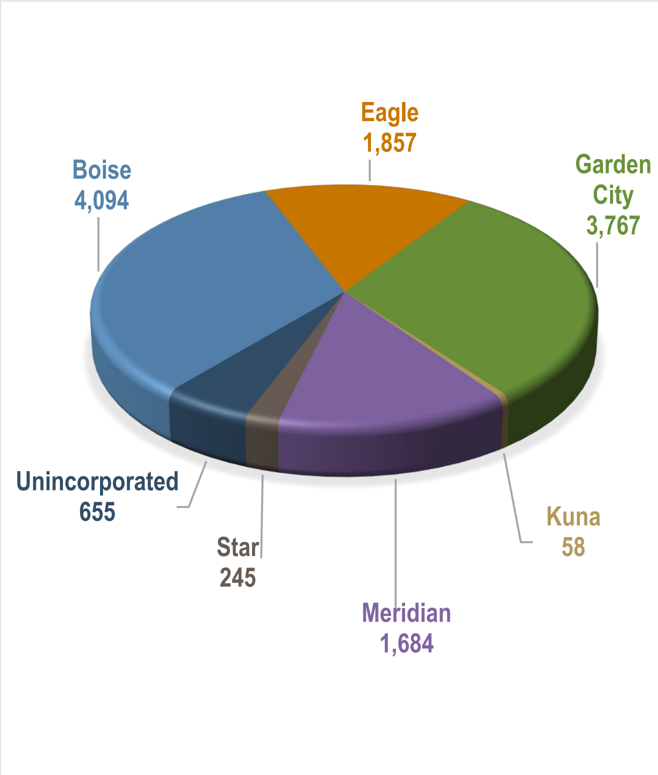
All populations living in mapped flood zones would be exposed to the risk of a flood. Figure 14-2 and Figure 14-3 summarizes the population living in the 1 percent and 0.2 percent annual chance flood zones, respectively, by municipality.

14.3.2 Property

The value of exposed buildings and contents in each jurisdiction is summarized in Figure 14-4 and Figure 14-5 for the 1 percent annual chance and 0.2 percent annual chance flood zones, respectively. Figure 14-6 and Figure 14-7 summarize the number of structures in the 1 percent annual chance and 0.2 percent annual chance flood zones, respectively by municipality and occupancy class.

14.3.3 Critical Facilities

GIS analysis determined that 197 of the planning area's critical facilities (9 percent of the planning area total) are in the 1 percent annual chance floodplain and 542 (26 percent) are in the 0.2 percent annual chance floodplain. Figure 14-8 summarizes critical facilities in the mapped floodplains for the countywide planning area. Detailed results by jurisdiction are provided in Appendix D.



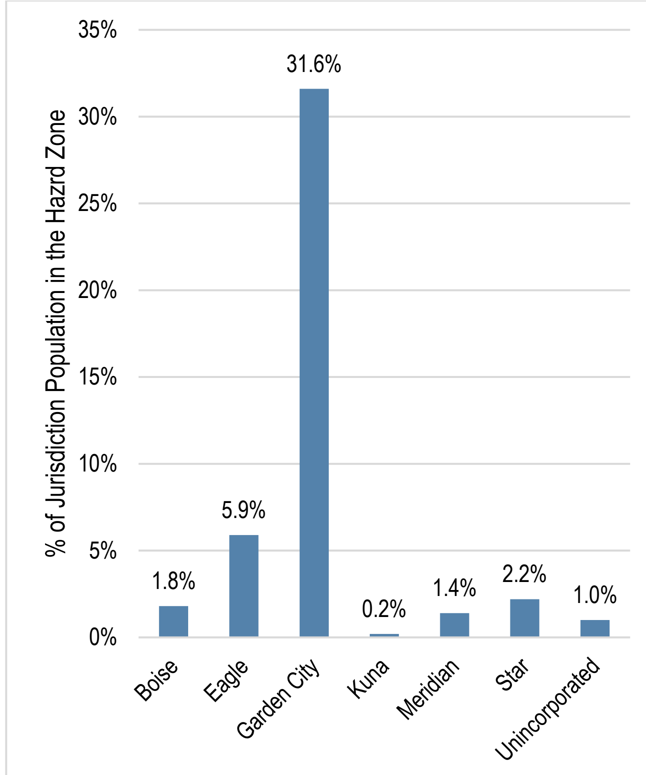
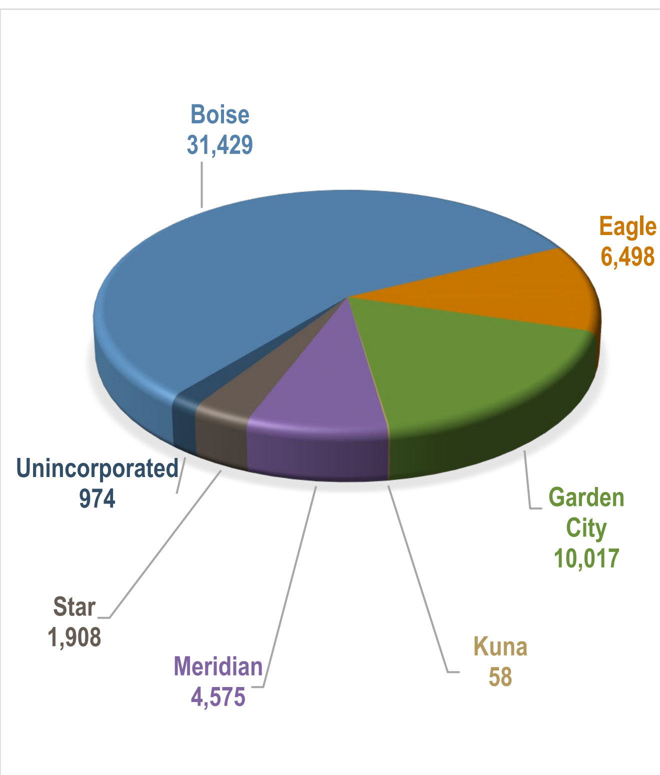


Figure 14-2. Population in the 1 Percent Annual Chance Flood Zone



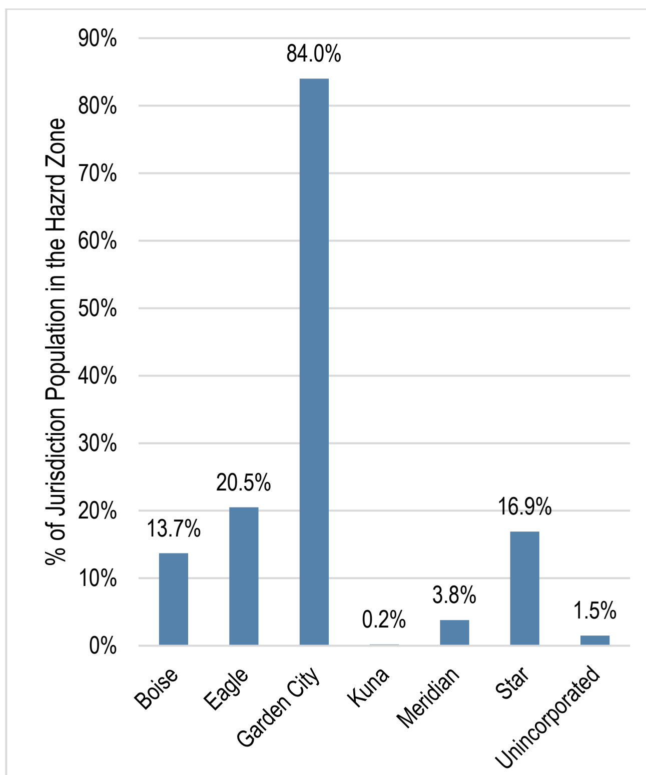


Figure 14-3. Population in the 0.2 Percent Annual Chance Flood Zone

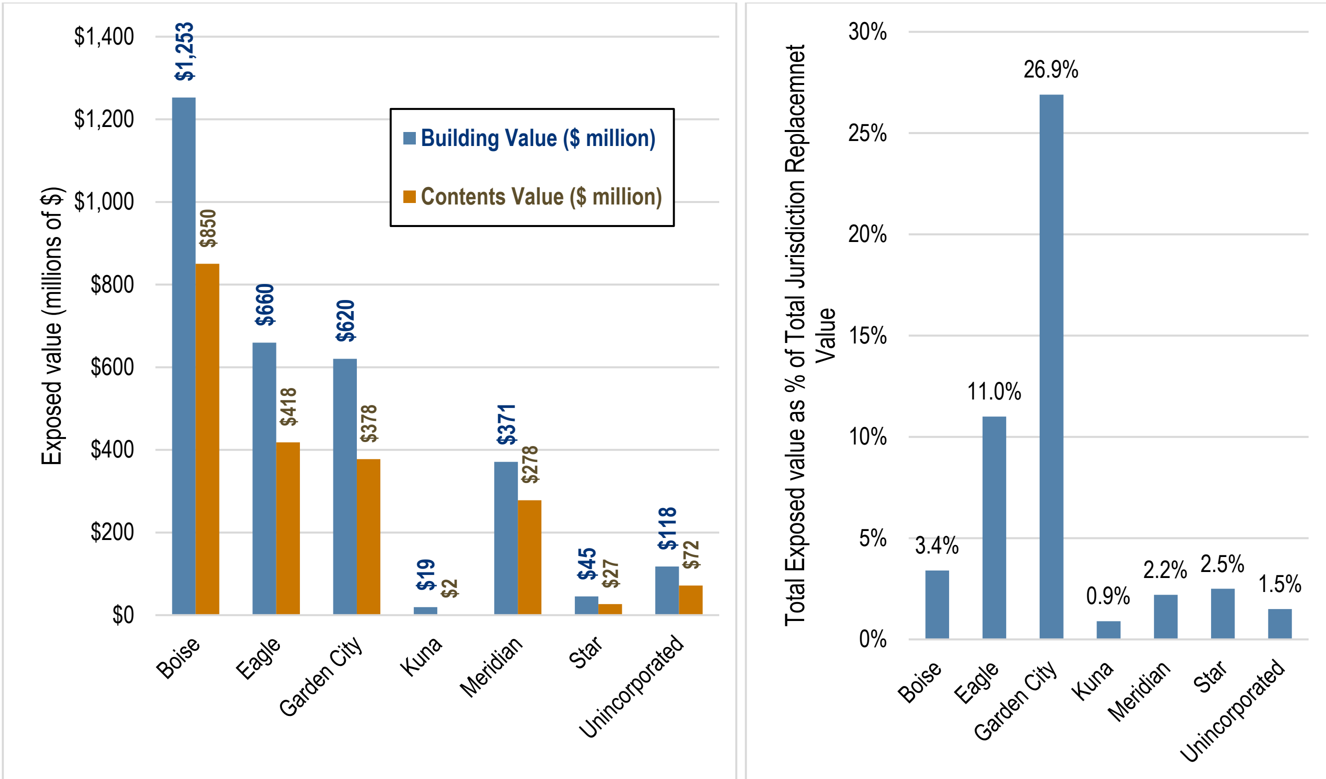


Figure 14-4. Value of Property in the 1% Annual Chance Flood Hazard Area

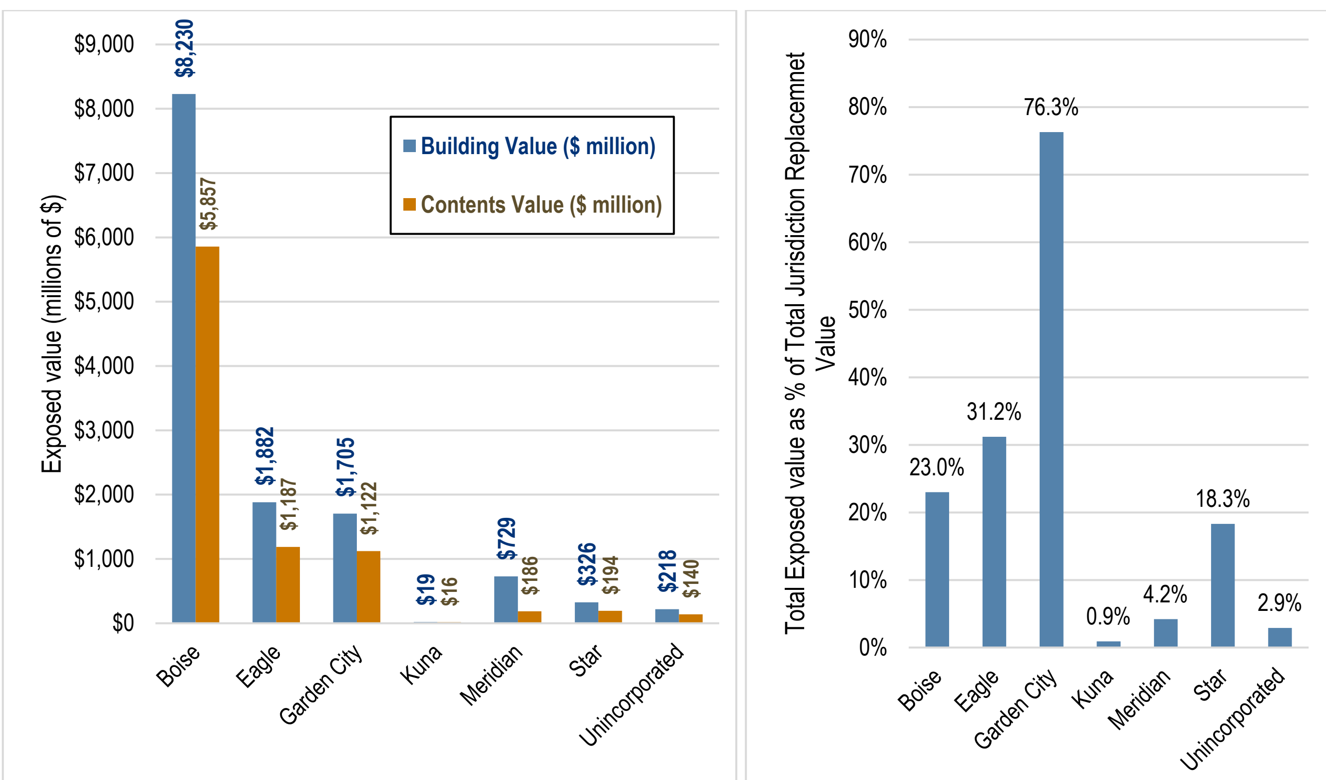


Figure 14-5. Value of Property in the 0.2% Annual Chance Flood Hazard Area

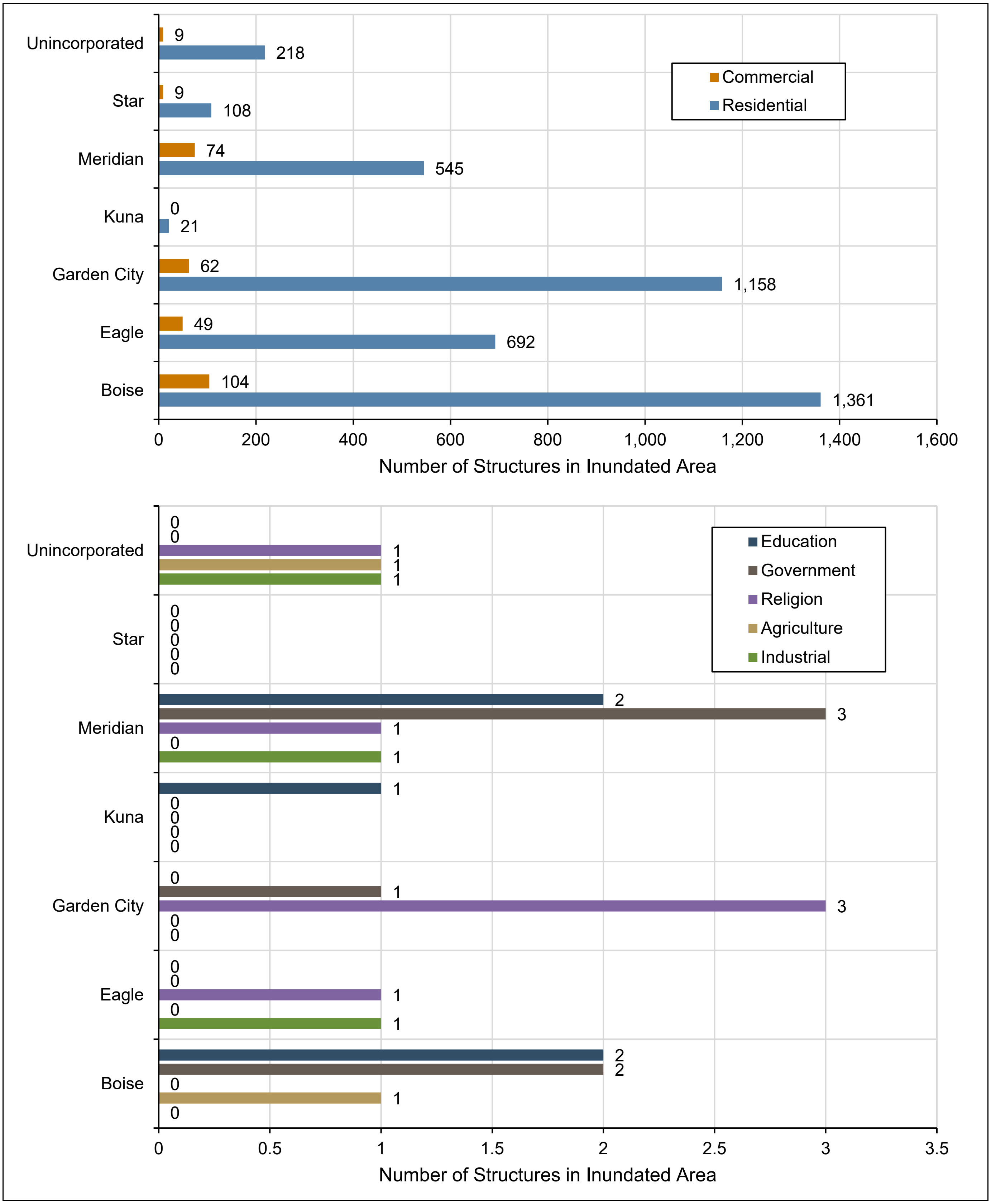


Figure 14-6. Number of Structures Within the 1% Annual Chance Flood Hazard Area

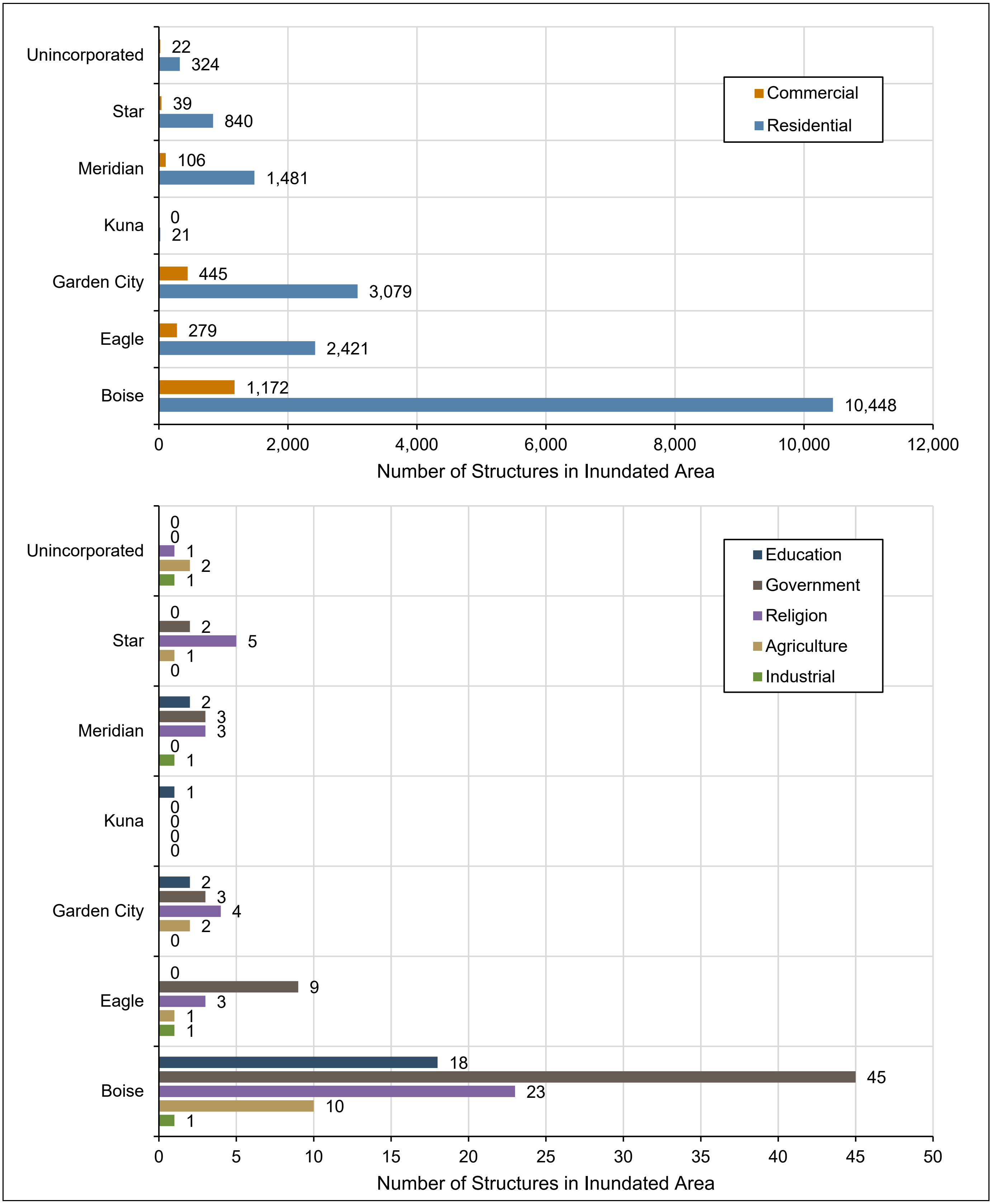


Figure 14-7. Number of Structures Within the 0.2% Annual Chance Flood Hazard Area

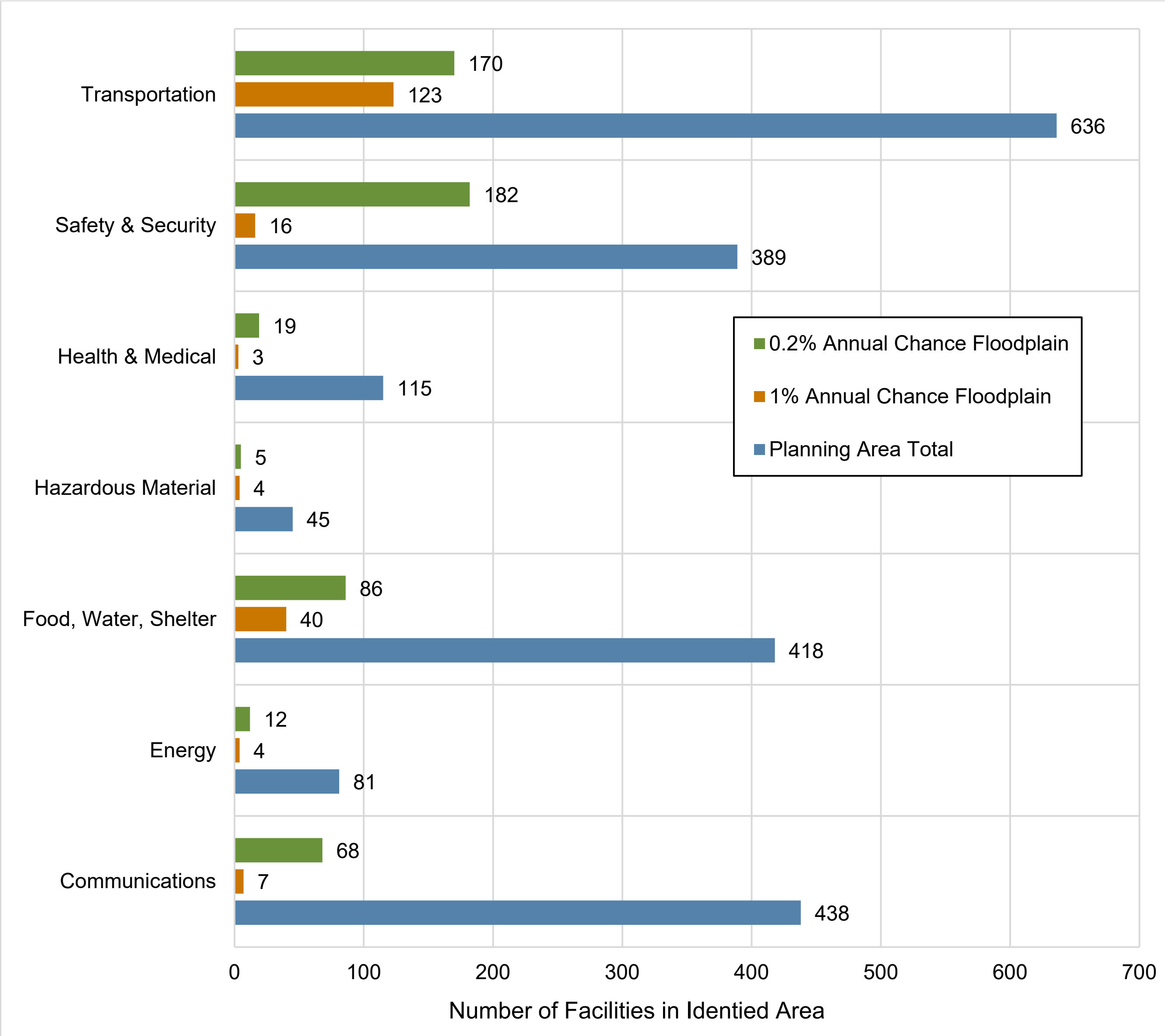


Figure 14-8. Critical Facilities in the Mapped Floodplains and Countywide

14.3.4 Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, with human development factored in, flooding can impact the environment in negative ways. Migrating fish can wash into roads or over dikes into flooded fields, with no possibility of escape. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees, and logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

Many species of mammals, birds, reptiles, amphibians and fish live in Ada County in plant communities that are dependent upon streams, wetlands and floodplains. Changes in hydrologic conditions can result in a change in the plant community. Wildlife and fish are impacted when plant communities are eliminated or fundamentally altered to reduce habitat. Wildlife populations are limited by shelter, space, food and water. Since water supply is a major limiting factor for many animals, riparian communities are of special importance. Riparian areas are the zones along the edge of a river or stream that are influenced by or are an influence upon the water body. Human disturbance to riparian areas can limit wildlife's access to water, remove breeding or nesting sites, and eliminate suitable areas for rearing young. Wildlife relies on riparian areas in the following ways:

- Mammals depend upon a supply of water for their existence. Riparian communities have a greater diversity and structure of vegetation than other upland areas. Beavers and muskrats are now recolonizing streams, wetlands and fallow farm fields, which are converted wetlands. As residences are built in rural areas, there is an increasing concern with beaver dams causing flooding of low-lying areas and abandoned farm ditches being filled in, which can lead to localized flooding.
- A great number of birds are associated with riparian areas. They swim, dive, feed along the shoreline, or snatch food from above. Rivers, lakes and wetlands are important feeding and resting areas for migratory and resident waterfowl. Threatened or endangered species such as the bald eagle or the peregrine falcon eat prey from these riparian areas.
- Amphibians and reptiles are some of the least common forms of wildlife in riparian areas, but species such as the western pond turtle and the spotted frog are known to inhabit the waterways and wetlands.
- Fish habitat throughout the county varies widely based on natural conditions and human influence.

14.4 VULNERABILITY

14.4.1 Population

Vulnerable populations are all populations living within the mapped floodplain who are incapable of escaping the area before floodwaters arrive. Impacts on persons and households for the mapped floodplains were estimated through the Level 2 Hazus analysis. Detailed results by jurisdiction are included in Appendix D; summaries are provided in Table 14-6.

14.4.2 Property

Figure 14-9 and Figure 14-10 summarize the Level 2 Hazus analysis of the flood hazard for the 1 percent annual chance and 0.2 percent annual chance floodplains, respectively.

14.4.3 Critical Facilities

Estimated Damage by Category

Hazus was used to estimate the percent of damage to the building and contents of critical facilities, using depth/damage function curves. The results are summarized in Figure 14-11 and Figure 14-12.

