SECTION 4: PLAN IMPLEMENTATION AND MAINTENANCE

The Plan Implementation and Maintenance section details the formal process that will ensure that the *2020 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan* (*2020 NHMP*) remains an active and relevant document. The initial section outlines assets, capabilities and success stories that support the ability of the county to implement actions in the plan during the planning period. The plan implementation and maintenance process includes a schedule for monitoring and evaluating the plan annually, as well as producing an updated plan every five years. This section also describes how Baker County, the City of Baker City and the City of Halfway will integrate public participation and participation of other interested jurisdictions as plan holders throughout the plan maintenance and implementation process.

Assets, Capabilities and Success Stories

Hazard planning implementation requires drawing on existing community assets and capabilities. Some comments made by participants in the process are shared below with respect to the valuable human, economic, built environment and natural environment assets in Baker County. For a compiled list of the building assets of the jurisdictions considered by DOGAMI in the Risk Report developed for this NHMP update, please see Volume III, Appendix A: Community Profile.

The 2016 *Baker County, Oregon Natural Resources Plan* elaborates on each of the county's natural resources and provides insight into management strategies to provide balanced multiple uses of these resources. It states that "The County's watersheds are diverse and dynamic. They consist of forestlands, shrublands and grasslands, mountains, canyons and valleys, uplands, floodplains, wetlands, channels, streams, springs, lakes, reservoirs, and groundwater. They continue to evolve under the influence of climate, plants, animals, geology, floods, landslides, faults, uplift, volcanoes, erosion and sedimentation, and human land use."[84]

Members of the Baker County NHMP Steering Committee recognize the natural resources of the county as one of its biggest assets and the reliance on these natural resources is one of its greatest vulnerabilities. Michelle Owen, Public Works Director for Baker City stated it this way, "This is an agricultural based community and the natural surroundings are valued. The most vulnerable impact would be loss of the watershed -our drinking water source-due to wildfire." She specifically mentioned concerns about the vulnerability to the impacts of wildfire on the water transmission line to Baker City, the Baker City water and wastewater treatment plant, Baker City Airport. She notes that these assets "are susceptible to wildland fires, (are) not within the city's fire district, (and) would be difficult and costly to replace while leaving citizens without basic necessities."[85]

[84] Baker County, Oregon Natural Resources Plan, p. 43
[85] Michelle Baker, personal communication, May-July 2019

Whitney Collins, NRCS District Manager, noted that the natural resources of the county including farming, timber and grazing resources "are all vulnerable to naturally occurring events. These are also the main drivers of our economy."[86]

Jason Yencopal, Baker County's Emergency Manager, expressed the dominance of drought as a natural hazard that impacts economic assets of the county. He notes that the impact of drought is felt by all Baker County residents and impacts agricultural producers, residents and visitors county-wide, and leads to other issues such as wildfire that are very destructive, but in terms of acres, drought covers more area than wildfire.[87]

In a resource economy where precipitation is limited, water management infrastructure is critical. The infrastructure in place in Baker County to manage water for irrigation and for consumption was mentioned by W. Collins as being among the most valued built assets and also among the most vulnerable assets to the impact of natural hazards. These assets included Mason Dam, Thief Valley Dam, Unity Dam, dams retaining the other reservoirs in the county and the irrigation infrastructure upon which agricultural producers depend.

Baker County, state and federal partner agencies and cities within the county employ a range of professionals to maintain and manage these natural and built assets.

The most valued and also the most vulnerable people in Baker County according to some who participated in the NHMP update process, are elderly people. This may be partly because they may be limited in the means by which they remain informed about impending natural hazards. Baker County counts among its successes in emergency management, the implementation of a mass notification system. This system was used during the August 2013 *Cryptosporidium* outbreak in Baker City's water supply system and the 2015 wildfires. This system is among the wide reaching, reliable methods that can be used to alert the most vulnerable residents in the event of an emergency.

The infrastructure in place to care for elderly people and all Baker County residents includes hospitals and grocery stores according to a participant in the NHMP update process. As has been recognized during the recent COVID-19 pandemic of 2020, the importance of small businesses and health care institutions cannot be under rated. It is for this reason that among the mitigation actions re-activated from a deferred status in this NHMP update is item MH 5: Increase the resilience of small businesses to natural hazards.

These community assets and capabilities along with a demonstrated ability to work together support the ability of jurisdictions of Baker County to utilize this plan to mitigate risks to natural hazards in the future.

Implementing the Plan

The 2020 *Baker County Multi-Jurisdictional Natural Hazard Mitigation Plan* will be formally adopted following approval by FEMA. The success of the *2020 NHMP* depends on how well the mitigation actions in Table 4 are implemented. In an effort to promote active implementation of the mitigation

[86] Whitney Collins, personal communications, May-June 2019
[87] Jason Yencopal, personal communications, February 2020

actions a coordinating body for plan maintenance and implementation will be formed, a convener will be designated, the identified activities will be prioritized and evaluated, and the plan will be implemented through existing plans, programs, procedures, and policies. The NHMP Implementation Committee will meet twice a year to implement the plan and updates to the plan will be done every five years.

Plan Adoption

Once the 2020 *Baker County Multi-Jurisdictional Natural Hazard Mitigation Plan* is locally reviewed and ready, the Plan Convener and DLCD will submit it to the State Hazard Mitigation Officer at Oregon's Office of Emergency Management (OEM). OEM will review the plan and submit it to the Federal Emergency Management Agency (FEMA) Region X for review. This review addresses the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201.6 and detailed in the FEMA Review Tool.

Upon pre-approval by FEMA, indicated by a letter provided from FEMA to Baker County called the "Approval Pending Adoption" (APA) the Baker County Board of Commissioner and other jurisdictions that have signed agreements to participate in this plan (the City Baker City and the City of Halfway) will then formally adopt the *2020 NHMP* via resolution. Once FEMA is provided with final resolution documentation for the first of these jurisdictions to adopt the plan, FEMA will issue a formal letter of approval indicating the effective dates of the plan. Following adoption by the other jurisdictions and districts adopting the plan a revision of this letter will be issued, however the effective dates of the plan will be the same for all. Following adoption of the FEMA approved NHMP, those jurisdictions (Baker County, City of Baker City and the City of Halfway) will be eligible to apply for FEMA Hazard Mitigation Assistance (HMA) pre- and post- disaster funds. These funds are distributed through the Pre-Disaster Mitigation (PDM) program, the Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. Additional resources for mitigation project grant funding can be found in Volume III, Appendix E – Grant Programs and Resources.

The final copy of the *2020 NHMP* will be produced once the FEMA approval letters and the copies of the resolutions of approval from Baker County, City of Baker City and the City of Halfway are received by the project manager. These documents will be incorporated into the document and the effective dates of the plan will be added. The final document will be provided to each jurisdiction and district for posting on their websites and for use as plan implementation begins.

The accomplishment of the *2020 NHMP* goals and actions depends upon regular Steering Committee participation and support from county and city leadership. Thorough familiarity with the *2020 NHMP* will result in the efficient and effective implementation of mitigation actions and a reduction in the risk and the potential for loss from future natural hazard events.

Convener

The Steering Committee determined at its May 19, 2020 meeting that the Baker County Emergency Manager will take responsibility for plan implementation and will facilitate the *2020 NHMP* Implementation Committee meetings. The Emergency Manager will lead the committee, assign tasks as appropriate, and solicit assistance from DLCD and OEM as needed. Plan implementation and evaluation should be a shared responsibility among all of the Implementation Committee members. The convener's responsibilities may include:

- Coordinating 2020 NHMP Implementation Committee meeting dates, times, locations, agendas, and member notification;
- Documenting the discussions and outcomes of Implementation Committee meetings;
- Serving as a communication conduit between the Implementation Committee and the public/stakeholders;
- Identifying funding sources for natural hazard mitigation projects or seek assistance from OEM and DLCD to do so; and
- Utilizing the Risk Assessment chapter and the Project Prioritization guidelines in Appendix D as a tool for prioritizing Mitigation Actions from Table 4.