Table 14-6. Estimated Flood Impacts on Persons and Households

	Number of Displaced Residents	Number of Residents Requiring Short-Term Shelter
1% Annual Chance Flood Zone		
Boise	1,042	133
Eagle	466	61
Garden City	2,225	153
Kuna	4	1
Meridian	231	45
Star	92	7
Unincorporated	84	16
Total	**4,144**	**416**
0.2% Annual Chance Flood Zone		
Boise	20,532	1,070
Eagle	3,562	226
Garden City	8,679	405
Kuna	4	1
Meridian	1,246	125
Star	1,074	54
Unincorporated	151	23
Total	**35,247**	**1,904**

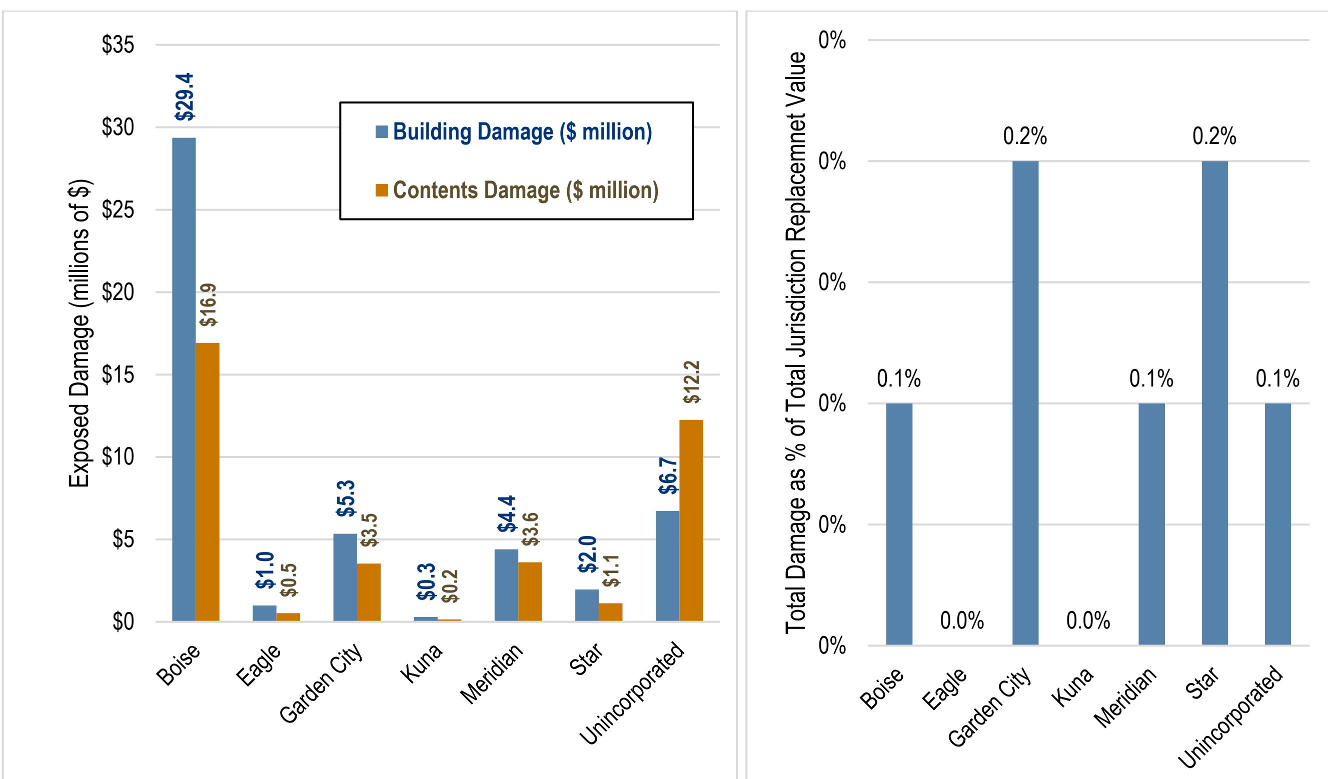


Figure 14-9. Estimated Property Damage in 1% Annual Chance Floodplain

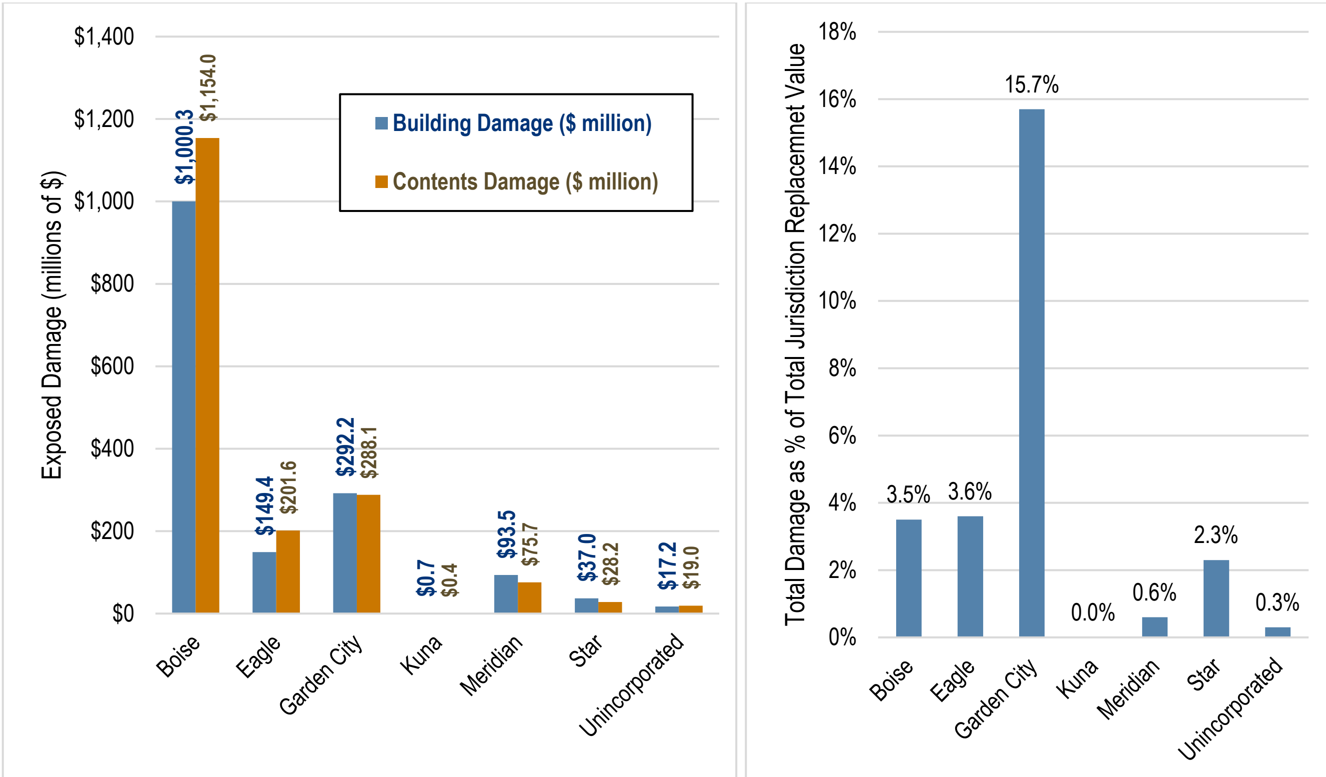


Figure 14-10. Estimated Property Damage in 0.2% Annual Chance Floodplain

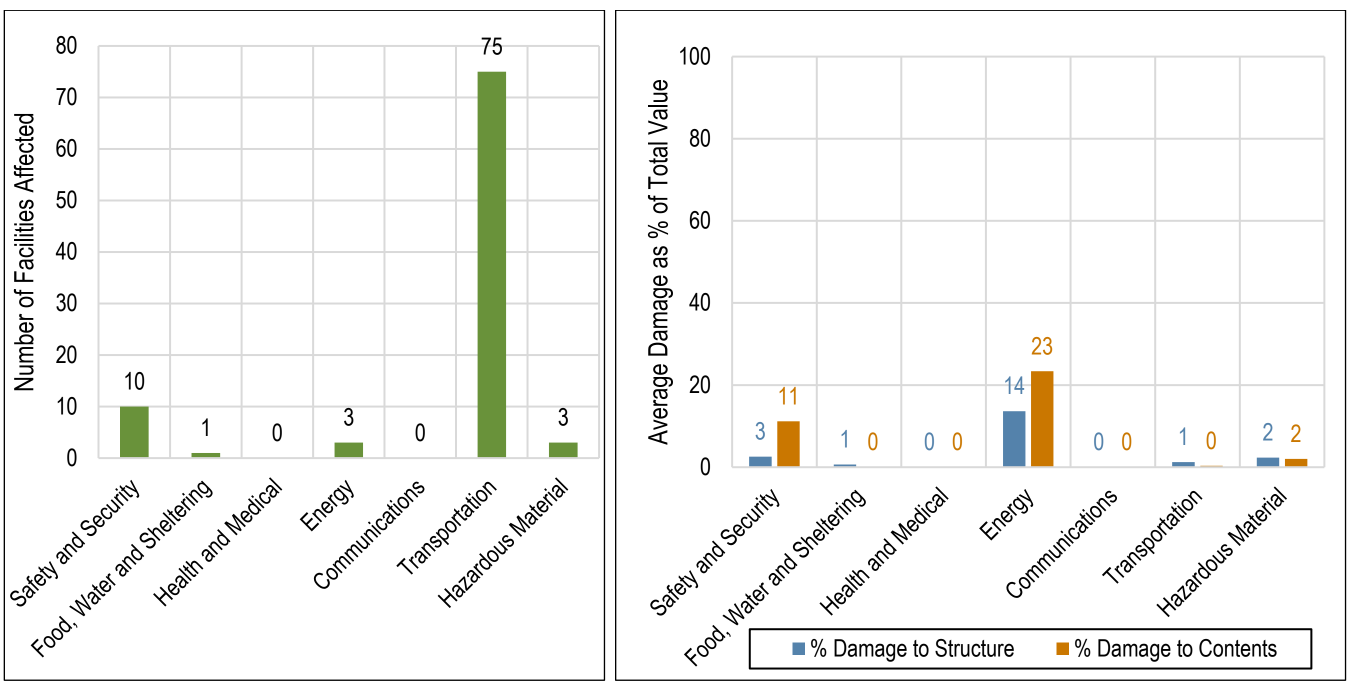
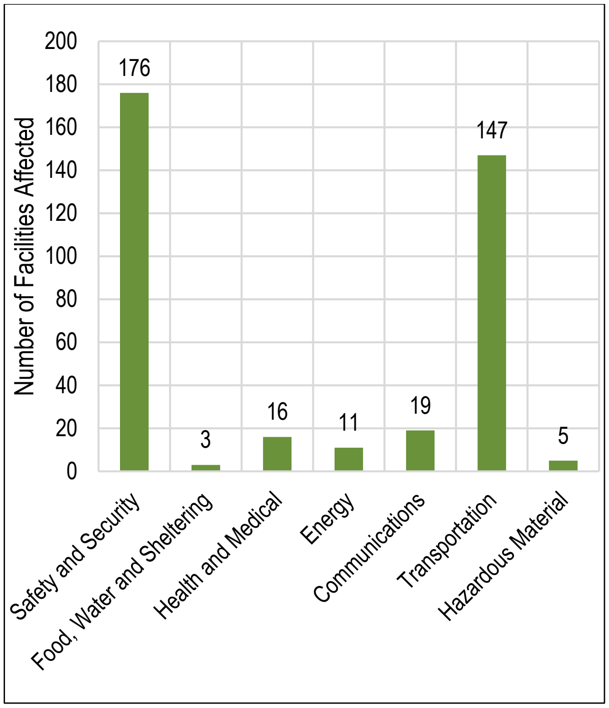


Figure 14-11. Estimated Damage to Critical Facilities from 1% Annual Chance Flood



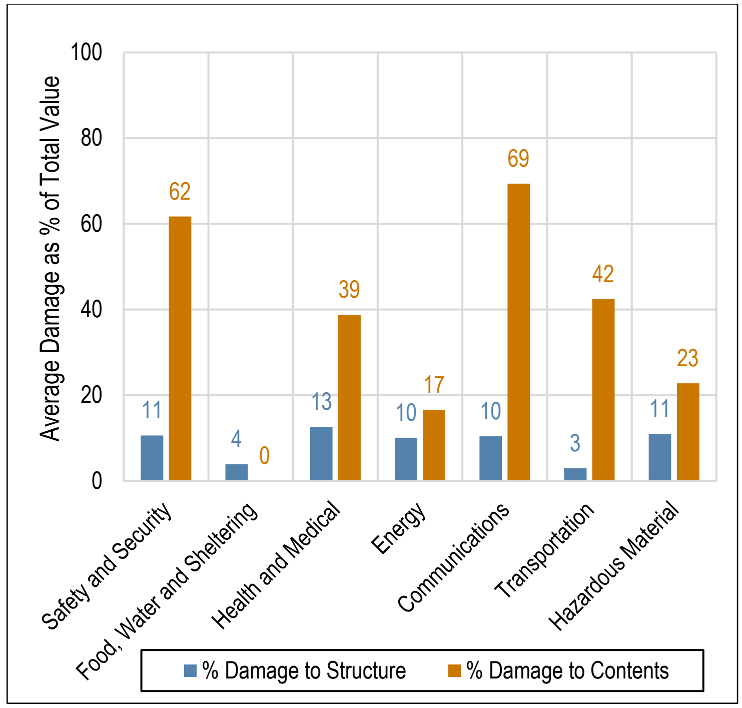


Figure 14-12. Estimated Damage to Critical Facilities from 0.2% Annual Chance Flood

Tier II Facilities

Tier II facilities are those that use or store materials that can harm the environment if damaged by a flood. During a flood event, containers holding hazardous materials can rupture and leak into the surrounding area. These facilities could release chemicals that cause cancer or other human health effects, significant adverse acute human health effects, or significant adverse environmental effects. The risk assessment identified three such facilities that would be affected by the 1 percent annual chance flood and five that would be affected by the 0.2 percent annual chance flood.

Utilities and Infrastructure

Roads that are blocked or damaged can isolate community members and can prevent access throughout the planning area, including for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Underground utilities can be damaged. Levees can fail or be overtopped, inundating the land that they protect. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers, and streams. The following sections describe the risk assessment for specific types of critical infrastructure.

Roads

The following major roads in Ada County pass through the 1 percent annual chance floodplain and thus are exposed to flooding:

- 8th Street
- Broadway Avenue
- Capitol Blvd.
- Eagle Road
- Eckert Road
- Glenwood Street
- Highway 21
- Highway 44
- Highway 55
- Interstate 84 (Connector)
- Linder Road
- Veterans Memorial Parkway

Some of these roads are built above the flood level, and others function as levees to prevent flooding. Still, in severe flood events these roads can be blocked or damaged, preventing access to some areas.

Bridges

Flooding events can significantly impact road bridges. These are important because often they provide the only ingress and egress to some neighborhoods. An analysis showed that there are 74 bridges that would be affected by the 1 percent annual chance floodplain and 144 bridges that would be affected by the 0.2 percent annual chance floodplain.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers and streams. The risk assessment identified one water/wastewater facility that would be affected by the 1 percent annual chance floodplain and three that would be affected by the 0.2 percent annual chance floodplain.

14.5 DEVELOPMENT TRENDS

The value of planning area properties exposed to the 1 percent annual chance flood hazard has increased by 59 percent ($1.9 billion) since the last hazard mitigation plan update in 2017. The value exposed to the 500-year flood hazard has increased by 4.51 percent. This increase in risk exposure can be attributed to the population growth of 13.6 percent in the same period.

Current comprehensive planning in the planning area appears to be adequately equipped to dictate sound land use practices within the designated floodplain. The key to this will be to identify flood hazard areas that accurately reflect the true flood risk within the planning area. Ada County finalized new flood maps through FEMA’s Risk MAP program during the maintenance period of the previous plan. The new maps are based on the abundance of available information on flood risk from creditable agencies such as IDWR and the Corps of Engineers.

All municipal planning partners for this plan are participants in the NFIP and have adopted flood damage prevention ordinances in response to its requirements. With 71 percent of communities in the county participating in the CRS program, there is incentive to adopt consistent, appropriate, higher regulatory standards in communities with the highest degree of flood risk. All municipal planning partners have committed to maintaining their good standing under the NFIP through actions identified in this plan. Communities participating or considering participation in the CRS program will be able to refine this commitment using CRS programs and templates as a guide.

14.6 SCENARIO

The primary water courses in Ada County have the potential to flood at irregular intervals, generally in response to a succession of intense thunderstorms in summer or rain-on-snowpack events in winter. Storm patterns of warm, moist air usually occur between early November and late March. A series of such weather events can cause severe flooding in the planning area. The worst-case scenario is a series of storms that flood numerous drainage basins in a short time. This could overwhelm the response and floodplain management capability within the planning area. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems.

Additionally, the potential impacts of future climate conditions on the operations of Lucky Peak Dam are real. The Boise River could see increased flows in response to a changing hydrograph that dictates dam operations.

14.7 ISSUES

The planning team has identified the following flood-related issues relevant to the planning area:

- The extent of the flood-protection currently provided by flood control facilities (dams, dikes and levees) is not known due to the lack of an established national policy on flood protection standards.
- The risk associated with the flood hazard overlaps the risk associated with other hazards such as earthquake, landslide and fishing losses. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- Additional efforts to coordinate land-use practices across all affected jurisdictions within the planning area are needed to expand floodplain management practices beyond the minimum requirements of the NFIP.
- Potential future climate conditions could alter flood conditions in Ada County.
- More information is needed on flood risk to support the concept of risk-based analysis of capital projects.
- There needs to be a sustained effort to gather historical damage data, such as high water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between jurisdictions affected by flood hazards in the county.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- The concept of residual risk should be considered in the design of future capital flood control projects and should be communicated with residents living in the floodplain.
- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.

- Existing floodplain-compatible uses such as agricultural and open space need to be maintained. There is constant pressure to convert these existing uses to more intense uses within the planning area during times of moderate to high growth.
- The economy affects a jurisdiction’s ability to manage its floodplains. Budget cuts and personnel losses can strain resources needed to support floodplain management.
- A buildable-lands analysis that looks at vacant lands and their designated land use would be a valuable tool in helping decision-makers make wise decisions about future development.
- The risk associated with flooding due to canal failure is unknown at this time. Data on this risk need to be gathered to better support communities’ preparedness and response efforts.

15. HAZARDOUS MATERIALS RELEASE

15.1 GENERAL BACKGROUND

Hazardous materials are substances that are considered severely harmful to human health and the environment, as defined by the U.S. Environmental Protection Agency's (EPA's) Comprehensive Environmental Response, Compensation, and Liability Act (commonly known as Superfund). Many hazardous materials are commonly used substances that are harmless in their normal uses but dangerous if released. The EPA designates about 800 substances as hazardous and identifies many more as potentially hazardous due to their characteristics and the circumstances of their release (EPA 2022). If released or misused, hazardous substances can cause death, serious injury, long-lasting health effects, and damage to structures, other properties, and the environment. Hazardous materials are present in nearly every city and county in the United States in facilities that produce, store, or use them:

- Fuel storage vessels (both in and above ground)
- Water treatment plants use chlorine to eliminate bacterial contaminants.
- Hazardous materials are transported along interstate highways and railways daily.
- The natural gas used in homes and businesses is a dangerous substance when a leak occurs.
- Many businesses, through intentional action, lack of awareness or accidental occurrences, have contamination in and around their property.

Hazardous material releases can pose a risk to life, public health, air quality, water quality and the environment. They may result in the evacuation of a facility or an entire neighborhood. In addition to the immediate risk, long-term public health and environmental impacts may result from sustained exposure to certain substances.

15.1.1 Types of Incidents

The following are the most common types of hazardous material incidents:

- **Fixed-Facility Hazardous Materials Incident**—This is the uncontrolled release of materials from a fixed site capable of posing a risk to health, safety, and property as determined by the Resource and Conservation and Recovery Act. It is possible to identify and prepare for a fixed-facility incident because federal and state laws require those facilities to notify state and local authorities about what is being used or produced at the site.
- **Hazardous Materials Transportation Incident**—A hazardous materials transportation incident is any event resulting in uncontrolled release of materials during transport that can pose a risk to health, safety, and property as defined by Department of Transportation Materials Transport regulations. Transportation incidents are difficult to prepare for because there is little if any notice about what materials could be

involved should an accident happen. Hazardous materials transportation incidents can occur at any place within the country, although most occur on the interstate highways or major federal or state highways, or on major rail lines.

15.1.2 Hazardous Materials Resulting from Hazard Events

Debris generated from natural disasters often includes hazardous materials. Large quantities of debris from natural disasters can hinder emergency personnel, damage or block access to necessary infrastructure, and pose threats to human health and the environment (State of Idaho Hazard Mitigation Plan 2018). Natural disaster debris that may contain hazardous materials includes:

- Aluminum composite material—asbestos pipe wrap, siding, ceiling and floor tiles
- Ammunition and explosives
- Asphalt
- Building contents—furniture, personal property
- Cylinders and tanks
- Electronics waste—televisions, computers, cell phones
- Household waste—household cleaners, freezer and refrigerator coolant
- Medical waste
- Municipal solid waste—trash, garbage
- PCB-containing waste—transformers, capacitors, other electrical equipment
- Pharmaceuticals
- Radiological-contaminated waste—hospital equipment
- Tires
- Toxic materials—batteries, pesticides, solvents, paint thinners, mercury-containing devices
- Treated wood—utility poles, fencing, decks
- Used oil and oil-contaminated waste
- Vehicles and vessels
- White goods—household appliances, such as stoves, refrigerators, washers/dryers, air conditioner units

15.1.3 Secondary Hazards

Secondary hazards associated with fixed-facility hazardous substance releases include those impacting the health of the community and environment. The secondary impacts have the potential to occur regardless of the mode or the source of release. In addition to the secondary impacts noted for the fixed-facility hazard, other impacts may include damage to infrastructure such as road beds or bridges in a hazardous materials transportation incident.

15.2 HAZARD PROFILE

15.2.1 Past Events

The Pipeline and Hazardous Materials Safety Administration tracks hazardous material releases through its nationwide database. Incidents are listed by state. Regulations in 49 CFR govern situations where hazardous materials are released and establish notification and reporting requirements. Unless they are properly reported, it is difficult to identify and track past hazardous materials releases. Between January 1, 2000, and December 31, 2021, 495 hazardous material incidents in Ada County were reported (Pipeline and Hazardous Materials Safety Administration 2022). None of these resulted in injury or fatality. One caused a serious evacuation and three incidents resulted in closure of a main transportation artery. Total damages were estimated at more than $514,000. See Table 15-1 for events by city.

Table 15-1. Hazardous Materials Incidents by City, 2000-2021

City	Mode of Transportation	Number of Events	Damage
Boise	Air	31	$0
	Highway	342	$190,780
Eagle	Highway	1	$0
Garden City	Highway	4	$0
Kuna	Highway	2	$0
Meridian	Highway	115	$323,784

15.2.2 Location

Because hazardous materials are so widely used, stored and transported, a hazardous material event could take place almost anywhere. Many hazardous materials are used, stored and transported in very large quantities, so the impacts of an event may be widespread and powerful. Hazardous material incidents usually occur on major highways and railways. According to the 2018 Idaho State Hazard Mitigation Plan, there are 213 Tier II facilities and 10 Toxic Release Inventory sites in Ada County (State of Idaho Hazard Mitigation Plan 2018). Ada County does not contain any hazardous waste Superfund sites (EPA 2021).

15.2.3 Frequency

Hazardous materials releases are difficult to predict; however, based on past events (Table 15-1), the County can expect to experience an event nearly 24 times a year.

15.2.4 Severity

Hazardous material releases can contaminate the air, water and soil. Releases may result in injury or loss of life. Hazardous materials can be carried quickly by water and wind, affecting the population and environment in surrounding areas.

For both accidental and intentional hazardous material releases, the severity of impact varies with mitigating or exacerbating conditions. Measures taken in advance of an event can reduce its severity. For example, shielding by sheltering in place and primary and secondary containment measures can protect people and the environment. However, adverse weather conditions, building code violations, and maintenance failures can substantially increase the hazard severity.

Severity is also dependent on the type of substance released and the response time of hazardous materials teams. The area with closest to the release is generally at greatest risk, but hazardous materials can be dispersed over large areas and affect the environment for a long period of time.

15.2.5 Warning Time

Warning times vary for incidents fixed facilities. Incidents may be sudden without any warning, such as an explosion, or may develop slowly, such as a leaking container. Facilities that store extremely hazardous substances are required to notify local officials when an incident occurs. Local emergency responders and emergency management officials determine the need to evacuate the public or to advise to shelter in place.

The amount of warning time for incidents associated with hazardous substances in transit varies based on the nature and scope of the incident. If an explosion does not occur immediately following an accident, there may be time for warning adjacent neighborhoods and facilitating appropriate protective actions.

15.3 EXPOSURE AND VULNERABILITY

Due to the nature of a hazardous materials release, all people, property and the environment of the planning area are exposed to some degree to the hazard. Populations who live or work near major transportation routes or sites that use and store large quantities of hazardous materials are likely to be more vulnerable.

15.4 DEVELOPMENT TRENDS

Not all land-use regulations restrict building around industrial facilities or along transportation routes. As the population increases, development will continue to increase in these areas, thereby exposing a greater number of individuals to the risk of a hazardous material release. Increased development will lead to increased vulnerability and potential losses.

15.5 SCENARIO

A worst-case event would involve a release on a major transportation route, in a developed area along a waterway. High winds could quickly spread the release. Such an event would have both short-term and longer-term effects. Initially, the affected transportation route would be closed, the surrounding area evacuated, and emergency response teams deployed. Longer-term effects would include environmental damage.

15.6 ISSUES

Important issues associated with hazardous materials release events in Ada County include the following:

- Facilities using or transporting hazardous materials need to continue to be monitored and regulated.
- Education needs to be provided to workers and emergency response personnel in appropriate techniques and safety measure for dealing with spills and incidents. This includes Hazardous Waste Operations & Emergency Response training and certification.
- The general public should be made aware of the hazards of household chemical products and methods for properly disposing of these products.

16. LANDSLIDE

16.1 GENERAL BACKGROUND

16.1.1 Landslide Causes

A landslide is a mass of rock, earth or debris moving down a slope. Slides are caused by a combination of geological and climate conditions and the influence of urbanization. They can be initiated by storms, earthquakes, fires, volcanic eruptions or human modification of the land. Vulnerable natural conditions are affected by human development and the infrastructure that supports it. In some cases, irrigation increases the landslide potential. The following factors can contribute to slide formation:

- Change in slope of the terrain
- Increased load on the land
- Shocks and vibrations
- Change in water content
- Groundwater movement
- Frost action
- Weathering of rocks
- Removing or changing the vegetation covering slopes

Ground saturation by water, steepening of slopes by erosion or construction, alternate freezing and thawing, and earthquake shaking are all factors that contribute to landslides. Landslides are typically associated with periods of heavy rainfall or rapid snow melt. Rain-saturated hill slopes and increased groundwater pressure on porous hillsides are triggering agents of slope failure. In areas burned by forest and brushfires, a lower threshold of precipitation may initiate landslides.

16.1.2 Landslide Risk Areas

Landslides are typically a function of soil type and steepness of slope. Soil type is a key indicator for landslide potential and is used by geologist and geotechnical engineers to determine soil stability for construction standards. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- A slope greater than 33 percent
- A history of landslide activity or movement during the last 10,000 years
- Stream activity that has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable
- The presence or potential for snow avalanches
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments
- The presence of impermeable soils such as silt or clay, mixed with granular soils such as sand and gravel.

Certain combinations of earth materials and steep topography increase the likelihood of slope failure. In Idaho, examples include basalt with sedimentary interbeds, altered volcanic rocks, fractured metamorphic rocks, glacial and lake deposits, and weathered granite. Basalt lava flows exposed in canyons hundreds of feet deep occur throughout the Snake River Plain and Columbia Plateau. Large landslides tend to form where the basalts are underlain by unconsolidated sediments. In some cases, irrigation increases the landslide potential. At Salmon Falls Creek south of Buel, translational and rotational slides and multiple lateral spreads have occurred where basalt overlies lake and fluvial sediments. On steep slopes in Idaho's river canyons, metamorphic rocks fractured by faulting and folding are prone to fail as falls, topples, and translational slides. Such landslides are common along the Salmon River and in Hells Canyon.

16.1.3 Landslide Types

The following are common types of mass landslides (see Figure 16-1):

- **Rotational Slides**—Blocks of fine-grained sediment that rotate and move down slope
- **Translational Slides**—Sediments that move along a flat surface without a rotational component
- **Block Slides**—Blocks of rock that slide along a slip plane as a unit down a slope.
- **Rock Falls**—Blocks of rock that fall away from a bedrock unit without a rotational component
- **Rock Topples**—Blocks of rock that fall away from a bedrock unit with a rotational component
- **Debris Flows (Mudslides)**—Rivers of rock, earth, organic matter, and other soil materials saturated with water. They develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt.
- **Debris avalanche**—A debris flow that travels faster than about 10 miles per hour (mph). Speeds in excess of 20 mph are not uncommon, and speeds in excess of 100 mph, although rare, can occur. The slurry can travel miles from its source, growing as it descends, picking up trees, boulders, cars, and anything else in its path.
- **Earth Flows**—Fine-grained sediments that flow downhill and typically form a fan structure
- **Creep**—A slow-moving landslide often only noticed through crooked trees and disturbed structures
- **Lateral spread**—Landslides that commonly form on gentle slopes and that have rapid fluid-like flow movement, like water

16.1.4 Secondary Hazards

Landslides can cause secondary effects such as blocking access to roads, which can isolate residents and businesses and delay transportation. This could result in economic losses for businesses. Other potential problems are power and communication failures. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents. They also can damage rivers or streams, potentially harming water quality, fisheries and spawning habitat.

Source: (U.S. Geological Survey 2006)

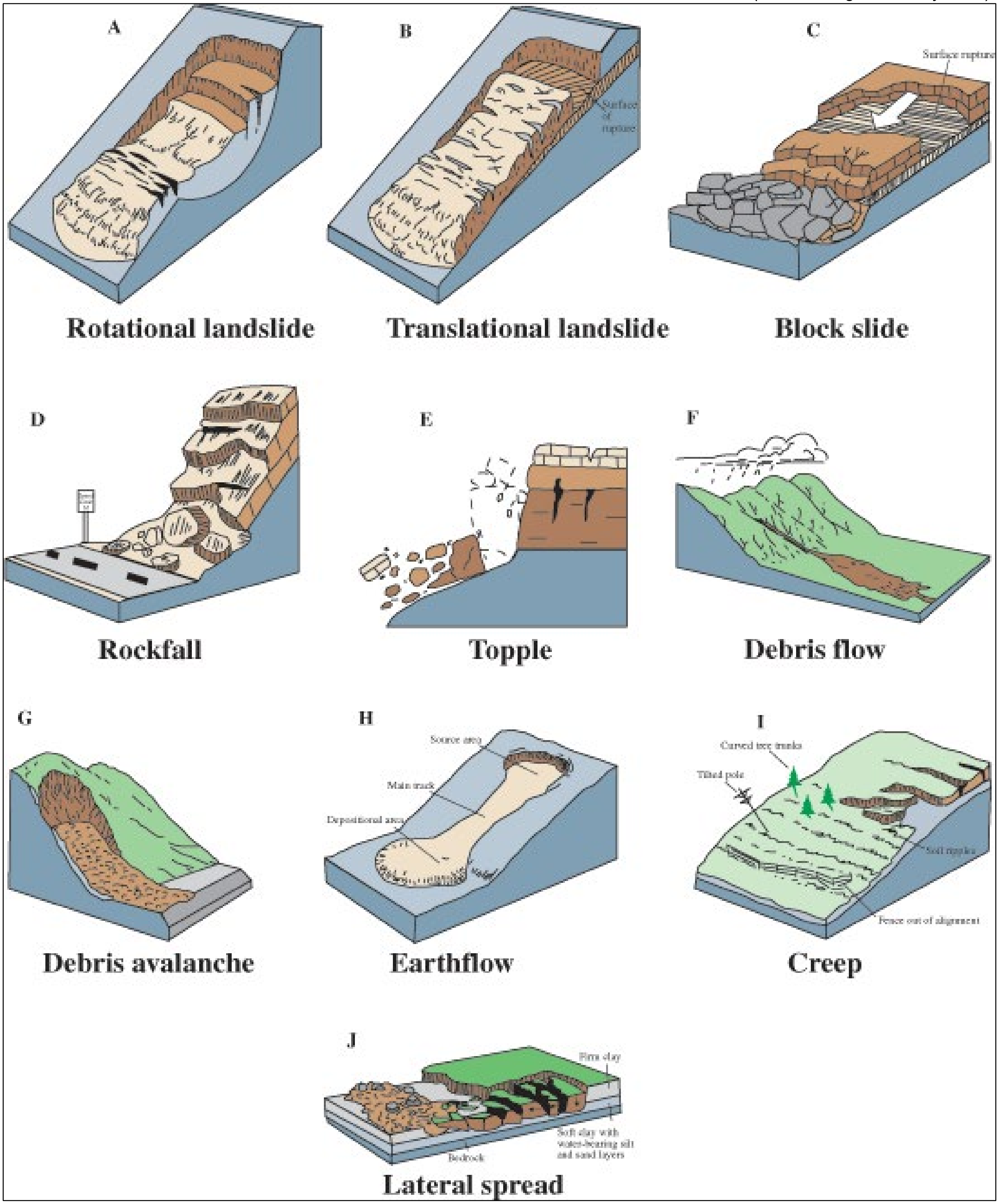


Figure 16-1. Common Landslide Types

16.2 HAZARD PROFILE

16.2.1 Past Events

Ada County has seen landslides primarily in the Boise Foothills. This area is most prone to landslides following large wildfires or heavy rain events. There are no records in the County of fatalities attributed to landslides. However, deaths have occurred across the western U.S. as a result of slides and slope collapses. Events that have caused property damage within the planning area are summarized below.

Early- to Mid-2016

The ground under the Terra Nativa subdivision in the Boise foothills experienced slow sliding for months. Roads and sidewalks buckled. The landslide caused homes to slide off their foundations (see Figure 16-2). Alto Via Court was closed; five of the six homes on the street were deemed unsafe to occupy and were demolished by the city. The sixth home is considered safe to live in, but is vacant. Another property on Strata Via Place was impacted by the landslide and is vacant.

Source: KTBV7

Figure 16-2. Residential and Infrastructure Damage, Alto Via Court

April 2003

Mud slid down a 400-yard embankment, crushed a 4-foot wooden fence and ripped a back door from its hinges on the 3800 block of McGonigull Street in Boise (see Figure 16-3).

December 1996

During the last days of 1996, warm unsettled air from the Pacific Ocean crossed into North Central Idaho dropping rain, snow, frozen rain, sleet and hail. Warming temperatures melted snow and saturated the soil of the area. The result was unstable soil conditions that led to mudslides along miles of the state’s primary roadways between Boise and Lewiston. Although the catastrophic mudslides north of Ada County received much of the press, smaller scale mudslides impacted the homes, driveways, and surface streets where cut banks had been created to site area roads.

Figure 16-3. McGonigull Street Slide

March – May 1973

Landslides along Warm Springs Mesa, some over 100 yards long, closed Starcrest Drive several times over a three-month period. The area was stabilized by installing 17 horizontal drains to release water.