Coordinating Body

The Baker County Emergency Manager, acting as convener will facilitate meetings of the NHMP Implementation Committee to maintain, update, and implement the *2020 NHMP*. The coordinating body may be composed of members of the NHMP Steering Committee and other representatives of the whole community. The Implementation Committee members' responsibilities include:

- Attending future plan maintenance and plan update meetings (or designating a representative to serve in your place);
- Prioritizing Mitigation Actions listed in Table 4 and assisting in seeking funding for mitigation projects.
- Evaluating and updating the Natural Hazards Mitigation Plan within the five year life of the plan;
- Developing and coordinating ad hoc and/or standing subcommittees as needed; and
- Coordinating public involvement activities.

To make the coordination and review of the *2020 NHMP* as broad and useful as possible, the Baker County Emergency Manager should engage stakeholders to implement the identified mitigation actions. Specific organizations have been identified as partners for most of the mitigation actions listed in Table 4 in the *2020 NHMP*; some of these are identified in Table 6. A subset of the mitigation actions are described in the more detailed Mitigation Action Item Forms found in Appendix C.

Implementation through Existing Programs

The *2020 NHMP* includes mitigation actions that, when implemented, are intended to reduce loss from hazard events throughout Baker County. Within the *2020 NHMP*, FEMA requires the identification of existing plans, programs, and policies that might be used to implement these mitigation actions.

Baker County, Baker City and the City of Halfway currently address Oregon's Statewide Planning Goals and legislative requirements through their comprehensive land use plans, capital improvement plans, mandated standards, and building codes. Because plans, programs, procedures, and policies already in existence often have support from local residents, businesses, and policy-makers, Baker County, Baker City and the City of Halfway should incorporate the mitigation actions from the *2020 NHMP* into those existing plans and programs. Many land use, comprehensive, and strategic plans are updated regularly, and can adapt easily to changing conditions and needs. Implementing the mitigation actions from the *2020 NHMP* through such plans and policies increases their likelihood of being supported and implemented.

Examples of plans, programs or agencies that may be used to implement mitigation actions:

- City and County Budgets
- Community Wildfire Protection Plans
- Comprehensive Land Use Plans
- Economic Development Action Plans
- Zoning Ordinances & Building Codes
- Emergency Operations Plans (EOP) and Continuity of Operations Plans (COOP)

The specific plans that presently exist and relate to the *2020 NHMP* are listed in Table 5. For additional examples of plans, programs, policies, procedures and agencies that may be used to implement mitigation actions, refer to the Appendix C: Mitigation Action Worksheets.

Steps in Plan Implementation

Plan implementation is a critical component of the *2020 NHMP*. The Implementation Committee comprised of local staff and other partners are responsible for implementing the plan over the five years it remains in effect. Below are steps that can be used to carry out the Mitigation Actions developed and evaluated by the Steering Committee.

Meetings

The Implementation Committee should include members of the 2020 Baker County NHMP Steering Committee. If this implementation committee can be joined with other emergency management or hazard plan implementing bodies, Baker County may find efficiencies by cooperating in carrying out the mitigation actions in this plan. In other counties in eastern Oregon the NHMP Implementation coordinating body also fills the role of Emergency Management Team (EMT) and the Local Emergency Preparedness Committee (LEPC). Whatever form the Implementation Committee takes, it should set a meeting schedule and convene regularly. Baker County Emergency Management is required by the EMPG grant to hold two NHMP meetings per year. Baker County may combine these committees. During these meetings the following could be discussed:

During the first meeting, the NHMP Implementation Committee could:

- Review existing action items to determine appropriateness for funding;
- Educate new members about the plan and mitigation in general;
- Identify issues that may not have been identified when the plan was developed; and
- Prioritize potential mitigation projects using the methodology described in Volume II, Appendix D.

During the second meeting the NHMP Implementation Committee could:

- Review status and progress of the mitigation actions;
- Document the status of the mitigation actions;
- Review existing and new risk assessment data;

- Discuss already held and upcoming public involvement events; and
- Document successes and lessons learned during the year.

These meetings are an opportunity for each jurisdiction and organization to report back to Baker County and the NHMP Implementation Committee on progress that has been made on mitigation actions in the NHMP and to develop new ways to mitigate the risk of damage from natural hazards.

The Baker County Emergency Manager as convener should be responsible for documenting the outcome of the regular meetings. A method the Implementation Committee may use to prioritize mitigation projects is described in Volume III, Appendix E "Evaluating Hazard Mitigation Projects" and briefly below in the "Project Prioritization Process" section.

The regularly scheduled meetings of the NHMP Implementation Committee provides an excellent forum for discussions such as those on the status of mitigation actions, new data, and opportunities for funding. An active and well documented implementation process will support the five year update process.

Continued Public Involvement & Participation

The participating jurisdictions and special districts have been dedicated to involving the public directly during the update process for the *2020 NHMP*. In addition to the members of the NHMP Implementation Committee, other members of the public should continue to have the opportunity to provide feedback about the *2020 NHMP*. Public notification and updates on the objectives and progress of the 2020 NHMP Implementation Committee is important to keep the community aware of the actions being taken or funding being sought by the group to implement the 2020 NHMP Mitigation Actions.

Among the ways to continue the public outreach that began during the plan update, the NHMP Implementation Committee can:

- Post copies of their meeting notices and agendas on the organizations' websites;
- Submit articles to the local newspaper informing the public about meetings where they can participate in the process and can provide feedback; and
- Use existing newsletters such as those from schools and flyers in regular mailings such as for utility bills to inform the public about meetings where they can participate in the process and can provide feedback.

The 2020 *NHMP* is posted on the County's website at : https://www.bakercounty.org/emergency/emgmt.html

The NHMP will also be archived and posted on the University of Oregon Libraries' Scholar's Bank Digital Archive at https://scholarsbank.uoregon.edu and on the Oregon Department of Land Conservation and Development's website at https://www.oregon.gov/lcd/Pages/index.aspx.

Five-Year Review of Plan

This plan will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. **With FEMA approval granted in 2020, the Baker County Multi-Jurisdictional NHMP would be due to be updated prior to expiration in 2025.**

Table 7 below offers a ‘toolkit’ of relevant questions that can assist the convener of the next NHMP update. It may be of use in determining which plan update activities should be discussed during regularly-scheduled plan maintenance meetings, and which activities require additional meeting time and/or the formation of sub-committees as the Implementation Committee works to implement the plan.