August 20, 1959

During severe thunderstorms in the northeast Boise Foothills, estimated to be a 50- to 100-year rainfall event, 0.30 inches of rain fell in 5 minutes at Deer Point. The peak flow on Cottonwood Creek was 3,000 cfs. Floodwaters were carried by other Foothills creeks draining Shaw Mountain and Aldape Summit. Earlier Lucky Peak fires had denuded the Foothills of vegetation.

Debris flows over 10 inches deep filled basements and yards in north and east Boise. Floodwaters were diverted along Broadway Avenue to the Boise River. Approximately 500 houses were damaged by mud up to 10 inches deep; over 160 acres were covered by silt and debris flows. Hardest hit areas were Reserve Street, East Jefferson, East State, Krall and East Bannock, and Avenues D and E and Warm Springs Avenue.

The agriculture area between Lucky Peak Dam and East Boise suffered extensive property, crop and livestock losses. The Boise police clubhouse on Mountain Cove Road was destroyed, and the Idaho National Guard headquarters on Reserve Street was inundated, breaking out the windows, filling the basement with several feet of water, and destroying equipment and records.

16.2.2 Location

Landslides are typically a function of soil type and steepness of slope. Soil type is a key indicator for landslide potential and is used by geologist and geotechnical engineers to determine soil stability for construction standards. Soils mapping is lacking for the Ada County planning area.

The best available predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant landslide sites is important in the identification of areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding.

To assess the location of potential landslide hazard areas, a dataset of steep slopes was generated using available digital elevation models. Two slope classifications were created: 15 to 30 percent; and greater than 30 percent. Figure 16-4 shows the estimated landslide hazard areas in the Ada County planning area, based on slopes.

16.2.3 Frequency

In Ada County, landslides typically occur during and after major storms, so the landslide potential largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. Until better data is generated specifically for landslide hazards, this severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard. The ground must be saturated prior to the onset of a major storm for significant landslides to occur. Most local landslides occur in January after the water table has risen during November and December. Water is involved in nearly all cases; and human influence has been identified in more than 80 percent of reported slides.

16.2.4 Severity

Landslides destroy property and infrastructure and can take the lives of people. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost to society of about $1.5 billion. There are no records in Ada County of fatalities attributed to landslides. The biggest assets at risk to landslides are roads and infrastructure in landslide-prone area. Landslides can isolate populations due to road closures.

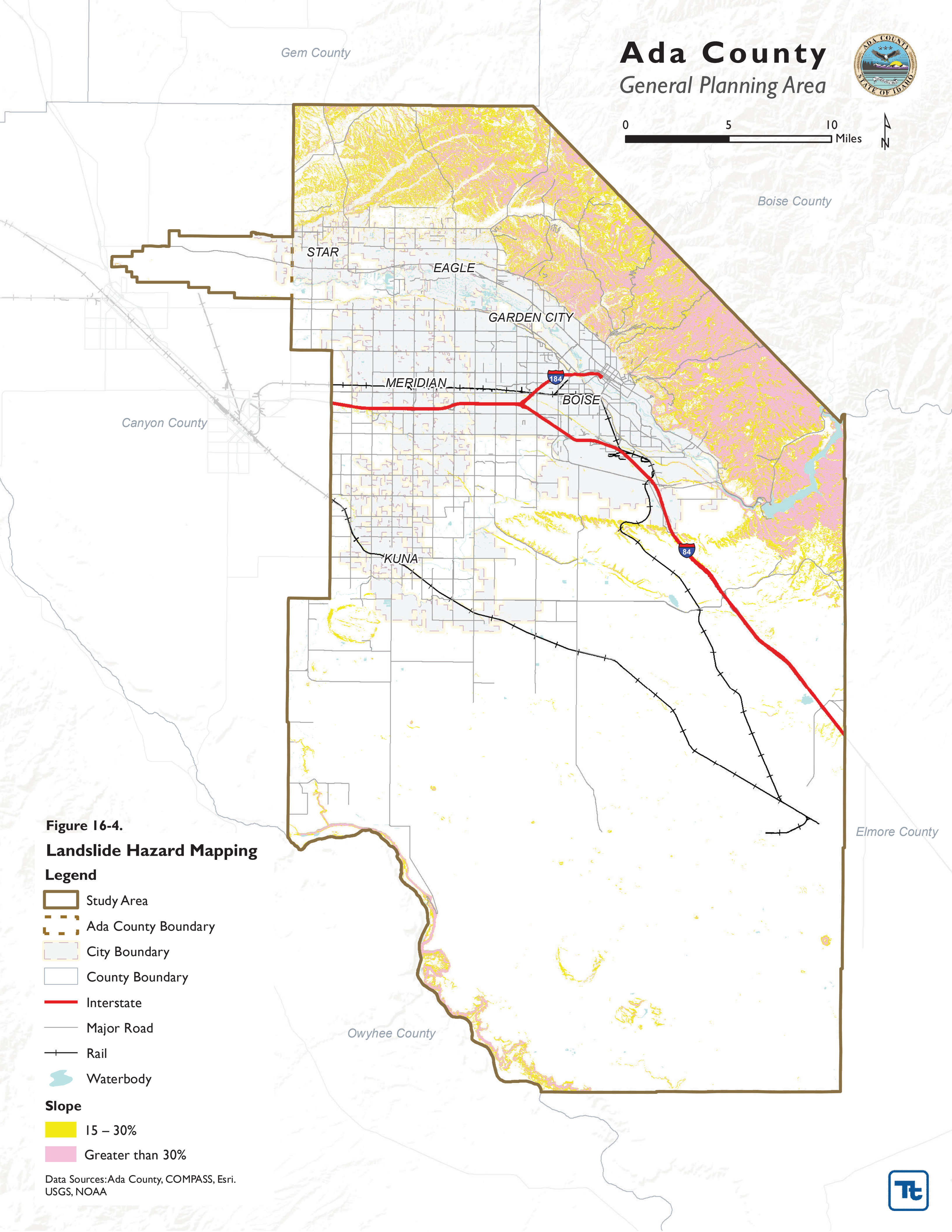


Figure 16-4.

Landslide Hazard Mapping

16.2.5 Warning Time

Landslide velocity can range from inches per year to many feet per second, depending on slope angle, material and water content. Generally accepted warning signs for landslide activity include the following:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped roadbeds
- Rapid increase in creek water levels, possibly accompanied by increased soil content
- Sudden decrease in creek water levels though rain is still falling or recently stopped
- Sticking doors and windows or visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together.

It is possible to determine areas at risk during general time periods based on geology, vegetation, and amount of predicted precipitation for an area. However, there is no practical warning system for individual landslides. The current procedure is to monitor situations on a case-by-case basis and respond after the event has occurred.

16.3 EXPOSURE

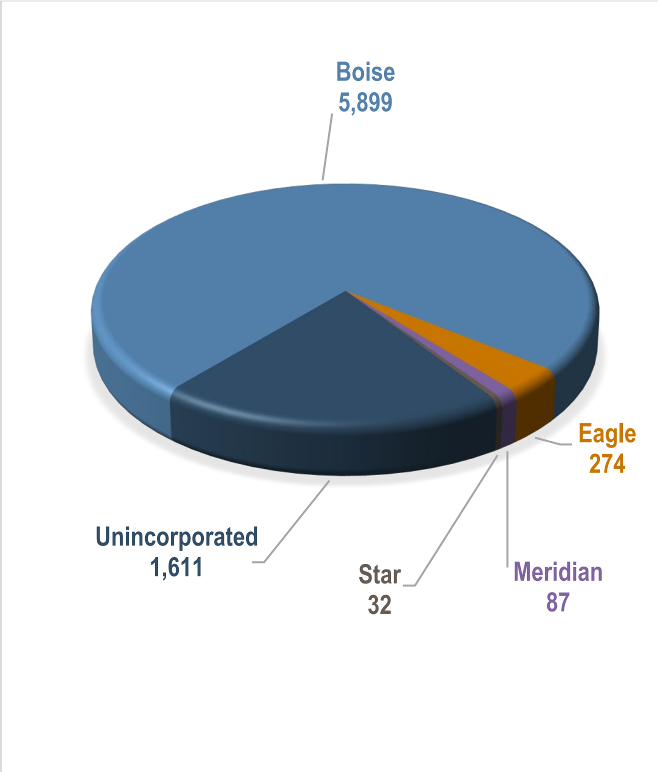
A Level 2 Hazus analysis was used to assess exposure to landslides in the planning area. Where possible, the Hazus default data was enhanced using local GIS data from county, state and federal sources.

16.3.1 Population

Population could not be examined by landslide hazard area because census block group areas do not coincide with the hazard areas. A population estimate was made using the structure count of buildings within the landslide hazard areas. Figure 16-5 and Figure 16-6 summarize the population by municipality living in the two landslide hazard zones (15 to 30 percent slopes, and slopes greater than 30 percent, respectively).

16.3.2 Property

The value of exposed buildings and contents in each jurisdiction is summarized in Figure 16-7 and Figure 16-8 for the 15 to 30 percent slope and greater than 30 percent slope landslide hazard zones, respectively.



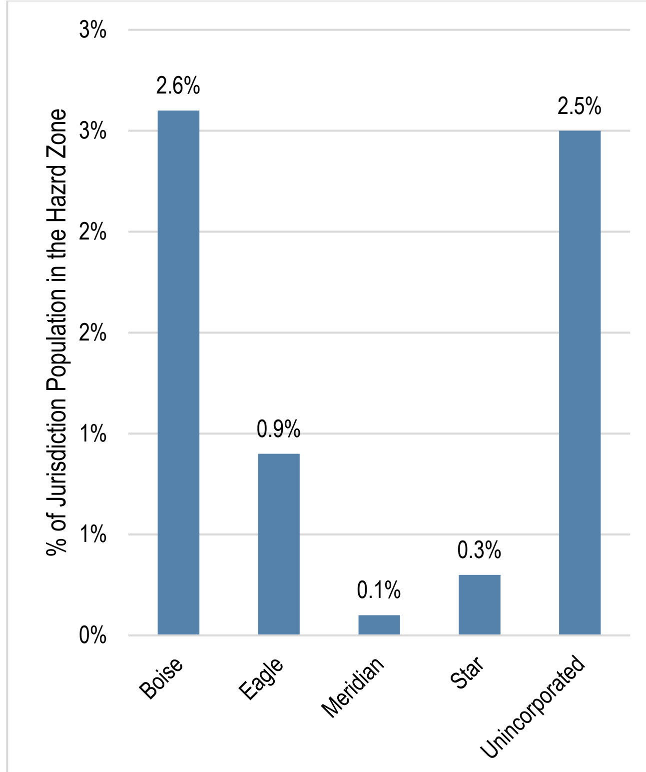
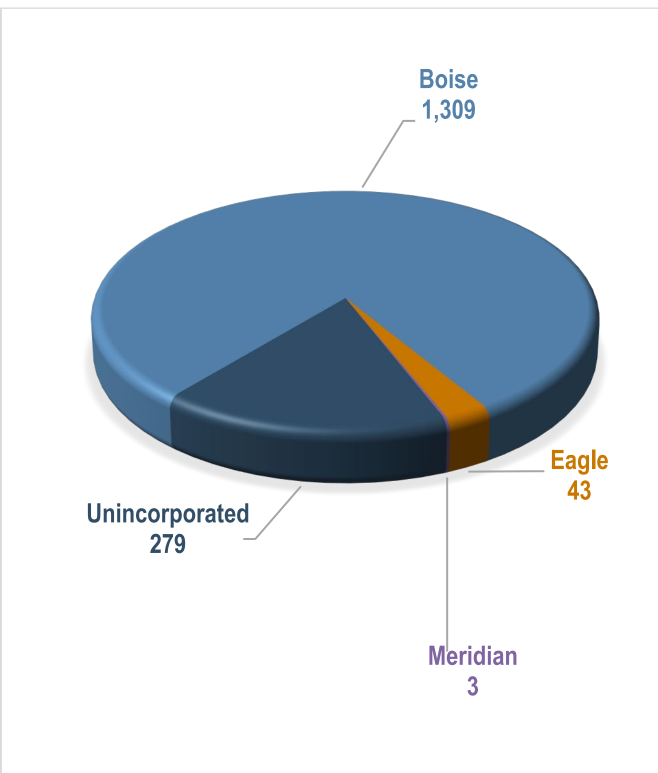


Figure 16-5. Population in the 15% to 30% Slope Landslide Hazard Area



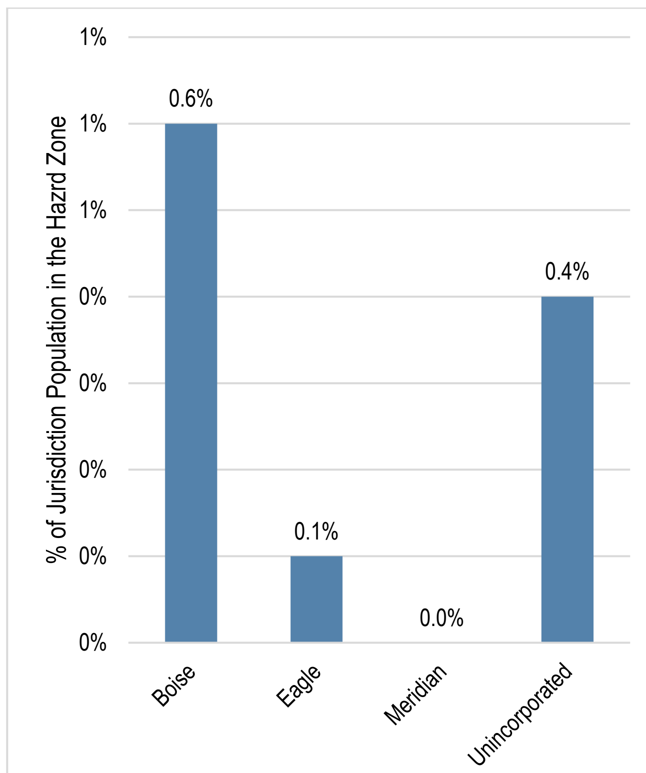


Figure 16-6. Population in the > 30% Slope Landslide Hazard Area

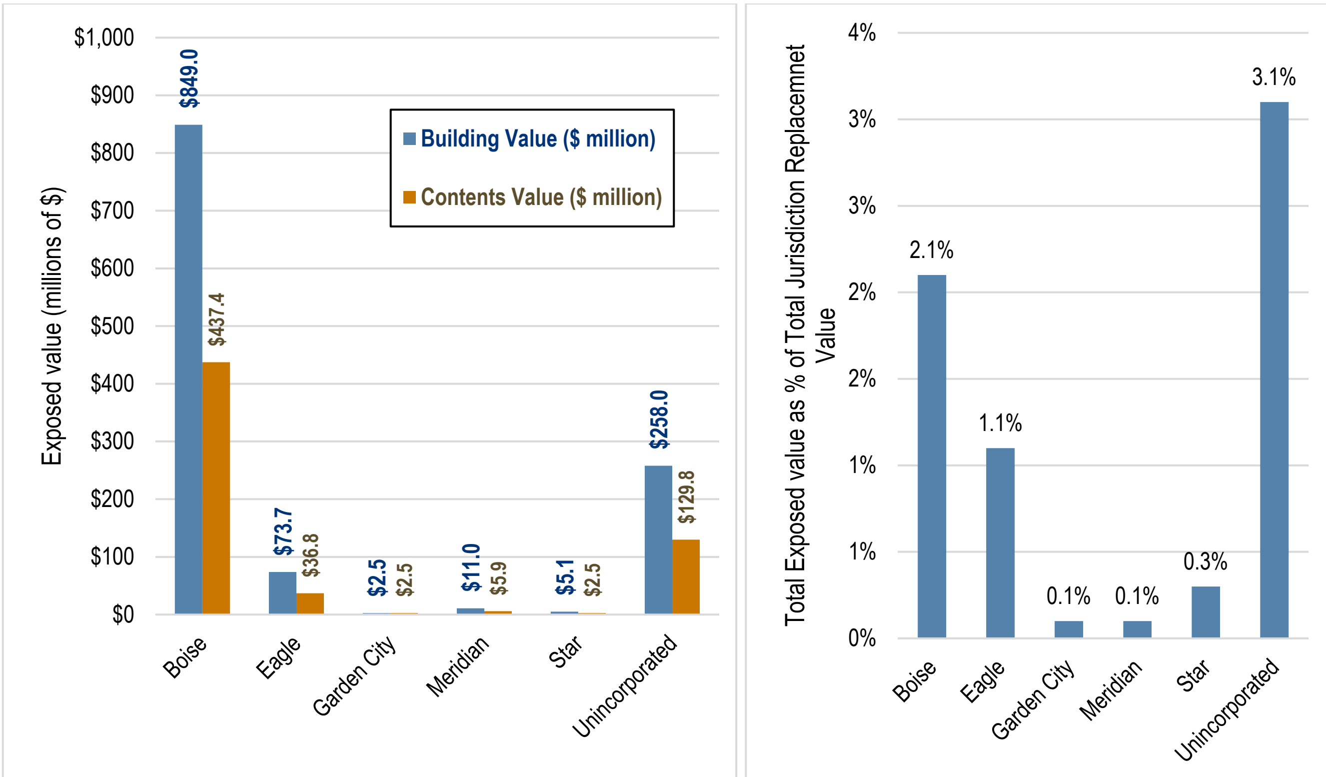


Figure 16-7. Value of Property in the 15% to 30% Slope Landslide Hazard Area

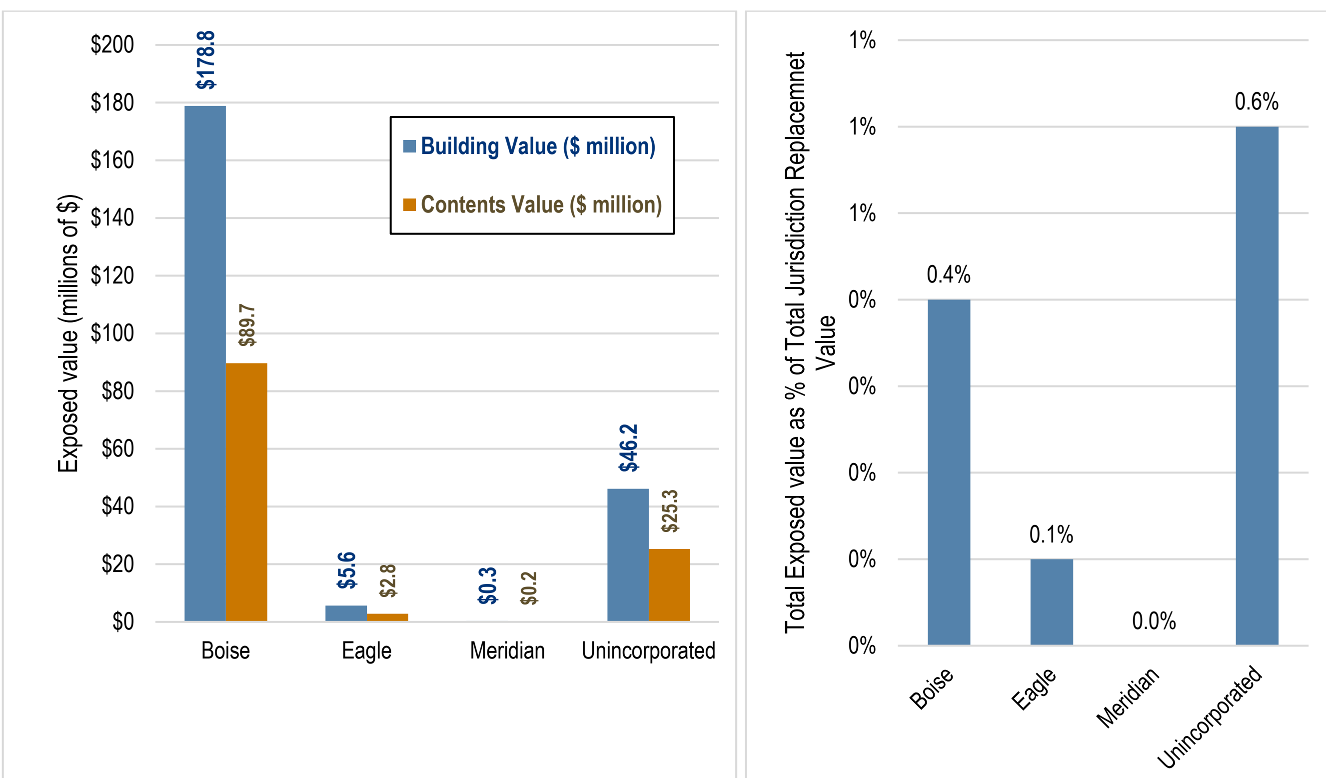


Figure 16-8. Value of Property in the > 30% Slope Landslide Hazard Area

Figure 16-9 summarizes the number of structures in the 15 to 30 percent slope landslide hazard zones by jurisdiction and occupancy class. In the greater than 30 percent slope landslide hazard zones, almost all of the exposed structures are residential, as shown in Figure 16-10. The only other exposed structures in this zone are one commercial structure in Boise and four in unincorporated Ada County.

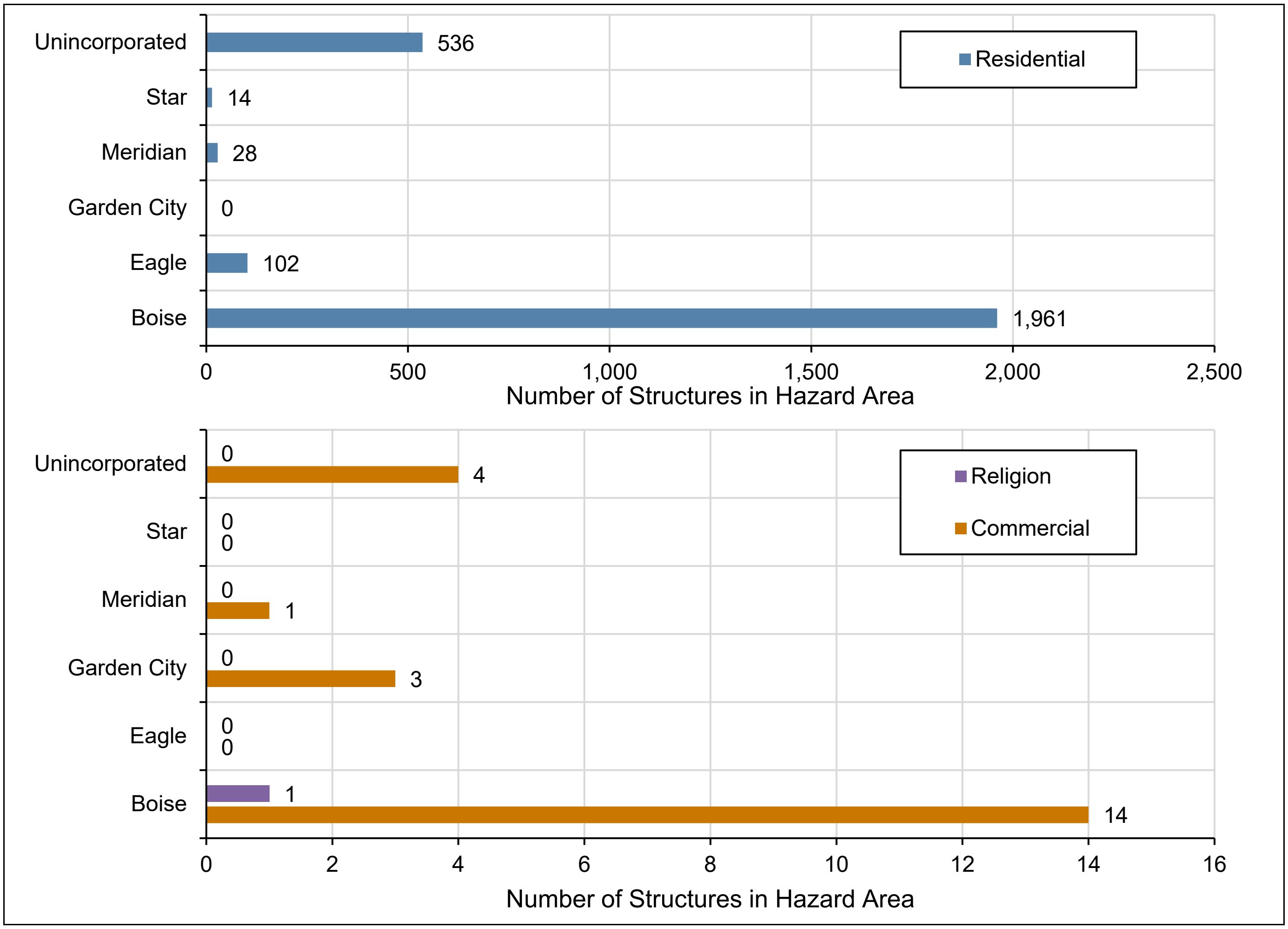


Figure 16-9. Number of Structures Within the 15% to 30% Slope Landslide Hazard Area

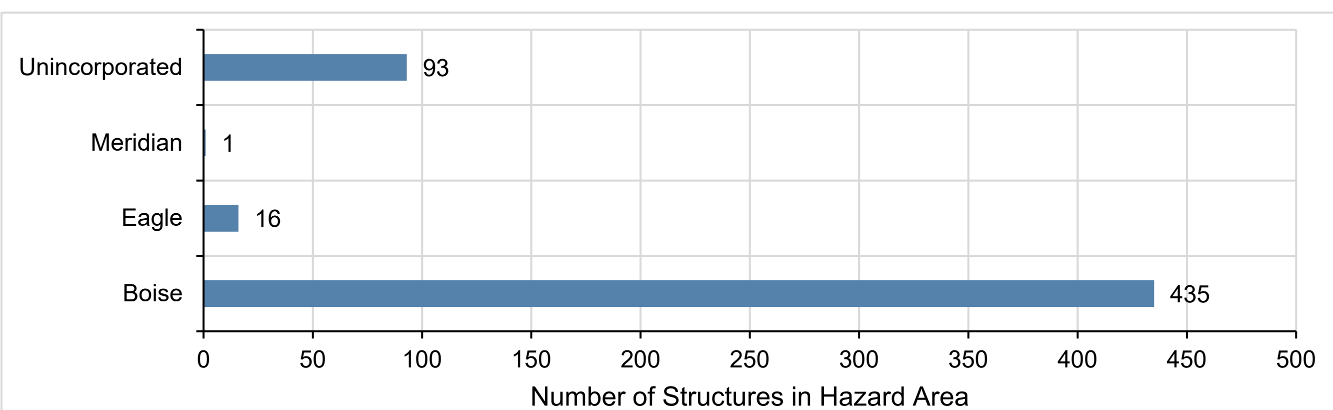


Figure 16-10. Number of Residential Structures Within the > 30% Slope Landslide Hazard Area

16.3.3 Critical Facilities

Figure 16-11 summarizes the critical facilities exposed to the landslide hazard for the countywide planning area. Detailed results by jurisdiction are included in Appendix D.

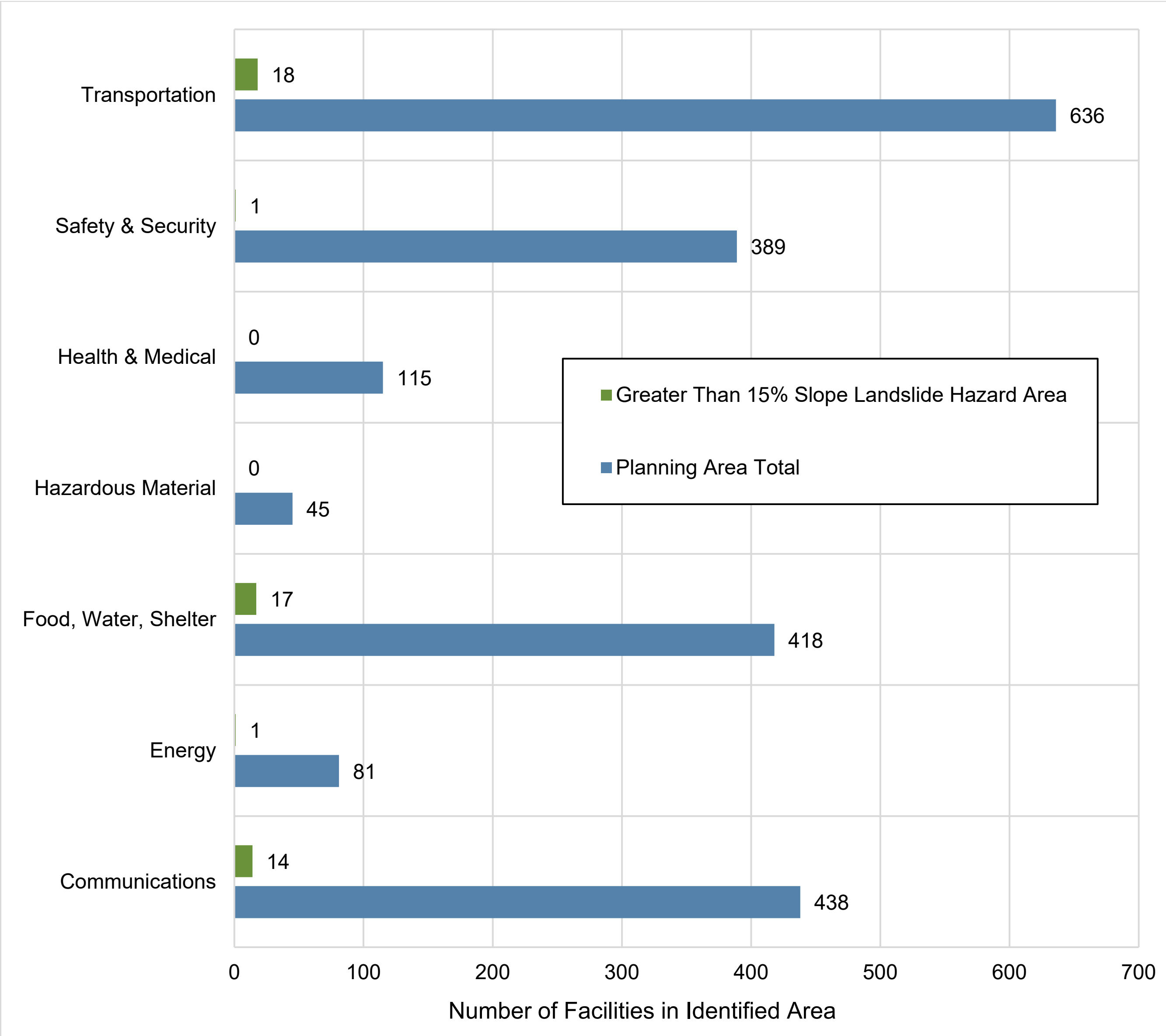


Figure 16-11. Critical Facilities in the Mapped Landslide Hazard Areas and Countywide

A significant amount of infrastructure can be exposed to landslides:

- **Roads**—Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.

- **Bridges**—Landslides can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power Lines**—Power line towers can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.

16.3.4 Environment

All natural areas within the mapped landslide hazard zones are considered to be exposed to the hazard.

16.4 VULNERABILITY

16.4.1 Population

All people exposed to the landslide hazard are potentially vulnerable to landslide impacts. Populations with access and functional needs as well as elderly populations and the very young are more vulnerable to the landslide hazards as they may not be able to evacuate quickly enough to avoid the impacts of a landslide.

16.4.2 Property

Loss estimations for the landslide hazard are not based on modeling using damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 16-1 shows the general building stock loss estimates in landslide risk areas.