Table 7. Natural Hazards Mitigation Plan Update Toolkit

Question	Yes	No	Plan Update Action
Is the planning process description still relevant?			**Modify this section to include a description of the plan update process. Document how the planning team reviewed and analyzed each section of the plan, and whether each section was revised as part of the update process. (This toolkit will help you do that).**
Do you have a public involvement strategy for the plan update process?			Decide how the public will be involved in the plan update process. Allow the public an opportunity to comment on the plan process and prior to plan approval.
Have public involvement activities taken place since the plan was adopted?			**Document activities in the "planning process" section of the plan update**
Are there new hazards that should be addressed?			Add new hazards to the risk assessment section
Have there been hazard events in the community since the plan was adopted?			**Document hazard history in the risk assessment section**
Have new studies or previous events identified changes in any hazard's location or extent?			Document changes in location and extent in the risk assessment section
Has vulnerability to any hazard changed?			**Document changes in vulnerability in the risk assessment section**
Have development patterns changed? Is there more development in hazard prone areas?			Document changes in vulnerability in the risk assessment section
Do future annexations include hazard prone areas?			**Document changes in vulnerability in the risk assessment section**
Are there new high risk populations?			Document changes in vulnerability in the risk assessment section
Are there completed mitigation actions that have decreased overall vulnerability?			**Document changes in vulnerability in the risk assessment section**
Did the plan document and/or address National Flood Insurance Program repetitive flood loss properties?			Document any changes to flood loss property status
Did the plan identify the number and type of existing and future buildings, infrastructure, and critical facilities in hazards areas?			**1) Update existing data in risk assessment section, or 2) determine whether adequate data exists. If so, add information to plan. If not, describe why this could not be done at the time of the plan update**
Did the plan identify data limitations?			If yes, the plan update must address them: either state how deficiencies were overcome or why they couldn't be addressed
Did the plan identify potential dollar losses for vulnerable structures?			**1) Update existing data in risk assessment section, or 2) determine whether adequate data exists. If so, add information to plan. If not, describe why this could not be done at the time of the plan update**
Are the plan goals still relevant?			Document any updates in the plan goal section
What is the status of each mitigation action?			**Document whether each action is completed or pending. For those that remain pending explain why. For completed actions, provide a 'success' story.**
Are there new actions that should be added?			Add new actions to the plan. Make sure that the mitigation plan includes actions that reduce the effects of hazards on both new and existing buildings.
Is there an action dealing with continued compliance with the National Flood Insurance Program?			**If not, add this action to meet minimum NFIP planning requirements**
Are changes to the action item prioritization, implementation, and/or administration processes needed?			Document these changes in the plan implementation and maintenance section
Do you need to make any changes to the plan maintenance schedule?			**Document these changes in the plan implementation and maintenance section**
Is mitigation being implemented through existing planning mechanisms (such as comprehensive plans, or capital improvement plans)?			If the community has not made progress on process of implementing mitigation into existing mechanisms, further refine the process and document in the plan.

Source: Oregon Partnership for Disaster Resilience, 2010.

Volume II: Hazard Annexes

Photo Credits: Smoke from Cornet/Windy Ridge fire by Lane Perry as published by the Baker City Herald; Mudslide photo by Ray Rau as published by the Baker City Herald on September 14, 2017

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INTRODUCTION

The following Hazard Annexes provide additional detail not previously provided in the 2014 NHMP. Annexes for drought, flood, wildfire, landslide, severe weather, earthquake and volcanic events are included in Volume II. Severe weather includes both winter storms and windstorms. Drought and Wildfire are ranked first and third respectively in terms of total threat to the communities of Baker County. Among the natural hazard events that occurred in Baker County during the 2014-2019 time period were two debris flows caused by intense, but short duration rain fall events in September 2017 and July 2018 where rain falling on burn scars carried large amounts of mud and woody debris into streams and rivers in southwestern Baker County. These events are discussed in both the Flood Hazard and the Wildfire Hazard Annexes.

Winter storms are ranked second, however, no updates to this information have been provided due to the thorough treatment of this topic in the 2014 NHMP. In brief severe winter storms can consist of rain, freezing rain, ice, snow, cold temperatures, and wind. Winter storms occur over eastern Oregon regularly during December through February, even into March. Baker County is known for cold, snowy winters. Relative to western Oregon, Baker County receives a large amount of annual snowfall. The snowfall is the source of stream flows during the spring, summer and fall. In general, the region is prepared for winter weather, and those visiting the region during the winter, usually come prepared. However, there are occasions when preparation cannot meet the challenge.

Drifting, blowing snow has often brought highway traffic to a standstill. Also, windy, icy conditions have often closed mountain passes and canyons to certain classes of truck traffic. In these situations, travelers must seek accommodations, sometimes in communities where lodging is very limited. Local residents also experience problems. During the winter, heating, food, and the care of livestock and farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers.

Recent history of winter storms is provided in Volume I of this plan.

DROUGHT HAZARD ANNEX

Drought is a hazard of nature. We can't see it ignite, like a fire, or predict where it is likely to touch down, as we do a tornado. Like its natural hazard cousins, however, drought can leave a trail of destruction that may even include loss of life.

And while we might refer to a fire's crackle or the roar of a tornado, a drought hazard does not announce its arrival. In fact, those familiar with drought call it a "creeping phenomenon," because what may first appear to be merely a dry spell can only be discerned in hindsight as the early days of a drought.

> Drought is the most important natural hazard in Baker County. As noted by the Jason Yencopal, the County Emergency Manager, during the process of assessing risk from all natural hazards experienced in Baker County, drought impacts the entire county, whereas wildfire, while devastating in the area burned, impacts a much smaller percentage of the population.

In the most general sense, drought is defined as a deficiency of precipitation over an extended period of time (usually a season or more), resulting in a water shortage. The effects of this deficiency are often called drought impacts. Natural impacts of drought can be made even worse by the demand that humans place on a water supply. [1]

Droughts are not just a summer-time phenomenon; winter droughts can have a profound impact on agriculture. Below average snowfall in higher elevations has a far-reaching effect, especially in terms of hydro-electric power, irrigation, recreational opportunities and a variety of industrial uses.

Drought can affect all segments of a jurisdiction's population, particularly those employed in water-dependent activities such as ranching, agriculture, hydroelectric generation, and recreation. Aquifer capacity may be a notable concern under drought conditions. Domestic water-users within the cities may be subject to stringent conservation measures such as water rationing and could be faced with significant increases in electricity rates. Baker City institutes water conservation as discussed within their Water Curtailment Plan (City Code 53.25).[2]

Baker County has been impacted numerous times by precipitation shortfalls/drought conditions. Seasonal irrigation water from mountain snow packs tails off towards the end of August. It is common to find municipal water systems imposing some type of water rationing during dry years.

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[1] University of Nebraska-Lincoln, National Drought Mitigation Center website https://drought.unl.edu/Education/DroughtBasics.aspx

[2] Baker City. "Water Curtailment Plan." 2008. https://library.municode.com/or/baker_city/codes/code_of_ordinances?nodeId=TITVPUWO_CH53WA_USPR_S53.25WACUPL .

Location of reservoirs helps mitigate the impact of a drought -- water availability is not always correlated to the amount of precipitation.

Facilities affected by drought conditions include communications facilities, hospitals, and correctional facilities that are subject to power failures. Storage systems for potable water, sewage treatment facilities, water storage for firefighting, and hydroelectric generating plants may be vulnerable to drought. Low water also means reduced hydroelectric production especially as the habitat benefits of water compete with other beneficial uses.

There also are environmental consequences. A prolonged drought in forests promotes an increase of insect pests, which in turn, damage trees already weakened by a lack of water. A moisture-deficient forest constitutes a significant fire hazard (see the Wildfire summary). Discussions with community members during the hazard identification process indicate that while drought may limit the growth of fuel for wildfires, it does provide ideal conditions for wildfires to occur. Drought significantly increases the probability for lightning-caused wildfires to occur, and provides ideal conditions for the rapid spread of wildfire. In addition, drought and water scarcity add another dimension of stress to species listed pursuant to the Endangered Species Act (ESA) of 1973.[3]

The Oregon Climate Change Research Institute conducted a study of potential future climate impacts in Baker County and predicts that what has been "normal" is likely to change. Drought conditions, as represented by low summer soil moisture, low spring snowpack, low summer runoff, and low summer precipitation are projected to become more frequent in Baker County by the 2050s relative to the historical baseline. By the end of the 21st century, summer low flows are projected to decrease in the Blue Mountains region putting some sub---basins at high risk for summer water shortage associated with low streamflow.[4]

Causes and Characteristics of Drought

A drought is a period of drier than normal conditions that results in water-related problems.[5] Drought occurs in virtually every climatic zone, but its characteristics vary significantly from one region to another.[6] Drought is a temporary condition – it is seen in an interval of time, generally months or years, when moisture is consistently below normal. It differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate.[7]

In the most general sense, drought is defined as a deficiency of precipitation over an extended period of time (usually a season or more), resulting in a water shortage. In the early 1980s, researchers with the National Drought Mitigation Center (NDMC) and the National Center for Atmospheric Research located more than 150 published definitions of drought. In order to simplify analysis, the NDMC now provides four different ways in which drought can be defined based on the

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[3] Northeast Oregon Multi-Jurisdictional Natural Hazard Mitigation Plan (2014)

[4] Future Climate Projection Baker County, Oregon, 2019, M. Dalton, Oregon Climate Change Research Institute

[5] Moreland, A. USGS, *Drought. Open File Report 93-642*, 1993, https://pubs.er.usgs.gov/publication/ofr93642.

[6] National Drought Mitigation Center. 2007. What is Drought? https://drought.unl.edu/Education/DroughtBasics.aspx , accessed June 2020.

[7] National Drought Mitigation Center, *Types of Drought,* https://drought.unl.edu/Education/DroughtIn-depth/TypesofDrought.aspx, accessed April, 2020.

impacts of the drought. They are as follows: meteorological, agricultural, hydrological, and socioeconomic. The first three approaches deal with ways to measure drought as a physical phenomenon. The last deals with drought in terms of supply and demand, tracking the effects of water shortfall as it ripples through socioeconomic systems.

Meteorological Droughts

Meteorological droughts are defined in terms of the departure from a normal precipitation pattern and the duration of the event. These are region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region. This drought type may relate specific precipitation departures to average amounts on a monthly, seasonal, or yearly basis.

Agricultural Droughts

Agricultural drought links various characteristics of meteorological or hydrological drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, and reduced groundwater or reservoir levels. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil. A good definition of agricultural drought accounts for the variable susceptibility of crops during different stages of crop development, from emergence to maturity.

Hydrological Droughts

Hydrological droughts refer to deficiencies in surface water and sub-surface water supplies. It is measured as stream flow, and as lake, reservoir, and ground water levels. When precipitation is reduced or deficient over an extended period of time, the shortage will be reflected in declining surface and sub-surface water levels.

Hydrological droughts are usually out of phase with the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, streamflow, and groundwater and reservoir levels. As a result, these impacts are out of phase with impacts in other economic sectors. Also, water in hydrologic storage systems (e.g., reservoirs, rivers) is often used for multiple and competing purposes (e.g., flood control, irrigation, recreation, navigation, hydropower, and wildlife habitat), further complicating the sequence and quantification of impacts. Competition for water in these storage systems escalates during drought and conflicts between water users increase significantly.

Socioeconomic Droughts

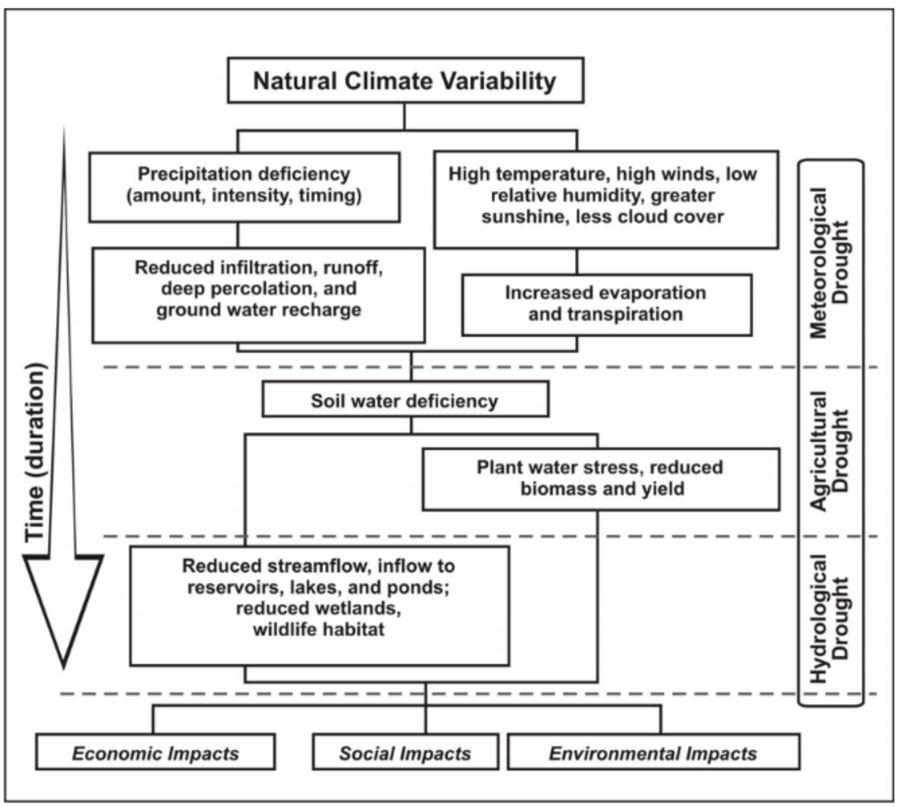
Socioeconomic definitions of drought associate the supply and demand of some economic good with elements of meteorological, hydrological, and agricultural drought. It differs from the other three types of drought because its occurrence depends on the time and space processes of supply and demand to identify or classify droughts. The supply of many economic goods, such as water, forage, food grains, fish, and hydroelectric power, depends on weather. Because of the natural variability of climate, water supply is ample in some years but unable to meet human and environmental needs in other years. Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply.

In most instances, the demand for economic goods is increasing as a result of increasing population and per capita consumption. Supply may also increase because of improved production efficiency, technology, or the construction of reservoirs that increase surface water storage capacity. If both supply and demand are increasing, the critical factor is the relative rate of change. Is demand increasing more rapidly than supply? If so, vulnerability and the incidence of drought may increase in the future as supply and demand trends converge.

Ecological Droughts

A more recent effort by conservationists focuses on defining drought in ecological terms. The Science for Nature and People Partnership (SNAPP) is a first-of-its-kind collaboration between three partners: The Nature Conservancy (TNC), the Wildlife Conservation Society (WCS), and the National Center for Ecological Analysis and Synthesis (NCEAS) at the University of California, Santa Barbara. They define ecological drought as "a prolonged and widespread deficit in naturally available water supplies — including changes in natural and managed hydrology — that create multiple stresses across ecosystems."[8]

Figure 1. Types of Drought and Impacts



Sequence of drought occurrence and impacts for commonly accepted drought types. All droughts originate from a deficiency of precipitation or meteorological drought but other types of drought and impacts cascade from this deficiency. (Source: NDMC)

[8] https://snappartnership.net/teams/ecological-drought/

How is Drought Hazard Identified?