Table 16-1. Estimated Building Losses in the Steep Slope Areas

	Building Count	Assessed Value	10% Damage	30% Damage	50% Damage
Boise	81,552	$61,280,836,767	$6,128,083,677	$18,384,251,030	$30,640,418,383
Eagle	12,437	$9,838,649,929	$983,864,993	$2,951,594,979	$4,919,324,964
Garden City	4,385	$3,705,101,875	$370,510,187	$1,111,530,562	$1,852,550,937
Kuna	8,831	$3,886,826,099	$388,682,610	$1,166,047,830	$1,943,413,050
Meridian	40,812	$28,959,315,273	$2,895,931,527	$8,687,794,582	$14,479,657,637
Star	5,065	$2,845,160,473	$284,516,047	$853,548,142	$1,422,580,237
Unincorporated	21,720	$12,472,792,807	$1,247,279,281	$3,741,837,842	$6,236,396,403
Total	**174,802**	**$122,988,683,223**	**$12,298,868,322**	**$36,896,604,967**	**$61,494,341,611**

16.4.3 Critical Facilities

There are 51 critical facilities with potential exposure to landslides due to their location on steep slopes. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from landslides should be done to determine if they could withstand impacts of a landslide.

Several types of infrastructure are exposed to landslides, including transportation, water and sewer and power infrastructure. Highly susceptible areas of the county include mountain roads and transportation infrastructure. At this time, all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available.

16.4.4 Environment

Natural Resources

Landslides can destroy natural assets that are highly valued by the community:

- Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality.
- Hillsides that provide wildlife habitat can be lost due to landslides.
- Endangered species and their critical habitat in the planning area may be located in landslide hazard areas.

Agricultural and Timber Resources

Agricultural resources include rangelands, timberlands, cultivated farmlands and dairy lands. Landslides can have major consequences to such resources, primarily timberland, due to the large percentage of such land in remote locations on steep slopes. Roads accessing timberlands are often susceptible to slides and frequently are contributing factors to landslides. Landslide activity on these roads can remove them from production.

Cultural Resources

Landslides can destroy cultural resources such as artifacts and structures.

16.5 DEVELOPMENT TRENDS

The value of planning area properties exposed to the landslide hazard has increased by 48 percent ($701.5 million) since the last hazard mitigation plan update in 2017. This increase in risk exposure can be attributed to a population growth of 13.6 percent in the same period.

While landslides are not generally hazards addressed in comprehensive plans, the risk assessment in this plan creates an opportunity for Ada County and its planning partners to consider the inclusion of landslide hazards in their comprehensive plans. A key component to support this action would be the availability of good sub-surface soil mapping using the best available data, science and technology. It is anticipated that this data will be available in the near future. In the meantime, Ada County and its planning partners are equipped to deal with new development on a case-by-case basis through enforcement of the International Building Code. The IBC includes provisions for geotechnical analyses in steep slope areas that have soil types susceptible to landslides. These provisions ensure that new construction is built to standards that reduce the vulnerability to landslides.

16.6 SCENARIO

Major landslides in Ada County occur as a result of soil conditions that have been affected by severe storms, groundwater or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm that had heavy rain and caused flooding. Landslides are most likely during late winter when the water table is high. After heavy rains from November to December, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and accumulates on impermeable silt, it will cause weakness and destabilization in the slope. A short intense storm could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table and poor soil exacerbate hazardous conditions.

Landslides are becoming more of a concern as development moves outside of city centers and into areas less developed in terms of infrastructure. Most landslides would be isolated events affecting specific areas. It is probable that private and public property, including infrastructure, will be affected. Landslides could affect bridges that pass over landslide prone ravines and knock out rail service through the county. Road obstructions caused by landslides would create isolation problems for residents and businesses in sparsely developed areas. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communication access to residents.

Continued heavy rains and flooding will complicate the problem further. As emergency response resources are applied to problems with flooding, it is possible they will be unavailable to assist with landslides occurring all over Ada County.

16.7 ISSUES

Important issues associated with landslides in Ada County include the following:

- Sub-surface soils mapping is needed to better understand the landslide risk potential within the planning area.
- There are existing homes in landslide risk areas throughout the county. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- Future development could lead to more homes in landslide risk areas, especially as development moves into the Boise Foothills.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- The impact of future climate conditions on landslides is uncertain. If future climate conditions impact atmospheric conditions, then exposure to landslide risks is likely to increase.
- Landslides may cause negative environmental consequences, including water quality degradation.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- A buildable-lands analysis that looks at vacant lands and their designated land use would be a valuable tool in helping decision-makers make wise decisions about future development.

17. PUBLIC HEALTH EMERGENCY/PANDEMIC

17.1 GENERAL BACKGROUND

17.1.1 Description

An outbreak is defined by the U.S. Centers for Disease Control and Prevention (CDC) as the occurrence of more cases of disease than normally expected within a specific place or group of people over a given period of time. State and local regulations require immediate reporting of any known or suspected outbreaks by health care providers, health care facilities, laboratories, veterinarians, schools, child day care facilities, and food service establishments. An epidemic is a localized outbreak that spreads rapidly and affects a large number of people or animals in a community. A pandemic is an epidemic that occurs worldwide or over a very large area and affects a large number of people or animals.

A new virus strain or subtype that easily transmits between humans can cause a pandemic. Bacteria that become resistant to antibiotic treatment may also be behind a rapid spread. Sometimes, pandemics occur when new diseases develop the ability to spread rapidly, such as COVID-19. Humans may have little or no immunity against a new virus. Often, a new virus cannot spread between animals and people. However, if the disease changes or mutates, it may start to spread easily, and a pandemic may result. Seasonal flu epidemics generally occur because of a viral subtype that is already circulating among people. Novel subtypes, such as COVID-19, generally cause pandemics. These subtypes will not previously have circulated among humans. A pandemic can lead to social disruption, economic loss, and general hardship on a wide scale (Felman 2020).

According to the 2018 Idaho State's Hazard Mitigation Plan, factors in Idaho that heighten the probability of occurrences of such events include large numbers of travelers arriving via the region's airports, the transportation of infected animals into the area, or disease transmission through individuals transporting or coming into contact with infectious patients. (State of Idaho Hazard Mitigation Plan 2018).

17.1.2 Diseases with Pandemic Potential

The Idaho Office of Emergency Management has identified the following diseases that have become, or have the potential to become widespread in the area:

- **COVID-19** is a respiratory virus. People at high risk (those with certain underlying conditions, the elderly, the very young, and pregnant women) can develop severe illness that results in hospitalization or death.
- **Ebola virus disease** is a rare and deadly disease caused by infection with one of the Ebola virus species. Ebola viruses are transmitted through direct contact with contaminated blood or body fluids of a person who is sick or has died from Ebola. There have been no reported cases of Ebola virus disease contracted

in the United States, but two U.S. residents were infected with Ebola virus in 2014 while traveling to areas where it is found, and were diagnosed in the United States. Two healthcare workers who provided care for the first of these patients also became infected with Ebola virus.

- **HIV** (human immunodeficiency virus) is a viral infection transmitted by sexual intercourse, sharing needles or syringes, contaminated blood transfusions, or from infected mother to child during pregnancy or breastfeeding. This disease, first recognized by the CDC in 1981, compromises the immune system. There is no effective cure for HIV, but HIV can be controlled with proper medical care and antiretroviral therapy.
- **Influenza** is an infectious viral disease of birds and mammals commonly transmitted through aerosols produced by coughing or sneezing. People who have influenza can have some or all of these symptoms: fever, cough, sore throat, runny nose, muscle aches, headaches, fatigue, and sometimes vomiting an diarrhea. Complications from influenza can be moderate (e.g., sinus or ear infections) to severe (e.g., pneumonia, inflammation of the heart, inflammation of the brain, failure of multiple organs, or death). Influenza virus strains that were new or had not circulated in a while caused pandemics in the late 20th and 21st centuries (CDC 2018).
- **Measles** is a serious respiratory disease caused by the measles virus. It can lead to pneumonia, encephalitis (swelling of the brain), and death. The measles-mumps-rubella vaccine protects against measles.
- **Mosquito-borne diseases** are those spread by the bite of an infected mosquito. Diseases that are spread to people by mosquitoes include Chikungunya, dengue, malaria, Saint Louis encephalitis, West Nile virus disease, and Zika virus disease.
- **Mumps** is a contagious disease caused by the mumps virus. It is spread through saliva or mucus from the mouth, nose, or throat through coughing, sneezing or talking, sharing items such as cups or eating utensils, and touching contaminated objects. Mumps typically starts with a few days of fever, headache, muscle aches, tiredness, and loss of appetite, followed by swollen and tender salivary glands under the ears on one or both sides. Some people who get mumps have very mild or no symptoms; most people with mumps recover completely in a few weeks. The best way to protect against mumps is to be vaccinated with the measles-mumps-rubella vaccine.
- **Pertussis (whooping cough)** is a highly contagious respiratory disease caused by the pertussis bacterium. It causes violent persistent coughing. Whooping cough is most harmful for young babies and can be deadly. Vaccines that protect against pertussis include DtaP, for babies and children, and Tdap for preteens, teens, and adults.
- **Plague** is a disease that affects mammals, caused by the bacterium *Yersinia pestis*. Humans usually get plague after rodent fleabite carrying the bacterium or by handling an infected animal. Historically, plague pandemics have killed millions of people in Asia and Europe (CDC 2021). Today, modern antibiotics are effective in treating plague. Without prompt treatment, the disease can cause serious illness or death. Human plague infections continue to occur in the western United States, but significantly more cases occur in parts of Africa and Asia. An outbreak of plague among ground squirrels occurred in southwestern Idaho during 2016 and 2017. In 2018, a boy in Elmore County, Idaho contracted the first case of bubonic plague in the state in 26 years.
- **Rabies** is a viral disease of mammals most often transmitted through the bite of a rabid animal. It infects the central nervous system, ultimately causing disease in the brain and death. Over the last 100 years, rabies in the United States has changed dramatically. More than 90 percent of all animal cases reported annually to CDC now occur in wildlife; before 1960 the majority were in domestic animals. Two bats with rabies were found in Ada County in 2020, but none were reported in 2021.

- **Severe acute respiratory syndrome (SARS)** is a viral respiratory illness caused by a coronavirus, called SARS-CoV. SARS was first reported in Asia in 2003. The illness spread to more than two dozen countries in North America, South America, Europe, and Asia before the global outbreak was contained.
- **Tuberculosis** is a disease caused by a bacterium called *Mycobacterium tuberculosis*. The bacteria usually attack the lungs, but can attack any part of the body such as the kidney, spine, and brain. If not treated properly, tuberculosis can be fatal. It is spread through the air from one person to another. The bacteria are put into the air when a person with tuberculosis coughs, sneezes, speaks, or sings.

17.1.3 Secondary Hazards

While pandemic events do not influence natural hazards, secondary impacts are far-reaching as has been seen during the COVID-19 pandemic. In addition to health impacts, disease outbreaks reaching pandemic proportions can cause social and economic impacts on a global scale (Shang, Li and Zhang 2021). Civil disorder, protests, depression, and anxiety are a few of the social impacts of the COVID-19 pandemic. Economic impacts include unemployment, price increases, and supply chain interruptions (Center on Budget and Policy Priorities 2022).

17.2 HAZARD PROFILE

17.2.1 Past Events

Between 1953 and 2022, FEMA issued only one disaster declaration for the State of Idaho for a pandemic-related event. Ada County was included in this declaration for COVID-19. Known disease outbreaks that have impacted Ada County between 1918 and 2022 are identified in Table 17-1.

Table 17-1. Public Health Emergencies and Pandemics in Ada County

Type of Event	Dates	Description
Influenza	1918	Caused an estimated 50 million deaths worldwide and about 675,000 in the United States. Communities throughout Idaho reported 1918 influenza outbreaks and deaths and prohibited public events. The state Board of Health cancelled public and private schools statewide in hopes of preventing the spread to children and families. The pandemic of 1918 first affected Idaho in Canyon County. In less than two weeks, the number of cases grew to the extent the state was unable to track the disease accurately. Case records are not available on a county level.
Influenza	1957-1958	Killed an estimated 1.1 million people worldwide and 116,000 in the United States. In Idaho, 49 deaths were attributed to the pandemic. Case records are not available on a county level.
Influenza	1968-1969	Caused an estimated 1 million deaths worldwide and about 100,000 in the United States. In Idaho, 61 deaths were attributed to the pandemic. Case records are not available on a county level.
West Nile Virus	2004-present	Between 2003 and 2021, 327 human cases of West Nile Virus were reported in Ada County. 2006 had the majority of the cases at 252 reported.
Influenza	2009-2010	Killed nearly 12,000 Americans from 2009 through 2010; widespread in Idaho and led to several deaths. Case records are not available on a county level.
COVID-19 Pandemic	January 2020-present	As of March 31, 2022, 112,335 confirmed COVID-19 cases and 1,009 deaths have been reported in Ada County.

Sources: (State of Idaho Hazard Mitigation Plan 2018), (CDC 2022), (Idaho Division of Public Health 2022)

17.2.2 Location

Public health emergencies and pandemics can occur without regard for location. However, factors such as density, visitation, and the length of time in which the public spends in a location all contribute to the spread of infectious diseases. For example, influenza and COVID-19 are more likely spread by persons in close contact. Indoor areas in which people are in close contact with each other appear to be significant vectors for diseases that are spread through respiratory droplets. Infectious diseases spread by insects may be subject to other types of location hazards. For example, the prevalence of standing water can provide breeding grounds for mosquito-borne diseases such as West Nile Virus. Diseases that can infect humans are variable in nature and methods of transmission. Ultimately, residents need to be vigilant about diseases altogether in order to better understand and respond to public health emergencies and pandemic hazards.

17.2.3 Frequency

Public health emergencies and pandemics have occurred at a rate of 1 every 15 to 20 years in Ada County. The COVID-19 pandemic is by far the longest in duration. It has been ongoing for more than two years at the writing of this plan.

17.2.4 Severity

Widespread sickness and loss of life can result from public health emergencies and pandemics. The COVID-19 pandemic infected nearly 500 million people and caused more than 6 million deaths worldwide in just 27 months and is still ongoing (Worldometer 2022).

17.2.5 Warning Time

Pandemics can occur with very little warning. Air travel can hasten the spread of a new organism and decrease the time available for early implementation of interventions. Influenza outbreaks are expected to occur simultaneously throughout much of the United States, preventing shifts in human and material resources that usually occur in response to other disasters. Warning time for influenza will depend on the origin of the virus and the amount of time needed to identify the virus.

17.3 EXPOSURE AND VULNERABILITY

Health hazards that affect the residents of Ada County may arise in a variety of situations, such as during a communicable disease outbreak, after a natural disaster, or as the result of a bioterrorism incident. All populations in Ada County are susceptible to pandemic events. Populations who are young or elderly or have compromised immune systems are likely to be more vulnerable. The relative ease of world-wide travel in addition to the world's expanding global food industry ensures that all countries are vulnerable to pandemic events at any time.

17.4 DEVELOPMENT TRENDS

Future population growth will directly impact the County's vulnerability to public health emergencies and pandemics. The population of Ada County is projected to increase by 186,756, or 37 percent between 2020 and 2040 (COMPASS 2021). As the population grows, so will population density, which will increase the chance of transmission of communicable diseases from person to person. New structures close to water bodies or areas with high population density are at an increased risk.

17.5 SCENARIO

A worst-case scenario would be a global pandemic similar to COVID-19. This could lead to sickness and deaths; strain on healthcare systems; income stress and financial loss; and negative mental health impacts.

17.6 ISSUES

Many lessons have been learned and issues have been overcome during the COVID-19 pandemic. However, adequate health care staffing and response capabilities should continue to be considered in emergency management.

18. RADIOLOGICAL EVENT

18.1 GENERAL BACKGROUND

18.1.1 Description

Radiological incidents produce radiation without detonation of a nuclear device. They may occur for a wide variety of reasons and can range significantly in scope and severity. Even very small amounts of certain radiological sources can cause significant contamination of the environment. Radiological incidents can occur anywhere within the United States and throughout the world.

Radiation can come in two forms (State of Idaho Hazard Mitigation Plan 2018):

- Ionizing radiation is energetic waves or particles that have sufficient energy to ionize other atoms. This results in the biological breakdown of DNA and cellular molecules in all living organisms exposed to it. This can lead to skin rash, radiation sickness (nausea, vomiting, diarrhea), or death, depending on the radiation dose absorbed by the body.
- Non-ionizing radiation is electromagnetic radiation that lacks sufficient energy to ionize atoms or molecules. The danger posed by non-ionizing radiation sources (lasers, microwave- or ultraviolet-producing machines and linear accelerators) is injury to the eyes or skin.

The most common radiological incidents occur because of loss, theft, or mismanagement of relatively minor or low-level radioactive sources material. Natural hazards, such as fires and extreme weather, may impact radiological facilities, resulting in an incident. The 2011 Fukushima Daiichi nuclear disaster is an example of how a natural hazard (in that case, a tsunami) could result in a major international nuclear or radiological incident. Radiological incidents can also result from terrorist attempts to acquire or use nuclear threat devices.

18.1.2 Types of Radiological Events

Naturally Occurring Radioactive Material

Natural sources of radioactive elements are found in air, water, soil, and human bodies. Ionizing particulate and electromagnetic radiation are generated in the environment by naturally occurring radioactive material in the earth's crust (terrestrial radioactivity, radon) or through the effects of cosmic radiation originating outside the earth's atmosphere. Thorium and uranium are naturally occurring radioactive elements that are used as nuclear fuels. The Treasure Valley, where Ada County is located, contains elevated levels of uranium in the groundwater (Neace 2020).

Technologically Enhanced Naturally Occurring Radioactive Material

Technologically enhanced naturally occurring radioactive material (TENORM) is defined as naturally occurring radioactive materials that have been concentrated or exposed to the accessible environment through human activities such as manufacturing, mineral extraction, or water processing (EPA 2021). Industrial sectors that generate TENORM are mining, energy production, community drinking water treatment, and some consumer products (fertilizer, cigarettes, building materials). TENORM is generated by nuclear reactors or high energy particle accelerators. Relatively high levels of ionizing electromagnetic radiation are produced using X-ray machines.

Radioactive materials are often encapsulated so that the ionizing electromagnetic radiation they produce may be used without the hazard posed by uncontained radioactive contamination. Technologically produced radioactivity and radiation are used extensively in medical and industrial applications. Everyone receives varying amounts of radiation exposure from natural and technological sources (Ada County Multi-Hazard Mitigation Plan 2017).

Radiological Dispersal

Radioactive material can be dispersed by conventional explosive or other mechanical means, such as a spray. Dirty bombs are one type of radiological dispersal device. A dirty bomb spreads radioactive material by detonation of conventional explosive (see Figure 18-1). It kills or injures people through the initial blast and spreads radioactive contamination over possibly a large area. Such bombs could be miniature devices or large truck bombs (U.S. Department of Health & Human Services 2022). Passive or active dispersion can be achieved with unsealed radioactive material through means such as depositing the material in soil or water or a dropping it from an airborne device. Radioactive sources can be solid, aerosol, gas, or liquid, and contamination of people may occur via air, water, soil, or food (U.S. Department of Health & Human Services 2022).

Source: U.S. Department of Health and Human Services

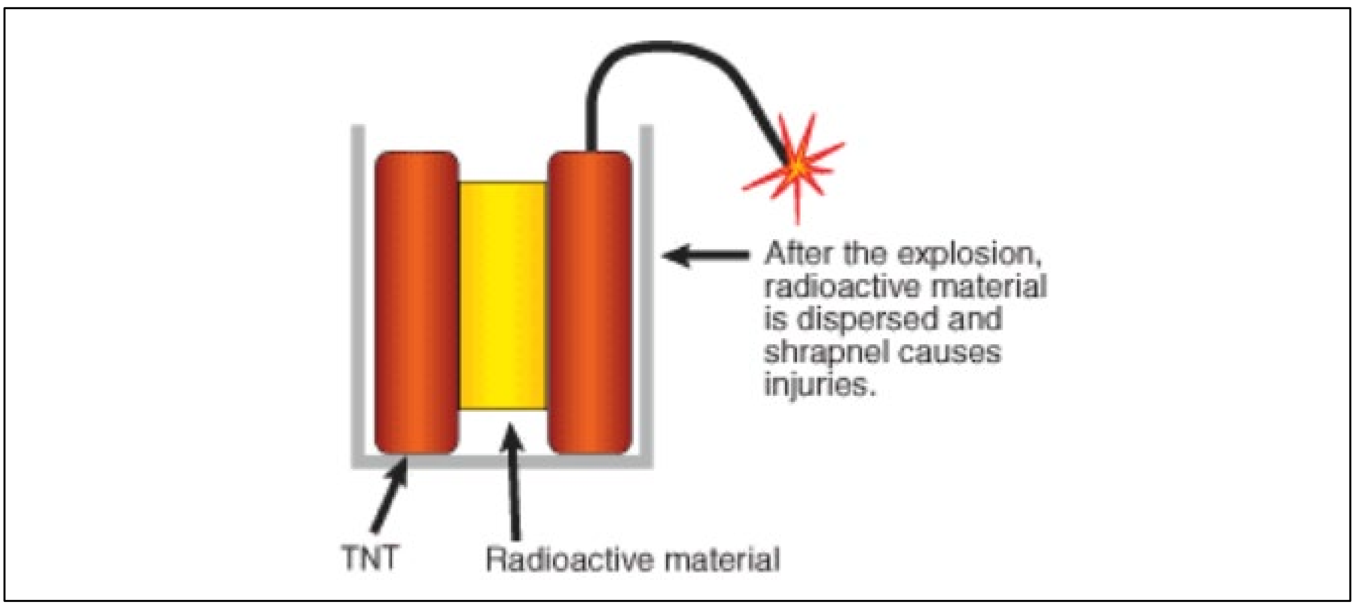


Figure 18-1. Dirty Bomb: Radiological Dispersal Device Using an Explosive

Radiological Exposure Device

A radiological exposure device, sometimes called a "hidden sealed source," is a terrorist device intended to expose people to significant doses of ionizing radiation without their knowledge. Constructed from partially or fully unshielded radioactive material, a radiological exposure device could be hidden from sight in a public place (e.g., under a subway seat, in a food court, or in a busy hallway), exposing those who sit or pass close by. If the seal around the source were broken and the radioactive contents released from the container, the device could become a radiological dispersal device, capable of causing radiological contamination.

18.1.3 Secondary Hazards

The secondary impacts associated with radiological incidents include those impacting the health of the community and environment. Depending on the severity of exposure, impacts may include temporary illness or injury, permanent medical conditions, or death. Secondary impacts have the potential to occur regardless of whether the incident is naturally occurring or man-made. From a human-caused perspective, it is possible that small or large-scale radiological incidents could initiate civil disturbances.

18.2 HAZARD PROFILE

18.2.1 Past Events

An example of radiological contamination using TENORM occurred in Ada County in 2014. An individual was collecting uranium and thorium ore, grinding it up, and trying to chemically activate and produce uranium yellow cake to sell online. This resulted in a multi-million dollar EPA cleanup of the individual's apartment and storage units. Given that these materials were naturally occurring, or below Nuclear Regulatory Commission (NRC) license limits, these activities went unnoticed for a long period of time until the NRC was notified about the individual attempting to ship a box into another country. This is an example of how small quantities of material can lead to large cleanup operations and a potential public hazard. While no members of the general public where exposed to these materials, an apartment fire could have drastically changed this scenario and its impact on surrounding neighborhoods (State of Idaho Hazard Mitigation Plan 2018).

Between 1954 and 2022, FEMA has not included Ada County or the State of Idaho in any radiological-related disasters or emergency declarations.

18.2.2 Location

Radiological materials are found in many locations. The NRC does not identify any licenses in Ada County, but it requires licenses only for sources with activities greater than 10 microcuries (a unit of radioactivity). Anyone can purchase industrial button sources of multiple isotopes online, and have them shipped to their home. While the quantity and activity of radioactive material in these sources is small, they could still be used for nefarious activities. Individuals also may be able to acquire naturally occurring materials like ore directly or from online sources.

Technologically produced sources are used extensively in medical and industrial applications. These sources have the highest probability of being involved in a radiological incident, due to the large quantities in medical facilities and the high frequency with which they are shipped or transported on local roads. They pose a high risk of overall impact on an area, depending on the isotope and its half-life.

Radiological incidents that happen in surrounding counties can also be carried into Ada County through multiple environmental and economic pathways. For these reasons, the risk for radiological emergencies exists throughout the entire county.

18.2.3 Frequency

Radiological events are difficult to predict. Currently, there are no identified TENORM issues in Ada County, although there is a relatively high potential for TENORM generation given the extractive industries operating in the county and the occurrence of uranium ore deposits in the county. Radioactive sources are used in a wide variety of industrial and consumer applications, including soil density/moisture gauges, smoke detection, well logging, weld inspection, and radioluminescent devices. Incidents involving manmade radioactivity in these applications have occurred sporadically, so the future rate of occurrence of incidents involving industrial radioactive sources cannot be projected on the basis of past experience. However, future incidents should be anticipated.

The most prevalent use of radioactive material in Idaho is for nuclear medicine. Hospitals and clinics in every region use radioactive isotopes for diagnostics and treatment. Medical isotopes are typically transported by common carrier either by air or road. Typically, nuclear medical applications involve use of relatively large amounts of short-lived radioactivity. Incidents involving radiopharmaceuticals could result in unintended exposures, but are not likely to pose a long-lasting hazard.

Safe transport will remain a small concern as nuclear spent fuel shipments continue in Idaho. Fuel shipments are transported in massive containment vessels via rail that undergo strict accident-proof testing criteria; therefore, these shipments pose little to no actual risk to the general public. Radioactive waste from the Idaho National Laboratory Cleanup Project facilities in eastern Idaho is transported by railway to the Waste Isolation Pilot Plant in New Mexico. These shipments pose a low risk for emergency due to the strict requirements for the vessels they are shipped in. No accidents have been reported in transporting spent fuel in Idaho.

18.2.4 Severity

All sources of energy pose some risk to human health or environmental quality. Radiation protection standards for humans, embodied in regulations that U.S. nuclear facilities must adhere to, exceed ample protection for other species and for ecosystems. Each year, U.S. residents receive an average dose from natural background radiation of about 3.1 millisievert (mSv). Medical procedures add another 3.1 mSv on average, for a total of 6.2 mSv per year. The NRC is the primary agency for regulating radioactive materials and ensuring public safety. The NRC set a radiation dose limit from regulated radiation sources of 1 mSv in a year and 0.02 mSv in an hour for a member of the public; this excludes natural and medical uses of ionizing radiation (U.S. Nuclear Regulatory Commission 2021).

Exposure to high levels of radiation is known to cause cancer and, at very high levels, radiation poisoning and even death. But the effects on human health from very low doses of radiation—such as exposure to varying levels of background radiation—does not significantly affect cancer incidence (UNSCEAR 2000).

18.2.5 Warning Time

The warning time for an incident occurring will vary and depends on the nature and scope of the incident. At facilities that handle radioactive material or any place where radiation-producing equipment is used, the radiation tri-foil sign (shown at right) must be displayed. This sign is used as a warning to protect people from being exposed to radioactivity (U.S. Departement of Health & Human Services 2021).

18.3 EXPOSURE AND VULNERABILITY

Radiological events that affect the residents of Ada County may arise in a variety of situations, such as a transportation accident involving radioactive materials, an accidental or intentional release at a fixed facility, or if used during a terrorist attack. All populations in Ada County are susceptible to radiological events. Populations who live or work near major transportation routes and fixed-facility locations are likely to be more vulnerable.

18.4 DEVELOPMENT TRENDS

Future population growth will directly impact the County's vulnerability to radiological events. The population of Ada County is projected to increase by 186,756, or 37 percent between 2020 and 2040 (COMPASS 2021). New structures close to fixed facilities and major transportation routes are at an increased risk.

18.5 SCENARIO

A worst-case scenario would be a terrorist attack using a radiological dispersal device. This could lead to immediate injury or death of those nearby from the explosion and sickness and death over a much larger area from radiation. The affected area could be considered contaminated and uninhabitable for decades.

18.6 ISSUES

Important issues associated with radiological events in Ada County include the following:

- Facilities using or transporting radiological materials need to continue to be monitored and regulated closely.
- Education needs to be available about naturally occurring radiological materials.

19. UTILITY FAILURE

19.1 GENERAL BACKGROUND

19.1.1 Description

A power failure (also referred to as a power outage) is any interruption or loss of electrical service caused by disruption of power transmission due to accident, sabotage, natural hazards, or equipment failure. A significant power failure is defined as any incident of a long duration, which would require the involvement of the local and/or state emergency management organizations to coordinate provision of food, water, heating, cooling, and shelter.

Widespread power outages can occur without warning or as a result of a natural disaster. Generally, warning times are short in the case of technological failure, such as a fire at a sub-station, traffic accident, human error or terrorist attack. When a power failure is caused by natural hazards, greater warning time is possible. For example, high wind events such as tornados and hurricanes often cause widespread power failure, and are often forecasted before they affect a community. Additionally, severe winter weather conditions such as ice storms, blizzards, and snowstorms often cause power failure. Incidents such as these often have plenty of warning time, so power response crews can stage resources to prepare for power failure.

19.1.2 Secondary Hazards

Power failures can lead to secondary hazards, with negative impacts on the health and safety of residents:

- During periods of extreme heat or extreme cold, vulnerable populations such as the elderly and medically frail can be susceptible to hypothermia or heat stroke.
- Power failure can lead to food spoilage, which has negative impacts on public health.
- Residents who rely on electric medical devices such as home oxygen machines, medication nebulizers, home dialysis, infusion pumps, and electric wheelchairs may face life-threatening situations if power failure extends beyond the battery backup timeframe of their device (Huff 2021).
- Power failure can result in a loss of communications capability by first responders, with negative impacts on public safety.
- Power outages can also lead to instances of civil disturbance, including looting.
- Power interruptions at chemical handling plants can allow for a chemical spill during restart (EPA 2001). Chemical spills can have significant health and environmental impacts.
- Wastewater and potable water utility interruption may occur as a result of a power failure. Interruption of these critical utilities may have cascading economic and environmental impacts.

- Lack of power can prevent fuel pumps from operating and lead to fuel shortages.
- Traffic accidents may increase because of the lack of traffic control devices such as stoplights and railroad crossing advisory signals. Power outages lasting a long time will force law enforcement officials to man traffic control points to prevent accidents.
- Downed power lines can spark an urban or wildland fire.

19.2 HAZARD PROFILE

19.2.1 Past Events

Power outages and downed utility line events in Ada County between 2000-2021 are listed in Table 19-1. Between 1954 and 2022, FEMA has not included Ada County or the State of Idaho in any utility failure disasters or emergency declarations.

Table 19-1. Ada County Utility Failure Events

Date	Event Type	Utility Failure Event Description
October 19, 2019	Thunderstorm Wind	Several large trees, power lines and fences down in Kuna.
August 30, 2017	Thunderstorm Wind	Power outages in Southeast Boise
August 11, 2015	Thunderstorm Wind	Idaho Power reported outages from thunderstorm winds throughout the Treasure Valley. A downed power pole started a brush fire.
March 17, 2014	High Wind	Numerous reports of power outages reported by Idaho Power.
August 22, 2013	Thunderstorm Wind	Downed trees and power poles were reported across Ada County.
November 16, 2012	High Wind	Trees and power lines down in Start and North Boise.
August 21, 2010	Thunderstorm Wind	68 mph wind gusts, downed trees and power lines. A wildfire started due to the downed power lines and burned a home and six out buildings.
June 4, 2010	Thunderstorm Wind	Power lines downed in Southwest Boise and trees and traffic lights down in Garden City.
October 26, 2009	High Wind	Numerous incidents of power outages and wind damage in the Boise metro area.
November 20, 2008	High Wind	Downed trees and power outages in Boise, Mountain Home, Garden City and Kuna.
July 22, 2008	Thunderstorm Wind	Thunderstorm winds caused power outages to 6,000 customers in Meridian, Boise and Eagle.
June 21, 2008	Thunderstorm Wind	Downed trees and power outages in the Boise metro area.
September 4, 2007	Thunderstorm Wind	Gusty winds and rain ripped through the Treasure Valley, causing power outages and knocking down huge trees.
June 29, 2006	Thunderstorm Wind	Widespread thunderstorms yielding numerous reports of nickel-size hail and wind damage, including downed trees and power lines.
August 21, 2004	Thunderstorm Wind	Trees and power lines were blown down.
July 25, 2002	Thunderstorm Wind	Thunderstorm winds brought down trees and power lines which left over 5,000 homes and businesses without power.
July 22, 2002	Thunderstorm Wind	Trees and power lines were blown down across west Boise and Horseshoe Bend.
July 13, 2002	Thunderstorm Wind	Numerous trees and power lines were blown down across Ada, Canyon, Payette and Gem Counties.
February 7, 2002	Thunderstorm Wind	Numerous trees and power lines were brought down by the storm.
August 4, 2000	Thunderstorm Wind	Trees and power lines were downed in Ada County and Idaho Power reported that about 10,000 residents were without power for several hours.
July 18, 2000	Tornado	An old growth tree was snapped and several power lines were felled.
May 16, 2000	Hail Storm	Idaho power company reported power outages in Nampa, Caldwell and Meridian due to numerous trees and limbs down on power lines.