Oregon Revised Statute (ORS) Chapter 536 identifies authorities available during a drought. "To trigger specific actions from the Water Resources Commission and the Governor, a "severe and continuing drought" must exist or be likely to exist. Oregon relies upon two inter-agency groups to evaluate water supply conditions, and to help assess and communicate potential drought-related impacts. The Water Supply Availability Committee (WSAC) is a technical committee chaired by the Water Resources Department. The other group—the Drought Readiness Council—is a coordinating body of state agencies co-chaired by the Water Resources Department and the Office of Emergency Management."[9]

An example of a tool used to estimate drought conditions is the Surface Water Supply Index (SWSI). The SWSI is an index of current water conditions throughout a state that the Natural Resources Conservation Service (NRCS) calculates to predict the surface water available in a basin compared to historic supply. The index utilizes parameters derived from snow, precipitation, reservoir and streamflow data and was provided for watershed in northeastern Oregon in the *2014 NHMP*.

Another tool produced by NRCS is the Water Supply Outlook Report (WSOR).[10] The Water Supply Outlook is a report containing forecasts of runoff and snowmelt runoff. It also contains a summary of current snowpack, precipitation, river flow volumes, reservoir storage and soil moisture, and data for these is published in the Maps and Data Summaries section. Runoff from the mountains is important for the major rivers in the province where reservoirs store water supplies for irrigation, hydroelectricity, community and municipal purposes. Up to date WSOR are available for Oregon.

Another drought index used by most federal agencies is the Palmer Method which incorporates precipitation, runoff, evaporation, and soil moisture. However, the Palmer Method does not incorporate snowpack as a variable. Therefore, it is does not provide a very accurate indication of drought conditions in Oregon and the Pacific Northwest, although it can be very useful because of its a long-term historical record of wet and dry conditions.

The Water Supply Availability Committee consists of state and federal agencies that meet early and often throughout the year to evaluate the potential for drought conditions. If drought development is likely, monthly meetings occur shortly after release of NRCS Water Supply Outlook reports for that year (second week of the month beginning as early as January) to assess conditions. The following are indicators used by the WSAC for evaluating drought conditions:

- Snowpack
- Precipitation
- Temperature anomalies
- Long range temperature outlook
- Long range precipitation outlook

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[9] State of Oregon, *Emergency Operations Plan*, *Incident Annex for Drought*, April 2016, https://www.oregon.gov/oem/Documents/2015_OR_EOP_IA_01_drought.pdf.

[10] Natural Resource Conservation Service, Water Supply Outlook reports https://www.wcc.nrcs.usda.gov/state_outlook_reports.htm

- Current stream flows and behavior
- Spring and summer streamflow forecasts
- Ocean surface temperature anomalies (El Nino, La Nina)
- Storage in key reservoirs
- Soil and fuel moisture conditions
- NRCS Surface Water Supply Index.[11]

In the *2015 Oregon Natural Hazards Mitigation Plan* (*2015 Oregon NHMP*), it states "Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. Mitigation actions specified in this plan including developing an improved methodology for gathering data and identifying the communities most vulnerable to drought and related impacts, and implementing this methodology continue to require adequate staffing and priority for funding.

Ranching, farming, and other agricultural activities contribute significantly to Baker County's economy. Drought can have a significant impact on the agricultural community and associated businesses that rely on this industry. Besides the economy, the *2015 Oregon NHMP* also describes impacts of droughts on the environment, population, infrastructure, critical/essential facilities, and state-owned and operated facilities.

History of Drought in Baker County and Oregon

Quantifying drought requires an objective criterion for defining the beginning and end of a drought period. The Palmer Drought Severity Index is most effective in determining long-term drought — e.g. several months — and is not as good with short-term forecasts, e.g. a matter of weeks.

The Palmer Method or Palmer Drought Severity Index (PDSI) indicates the prolonged and abnormal moisture deficiency or excess. It indicates general conditions and not local conditions caused by isolated rain. The PSDI is an important climatological tool for evaluating the scope, severity, and frequency of prolonged period of abnormally dry or wet weather. It can be used to delineate disaster areas and indicate the availability of irrigation water supplies, reservoir levels, range conditions, amount of stock water, and potential intensity of forest fires.

The PDSI uses readily available temperature and precipitation data to estimate relative dryness. It is a standardized index that spans -10 (dry) to +10 (wet). As it uses temperature data and a physical water balance model, it can capture the basic effect of global warming on drought through changes in potential evapotranspiration. Monthly PDSI values do not capture droughts on time scales less than about 12 months. The PDSI uses a zero (0) as normal, and drought is shown in terms of negative numbers; for example, negative two (-2.00) is moderate drought, negative three (-3.00) is severe drought, and negative four (-4.00) is extreme drought.[12] See Figure 1.

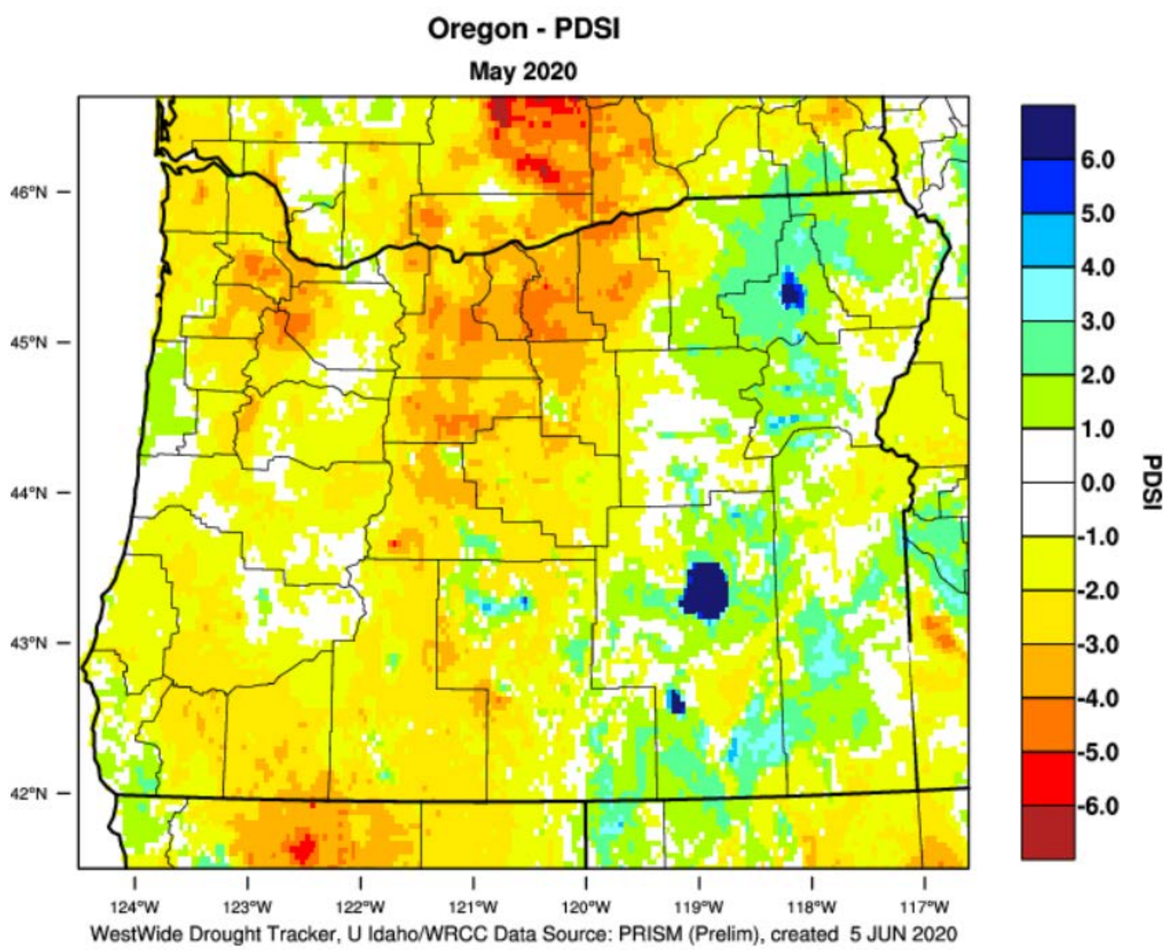
Some Oregon droughts were especially significant during the period of 1928 to 1994. The period from 1928 to 1941 was a prolonged drought that caused major problems for agriculture. The only

[11] State of Oregon, *Emergency Operations Plan*, *Incident Annex for Drought*, April 2016, https://www.oregon.gov/oem/Documents/2015_OR_EOP_IA_01_drought.pdf.
[12] https://climatedataguide.ucar.edu/climate-data/palmer-drought-severity-index-pdsi

area spared was the northern coast, which received abundant rains in 1930-33. The three Tillamook burns (1933, 1939, and 1945) were the most significant results of this very dry period.

During 1959-1962 stream flows were low throughout Eastern Oregon, but areas west of the Cascades had few problems. The driest period in Western Oregon was the summer following the benchmark 1964 flood. Low stream flows prevailed in Western Oregon during the period from 1976-81, but the worst year, by far, was 1976-77, the single driest year of the century. The Portland airport received only 7.19 inches of precipitation between Oct. 1976 and Feb. 1977, only 31% of the average 23.16 inches for that period. The 1985-94 drought was not as severe as the 1976-77 drought in any single year, but the cumulative effect of ten consecutive years with mostly dry conditions caused statewide problems. The peak year of the drought was 1992, when a drought emergency was declared for all of Oregon. Forests throughout the state suffered from a lack of moisture. Fires were common and insect pests, which attacked the trees, flourished. In 2001 and 2002 Oregon experienced drought conditions.

Figure 2. Oregon Counties Palmer Drought Severity Index Map for March 2020



Source: West Wide Drought Tracker, Oregon – PDSI, https://wrcc.dri.edu/wwdt/index.php?region=or

During the 2005 drought the Governor issued declarations for eight counties, all east of the Cascades, and the USDA issued three drought declarations, overlapping two of the Governor's. State declarations were made for Baker, Crook, Gilliam, Hood River, Klamath, Morrow, Sherman, and Umatilla counties. Federal declarations were made in Coos, Klamath, and Umatilla counties. Wheeler County made a county declaration. The USDA declarations provided access to emergency loans for crop losses. Baker County has been under an emergency drought declaration eight times and is considered one of the communities most vulnerable to drought conditions.[13]

Table 1. History of Drought in Baker County

Year	Location	Description
1938-1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country
1977	N & S central Oregon; eastern Oregon	a severe drought for northeast Oregon
1994	Regions 4–8	in 1994, Governor's drought declaration covered 11 counties located within regions 4, 5, 6, 7, and 8
1999	Baker, Grant, Union and Wallowa	Baker, Grant, Union and Wallowa Counties were declared disaster areas by the Department of Agriculture due to drought. Approximately one-third of the wheat crop in those areas was lost due to weather.
2002	southern and eastern Oregon	2001 drought declarations remain in effect for all counties, including Region 7's Baker, Union, and Wallowa Counties; Governor adds Grant County in 2002, along with five additional counties, bringing statewide total to 23 counties under a drought emergency.
2003	southern and eastern Oregon	Grant County 2002 declaration remains in effect through June 2003; Governor issues new declarations for Baker, Union, and Wallowa Counties, which are in effect through December 2003
2004	Region 5–8	Baker County receives Governor-declared drought emergency on June 2004, along with three other counties in neighboring regions
2005	Regions 5–7	13 counties affected Baker and Wallowa County receive a Governor drought declaration; all Region 5 counties affected, and most of Region 6 affected
2007	Regions 6–8	Grant, Baker, and Union Counties receive a Governor drought declaration; three other counties affected in neighboring regions
2013	Regions 5-8	Baker County receives a drought declaration, as well as four other counties in neighboring regions
2014	Regions 4, 6–8	Grant and Baker County receive drought declarations, including eight other counties in other regions
2015	statewide	36 Oregon Counties across the state receive federal drought declarations, including 25 under Governor's drought declaration
2018	Regions 1, 4-8	Baker and Grant County receive Governor's drought declarations, including 9 other counties in 5 other regions

Source: 2015 Oregon State Hazard Mitigation Plan update;

[13] 2015 Oregon Natural Hazard Mitigation Plan

WILDFIRE HAZARD ANNEX

Causes and Characteristics of Wildfire

Countywide exposure

- Number of buildings: **1,798**
- Exposure Value: **$240,321,000**
- Ratio of Exposure Value: **7.6%**
- Critical facilities exposed: **0**
- Potentially Displaced Population: **830**

The majority of wildfires primarily occur in Eastern and Southern Oregon. Fire is an essential part of Oregon's ecosystem, but it is also a serious threat to life and property particularly in the state's growing rural communities. Wildfire is defined as am uncontrollable burning of forest, brush, or rangeland. Fire has always been a part of high desert ecosystems and can have both beneficial and devastating effects.[14]

Wildfires threaten valued forest and agricultural lands and individual home sites. State or federal firefighters provide the only formal wildfire suppression service in some areas, and they do not protect structures as a matter of policy. As a result, many rural dwellings have no form of fire protection. Once a fire has started, homes and development in wildland settings complicate firefighting activities and stretch available human and equipment resources. The loss of property and life, however, can be minimized through cooperation, preparedness, and mitigation activities.

The Baker County Natural Resources Plan addresses wildfire as well and notes that a high degree of coordination between federal, state, and local agencies is necessary for maximal prevention and suppression of wildfire. It urges Federal agencies to incorporate local fire association plans into their fire suppression and control plans and to enter into coordination (as required by FLPMA and NFMA) with local fire agencies (such as RFPAs) at the local agencies' request.

Baker County has nine Structural Fire Protection Districts and three Rangeland Fire Protection Associations. A large area of the remaining land in the county is federally owned and managed by the US Forest Service, the Bureau of Land Management and the Eastern Oregon Forest Protection Unit of the Oregon Forestry Department.

Wildland Urban Interface (WUI) areas are where the human developed areas meet the undeveloped areas; it is a transition area. If population in Baker County grows, development in the WUI may increase. Concern is warranted when development patterns increase the threat of wildfire to life and property. Nearly 3,700 sq. mi. or 2.4 million acres are considered WUI areas in Oregon, which is about 3.8% of the state. Of the nearly 1.7 million total homes in Oregon, over 603,000 or 36%, are in the WUI.[15]