Source: (National Climatic Data Center 2022)

19.2.2 Location

Power failures in Ada County are usually localized and are usually the result of a natural hazard event involving high winds or heavy snowfall.

19.2.3 Frequency

The utility failure events for Ada County shown in Table 19-1 are often related to high winds associated with thunderstorms. Based on the frequency of these high wind events, the planning area can expect to experience a utility failure event at least annually.

Power failures also often result from damage to or electrical hazards within an electric power system. System components include power generation plants, substations, circuits, switches, transformers, power lines, and power poles. Due to the varied nature of power outage causes ranging from vehicle accidents to severe weather, utility interruptions can happen at any time.

19.2.4 Severity

The extent and severity of a power outage depends on the cause, location, duration, and time of year. It can range from a small, localized event to a countywide power outage. Impacts from an outage can be significant to the county and its residents.

Power failures lead to the inability to use diverse electric-powered equipment: lighting; heating, ventilation, and air conditioning; communication equipment (telephones, computers, etc.); fire and security systems; small appliances such as refrigerators, sterilizers, etc.; and medical equipment. This all can lead to food spoilage, loss of heating and cooling, basement flooding due to sump pump failure, and loss of water due to well pump failure.

Power failure is particularly problematic for homes that are cooled or heated with electricity. Widespread power outages during the summer and winter can directly impact vulnerable populations such as the elderly and medically frail. According to the 2020 American Community Survey 5-Year Estimates, 24.9 percent of homes across Ada County are heated with electricity.

19.2.5 Warning Time

Utility failures can occur without warning. Since they are often the result of severe weather events, the potential for a utility failure can be anticipated with the same warning time as the impending severe weather event. This includes extreme heat events that overload power systems due to heavy use of cooling systems. However, not every weather event triggers a utility failure. Many other events, such as transportation and construction accidents that may impact utility infrastructure, occur without warning.

19.3 EXPOSURE AND VULNERABILITY

The entire Ada County is exposed to the utility failure hazard. The most vulnerable residents are those over 65 or under 5 years of age, below the poverty threshold, or who rely on power for home medical devices.

19.4 DEVELOPMENT TRENDS

Future population growth will directly impact the County's vulnerability to utility failure events. The population of Ada County is projected to increase by 186,756, or 37 percent, between 2020 and 2040 (COMPASS 2021).

19.5 SCENARIO

A worst-case scenario would be a strong wind event that damages power lines and downs trees. Streets blocked by fallen trees would impact the ability of emergency utility crews to access and repair damaged lines.

19.6 ISSUES

Emergency management will need to continue to consider emergency backup power needs for critical facilities throughout the planning area.

20. VOLCANO (ASH FALL)

20.1 GENERAL BACKGROUND

A volcano is a vent in the earth's crust through which magma, rock fragments, gases and ash are ejected from the earth's interior. Over time, accumulation of these erupted products on the earth's surface creates a volcanic mountain. Figure 20-1 illustrates how Cascade volcanoes were formed.

Source: (U.S. Geological Survey 2016)

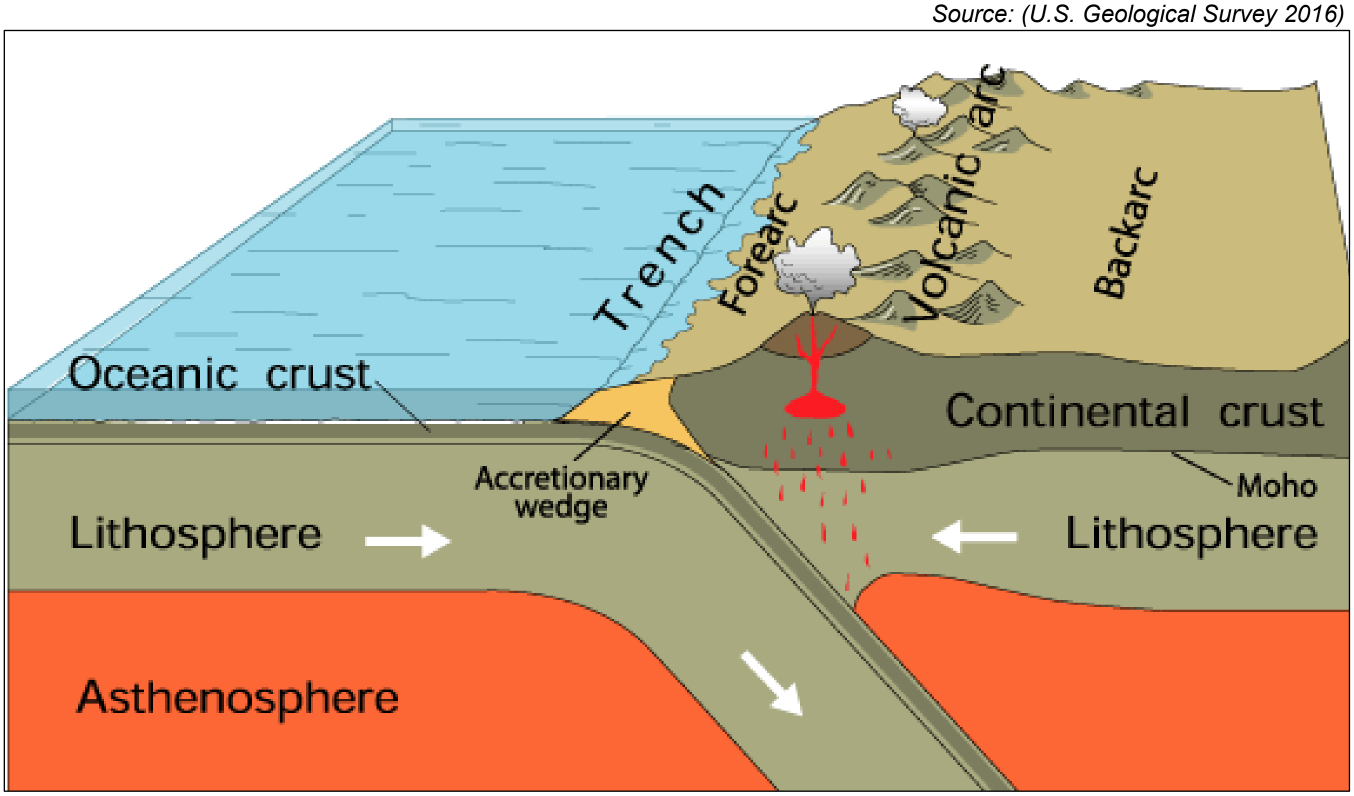


Figure 20-1. How Cascade Volcanoes Are Formed

There are a wide variety of hazards related to volcanoes and volcanic eruptions. The hazards are distinguished by the different ways in which volcanic materials and other debris flow from the volcano. The molten rock that erupts from the volcano (lava) forms a hill or mountain around the vent. The lava may flow out as a viscous liquid, or it may explode from the vent as solid or liquid particles. Ash and fragmented rock material can become airborne and travel far from the erupting volcano to affect distant areas.

Volcanoes can lie dormant for centuries between eruptions. When they erupt, high-speed avalanches of hot ash and rock called pyroclastic flows, lava flows, and landslides can devastate areas 10 or more miles away, while huge mudflows of volcanic ash and debris called ***lahars*** can inundate valleys more than 50 miles downstream. Falling ash from explosive eruptions, called ***tephra*,** can disrupt human activities hundreds of miles downwind, and drifting clouds of fine ash can cause severe damage to the engines of jet aircraft hundreds or thousands of miles away.

20.1.1 Idaho Volcanic Activity

Currently there are no active volcanoes in Idaho, but there is evidence of several types of volcanoes.

Craters of the Moon

Craters of the Moon is a volcanic field of basalt composition, 17,000 to 19,000 feet in elevation, that experienced eight eruptive episodes from 15,000 to 2,000 years ago. Its lava field lies along the northern border of the Snake River Plain, midway between Arco and Carey, Idaho. The Snake River Plain is a volcanic province that was created by a series of cataclysmic caldera-forming super-eruptions that started about 15 million years ago. The Yellowstone hotspot (see Section 12.1.1) was under the Craters of the Moon area some 10 to 11 million years ago but moved as the North American Plate migrated southwestward. Pressure from the hotspot heaves the land surface up, creating fault-block mountains. After the hotspot passes, the pressure is released and the land subsides. Leftover heat from this hotspot was later liberated by Basin and Range-associated rifting and created the overlapping lava flows that make up the Lava Beds of Idaho. The largest rift zone is the Great Rift; it is from the Great Rift fissure system that Craters of the Moon, Kings Bowl, and Wapi lava fields were created.

A typical eruption along the Great Rift and similar basaltic rift systems starts with a curtain of very fluid lava shooting up to 1,000 feet high along a segment of the rift up to 1 mile long. As the eruption continues, pressure and heat decrease and the lava becomes slightly more silica rich. The curtain of lava responds by breaking apart into separate vents. Various types of volcanoes may form at these vents: gas-rich pulverized lava creates cinder cones, and pasty lava blobs form spatter cones. Later stages of an eruption push lava streams out through the side or base of cinder cones, which usually ends the life of the cinder cone. This will sometimes breach part of the cone and carry it away as large and craggy blocks of cinder. Solid crust forms over lava streams, and lava tubes (a type of cave) are created when lava vacates its course.

Geologists feared that a large earthquake that shook Borah Peak, Idaho’s tallest mountain, in 1983 would restart volcanic activity at Craters of the Moon, though this proved not to be the case. Geologists predict that the area will experience its next eruption sometime in the next 900 years, with the most likely period in the next 100 years.

Bruneau-Jarbidge Caldera

The Bruneau-Jarbidge caldera (sometimes called a super volcano) is located in present-day southwest Idaho. The volcano erupted during the Miocene, between 10 and 12 million years ago, spreading a thick blanket of ash and forming a caldera. At the time, the caldera was above the Yellowstone hotspot. Prevailing westerly winds deposited distal ash fall over a vast area of the Great Plains. The evolving composition of the erupted material indicates that while it is derived in large part from melted material from the middle or upper crust, it also incorporated a young basaltic component.

Henry's Fork Caldera

The Henry's Fork Caldera in Idaho is located in an area known as Island Park west of Yellowstone National Park. The caldera was formed by a super-volcano in an eruption of more than 67 cubic miles 1.3 million years ago, and is the source of the Mesa Falls Tuff (tuff is a consolidated volcanic ash). The Henry's Fork Caldera is nested inside the Island Park Caldera; the two calderas share a rim on the western side. The older Island Park Caldera is much larger and more oval and extends well into Yellowstone Park. Although much smaller than the Island Park Caldera, the Henry's Fork Caldera is still sizeable at 18 miles long and 23 miles wide and its curved rim is plainly visible from many locations in the Island Park area. Of the many calderas formed by the Yellowstone hotspot, the Henry's Fork Caldera is the only one that is currently clearly visible.

Henry's Fork of the Snake River flows through the Caldera and drops out at Upper and Lower Mesa Falls. The caldera is bounded by Ashton Hill on the south, Big Bend Ridge and Bishop Mountain on the west, Thurburn Ridge on the north and Black Mountain and the Madison Plateau on the east.

Mahogany Mountain

Mahogany Mountain is an ancient caldera volcano on the border of Malheur County Oregon and Owyhee County Idaho. Its last eruption was probably 15.5 million years ago. This eruption ejected layers of volcanic rock tuff, creating formations of rock in the Leslie Gulch. A part of the Basin and Range Province, the volcano's most recent eruptive activity dates to 15 million years ago (the Miocene), forming during a period of active volcanism. It formed around the same time as Three Fingers, Castle Peak, and three other volcanoes. Today the volcano appears gnarled due to erosion and is topped by pine forests. The caldera is narrow and shaped like a ridge, with precipitous slopes and an escarpment on the northwest flank.

Leslie Gulch lies within the depression of the volcano. Layers of ash and tuff are evident in the formation, and leftover volcanic rocks sit in it as well. The gulch features an array of rock formations and ash erupted from the volcano 15.5 million years ago.

Menan Buttes

The North and South Menan Buttes in southeastern Idaho are two of the world's largest volcanic tuff cones. They are located in Madison County, with lower slopes extending westward into Jefferson County. The two cones, with four smaller associated cones, align along a north-northwest line and make up the Menan Complex. The buttes rise about 800 feet above the surrounding Snake River plain and are late Pleistocene in age, dating to 10,000 years ago. The buttes are the remains of the only volcanic eruptions that have occurred in freshwater within the boundaries of the modern United States. The South Menan Butte is currently in private hands, but North Menan Butte is publicly owned and has been designated as a National Natural Landmark and a Research Natural Area by the U.S. Congress. The BLM designated the North Butte as an Area of Critical Environmental Concern.

The volcanoes forming the two major Menan Buttes were created when basaltic magma came into contact with a shallow aquifer or with the precursor of the modern Snake River. Particles of volcanic glass were created as the water turned to steam and explosively fragmented the hot magma. The cone-shaped deposits are fairly uniform and consist primarily of tuff in small stone-sized particles. Some deposit layers preserve indentations made as larger pyroclastic particles landed on soft layers of tuff.

The Menan Buttes stand at an elevation of 5,619 feet and are very similar in size and shape. North Menan Butte is slightly larger and elliptical, with axes 2 and 2.5 miles in length. South Menan Butte measures 2 miles by 1 mile.

The crater of the North Menan Butte is about 3,000 feet in diameter and the cone is about 6,000 feet in diameter. The North Butte's volume is 0.16 cubic miles and the South Butte measures at 0.07 cubic miles. In comparison, the better-known tuff cone Diamond Head on Oahu has a volume of 0.15 cubic miles. The larger buttes in the Menan Complex are asymmetrical. Each has a greater accumulation of material on the northeast, presumably due to strong southwest winds during the initial eruption.

Yellowstone Caldera

The Yellowstone Caldera, sometimes referred to as the Yellowstone super-volcano, is located in Yellowstone National Park in the northwest corner of Wyoming. The major features of the caldera measure about 34 miles by 45 miles. The last full-scale eruption of the Yellowstone super-volcano, the Lava Creek eruption nearly 640,000 years ago, ejected 240 cubic miles of rock and dust into the sky.

The upward movement of the Yellowstone caldera floor between 2004 and 2008—almost 3 inches each year, and as much as 8 inches at the White Lake GPS station—was more than three times greater than ever observed since measurements began in 1923. By the end of 2009, the uplift had slowed significantly and appeared to have stopped. In January 2010, the USGS stated "that uplift of the Yellowstone Caldera has slowed significantly" and uplift continues but at a slower pace. Scientists with the Yellowstone Volcano Observatory say there is no evidence that a cataclysmic eruption will occur at Yellowstone in the foreseeable future.

20.1.2 Secondary Hazards

The secondary hazards associated with volcanic eruptions are mudflows and landslides and possibly seismic activity in the region of the eruption.

20.2 HAZARD PROFILE

The greatest volcano risk to the planning area is tephra accumulation from Cascade Range eruptions. The Cascade Range extends more than 1,000 miles from southern British Columbia into northern California and includes 13 potentially active volcanic peaks in the U.S. The heart of the Cascade Range lies 320 miles west of the Ada County planning area. Many of these volcanoes are far from the county or not directly upwind of the county.

20.2.1 Past Events

Figure 20-2 summarizes past eruptions in the Cascades. The last major volcanic eruption in the continental United states was the explosion of Mount St. Helens on May 18, 1980. Due to its great distance, and location across the continental divide of the Cascades, the lava and lahar flow from this eruption did not affect the Ada County planning area. West-central and southwestern Idaho did see small amounts (less than 1 inch) of tephra (ash) fall.

20.2.2 Location

The most hazardous volcanoes are those directly west and southwest of the county (along the direction of prevailing winds). The closest volcanoes due west of the planning area are Sisters, (330 miles) and Newberry Crater (285 miles). Mount Shasta in California is within 500 miles and is southwest of the Ada County planning area. With prevailing wind directions, volcanic eruption of Mount Shasta would put the Ada County planning area in the direct path for significant tephra accumulation. Figure 20-3 shows active volcanoes within the western United States.

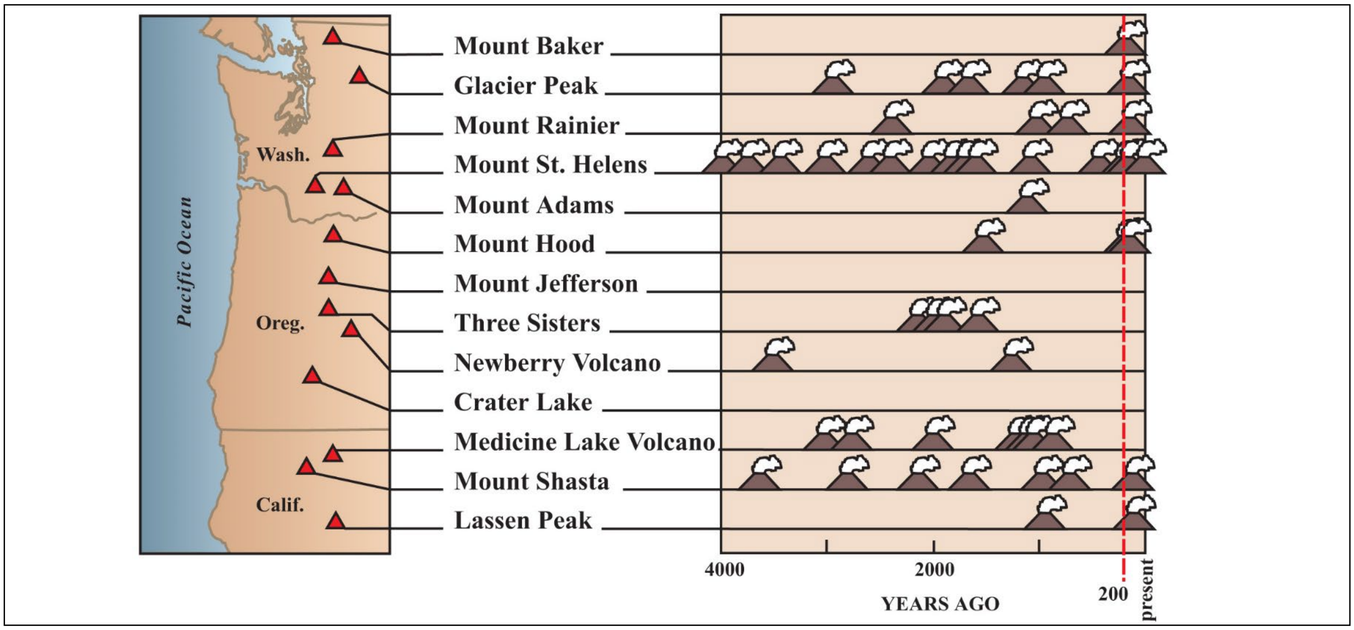


Figure 20-2. Past Eruptions in the Cascade Range

Figure 20-3. Potentially Active Volcanoes in the Western U.S.

20.2.3 Frequency

Eruptions in the Cascades have occurred at an average rate of 1 or 2 per century during the last 4,000 years. Mount St. Helens is by far the most active volcano in the Cascades, with four major explosive eruptions in the last 515 years. Still, the probability of an eruption in any given year is extremely low.

20.2.4 Severity

A 1-inch deep layer of ash weighs an average of 10 pounds per square foot, causing danger of structural collapse. Ash is harsh, acidic and gritty, and it has a sulfuric odor. Ash may also carry a high static charge for up to two days after being ejected from a volcano. When an ash cloud combines with rain, sulfur dioxide in the cloud combines with the rainwater to form diluted sulfuric acid that may cause minor, but painful burns to the skin, eyes, nose and throat.

20.2.5 Warning Time

The best warning of a volcanic eruption is one that specifies when and where an eruption is likely and what type and size eruption should be expected. Such accurate predictions are sometimes possible but still rare. The most accurate warnings are those in which scientists indicate an eruption is probably only hours to days away, based on significant changes in a volcano's earthquake activity, ground deformation, and gas emissions. Experience from around the world has shown that most eruptions are preceded by such changes over a period of days to weeks. A volcano may begin to show signs of activity several months to a few years before an eruption. However, a warning that specifies months or years in advance when it might erupt are extremely rare.

20.3 EXPOSURE

The Ada County planning area has no direct volcanic exposure. The planning area is generally downwind of three Cascade Range volcanoes, and could experience the impacts of a tephra fall from any of these. Additionally, there are several dormant volcanic sources in Idaho that could create significant exposure to the planning area should they become active. Using the latest eruption of Mount St. Helens as an indicator, a tephra fall in Ada County could be anywhere from a half-inch to an inch. Nonetheless, some people, property and the environment are vulnerable to the effects of a tephra fall, as discussed below

20.3.1 Population

The whole population of the planning area would be exposed to some degree to the effects of a tephra fall from volcanic eruptions in the Cascade Range or volcanic sites in Idaho. The degree of exposure is highly dependent upon the magnitude of the eruption and the prevailing wind speed and direction.

20.3.2 Property

All property within the planning area could be exposed to the effects of a tephra fall to some degree. The degree of exposure would be highly dependent upon proximity to the event, magnitude of the event and the prevailing wind speed and direction at the time of the event.

20.3.3 Critical Facilities

All critical facilities could have some degree of exposure to tephra accumulation. All transportation routes are exposed to ash fall and tephra accumulation, which could create hazardous driving conditions on roads and highways and hinder evacuations and response

20.3.4 Environment

The environment is highly exposed to the effects of a volcanic eruption.

20.4 VULNERABILITY

20.4.1 Population

While accumulations of tephra would not be considered to be significant, the populations most vulnerable to the effects of a tephra fall are the elderly, the very young and those already experiencing ear, nose and throat problems. Homeless people, who may lack adequate shelter, are also vulnerable to the effects of a tephra fall, although Ada County has few homeless people who would not be able to find adequate shelter or assistance during an event.

20.4.2 Property

The planning team was not able to generate damage estimates for this hazard because there are no generally accepted damage functions for volcanic hazards in risk assessment platforms such as Hazus. Vulnerable property includes equipment and machinery left out in the open, such as farm equipment, whose parts can become clogged by the fine dust. Since Ada County receives snow every year, and roofs are built to withstand snow loads, most roofs are not vulnerable and would be able to withstand the potential load of ash. Infrastructure, such as drainage systems, is also potentially vulnerable to the effects of a tephra fall, since the fine ash can clog pipes and culverts. This may be more of a problem if an eruption occurs during winter or early spring when precipitation is highest and floods are most likely.

20.4.3 Critical Facilities

Critical facilities in the direction of wind would be vulnerable to tephra accumulations. Water treatment plants, power generation stations and wastewater treatment plants are vulnerable to contamination from ash fall.

20.4.4 Environment

The environment is very vulnerable to the effects of a volcanic eruption, even if the eruption does not directly impact the planning area. This is highly dependent upon the amount of tephra accumulation. Rivers and streams in the Boise River watershed are vulnerable to damage due to ash fall, especially since ash fall can be carried throughout the county by these water courses. The sulfuric acid contained in volcanic ash could be damaging to area vegetation, waters, wildlife and air quality.

Even if ash from a volcanic eruption were to fall elsewhere, it could be spread throughout the county by the rivers and streams. A volcanic blast would expose the local environment to many effects such as lower air quality, and many other elements that could harm local vegetation and water quality.

20.5 DEVELOPMENT TRENDS

Because all of the planning area is exposed to the volcanic ash fall hazard, the increase in exposed population and property since the last hazard mitigation plan update is equal to the countywide trend over that time period: a 17.8 percent increase in population, a 19.4 percent increase in number of general building stock structures, and an 46.7 percent increase in total assessed property value (see Section 4.4.4). However, since the majority of this growth was new development, the increase in vulnerability to volcanic ash fall is considered to be minimal due to the influence of strong codes and code enforcement within the planning area.

All future development has the potential of being impacted by ash fall generated from a volcanic event. While this potential impact on the built environment is not considered to be significant, the economic impact on industries that rely on machinery and equipment such as agriculture or civil engineering projects could be significant. The extent of this hazard is difficult to gauge because it is dependent upon many variables, so the ability to institute land use recommendations based on potential impacts of this hazard is limited. While the impacts of volcanic hazards are sufficient to warrant risk assessment for emergency management purposes, the impacts are not considered to be sufficient to dictate land use decisions.

20.6 SCENARIO

The worst-case scenario for the Ada County planning area would be any volcanic activity associated with the Yellowstone hotspot. Geologic history has shown that volcanic activity associated with the hotspot could be catastrophic if it were to occur in today's environment. The probability of such an event occurring in the near term is up for geologic debate. A more likely scenario is volcanic activity in the Cascade Range producing a significant amount of ash fall within the planning area. No one would be injured or killed, but businesses and non-essential government would be closed until the cloud passes. People and animals without shelter would be affected. Structures would be safe, but private property left out in the open, such as farm equipment, might be damaged by the fine ash dust.

20.7 ISSUES

Since volcanic episodes have been fairly predictable in the recent past, there is not much concern about loss of life, or impact on property. However, economic and environmental impacts are something to consider in emergency management.

21. WILDFIRE

21.1 GENERAL BACKGROUND

A wildfire is an uncontrolled fire on undeveloped or developed land, in most cases requiring fire suppression. They can be ignited by lightning or by human activity such as smoking, campfires, equipment use and arson. Wildfires occur when all of the necessary elements of a fire come together in a wooded or grassy area: an ignition source is brought into contact with a combustible material such as vegetation that is subjected to sufficient heat and has an adequate supply of oxygen from the ambient air.

A wildfire front is the portion of a wildfire sustaining continuous flaming combustion, where unburned material meets active flames. As the front approaches, the fire heats the surrounding air and vegetative material. At a temperature of 212ºF, vegetative material is dried as water in it is vaporized. At 450ºF, the wood releases flammable gases. Wood smolders at 720ºF and ignites at 1,000ºF. Before the flames of a wildfire arrive, heat from the wildfire front can warm the air to 1,470ºF, which pre-heats and dries flammable materials, causing them to ignite faster and allowing the fire to spread faster. High temperature and long-duration surface wildfires may encourage flashover or *torching*: the drying of tree canopies and their subsequent ignition from below.

Large wildfires may affect air currents by the stack effect: air rises as it is heated, so large wildfires create powerful updrafts that draw in new, cooler air from surrounding areas in thermal columns. Great vertical differences in temperature and humidity encourage fire-created clouds, strong winds, and fire whirls with the force of tornadoes at speeds of more than 50 mph. Rapid rates of spread, prolific crowning or spotting, the presence of fire whirls, and strong convection columns signify extreme conditions.

21.1.1 Wildfire Types

Fire types can be generally characterized by their fuels as follows:

- Ground fires are fed by subterranean roots, duff and other buried organic matter. This fuel type is especially susceptible to ignition due to spotting. Ground fires typically burn by smoldering, and can burn slowly for days to months.
- Crawling or surface fires are fueled by low-lying vegetation such as leaf and timber litter, debris, grass, and low-lying shrubbery.
- Ladder fires consume material between low-level vegetation and tree canopies, such as small trees, downed logs and vines. Invasive plants that scale trees may encourage ladder fires.
- Crown, canopy or aerial fires burn suspended material at the canopy level, such as tall trees, vines and mosses. The ignition of a crown fire, called *crowning*, depends on the density of the suspended material, canopy height, canopy continuity, and the presence of surface and ladder fires to reach the tree crowns.

21.1.2 Factors Affecting Wildfire Risk

Three principal factors have a direct impact on the behavior of wildfires: topography, fuel, and weather.

Topography

Topography can have a powerful influence on wildfire behavior. The movement of air over the terrain tends to direct a fire's course. Gulches and canyons can funnel air and act as a chimney, intensifying fire behavior and inducing faster rates of spread. Saddles on ridge tops offer lower resistance to the passage of air and will draw fires. Solar heating of drier, south-facing slopes produces upslope thermal winds that can complicate behavior.

Slope is an important factor. If the percentage of uphill slope doubles, the rate of spread of wildfire will likely double. On steep slopes, fuels on the uphill side of the fire are closer physically to the source of heat. Radiation preheats and dries the fuel, thus intensifying fire behavior. Fire travels downslope much more slowly than it does upslope, and ridge tops often mark the end of wildfire's rapid spread.

Fuels

Fuels are classified by weight or volume (fuel loading) and by type. Fuel loading, often expressed in tons per acre, can be used to describe the amount of vegetative material available. If fuel loading doubles, the energy released also can be expected to double. Each fuel type is given a burn index, which is an estimate of the amount of potential energy that may be released, the effort required to contain a fire in a given fuel, and the expected flame length. Different fuels have different burn qualities. Some fuels burn more easily or release more energy than others. Grass, for instance, releases relatively little energy, but can sustain very high rates of spread.

Continuity of fuels is expressed in terms of horizontal and vertical dimensions. Horizontal continuity is what can be seen from an aerial photograph and represents the distribution of fuels over the landscape. Vertical continuity links fuels at the ground surface with tree crowns via ladder fuels.

Another essential factor is fuel moisture. Fuel moisture is expressed as a percentage of total saturation and varies with antecedent weather. Low fuel moistures indicate the probability of severe fires. Given the same weather conditions, moisture in fuels of different diameters changes at different rates. A 1,000-hour fuel, which has a 3- to 8-inch diameter, changes more slowly than a 1- or 10-hour fuel.

Weather

Of all the factors influencing wildfire behavior, weather is the most variable. Extreme weather leads to extreme events, and it is often a moderation of the weather that marks the end of a wildfire's growth and the beginning of successful containment. High temperatures and low humidity can produce vigorous fire activity. The cooling and higher humidity brought by sunset can dramatically quiet fire behavior.

Fronts and thunderstorms can produce winds that are capable of radical and sudden changes in speed and direction, causing similar changes in fire activity. The rate of spread of a fire varies directly with wind velocity. Winds may play a dominant role in directing the course of a fire. The radical and devastating effect that wind can have on fire behavior is a primary safety concern for firefighters. In July 1994, a sudden change in wind speed and direction on Storm King Mountain led to a blowup that claimed the lives of 14 firefighters. The most damaging firestorms are usually marked by high winds.

21.1.3 Historical Fire Regime and Current Condition Classification

Land managers need to understand historical fire regimes (that is, fire frequency and fire severity prior to significant human settlement) to be able to define ecologically appropriate goals and objectives for an area. This understanding must include knowledge of how historical fire regimes vary across the landscape. Five historical fire regimes are classified based on average number of years between fires (fire frequency) and the severity of the fire (amount of replacement) on the dominant overstory vegetation:

I. 0- to 35-year frequency and low (surface fires most common) to mixed severity (less than 75 percent of the dominant overstory vegetation replaced)

II. 0- to 35-year frequency and high (stand replacement) severity (greater than 75 percent of the dominant overstory vegetation replaced)

III. 35- to 100-year frequency and mixed severity (less than 75 percent of the dominant overstory vegetation replaced)

IV. 35- to 100-year frequency and high (stand replacement) severity (greater than 75 percent of the dominant overstory vegetation replaced)

V. >200-year frequency and high (stand replacement) severity.

Understanding ecosystem departures—how ecosystem processes and functions have changed—provides a context for managing sustainable ecosystems. The fire regime condition class (FRCC) is a classification of the amount of departure from the historical fire regime. There are three condition classes for each historical fire regime. All wildland vegetation and fuel conditions fit within one of the three classes. The classification is based on a relative measure describing the degree of departure from the historical fire regime. This departure results in changes to one or more of the following ecological components:

- Vegetation characteristics (species composition, structural stages, stand age, canopy closure and mosaic pattern)
- Fuel composition
- Fire frequency, severity, and pattern
- Associated disturbances (e.g., insect and disease mortality, grazing, and drought).