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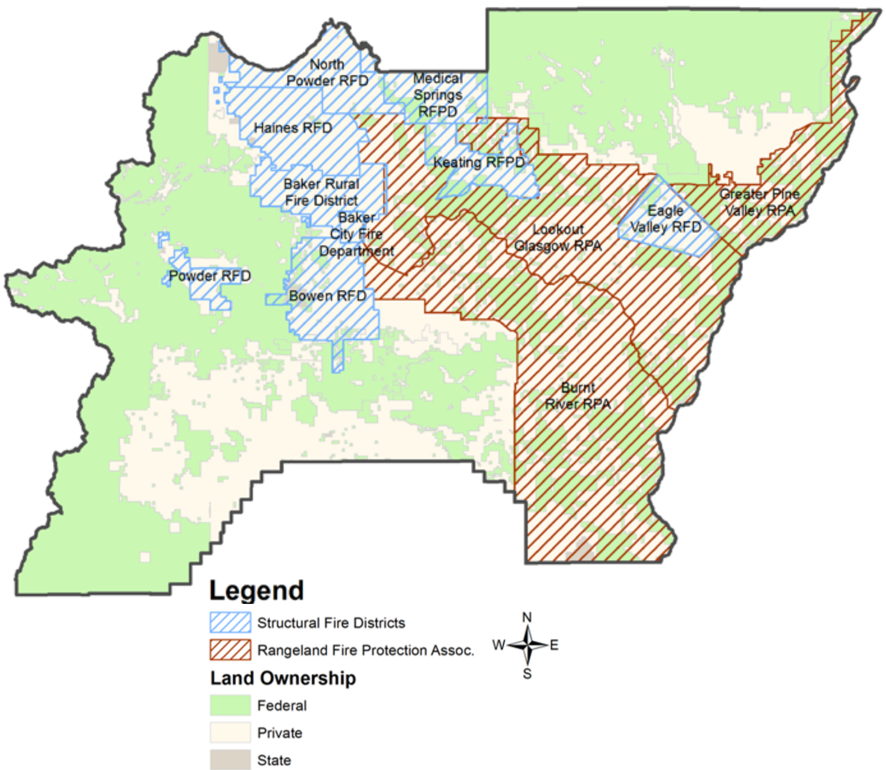
[14]Fire Ecology, Pacific Biodiversity Institute http://www.pacificbio.org/initiatives/fire/fire_ecology.html and Evaluating the ecological benefits of wildfire by integrating fire and ecosystem simulation models, USDA, Treesearch, https://www.fs.usda.gov/treesearch/pubs/34994

[15] Oregon Wildfire Risk Explorer, December 2019.

Figure 3. Baker County Structural Fire Districts and Rangeland Fire Protection Associations



In Baker County, 503,000 acres of WUI land has been identified in 28 different WUI areas across the county. Within those areas, 42 communities would be directly threatened or affected by a large wildfire event. Approximately 2600 homes are located within these WUI areas.

Wildfires threaten the limited but valued and valuable forest resources, agricultural land, rangelands, and individual home sites. Mutual Aid Agreements exist among the fire authorities for mutual aid and support in the event of a wildfire incident; however, each fire authority operates under regulations that dictate their area of responsibility and specify limitations. State and federal wildland firefighters can provide wildfire suppression service on non-state and non-federal areas through formal agreements.

To reduce the impact of wildfire, Baker County adopted the *Baker County Community Wildfire Protection Plan* in 2003. The *Baker County Community Wildfire Protection Plan* is the result of analyses, professional cooperation and collaboration, assessments of wildfire risks and other factors considered with the intent to reduce the potential for wildfires that threaten people, structures, infrastructure, and values in Baker County. The plan was revised in 2012 and the most recent revision to the plan is the 2015 *Baker County Community Wildfire Protection Plan (2015 Baker County CWPP)*. A further update is underway at this writing.

The references to wildfire risk and mitigation in the *2020 Baker County NHMP* are based on the 2015 *Baker County CWPP* as the primary source of wildfire information and mitigation actions for the county. The 2020 Baker County NHMP also draws on the Oregon State NHMP and the ongoing update for statewide analysis of wildfire risk and mitigation strategies.

The 2015 *Baker County CWPP* provides detailed information on the vulnerability and history of wildfire in the County, and provides mitigation actions the County can implement to reduce the impact of wildfire. Baker County uses a multi-faceted approach to wildfire mitigation. Mitigation actions in the 2015 Baker County CWPP are focused at the level of 28 identified WUI areas and take into consideration the resources available at the local level. Goals and projects are identified along with lead agencies and cooperators. The Wildfire mitigation actions in the *2020 NHMP* refocus emergency management back to the 2015 CWPP and the current update.

The WUI areas are prioritized using a Communities-At-Risk scoring system developed by the American Association of State Foresters[16] and the Oregon Department of Forestry.[17] The CAR methodology for wildfire hazard assessment takes into account a range of rating factors. These include the likelihood of fire, topographic hazard, total fuel hazard, overall fire protection capability, weather factor, and values at risk. A Community-At-Risk (CAR) is defined as a group of homes or other structures with basic infrastructure (such as shared transportation routes) and services within or near federal land. A Wildland-Urban Interface (WUI) area surrounds a community-at-risk, including that community's infrastructure or water source, and may extend 1 ½ miles or more beyond that community.

[16] Field Guidance: Identifying and Prioritizing Communities at Risk. National Association of State Foresters. June 27, 2003. (Available at: http://www.stateforesters.org/field-guidance-identifying-and-prioritizing-communities-risk-june-2003)

[17] Concept for Identifying and Assessment of Communities at Risk in Oregon. Draft prepared by Jim Wolf, Fire Behavior Analyst, Oregon Department of Forestry. July 19, 2004.

Table 2. Communities At Risk (CAR) scores for Baker County communities

Table 1. Baker County Wildland-Urban Interface Areas – Listed by Total Average CAR Score

Priority Level	WUI Name	Total Score
HIGH Priority (15-22 points)	Woodtick Village/Rattlesnake Est.	21
	Pleasant Valley	21
	Stices Gulch	19
	Bourne	18
	Surprise Spring	17
	Greenhorn	16
	Auburn Gulch	16
	Oxbow / Copperfield	16
	Rock Creek/Bulger Flats	16
	Elkhorn Estates / Deer Cr. / McEwen	16
	Sparta	16
	Huntington	15
	Face of the Elkhorns / Baker City Watershed,	15
	Eagle Creek, / Tamarack	15
	East Eagle, Main Eagle	15
	Cornucopia,	15
	Sumpter / McCully Forks Watershed	15
	Black Mountain	15
	Anthony Lakes	15
Moderate Priority (11-14 points)	Whitney	14
	Brownlee / Bridge	14
	Durkee	13
	Richland / New Bridge	13
	Rye Valley	13
	Keating / Wirth Junction	12
	Carson / Pine Valley	12
	Hereford	12
	Oregon Trail Interpretive Center,	11

Source: 2015 Baker County CWPP

The impact on communities from wildfire can be huge. Reporting by the Oregonian stated that in 2017, more than 1.1 million acres were scorched by wildfire in Oregon and Washington. 2018 was even worse, with 1.3 million acres of forest and fields going up in flame. That's an area close to the size of Delaware up in smoke each year. Fighting wildfires cost Oregon and Washington more than a $1 billion in 2017 and 2018 combined, according to the Northwest Interagency Coordination Center.

The fire season in 2019 was a much different story: Just over 200,000 acres were scorched across both states, a nearly 84 percent drop from the two previous years. In 2019, both states spent less than $100 million, a 92 percent drop in costs. Much of the quiet season can be attributed to weather. The relatively cool temperatures kept fuels in forests and grasslands from drying into the tinderboxes they were in recent years. [18]

[18]Portland Oregonian, Oregonlive.com https://www.oregonlive.com/environment/2019/10/summer-2019-the-oregon-wildfire-season-that-wasnt.html

Wildfire can be divided into four categories: interface fires, wildland fires, firestorms, and prescribed fires.[19] These descriptions are provided for a brief but comprehensive understanding of wildfire.

Interface Fires

An interface fire occurs where wildland and developed areas come together with both vegetation and structural development combining to provide fuel. The wildland/urban interface (sometimes abbreviated to WUI or called rural interface in small communities or outlying areas) can be divided into categories.