The three classes indicate low (FRCC 1), moderate (FRCC 2) and high (FRCC 3) departure from the historical fire regime. Low departure is considered to be within the historical range of variability, while moderate and high departures are outside.

Characteristic vegetation and fuel conditions are those that occurred within the historical fire regime. Uncharacteristic conditions are those that did not occur within the historical fire regime, such as invasive species (e.g. weeds, insects, and diseases), "high graded" forest composition and structure (e.g. large trees removed in a frequent surface fire regime), or repeated annual grazing that reduces grassy fuels across relatively large areas to levels that will not carry a surface fire.

Determination of the amount of departure is based on comparison of a composite measure of fire regime attributes to the central tendency of the historical fire regime. The amount of departure is then classified to determine the fire regime condition class. Table 21-1 presents a simplified description of the fire regime condition classes and associated potential risks.

Table 21-1. Fire Regime Condition Class Definitions

Description	Potential Risks
Fire Regime Condition Class 1	
Within the historical range of variability.	• Fire behavior, effects, and other associated disturbances are similar to those that occurred prior to fire exclusion (suppression) and other types of management that do not mimic the natural fire regime and associated vegetation and fuel characteristics. • Composition and structure of vegetation and fuels are similar to the natural (historical) regime. • Risk of loss of key ecosystem components (e.g. native species, large trees and soil) is low.
Fire Regime Condition Class 2	
Moderate departure from the historical regime of variability.	• Fire behavior, effects, and other associated disturbances are moderately departed (more or less severe). • Composition and structure of vegetation and fuel are moderately altered. • Uncharacteristic conditions range from low to moderate. • Risk of loss of key ecosystem components is moderate.
Fire Regime Condition Class 3	
High departure from the historical regime of variability.	• Fire behavior, effects, and other associated disturbances are highly departed (more or less severe). • Composition and structure of vegetation and fuel are highly altered. • Uncharacteristic conditions range from moderate to high. • Risk of loss of key ecosystem components is high.

21.1.4 Secondary Hazards

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs, destroy transmission lines and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

21.2 HAZARD PROFILE

Wildfire presents a risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, destruction of cultural and economic resources, and potential impacts on water supply and community infrastructure. Vulnerability to flooding increases due to the destruction of watersheds. The potential for significant damage to life and property exists in areas designated as wildland urban interface (WUI) areas, where development is adjacent to densely vegetated areas. For the Ada County Planning area, a WUI has been identified and mapped based on the following definition:

> *The geographical area where structures and other human development meet or intermingle with wildland or vegetative fuels.*

This definition comes from the 2012 *International Wildland Urban Interface Code* and it is defined geographically in the planning layers. Ada County and its planning partners use this definition to implement land use regulations in the identified WUI. All references to the WUI in this hazard mitigation plan are for areas identified and mapped under this definition.

21.2.1 Past Events

In the fire-adapted ecosystems of Idaho, fire is the dominant process constraining terrestrial vegetation patterns, habitat, and species composition. Fire was once an integral function of the majority of ecosystems in Idaho, including the Ada County planning area. The seasonal cycling of fire across the landscape was as regular as the July, August and September lightning storms plying across the canyons and mountains. Depending on the plant community composition, structural configuration, and buildup of plant biomass, fire resulted from ignitions with varying intensities and extent across the landscape. Shorter return intervals between fire events often resulted in less dramatic changes in plant composition. The fires burned with a varied return interval, but much of the county burned through a stand-replacing fire that occurred on a moderate return interval of 20 to 80 years.

Native plant communities in this region developed under the influence of fire, and adaptations to fire are evident at the species, community and ecosystem levels. Fire history data (from fire scars and charcoal deposits) suggest fire has played a role in shaping the vegetation in the region for thousands of years.

Detailed records of fire perimeter and ignition and extent have been obtained from the BLM for the Ada County planning area. Since 2000, there were 239 fire events on or near BLM lands within the Ada County planning area, burning over 95,350 acres. These ignitions and perimeter points are shown in Figure 21-1. Table 21-2 is a summary of the number of fires per year from 2000 to 2021 on or near BLM lands in the Ada County planning area. There are over 589,000 acres of BLM-managed land in the Ada County planning area, representing 86 percent of the planning area. Much of this land is in or adjacent to privately held lands within the WUI as well as the overall planning area.

Table 21-2. BLM Fire Statistics—Fires per Year in Ada County Planning Area, 2000-2021

Fire Year	# Fires	Total Acres	Causes	Fire Year	# Fires	Total Acres	Causes
2021	8	556.05	2 Natural, 6 Human	**2009**	6	629.17	N/A
2020	6	240.65	1 Natural, 5 Human	**2008**	3	584.73	N/A
2019	6	102.95	2 Natural, 4 Human	**2007**	32	6,685.70	N/A
2018	9	69.2	2 Natural, 7 Human	**2006**	8	2,531.13	N/A
2017	9	215.45	4 natural, 5 human	**2005**	13	10,286.88	N/A
2016	19	7,144.1	3 natural, 16 Human	**2004**	2	126.12	N/A
2015	6	178.10	6 Human	**2003**	3	1,295.72	N/A
2014	6	1,540.88	2 natural, 6 human	**2002**	7	5,189.88	N/A
2013	16	5,208.07	4 natural, 12 human	**2001**	26	1,1740.08	N/A
2012	24	10,804.70	2 natural, 22 human	**2000**	9	5,789.50	N/A
2011	14	18,050.43	7 natural, 7 Human	**Total**	**109**	**44,858.91**	
2010	7	6,381.03	N/A	***Average***	***10.86***	***4,334.11***	

21.2.2 Location

The wildfire risk assessment for this hazard mitigation plan update used different data from what was used for previous plans. In 2016 EMCR coordinated with fire agencies and districts to develop and complete the Ada County Enhanced Wildfire Risk Map. This project produced wildfire maps and GIS data at the block level within the wildland urban interface (WUI) and at a study region level outside the WUI (study regions were delineated by defined characteristics such as interior urban environment or irrigated agriculture). This data and modeling were identified by the Steering Committee as the best data available to assess the wildfire risk for the current update. Figure 21-2 shows the extent and location of the wildfire hazard based on the new data.

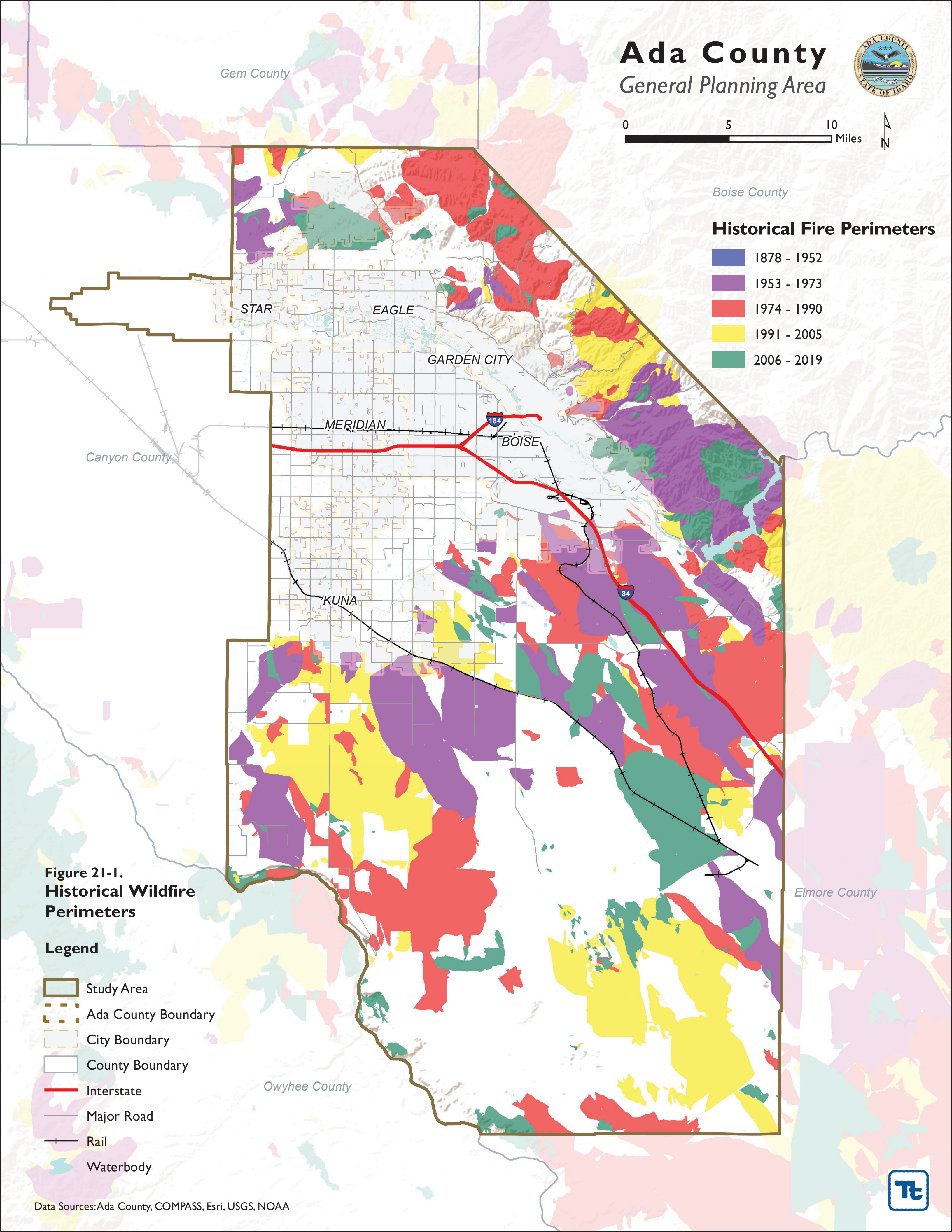


Figure 21-1.
Historical Wildfire Perimeters

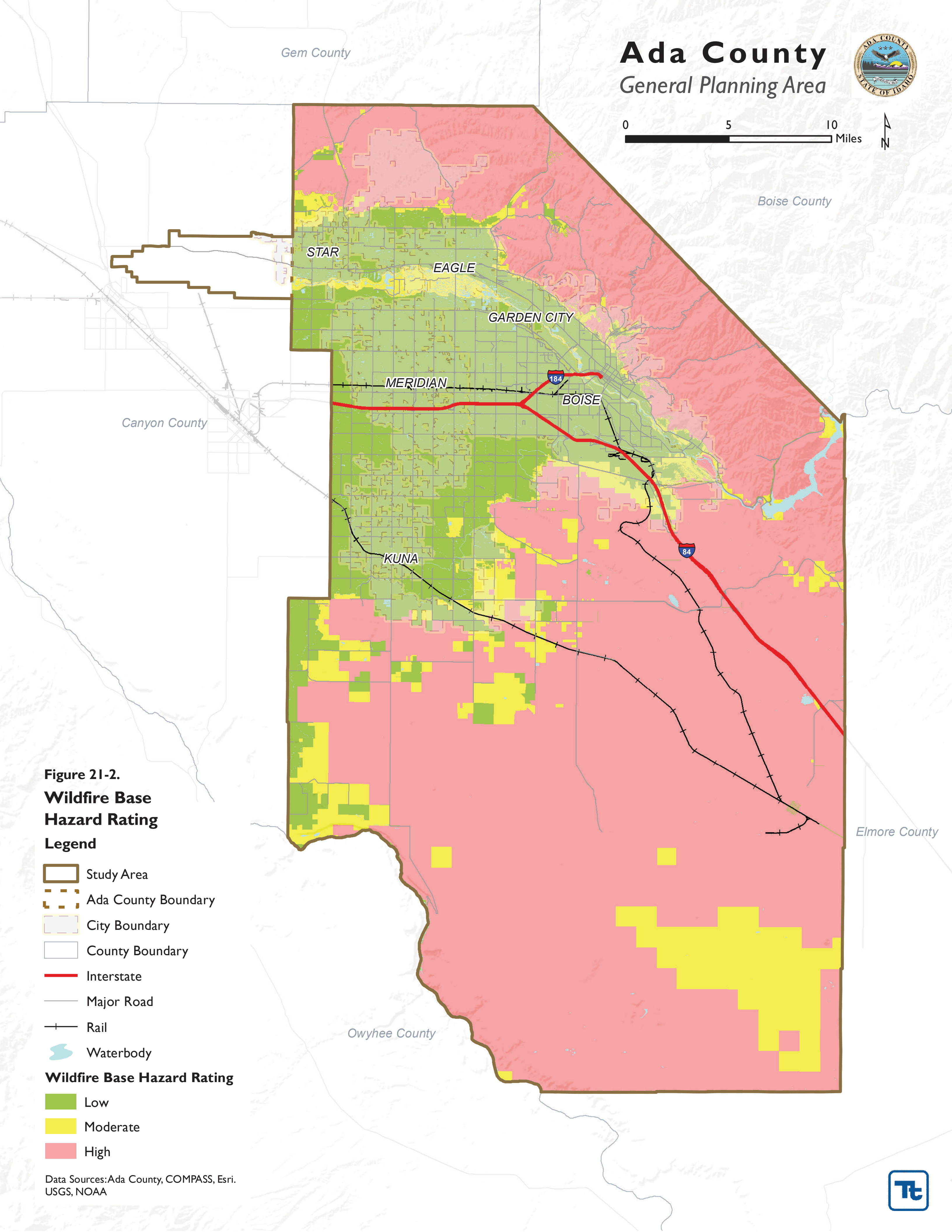


Figure 21-2.
Wildfire Base Hazard Rating

21.2.3 Frequency

Fire ecologists use natural fire rotation to establish recurrence intervals for a planning area. Fire rotation is a measure of relative expected intervals between fires at regional scales, where site-specific fire frequency estimates are not available. Natural fire rotation is defined as the number of years necessary for fires to burn over an area equal to that of the study area (Heinselman, 1981). It is calculated for large areas using past fire size records by dividing the length of the record period in years by the percentage of total area burned during that period. Modern-era fire rotation analysis summarizes areas into the following classes of expected fire frequency:

- High (fire rotation less than 100 years)
- Medium (fire rotation more than 100 years and less than 300 years)
- Low (fire rotation more than 300 years).

As shown in Table 21-2, Ada County experienced an average of 10.86 fires per year on or near BLM-managed lands from 2000 to 2021, burning 4,334 acres per fire. This yields a natural fire rotation of 109.2 years, a medium rating, almost a high rating.

21.2.4 Severity

Fire severity has been defined as "the magnitude of significant negative fire impacts on wildland systems" (Simard, 1991). This definition has nothing to do directly with the fire itself—not the fire's behavior, flame length, rate of spread, or any of the other measures of the fire. Rather, it is defined by the effects of a fire on wildland systems. This definition was born out of the need to provide a description of how fire intensity affects ecosystems, particularly wildfires for which direct information on fire intensity was absent and effects vary among different ecosystems (Keely, 2009).

Within the WUI, risks are associated with the probability that an area will burn, its severity, and the likely behavior of fire in the area. It was assumed that burn probability and fire behavior contribute equally to the risks to communities. Agriculture areas, rock, urban areas, and water are not assigned a burn probability or relative fire behavior. Communities with these cover classes are assumed to not be at risk from wildfire.

Wildfire impacts beyond those on ecosystems include impacts on human life, built improvements, and natural resources such as watersheds, grazing lands and recreational areas. Although fire suppression capabilities in the WUI areas are substantial, the volatile nature of wildfires makes fighting them a challenge. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly and those with respiratory and cardiovascular diseases. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds. There are two reported incidents of loss of life from wildfires in the planning area. One involved first responders and the other involved a resident who lived within a WUI.

21.2.5 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. The weather can provide an element of warning for local governments in that nicer weather heightens public activity in interface areas. Within Ada County the planning area, there is always a heightened state of readiness by fire response personnel during the spring, summer and fall as weather and the increased recreational uses within the WUI can trigger events.

Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Extreme weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The spread of cellular and two-way radio communications in recent years has contributed to a significant improvement in warning time.

21.2.6 Performance Period Wildfire Mitigation Activities

Several organizations in Ada County have implemented wildfire mitigation projects since completion of the 2017 plan. These projects have been well-supported by the community and are helping to lessen the impact of wildfires on Ada County residents, structures, ecosystems, and economy. A summary of all project activities by implementing agencies is provided in Appendix E of this volume.

21.2.7 Firefighting Resources and Capabilities

Fire district personnel are often the first responders during emergencies. In addition to structure fire protection, they are called on during wildfires, floods, landslides, and other events. There are many in Ada County serving fire protection departments in various capacities. A complete inventory of resources and capabilities of fire-fighting agencies in the Ada County planning area is provided in Appendix F of this volume.

21.3 EXPOSURE

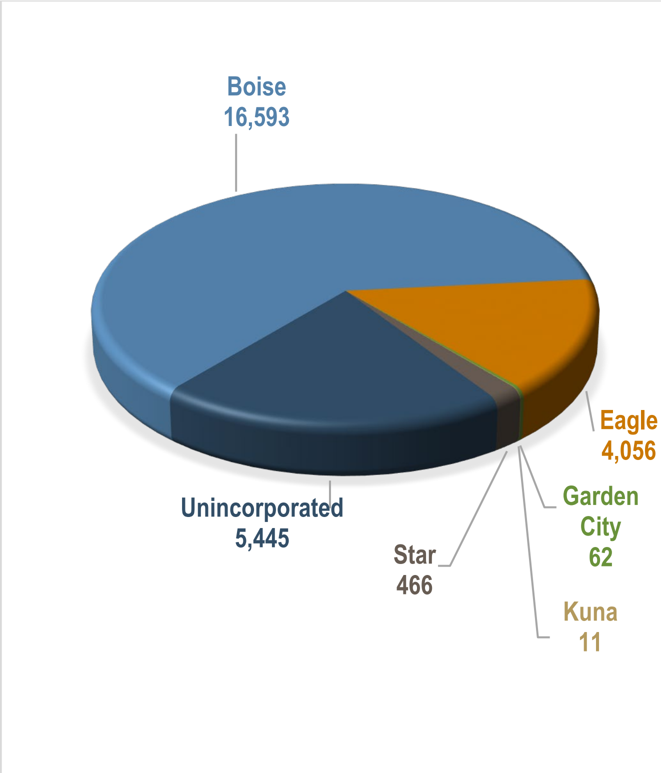
A Level 2 Hazus analysis was used to assess exposure to wildfire in the planning area. Where possible, the Hazus default data was enhanced using local GIS data from county, state and federal sources. Population could not be examined by wildfire hazard area because census block group areas do not coincide with the hazard areas. A population estimate was made using the structure count of buildings within the wildfire hazard areas.

21.3.1 Population

Figure 21-3 and Figure 21-4 summarize the population living in the moderate and high wildfire hazard zones.

21.3.2 Property

The value of exposed buildings and contents in each jurisdiction is summarized in Figure 21-5 through Figure 21-6 for the moderate, moderate/high, and high wildfire hazard zones, respectively. Figure 21-7 through Figure 21-8 summarize the number of structures in the moderate, moderate/high, and high wildfire hazard zones, respectively, by municipality and occupancy class.



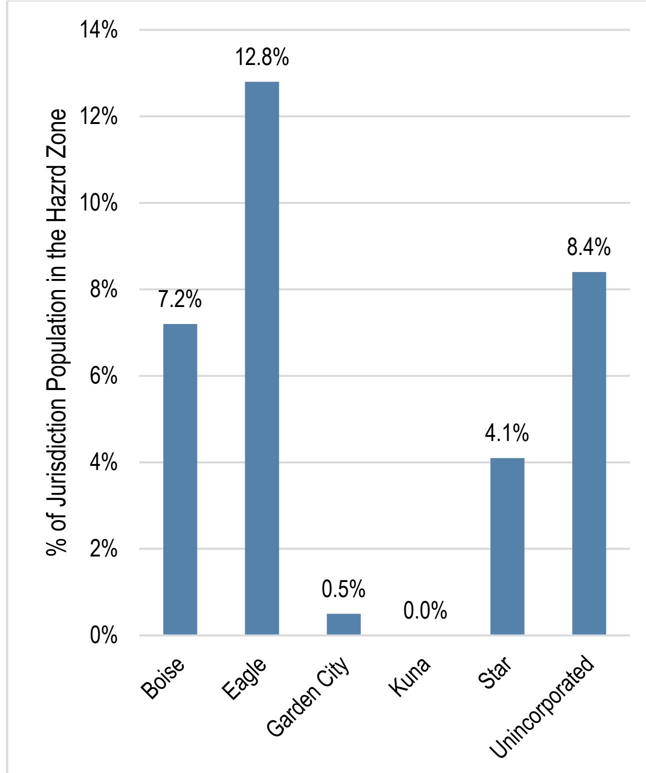
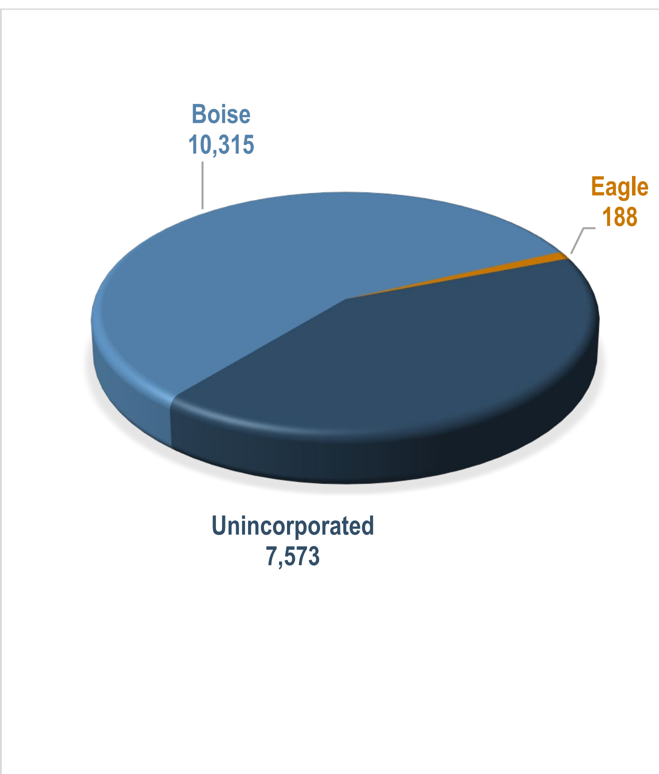


Figure 21-3. Population in the Moderate Wildfire Hazard Area



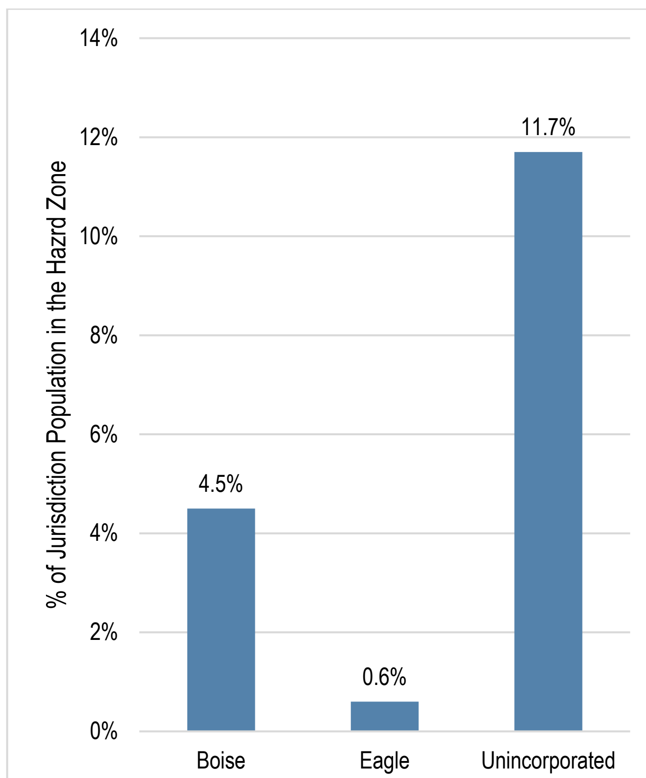


Figure 21-4. Population in the High Wildfire Hazard Area

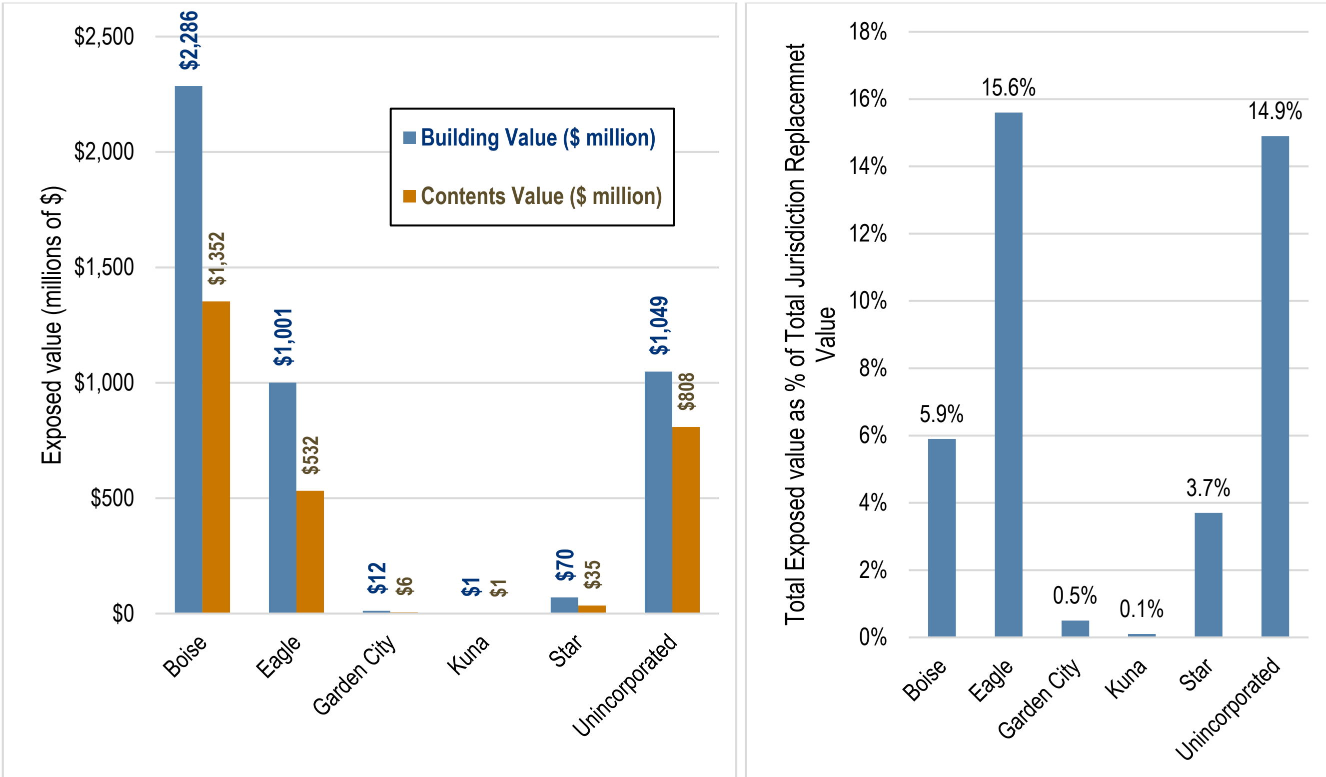


Figure 21-5. Value of Property in the Moderate Wildfire Hazard Area

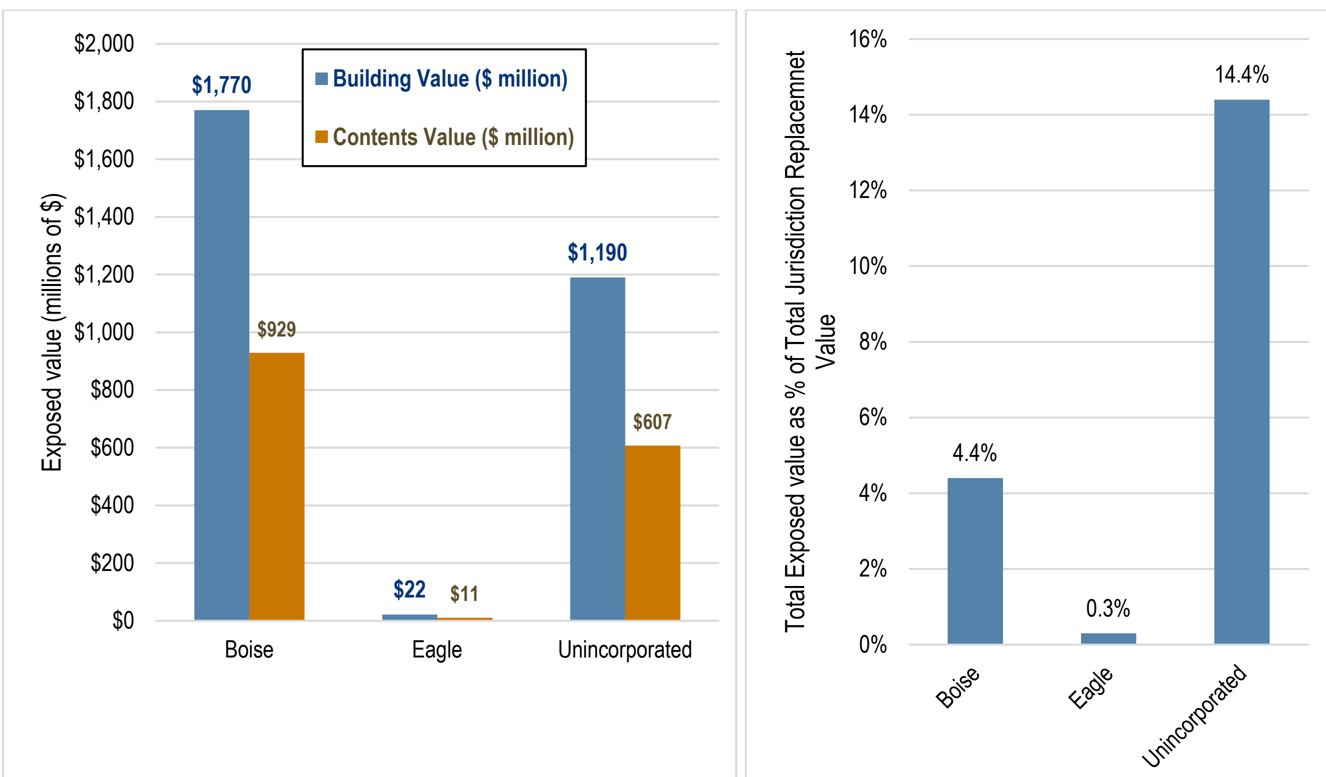


Figure 21-6. Value of Property in the High Wildfire Hazard Area

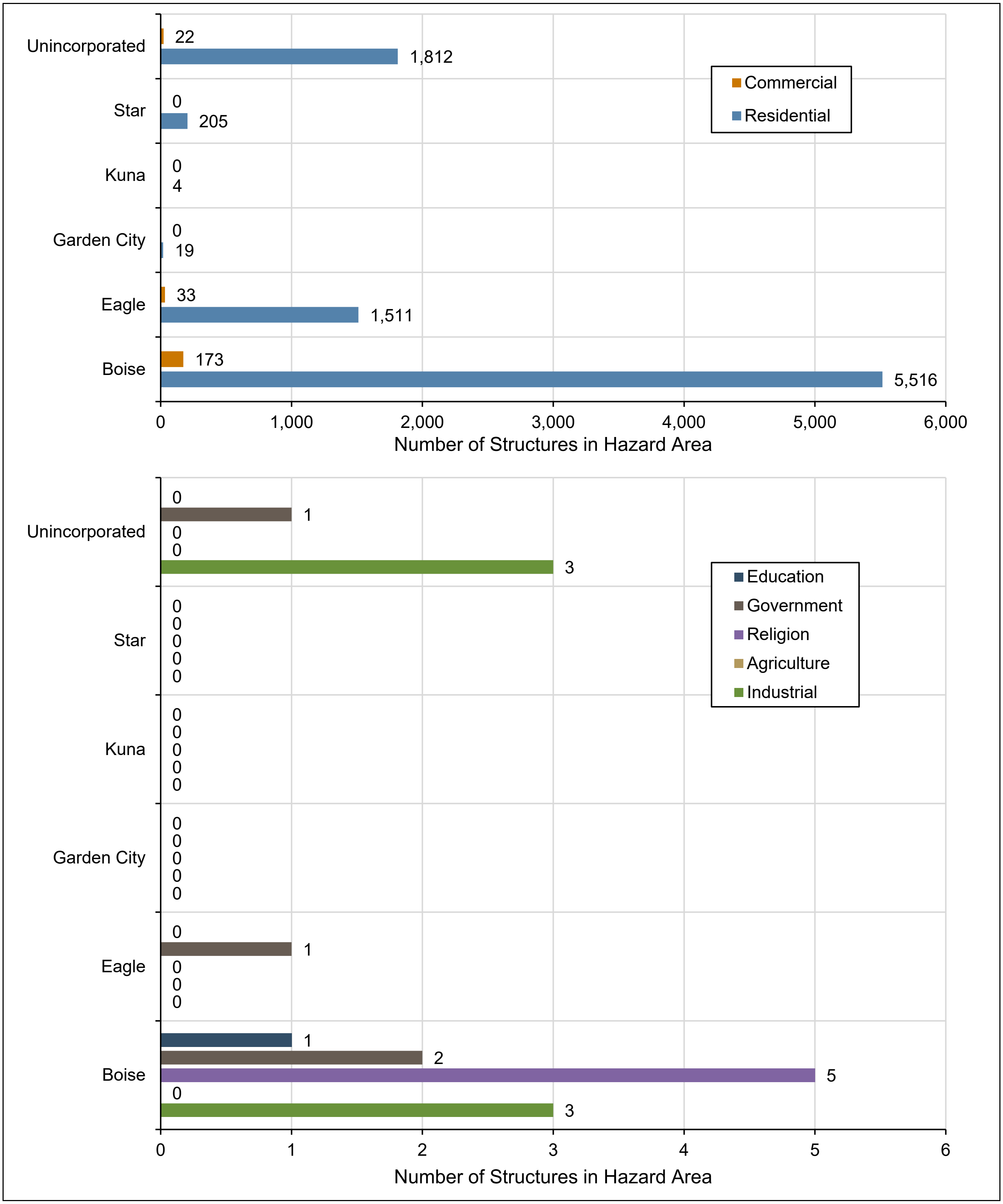


Figure 21-7. Number of Structures Within the Moderate Wildfire Hazard Area

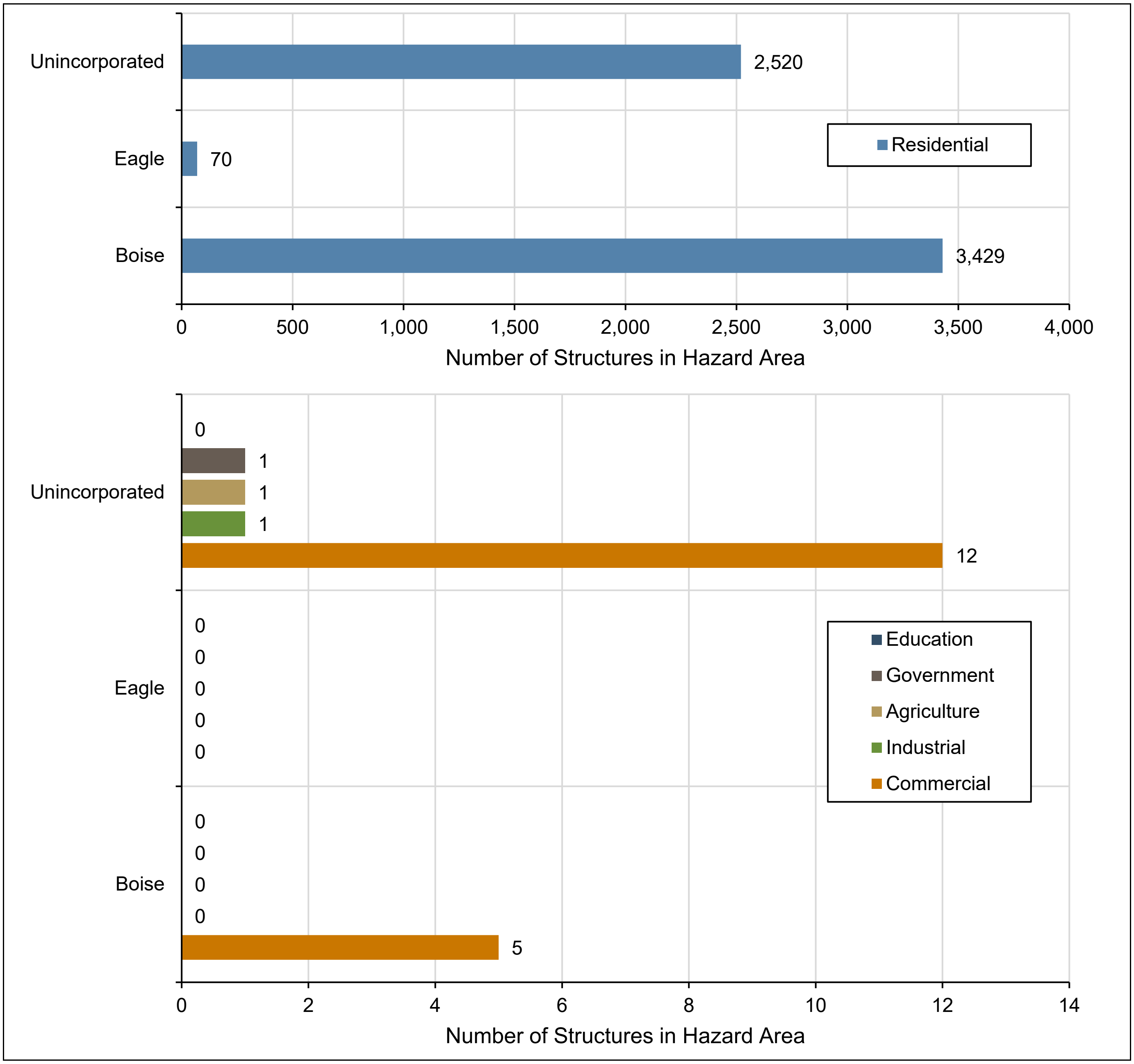


Figure 21-8. Number of Structures Within the High Wildfire Hazard Area

21.3.3 Critical Facilities

Figure 21-9 summarizes the critical facilities exposed to the wildfire hazard for the countywide planning area. Results for individual jurisdictions are provided in Appendix D.

In the event of wildfire, there would likely be little damage to the majority of infrastructure. Most road and railroads would be without damage except in the worst scenarios. Power lines are the most at risk to wildfire because most are supported on poles made of wood and susceptible to burning. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion.

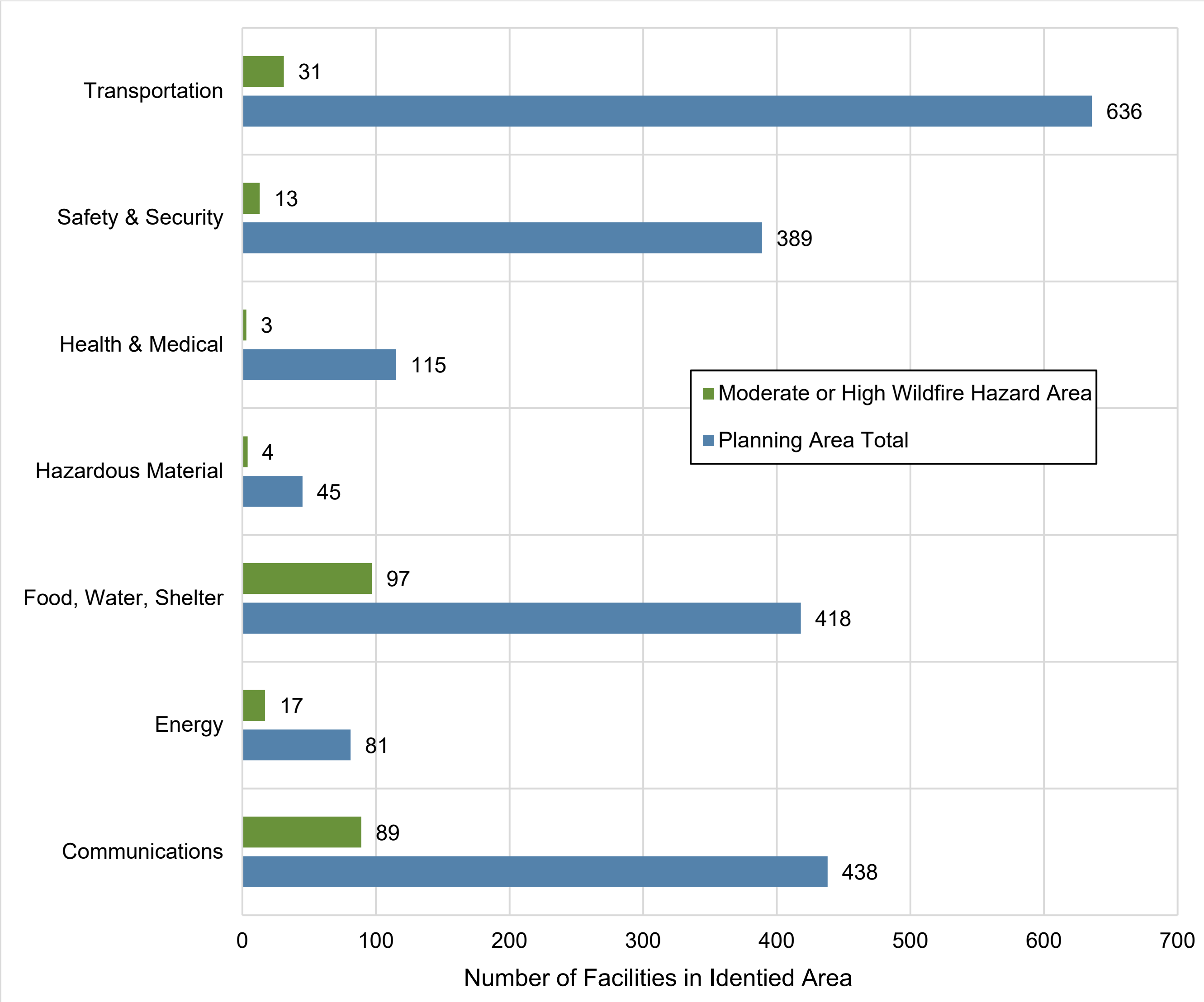


Figure 21-9. Critical Facilities in the Mapped Wildfire Hazard Areas and Countywide

During a wildfire event, hazardous material containers at Tier II material containment sites could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition, they could leak into surrounding areas, saturating soils and seeping into surface waters, and have a disastrous effect on the environment.

21.3.4 Environment

All natural areas within the mapped wildfire hazard zones are considered to be exposed to the hazard.

21.4 VULNERABILITY

There are currently no recognized models that estimate the vulnerability of people, property or infrastructure in for wildfire. There are too many variables with wildfire behavior to establish damage curves for the various wildfire severity zones. The vulnerabilities to wildfires are many. This section quantifies vulnerabilities in a fashion consistent with FEMA-suggested best management practices for risk assessment for hazard mitigation planning. For vulnerabilities that are not quantifiable, a qualitative assessment is provided. Except as discussed in this section, vulnerable populations, property, infrastructure and environment are assumed to be the same as described in the section on exposure.

21.4.1 Population

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility. Wildfire may also threaten the health and safety of those fighting the fires.

21.4.2 Property

Loss estimations for this assessment were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Loss estimates for the general building stock for jurisdictions that have an exposure to the top three hazard risk areas are listed in Table 21-3 and Table 21-4.

Table 21-3. Potential Damage to Buildings in High Wildfire Risk Areas

	Assessed Value	10% Damage	30% Damage	50% Damage
Boise	$2,699,393,432	$269,939,343	$809,818,029	$1,349,696,716
Eagle	$32,296,279	$3,229,627	$9,688,883	$16,148,139
Garden City	$0	$0	$0	$0
Kuna	$0	$0	$0	$0
Meridian	$0	$0	$0	$0
Star	$0	$0	$0	$0
Unincorporated	$1,797,462,158	$179,746,215	$539,238,647.40	$898,731,079
Total	**$4,529,151,869**	**$452,915,187**	**$1,358,745,561**	**$2,264,575,935**

Table 21-4. Potential Damage to Buildings in Moderate Wildfire Risk Areas

	Assessed Value	10% Damage	30% Damage	50% Damage
Boise	$3,638,292,936	$363,829,293	$1,091,487,880	$1,819,146,468
Eagle	$1,532,844,195	$153,284,419	$459,853,258	$766,422,097
Garden City	$17,512,716	$1,751,271	$5,253,814	$8,756,358
Kuna	$2,067,968	$206,796	$620,390	$1,033,984
Meridian	$0	$0	$0	$0
Star	$104,906,482	$10,490,648	$31,471,944	$52,453,241
Unincorporated	$1,856,895,561	$185,689,556	$557,068,668	$928,447,780
Total	**$7,152,519,858**	**$715,251,985**	**$2,145,755,957**	**$3,576,259,929**

21.4.3 Critical Facilities

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

Transportation infrastructure increases the wildfire vulnerability of adjacent lands because it provides access to the WUI. For example, a car towing a trailer through the WUI with a safety chain dragging on the ground that cause sparks can start a wildfire. Any access to a wildfire hazard area increases the vulnerability of that area.

21.4.4 Ecosystem Impacts

Wildfire is a part of nature. It plays a key role in shaping ecosystems by serving as an agent of renewal and change. But fire can be deadly, destroying homes, wildlife habitat and timber, and polluting the air with emissions harmful to human health. Fire also releases carbon dioxide—a key greenhouse gas—into the atmosphere. Fire's effect on the landscape may be long-lasting. Fire effects are influenced by forest conditions before the fire and management action taken or not taken after the fire. Fire can shape ecosystem composition, structure and functions in multiple ways:

- By selecting fire-adapted species and removing other, susceptible species
- By releasing nutrients from the biomass and improving nutrient cycling
- By affecting soil properties through changing soil microbial activities and water relations
- By creating heterogeneous mosaics, which in turn, can further influence fire behavior and ecological processes
- By damaging watersheds that serve as water supplies for urban areas
- By eliminating natural grazing areas.

Fire as a destructive force can rapidly consume large amount of biomass and cause negative impacts such as post-fire soil erosion and water runoff, and air pollution; however, as a constructive force, fire is also responsible for maintaining the health and perpetuity of fire-dependent ecosystems. Considering the unique ecological roles of fire in mediating and regulating ecosystems, fire should be incorporated as an integral component of ecosystems and management.

Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability. In such cases, wildfires can cause severe environmental impacts:

- Damaged Fisheries—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- Soil Erosion—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.

- Spread of Invasive Plant Species—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- Disease and Insect Infestations—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- Destroyed Endangered Species Habitat—Catastrophic fires can devastate endangered species.
- Soil Sterilization—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

21.5 DEVELOPMENT TRENDS

The planning area appears to be well equipped to deal with the wildfire hazard to future development. The key will be the availability of good hazard identification mapping that accurately reflects risks. As new science, data and technology become available, wildfire mapping should be updated.

Another key element to dealing with future development trends will be the ability of fire districts to maintain their levels of service. In a weak economy with decreasing tax revenues, fire districts struggle to maintain their resources at existing levels. Maintaining and or improving service will be a key element to dealing with future growth in the WUI.

County-wide adoption of stricter building codes for structures in the WUI is the first step to reducing risk in new construction. Increased public outreach will be the tool used to educate and assist property owners already in the WUI on how to comply with new codes and reduce the risk to their property. This combination of public education and code enforcement will be critical to reducing the risk of wildfire countywide.

21.5.1 Boise City Foothills Policy Plan

The purpose of the *Boise City Foothills Plan* of 1997 is to preserve multiple qualities and values of the Foothills while allowing for controlled development. The plan recognizes the constraints to Foothills development, including the wildfire hazard and the need for appropriate subdivision design, street layout, building materials and design, and landscaping. As an amendment of the Boise City Comprehensive Plan, the Foothills Plan has adopted zoning and building codes with specific wildfire prevention provisions.

21.5.2 Wildland Urban Fire Interface Overlay District

Ada County has delineated its high hazard area as a Wildland Urban Fire Interface overlay district, with specific requirements for building construction and defensible space. The building requirements are listed in Section 419.3 – 419.12.3 of the County's Uniform Building Code of 1997. The zoning code regulations apply to the area within the overlay district. Any new construction, alteration, moving, or change of use of a habitable structure is required to establish and maintain a minimum 50-foot defensible space around its perimeter. Within this defensible space buffer zone, there can be only single specimens of trees or ornamental vegetation, and cultivated ground cover or grasses up to a maximum height of 4 inches. All dead wood must be removed from trees, and clusters of trees must be thinned so that the crowns do not overlap. Trees must be pruned up to 6 feet. Areas adjacent to private roads and driveways must be cleared of vegetation. Areas within 5 feet on either side of driveways must be cleared, and the entire width of the easement of private roads must be cleared. Other regulations in the code address the location of liquefied petroleum gas, firewood, and other combustible materials near structures, road access to subdivisions, length of cul-de-sacs and water supply needs for fire flow.

21.6 SCENARIO

A major conflagration in Ada County might begin with a wet spring, adding to fuels already present on the forest floor. Flashy fuels would build throughout the spring. The summer could see the onset of insect infestation. A dry summer could follow the wet spring, exacerbated by dry hot winds. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lighting storm could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers would be deep in the forests and interface zones. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These new small fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

The worst-case scenario would include an active fire season throughout the American west, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be useful in the WUI areas, they have limited wildfire response capabilities and would have a difficult time responding to the ignition zones due to topography and other access limitations. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately. An initially manageable fire can become out of control before resources can reach the area.

Heavy rains could follow, causing flooding and landslides and releasing sediment into rivers, permanently changing floodplains and damaging sensitive habitat. With the forests removed from the watershed, stream flows could easily double. High-magnitude floods could increase in frequency.

21.7 ISSUES

The major issues for wildfire are the following:

- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Future climate conditions could affect the wildfire hazard.
- Future growth into interface areas should continue to be managed.
- Area fire districts need to continue to train on wildland urban interface events.
- Vegetation management activities would include enhancement through expansion of the target areas as well as additional resources.
- Regional consistency is needed for higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.

- Additional fire department water supply is needed in high risk wildfire areas.
- A buildable-lands analysis that looks at vacant lands and their designated land use would be a valuable tool in helping decision-makers make wise decisions about future development.

22. PLANNING AREA RISK RANKING

A risk ranking for the entire planning was performed for the hazards of concern described in this plan. This risk ranking assesses the probability of each hazard's occurrence as well as its likely impact on the people, property, and economy of the planning area. The risk ranking was conducted via facilitated brainstorming sessions with the Steering Committee. Estimates of risk were generated with data from Hazus using methodologies promoted by FEMA. Separate risk rankings for each planning partner city and the unincorporated county are provided in Volume 2. The ranking assessed only the natural hazards of concern and the dam/canal failure hazard. Other human-caused hazards of concern were not included.

22.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a factor determined by the likelihood of annual occurrence, based on past hazard events in the area:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor =2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor =1)
- No exposure—There is no probability of occurrence (Probability Factor = 0)

Figure 22-1 summarizes the probability assessment for each hazard of concern for this plan. The probability factor is the same for the baseline ranking and the equity lens ranking.

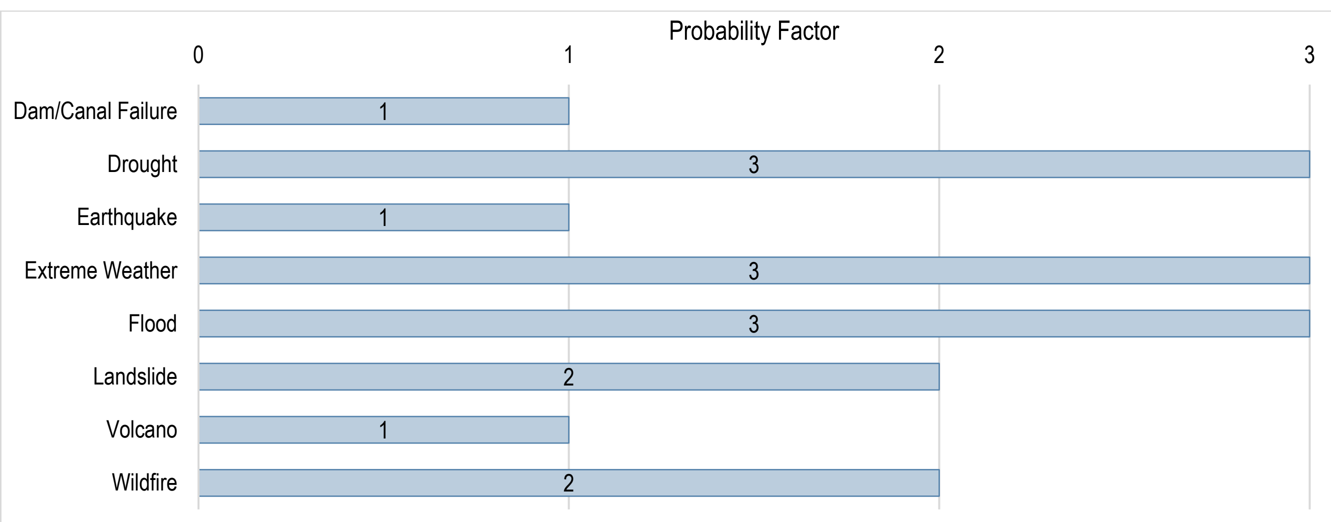


Figure 22-1. Probability Factors for Hazards of Concern

22.2 IMPACT

Hazard impacts were assessed in three categories: impacts on people, impacts on property and impacts on the local economy. Numerical impact factors were assigned as follows:

- **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. The rating of this impact assumes, for simplicity and consistency, that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. Planners can use an element of subjectivity when assigning values for impacts on people. Impact factors for people were assigned as follows:
    - High—50 percent or more of the population is exposed to a hazard (Impact Factor = 3)
    - Medium—25 percent to 49 percent of the population is exposed to a hazard (Impact Factor = 2)
    - Low—25 percent or less of the population is exposed to the hazard (Impact Factor = 1)
    - No impact—None of the population is exposed to a hazard (Impact Factor = 0)
- **Property**—Values were assigned based on the percentage of the total ***property value exposed*** to the hazard event:
    - High—30 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
    - Medium—15 percent to 29 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2)
    - Low—14 percent or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
    - No impact—None of the total assessed property value is exposed to a hazard (Impact Factor = 0)
- **Economy**—Values were assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total assessed value of the property exposed to the hazard. For some hazards, such as wildfire, landslide and extreme weather, vulnerability was considered to be the same as exposure due to the lack of loss estimation tools specific to those hazards. Loss estimates separate from the exposure estimates were generated for the earthquake and flood hazards using Hazus.
    - High—Estimated loss from the hazard is 20 percent or more of the total assessed property value (Impact Factor = 3)
    - Medium—Estimated loss from the hazard is 10 percent to 19 percent of the total assessed property value (Impact Factor = 2)
    - Low—Estimated loss from the hazard is 9 percent or less of the total assessed property value (Impact Factor = 1)
    - No impact—No loss is estimated from the hazard (Impact Factor = 0)

The impacts of each hazard category were assigned a weighting factor to reflect the significance of the impact. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the operations was given a weighting factor of 1. Figure 22-2 and Figure 22-3 summarize the unweighted and weighted impact factors, respectively, for each hazard.

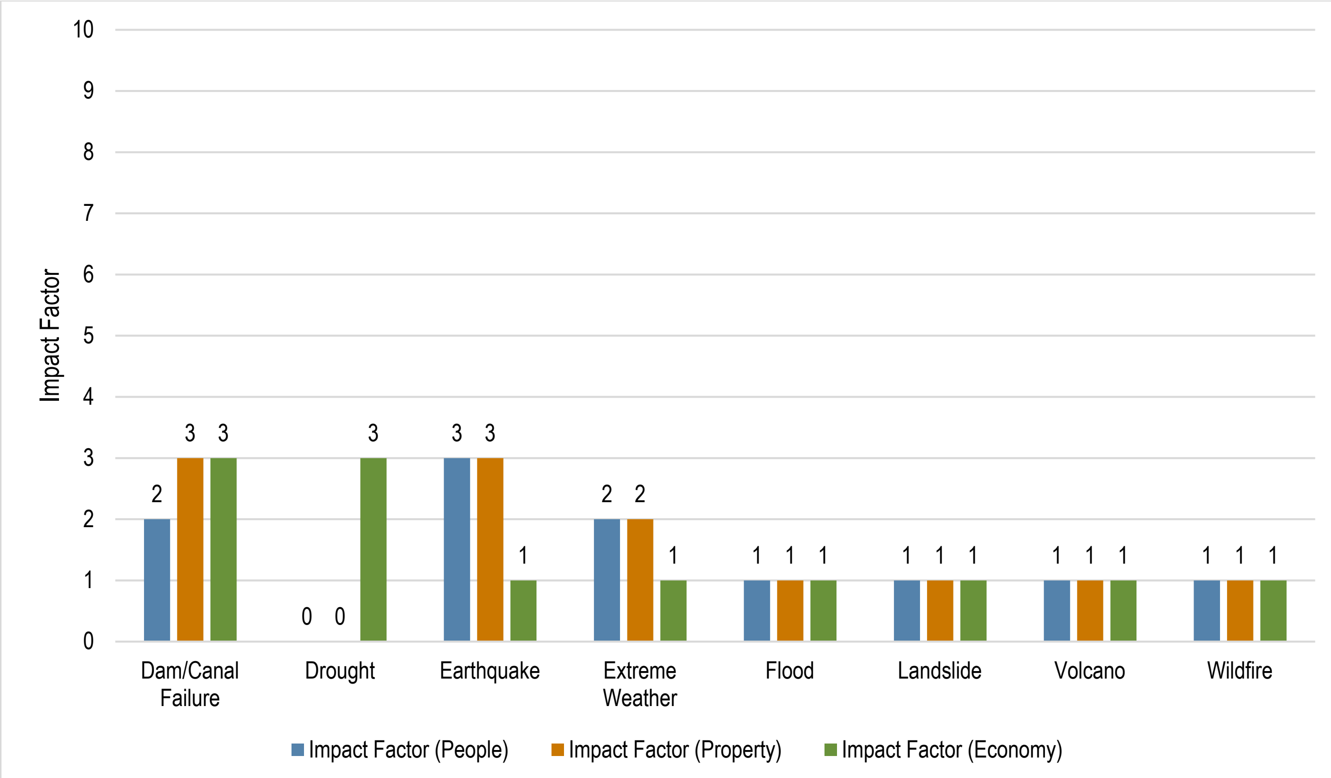


Figure 22-2. Impact Factors for Hazards of Concern

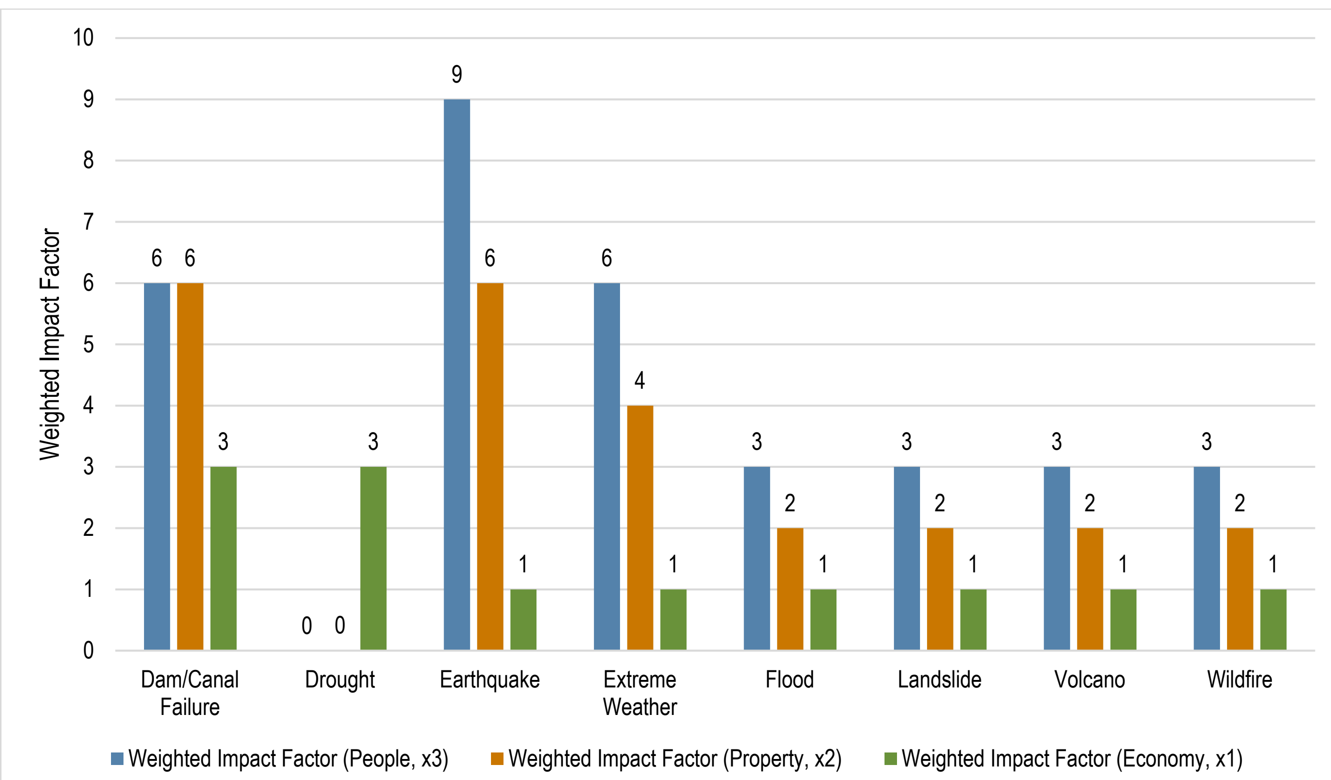


Figure 22-3. Weighted Impact Factors for Hazards of Concern

22.3 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property, and operations, as summarized in Figure 22-4. Based on these ratings, a priority of high, medium, or low was assigned to each hazard. Figure 22-5 shows the hazard risk ranking.

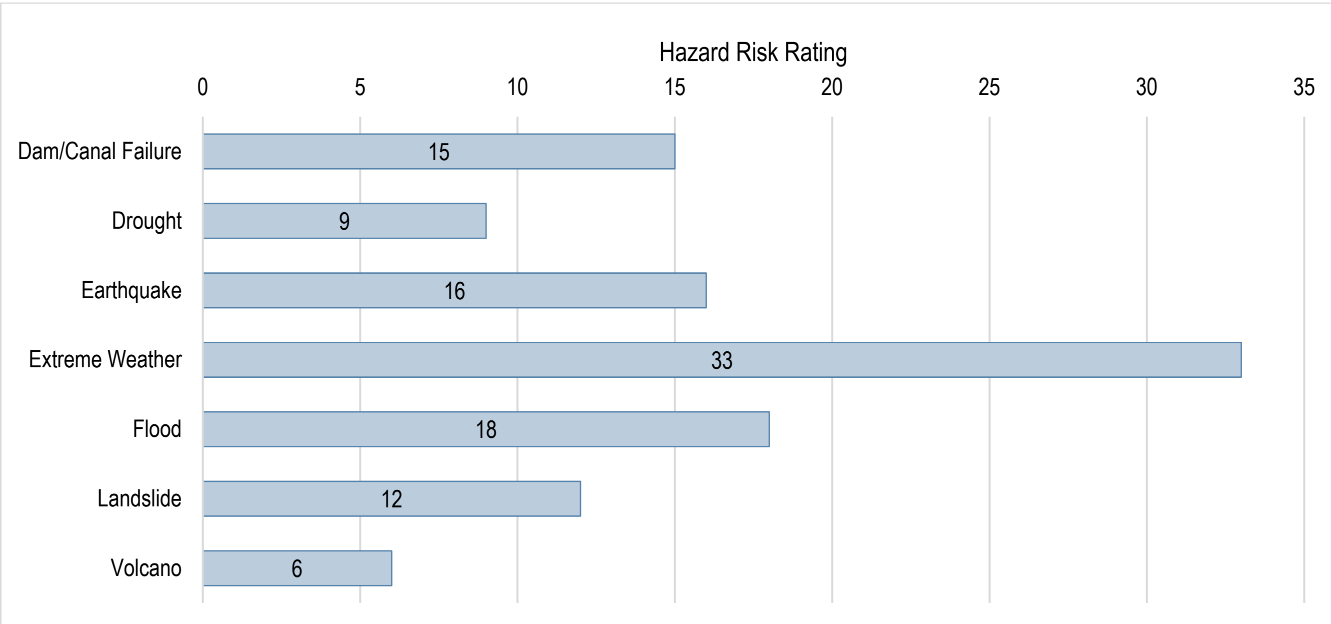


Figure 22-4. Total Risk Rating for Hazards of Concern

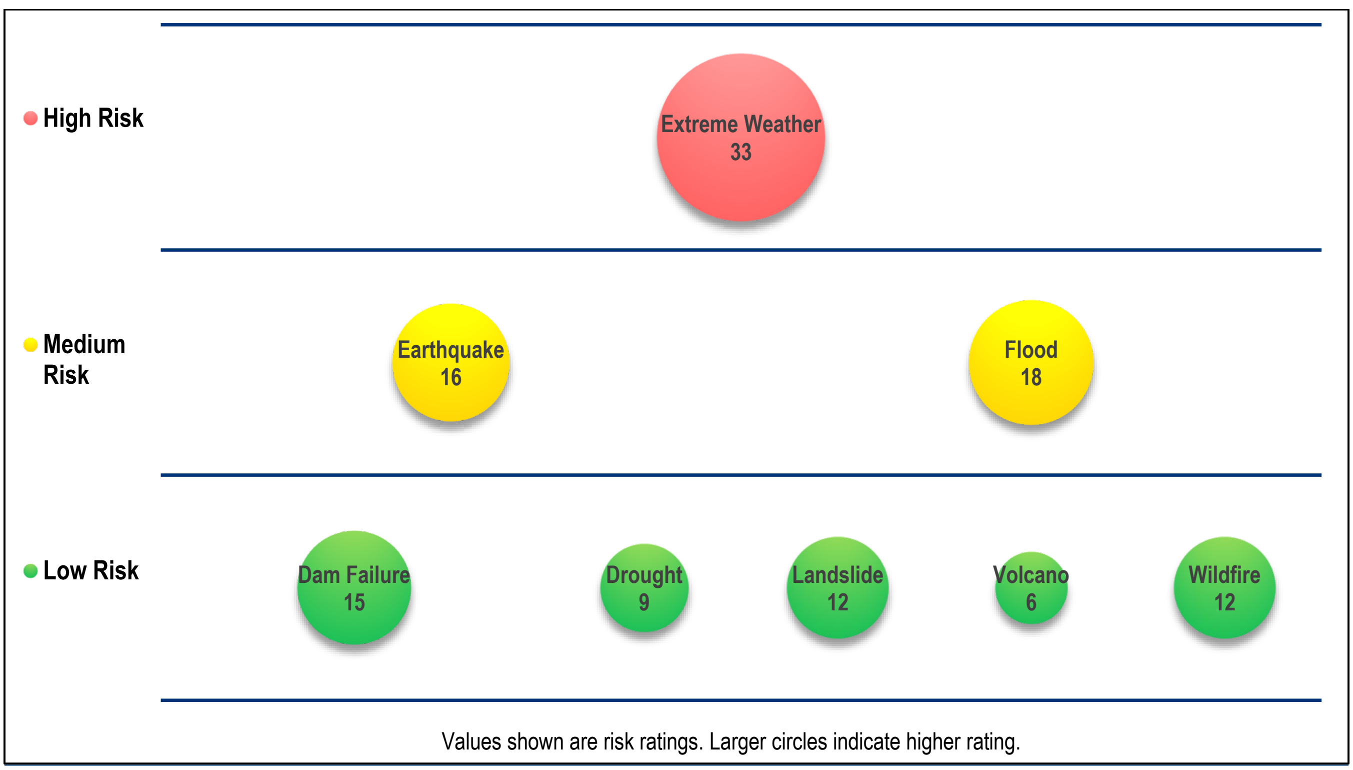


Figure 22-5. Hazard Risk Ranking

23. CONSIDERATION OF FUTURE CLIMATE CONDITIONS

23.1 WHAT ARE FUTURE CLIMATE CONDITIONS?

Climate, consisting of patterns of temperature, precipitation, humidity, wind and seasons, plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. "Future climate conditions" refers to variations in natural climate conditions over a long period of time. The current trend in climate conditions cannot be explained by natural processes alone.

The well-established worldwide warming trend of recent decades and its related impacts are caused by increasing concentrations of carbon dioxide and other greenhouse gases in the earth's atmosphere. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. Carbon dioxide is the most commonly known greenhouse gas; however, methane, nitrous oxide and fluorinated gases also contribute to warming. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels, agricultural production, and changes in land use. According to the National Aeronautics and Space Administration (NASA), carbon dioxide concentrations measured about 280 parts per million (ppm) before the industrial era began in the late 1700s and have risen dramatically since then, surpassing 400 ppm in 2013 for the first time in recorded history (see Figure 23-1).

Source: (National Aeronautics and Space Administration 2022)

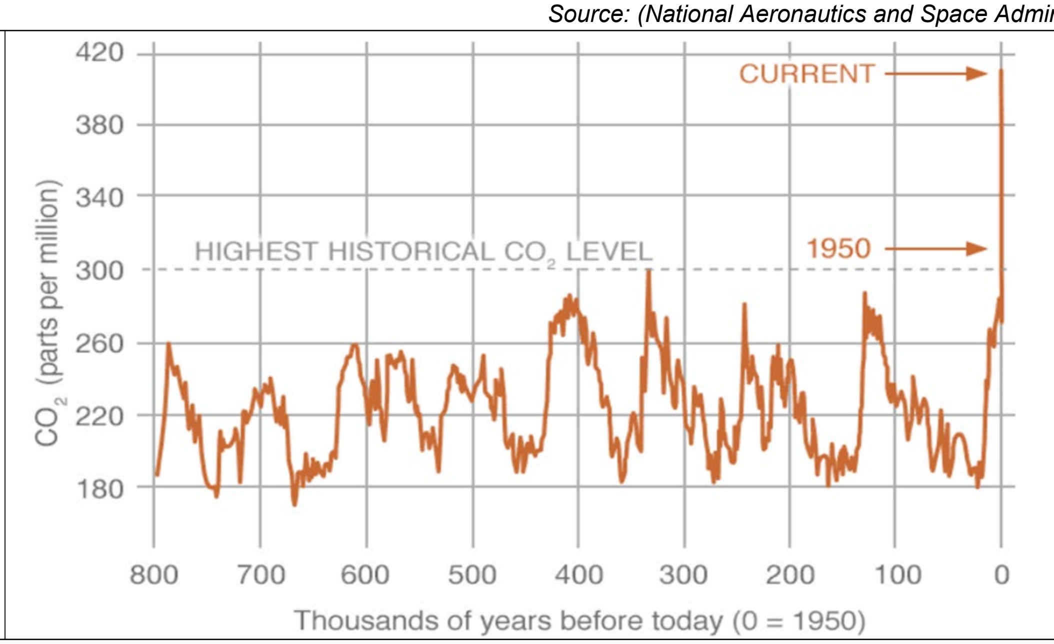


Figure 23-1. Global Carbon Dioxide Concentrations Over Time

23.2 HOW CLIMATE CONDITIONS AFFECT HAZARD MITIGATION

Future climate conditions will have a measurable impact on the occurrence and severity of natural hazards, affecting the people, property, economy and ecosystems of Ada County in a variety of ways. Impacts are likely to be associated with changes such as increased flooding, heat-related illnesses, or public health concerns.

An essential aspect of hazard mitigation is predicting the likelihood of hazard events. Typically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of hazard events remains essentially unchanged over time. Thus, averages based on the past frequencies of, for example, floods are used to estimate future frequencies: if a river has flooded an average of once every 5 years for the past 100 years, then it can be expected to continue to flood an average of once every 5 years.

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior is not valid if climate conditions are changing. As flooding is generally associated with precipitation frequency and quantity, for example, the frequency of flooding will not remain constant if broad precipitation patterns change over time. Specifically, as hydrology changes, storms currently considered to be a 1 percent-annual-chance event might strike more often, leaving many communities at greater risk. The risks of landslide, severe storms, extreme heat and wildfire are all affected by climate patterns as well. For this reason, an understanding of climate conditions is pertinent to efforts to mitigate natural hazards. Information about how climate patterns are changing provides insight on the reliability of future hazard projections used in mitigation analysis. This chapter summarizes current understandings about future climate conditions in order to provide a context for the recommendation and implementation of hazard mitigation measures.

23.3 CURRENT INDICATORS OF FUTURE CLIMATE CONDITIONS

23.3.1 Global Indicators

The major scientific agencies of the United States—including NASA and the National Oceanic and Atmospheric Administration (NOAA)—have presented evidence of trends for future climate conditions over an extended period of time. NASA summarizes key evidence as follows (National Aeronautics and Space Administration 2022):

- **Global Temperature Rise**—The planet's average surface temperature has risen about 2 ºF since the late 19th century. Most of the warming occurred in the past 40 years, with the seven most recent years being the warmest. The years 2016 and 2020 are tied for the warmest year on record.
- **Warming Ocean**—The ocean has absorbed much of this increased heat, with the top 300 feet of ocean showing warming of more than 0.6 ºF since 1969. Earth stores 90 percent of its extra energy in the ocean.
- **Shrinking Ice Sheets**—The Greenland and Antarctic ice sheets have decreased in mass. Data from NASA's Gravity Recovery and Climate Experiment show Greenland lost an average of 279 billion tons of ice per year between 1993 and 2019, and Antarctica lost about 148 billion tons of ice per year.
- **Glacial Retreat**—Glaciers are retreating almost everywhere around the world—including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa.
- **Decreased Snow Cover**—Satellite observations reveal that the amount of spring snow cover in the Northern Hemisphere has decreased over the past five decades and the snow is melting earlier.

- **Sea Level Rise**—Global sea level rose about 8 inches in the last century. The rate in the last two decades is nearly double that of the last century and is accelerating slightly every year.
- **Declining Arctic Sea Ice**—Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades
- **Extreme Events**—The number of record high temperature events in the United States has been increasing, while the number of record low temperature events has been decreasing, since 1950. The U.S. has also witnessed increasing numbers of intense rainfall events.
- **Ocean Acidification**—Since the 18th century, the acidity of surface ocean waters has increased by about 30 percent. This increase is the result of more carbon dioxide in the atmosphere and hence more being absorbed into the ocean. The amount of carbon dioxide absorbed by the upper layer of the oceans has increased to about 7 to 10 billion metric tons per year.

23.3.2 Idaho Indicators

Monitoring and research efforts across Idaho have generated data that describe observed changes already underway in the state. Notable examples across the state include the following (Abatzoglou, Marshall and Harley 2021) (University of Idaho n.d.).

- **Statewide Warming Trends—**While the warmest year in Idaho was 1934 during the Dust Bowl, seven of the ten warmest years from 1895 through 2020 have occurred since 1990; only one of the 10 coldest years has occurred since 1990. Warming trends are evident in all seasons over the past five decades. From 1918 through 2010, observations show approximately a two-week lengthening in the freeze-free season for lower elevation weather stations across Idaho.
- **Snowpack Decline**—The elevation of the freezing level in Idaho has increased over 500 feet from November through April since 1950. Widespread reductions in snowfall are evident across the state, with reduction of up to 15 percent in the Bitterroot Mountains from 1950 through 2020.
- **Streamflow Changes**—In unregulated basins in Idaho, there has been a reduction in total annual stream flow since 1950. In snowmelt-dominated regions, peak stream flow has occurred 1 to 2 weeks earlier in the year, tracking the reduction in spring snowpack. Stream gage measurements show decreases in minimum annual streamflow. Summer stream temperatures warmed by an average of 1.5ºF from 1975 to 2015.
- **Heavier Spring Rainfall**—The intensity of the biggest rainfall event of the season has increased, with most of the large events having occurred since 1990.
- **Drought—**There has been a notable trend toward warmer and drier summers over the past five decades that have increased atmospheric water demand and dryness. Such changes have contributed to a substantial decrease in fuel moisture, contributing to escalating fire potential.
- **Increasing Forest Wildfire Activity—**Since 1986, longer, warmer summers in the western United States have resulted in four times as many major wildfires and six times as much area of forest burned, compared to 1970 through 1986. The length of the wildfire season (when fires are actively burning) has increased by 78 days. The average time-span of large fires has increased from 7.5 to 37.1 days. Earlier snowmelt, higher summer temperatures, and a longer fire season have contributed to these changes in fire activity.
- **Plants and Forests**—Through observations of plant life cycle events and temperature data, scientists have determined that indicator plant species are blooming earlier on average.

- **Salmon Migration**—Sockeye salmon migration has been occurring earlier in the spring. Thirty years' worth of data suggests that salmon are returning to freshwater streams about one day earlier per decade.
- **Wildlife**—Changes in temperature impact plant and animal life cycle events. Tracking by citizen scientists has provided data that indicates that mountain bluebirds in Idaho lay eggs earlier when spring temperatures are warmer.

23.4 PROJECTED FUTURE IMPACTS

Projections about future climate conditions contain inherent uncertainty, largely because they depend on future greenhouse gas emission scenarios. Generally, the uncertainty in greenhouse gas emissions is addressed by the presentation of differing scenarios: low-emissions or high-emissions scenarios. In low-emissions scenarios, greenhouse gas emissions are reduced substantially from current levels. In high-emissions scenarios, greenhouse gas emissions generally increase or continue at current levels. Uncertainty in outcomes is generally addressed by averaging a variety of model outcomes. Despite this uncertainty, future climate condition projections present valuable information to help guide decision-making for possible future conditions.

23.4.1 Global and National Projections

The Intergovernmental Panel on Climate Change, which includes more than 1,300 scientists from the United States and other countries, project that Earth's average temperatures will raise 2.5 to 10 ºF over the next century (National Aeronautics and Space Administration 2022). The Third and Fourth *National Climate Assessment Reports* indicate the following:

- **Change Will Continue Through This Century and Beyond**—Global climate is projected to continue to change over this century and beyond. The magnitude of change beyond the next few decades depends primarily on the amount of heat-trapping gases emitted globally, and how sensitive the Earth's climate is to those emissions.
- **Temperatures Will Continue to Rise**—Because human-induced warming is superimposed on a naturally varying climate, the temperature rise has not been, and will not be, uniform or smooth across the country or over time.
- **Frost-Free Season and Growing Season will Lengthen**—The length of the frost-free season and the corresponding growing season has been increasing nationally since the 1980s, with the largest increases occurring in the western United States, affecting ecosystems and agriculture. Across the United States, the growing season is projected to continue to lengthen. In a future in which heat-trapping gas emissions continue to grow, increases of a month or more in the lengths of the frost-free and growing seasons are projected across most of the United States by the end of the century, with slightly smaller increases in the northern Great Plains. The largest increases in the frost-free season (more than eight weeks) are projected for the western United States, particularly in high elevation and coastal areas. The increases will be smaller if heat-trapping gas emissions are reduced.

23.4.2 Projections for Idaho

A research project at the University of Idaho sought to identify future climate projections from climate models in the State of Idaho. The following information is summarized from their findings (Abatzoglou, Marshall and Harley 2021):

Temperature and Precipitation

Projected changes in temperature in Idaho largely mirror projected changes for the northwestern United States. The annual mean temperature averaged for Idaho is projected to warm 11 ºF on average above 1950 through 1999 values by 2100 under a high-warming scenario, compared with a warming of 6 ºF on average under a moderate-warming scenario. All models show faster rates of warming over the 21st century than in the 20th century.

The length of the freeze-free season is projected to increase substantially across Idaho. For example, in Nampa, the length of the freeze-free season extends from around 160 days for the late 20th century to 210 days by the mid-21st century under a high-warming scenario.

Summer precipitation and cloud cover are projected to decrease slightly. Despite small decreases in relative humidity, increased temperatures and increased overall atmospheric moisture are projected to dramatically increase the occurrence of days with elevated heat index values across Idaho. The heat index—which incorporates a combination of air temperature and relative humidity—is used by the National Weather Service and health information services across the country to assess heat-related impacts. While Boise saw an average of less than one day per year with heat indices over 100 ºF from 1971 through 2000, model projections suggest the region could see upwards of two weeks of such conditions by the mid-21st century under a high-warming scenario.

Projected changes include a slight increase (5 to 10 percent) in total annual precipitation by 2100. In addition to changes in cumulative precipitation, models suggest changes in the character of precipitation. The frequency of extremely heavy hourly precipitation from December through February is projected to increase 3- to 5-fold across Idaho by the end of the 21st century using a high-warming scenario. Compensatory changes in the frequency of precipitation are also projected for the region, with a few additional days per year without notable precipitation.

Snowpack

Despite uncertain projected changes in the total amount of precipitation, warming results in decreased snowpack as precipitation falls more as rain and less as snow. April 1 volumetric snowpack storage across Idaho is projected to decrease by one-third by the mid-21st century under a high-warming scenario. In addition, multiple consecutive years of snow drought—years with very low snow or snow that melts very early—are projected to become much more common. A larger fraction of the annual snowpack is projected to come from large storm events.

Drought

The likelihood, duration, magnitude, and character of drought are also likely to change across the state in the coming decades. Warming, associated increased evaporative demand, and reduced mountain snowpack all favor a future of increased summer drought.

23.5 RESPONSES TO FUTURE CLIMATE CONDITIONS

Communities and governments worldwide are working to address, evaluate and prepare for future climate conditions that are likely to impact communities in coming decades. Generally, future climate condition discussions encompass two separate but inter-related considerations: mitigation and adaptation.

The term “mitigation” has multiple meanings across disciplines. Mitigation in emergency management, as generally addressed in this hazard mitigation plan, is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters. Mitigation in climate condition discussions is defined as a human intervention to reduce impacts on the climate system. It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks. In this chapter, mitigation is used as defined by the climate condition community. In the other chapters of this plan, mitigation is primarily used in an emergency management context.

Adaptation refers to adjustments in natural or human systems in response to the actual or anticipated effects of future climate conditions and associated impacts. These adjustments may moderate harm or exploit beneficial opportunities. Mitigation and adaptation are related, as the world’s ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Some initiatives and actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions.

Societies across the world are facing the need to adapt to changing conditions associated with natural disasters and climate conditions. Farmers are altering crops and agricultural methods to deal with changing rainfall and rising temperature; architects and engineers are redesigning buildings; planners are looking at managing water supplies to deal with droughts or flooding.

Adaptive capacity goes beyond human systems, as some ecosystems are able to adapt to change and to buffer surrounding areas from the impacts of change. Forests can bind soils and hold large volumes of water during times of plenty, releasing it through the year; floodplains can absorb vast volumes of water during peak flows; coastal ecosystems can hold out against storms, attenuating waves and reducing erosion. Other ecosystem services—such as food provision, timber, materials, medicines, and recreation—can provide a buffer to societies in the face of changing conditions. Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of future climate conditions. This includes the sustainable management, conservation and restoration of specific ecosystems that provide key services.

23.6 FUTURE CLIMATE CONDITION IMPACTS ON HAZARDS

The following sections provide information on how each identified hazard of concern for this planning process may be impacted by future climate conditions and how these impacts may alter current exposure and vulnerability for the people, property, critical facilities and the environment in Ada County to these hazards.

23.6.1 Civil Disturbance and Terrorism

Impacts on the Hazard

Because civil disturbance and terrorism are short-term, human-caused hazards, no future climate condition impacts are associated with the hazard.

Population, Property, Critical Facilities and the Environment

Increases in exposure and vulnerability of the local resources are not able to be determined. However, adverse effects on the population due to future climate conditions could create a possibility for civil disturbance instances. An example would be critical resource shortages (such as water) during a drought, or prolonged power and service issues resulting from floods or severe storms causing people to become angry with government.

23.6.2 Cyber Disruption

Impacts on the Hazard

Although cyber disruption is categorized as a human-caused hazard, future climate condition impacts could have cascading effects potentially causing a cyber disruption. Such instances would be severe storms, as well as flooding associated with potential rain on snow events. If the damage were caused to computer systems or servers, this could cause a cyber disruption for that agency or building.

Population, Property, Critical Facilities and the Environment

Increases in exposure and vulnerability of the local resources are not able to be determined.

23.6.3 Dam Failure

Impacts on the Hazard

Small changes in rainfall, runoff, and snowpack conditions may have significant impacts for water resource systems, including dams. Dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream.

Dams are constructed with safety features known as "spillways." Spillways are put in place on dams as a safety measure in the event of the reservoir filling too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. Although future climate conditions will not increase the probability of catastrophic dam failure, they may increase the probability of design failures.

Population

Population exposure and vulnerability to the dam failure hazard are unlikely to change as a result of future climate conditions.

Property

Property exposure and vulnerability to the dam failure hazard are unlikely to change as a result of future climate conditions.

Critical Facilities

The exposure and vulnerability of critical facilities are unlikely to change as result of future climate conditions. Dam owners and operators may need to alter maintenance and operations to account for changes in the hydrograph and increased sedimentation.

Environment

The exposure and vulnerability of the environment to dam failure are unlikely to change as a result of future climate conditions. Ecosystem services may be used to mitigate some of the factors that may increase the risk of design failures, such as increasing the natural water storage capacity in watersheds above dams.

23.6.4 Drought

Impacts on the Hazard

The long-term effects of future climate conditions on regional water resources are unknown, but global water resources are already experiencing the following stresses:

- Growing populations
- Increased competition for available water
- Poor water quality
- Environmental claims
- Uncertain reserved water rights
- Groundwater overdraft
- Aging urban water infrastructure.

With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. According to the National Climate Assessment, "higher surface temperatures brought about by global warming increase the potential for drought. Evaporation and the higher rate at which plants lose moisture through their leaves both increase with temperature. Unless higher evapotranspiration rates are matched by increases in precipitation, environments will tend to dry, promoting drought conditions" (U.S. Climate Resilience Toolkit 2021).

Much of the water needed for agriculture, public supplies, and other uses comes from mountain snowpack, which melts in spring and summer and runs off into rivers and fills reservoirs. As the climate warms, less precipitation falls as snow, and more snow melts during the winter, which decreases the snowpack. Since the 1950s, Idaho's snowpack has been decreasing in most locations. A warming climate makes water less available during summer. As snowpack melts earlier, flows of fresh water in rivers and streams increase during late winter and early spring, but decrease during summer (Environmental Protection Agency 2016).

By addressing current stresses on water supplies and by building a flexible, robust program, Ada County will be able to more adeptly respond to changing conditions and to survive dry years.

Population

Population exposure and vulnerability to drought are unlikely to increase as a result of future climate conditions. While greater numbers of people may need to engage in behavior change, such as water saving efforts, significant life or health impacts are unlikely.

Property

Property exposure and vulnerability may increase as a result of increased drought resulting from future climate conditions, although this would most likely occur in non-structural property such as crops and landscaping. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire, may increase and threaten structures.

Critical Facilities

Critical facility exposure and vulnerability are unlikely to increase as a result of increased drought resulting from future climate conditions; however, critical facility operators may need to alter standard management practices and actively manage resources, particularly in water-related service sectors.

Environment

The vulnerability of the environment may increase as a result of increased drought resulting from future climate conditions. The ecosystems and biodiversity in Ada County are already under stress from development and water diversion activities. Prolonged or more frequent drought resulting from future climate conditions may further stress the ecosystems in the region.

23.6.5 Earthquake

Impacts on the Hazard

The impacts of global future climate conditions on earthquake probability are unknown, although scientists have identified tiny earthquakes triggered by the change of fault stress loads from rain and snow. Similarly, long-term drought can result in a significant change in the stress load on earth's crust.

Secondary impacts of earthquakes could be magnified by future climate conditions. Soils saturated by repetitive storms or heavy precipitation could experience liquefaction or an increased propensity for slides during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events.

Population, Property, Critical Facilities and the Environment

Because impacts on the earthquake hazard are not well understood, increases in exposure and vulnerability of the local resources are not able to be determined.

23.6.6 Extreme Weather

Impacts on the Hazard

Future climate conditions present a challenge for risk management associated with extreme weather. The frequency of extreme weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for extreme weather events increases in a warmer climate.

This increase in average surface temperatures can also lead to more intense heat waves that can be exacerbated in urbanized areas by what is known as urban heat island effect. The evidence suggests that heat waves are already increasing, especially in western states.

Population and Property

Population and property exposure and vulnerability would be unlikely to increase as a direct result of future climate condition impacts on the extreme weather hazard. Extreme weather events may occur more frequently, but exposure and vulnerability will remain the same. Secondary impacts, such as the extent of localized flooding, may increase, thus impacting greater numbers of people and structures.

Critical Facilities

Critical facility exposure and vulnerability would be unlikely to increase as a result of future climate condition impacts on the extreme weather hazard; however, critical facility owners and operators may experience more frequent disruptions. For example, more frequent and intense storms may cause more frequent disruptions in power service.

Environment

Exposure and vulnerability of the environment would be unlikely to increase; however, more frequent storms and heat events and more intense rainfall may place additional stressors on already stressed systems.

23.6.7 Flood

Impacts on the Hazard

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers future climate conditions must be adopted. Future climate conditions are already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by future climate conditions will allow more mountain areas to contribute to peak storm runoff. High frequency flood events (e.g. 10-year floods) in particular will likely increase with future climate conditions. Along with reductions in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to future climate conditions, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 1-percent-annual-chance flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains.

Population and Property

Population and property exposure and vulnerability may increase as a result of future climate condition impacts on the flood hazard. Runoff patterns may change resulting in flooding in areas where it has not previously occurred.

Critical Facilities

Critical facility exposure and vulnerability may increase as a result of future climate condition impacts on the flood hazard. Runoff patterns may change resulting in risk to facilities that have not historically been at risk from flooding. Additionally, changes in the management and design of flood protection critical facilities may be needed as additional stress is placed on these systems.

Environment

The exposure and vulnerability of the environment may increase as a result of future climate condition impacts on the flood hazard. Changes in the timing and frequency of flood events may have broader ecosystem impacts that alter the ability of already stressed species to survive.

23.6.8 Hazardous Materials Release

Impacts on the Hazard

Hazardous materials are an important factor and often a cascading effect in every natural and many man-made disasters. Therefore, there are serious implications for impacts from future climate conditions.

Population, Property, Critical Facilities and the Environment

Increases in exposure and vulnerability of local resources are not able to be determined with certainty, but hazardous materials are subject to the same future climate considerations as every other hazard.

23.6.9 Landslide

Impacts on the Hazard

Future climate conditions may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature is likely to affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

Population and Property

Population and property exposure and vulnerability would be unlikely to increase as a result of future climate condition impacts on the landslide hazard. Landslide events may occur more frequently, but the extent and location should be contained within mapped hazard areas and recently burned areas.

Critical Facilities

Critical facility exposure and vulnerability would be unlikely to increase as a result of future climate condition impacts on the landslide hazard; however, critical facility owners and operators may experience more frequent disruption to service provision as a result of landslide hazards. For example, transportation systems may experience more frequent delays if slides blocking these systems occur more frequently.

Environment

Exposure and vulnerability of the environment would be unlikely to increase as a result of future climate conditions, but more frequent slides in riverine systems may impact water quality and have negative impacts on already stressed species.

23.6.10 Public Health Emergency/Pandemic

Impacts on the Hazard

Worldwide, there has been an apparent increase in reports of infectious diseases, many of which reflect the combined effects of rapid demographic, environmental, social, technological, and other changes in how we live. Future climate conditions will likely affect changes in transmission patterns of infectious diseases (Centers for Disease Control and Prevention 2020). Emergence of new pathogens and improved detection and reporting can also contribute to increases in numbers of reported cases.

Population, Property, Critical Facilities and the Environment

The relationship between climate conditions and infectious diseases is complex and not well understood. The ranges and impacts of important pathogens might change as a result of changing temperatures and precipitation. Future climate conditions might increase or change the range of disease vectors such as mosquitoes or rodents. Heavy rainfall and flooding can be associated with waterborne disease outbreaks. Increases in exposure to property, critical facilities, and the environment are unknown.

23.6.11 Radiological Event

Impacts on the Hazard

In addition to increase in temperature, the stratospheric ozone is depleting. Stratospheric ozone absorbs much of the incoming solar ultraviolet radiation. A depleting ozone increases the amount of ultraviolet-B in the atmosphere, raising concern about the levels of biologically damaging radiation reaching the ground.

Population, Property, Critical Facilities and the Environment

Loss of stratospheric ozone may lead to human health impacts, affecting the skin, eyes, immune system and general well-being. Many studies have indicated that solar radiation is a cause of skin cancer and there may be an increase in skin cancer incidence and sunburn severity due to ozone depletion (Cancer Data Registry of Idaho 2004). Increases in exposure to property, critical facilities, and the environment are unknown.

23.6.12 Utility Failure

Impacts on the Hazard

Declining snowpack and resulting lower streamflow would mean less hydroelectric power. (Environmental Protection Agency 2016).

Population, Property, Critical Facilities and the Environment

Increases in exposure and vulnerability of local resources are not able to be determined.

23.6.13 Volcano (Ash Fall)

Impacts on the Hazard

Future climate conditions are not likely to affect the risk associated with volcanoes; however, volcanic activity can affect future climate conditions. Volcanic clouds absorb terrestrial radiation and scatter a significant amount of incoming solar radiation. By reducing the amount of solar radiation reaching the Earth's surface, large-scale volcanic eruptions can lower temperatures in the lower atmosphere and change atmospheric circulation patterns. The massive outpouring of gases and ash can influence climate patterns for years following a volcanic eruption. Additionally, while future climate conditions are not likely to increase the frequency of eruptions, changes in precipitation amounts could increase the potential for lahars or debris avalanches in volcanic areas.

Population, Property, Critical Facilities and the Environment

Exposure and vulnerability to the volcano hazard are unlikely to change as a direct result of future climate conditions.

23.6.14 Wildfire

Impacts on the Hazard

Wildfire is determined by climate variability, local topography, and human intervention. Future climate conditions have the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. Additionally, changes in climate patterns may impact the distribution and perseverance of insect outbreaks that create dead trees (increase fuel). When climate alters fuel loads and fuel and soil moisture, forest susceptibility to wildfires changes (Environmental Protection Agency 2016). Future climate conditions also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Population, Property and Critical Facilities

Larger, more severe, and more frequent fires may impact the people, property and critical facilities by increasing the risk of ignition from nearby fire sources. Additionally, secondary impacts such as air quality issues may increase.

Environment

It is possible that the exposure and vulnerability of the environment will be impacted by impacts on wildfire risk from future climate conditions, as natural fire regimes may change, resulting in more frequent or higher intensity burns. These impacts may alter the composition of the ecosystems in the areas in and surrounding Ada County.