- The **classic wildland-urban interface** exists where well-defined urban and suburban development presses up against open expanses of wildland areas.
- The **mixed wildland-urban interface** is more typical of the problems in areas of exurban or rural development: isolated homes, subdivisions, resorts and small communities situated in predominantly in wildland settings.
- The **occluded wildland-urban interface** where islands of wildland vegetation exist within a largely urbanized area.[20]

Wildland Fires

A wildland fire's main fuel source is natural vegetation. Often referred to as forest or rangeland fires, these fires occur in national forests and parks, private timberland, and on public and private rangeland. A wildland fire can become an interface fire if it encroaches on developed areas.

Firestorms and Mega-Fires

A firestorm is a very intense and destructive fire usually accompanied by high winds; it may be a large fire that is difficult to impossible to control. [21] Firestorms are events of such extreme intensity that effective suppression is virtually impossible. Firestorms often occur during dry, windy weather and generally burn until conditions change or the available fuel is consumed.

In 1987, widespread dry lightning in late August ignited fires throughout northern California and southwest Oregon. Two of these were over 10,000 acres, and according to the Oregon Department of Forestry, this series of events fits the definition of a firestorm. Resources were brought in from other states and Canada to fight them.[22] Another term used is mega-fire which is a fire that is more than 100,000 acres in size.

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[19] Federal Emergency Management Agency, *Multi-hazard, Identification and Risk Assessment Report*, 1997, Washington, D.C., https://www.fema.gov/media-library/assets/documents/7251.

[20] Ibid.

[21] Definition of firestorm, Merriam-Webster Dictionary, https://www.merriam-webster.com/dictionary/firestorm and Cambridge Dictionary, https://dictionary.cambridge.org/us/dictionary/english/firestorm.

[22] Wolf, Jim, ODF, personal communication, May 8, 2001.

Prescribed Fires

Prescribed fires are intentionally set or are select natural fires that are allowed to burn for beneficial purposes. Before humans suppressed forest fires, small, low intensity fires cleaned the underbrush and fallen plant material from the forest floor while allowing the larger plants and trees to live through the blaze. These fires were only a few inches to two feet tall and burned slowly. Forest managers now realize that a hundred years of prevention has contributed to the unnatural buildup of plant material that can flare up into tall, fast moving wildfires. These can be impossible to control and can leave a homeowner little time to react.

Conditions Contributing to Wildfires

Ignition of a wildfire may occur naturally from lightning or from human causes such as debris burns, arson, careless smoking, recreational activities, equipment, or an industrial accident. Once started, four main conditions affect the fire's behavior: fuel, topography, weather and development.

Fuel

Fuel is the material that feeds a fire. Fuel is classified by volume and type. Forested lands provide a larger fuel source to wildfires than other vegetated lands due to the presence of large amounts of timber and other dense vegetation in these areas. Grassland are included in the rangeland areas Grasslands, which naturally cover much of the region, are highly susceptible to wildfire. According to BLM staff, there is an increasing amount of invasive grasses in the grasslands; these invasive grasses are more susceptible to burn. The variability of the fire likelihood is great, as the factors of soil moisture, soil temperature, and amount of and nature of grass there varies. Vegetation such as agricultural lands and rangelands also provides fuel for wildfires.

Topography

Topography influences the movement of air and directs a fire's course. Slope and hillsides are key factors in fire behavior. Hillsides with steep topographic characteristics are often also desirable areas for residential development.

In this region, much of the topography is hilly or mountainous which can exacerbate wildfire hazards. These areas can cause a wildfire to spread rapidly and burn larger areas in a shorter period of time, especially, if the fire starts at the bottom of a slope and migrates uphill as it burns. Wildfires tend to burn more slowly on flatter lying areas, but this does not mean these areas are exempt from a rapidly spreading fire. Hazards that can affect these areas after the fire has been extinguished include landslides (debris flows), floods, and erosion.

Weather

Weather is the most variable factor affecting wildfire behavior. High-risk areas in Oregon share a hot, dry season in late summer and early fall with high temperatures and low humidity.

The natural ignition of wildfires is largely a function of weather and fuel; human caused fires add another dimension to the probability. Lightning strikes in areas of forest or rangeland combined with any type of vegetative fuel source will always remain as a source for wildfire. Thousands of lightning strikes occur each year throughout much of the region. Fortunately, not every lightning strike causes a wildfire, though they are a major contributor.

Development

The increase in residential development in interface areas has resulted in greater wildfire risk. Fire has historically been a natural wildland element and can sweep through vegetation that is adjacent to a combustible home. New residents in remote locations are often surprised to learn that in moving away from urban areas, they have left behind readily available fire services providing structural protection. Rural locations may be more difficult to access and or simply take more time for fire protection services to get there.

Future Climate Projections

Oregon's Department of Land Conservation and Development (DLCD) contracted with the Oregon Climate Change Research Institute (OCCRI) of Oregon State University to perform and provide analysis of the influence of climate change on natural hazards for Baker County. The report referenced here (and provided in Appendix F) presents future climate projections for Baker County relevant to specific natural hazards for the 2020s (2010–2039 average) and 2050s (2040–2069 average) as compared to the 1971–2000 average historical baseline. [23]

Over the last several decades, warmer and drier conditions during the summer months have contributed to an increase in fuel aridity and enabled more frequent large fires, an increase in the total area burned, and a longer fire season across the western United States, particularly in forested ecosystems. The lengthening of the fire season is largely due to declining mountain snowpack and earlier spring snowmelt. As a proxy for wildfire risk, the OCCRI report considers a fire danger index called 100---hour fuel moisture (FM100), which is a measure of the amount of moisture in dead vegetation in the 1–3 inch diameter class available to a fire. It is expressed as a percent of the dry weight of that specific fuel. The OCCRI report defines a "very high" fire danger day to be a day in which FM100 is lower (i.e., drier) than the historical baseline 10th percentile value. By definition, the historical baseline has 36.5 very high fire danger days annually. The future change in wildfire risk is expressed as the average annual number of additional "very high" fire danger days for two future periods under two emissions scenarios compared with the historical baseline.[24]

The key conclusions of the analysis by OCCRI are as follows:

- Wildfire risk, as expressed through the frequency of very high fire danger days, is projected to increase under future climate change in Grant County.
- In Grant County, the frequency of very high fire danger days per year is projected to increase on average by about 15 days above the historical baseline (with a range of -3 to +36 days) by the 2050s under the higher emissions scenario compared to the historical baseline.
- This represents an increase in the frequency of very high fire danger days per year of on average by about 42% (with a range of -7 to +98%) by the 2050s under the higher emissions scenario compared to the historical baseline.[25]

[23] Future Climate Projections Baker County (Dalton, February 2020)

[24] Ibid

[25] Ibid

History of Wildfire in Baker County

Densely forested Douglas fir forests and stands of ponderosa pine may highly vulnerable to wildfire because of natural aridity of the climate in Baker County and the frequency of lightning strikes. Grasslands, which naturally cover much of the region, also are potentially flammable. Nevertheless, the ecosystems of most forest and wildlands depend upon fire to maintain functions.

The effects of fire on ecosystem resources can include damages, benefits, or some combination of both. The benefits can include, depending upon location and other circumstances, reduced fuel load, disposal of slash and thinned tree stands, increased forage plant production, and improved wildlife habitats, hydrological processes, and aesthetic environments. Despite the benefits, fire has historically been suppressed for years because of its effects on rangelands, grasslands, recreation areas, agricultural operations, and the significant threat to property and human life.

Knowing the fire history of a place is important to understand the fire environment of the area. Knowing where and why fires start is one of the first steps in prevention and mitigation efforts. Understanding the burn probability, the hazard to potential structures, the fire intensity and flame length, and the sub-watershed level for context, provides comprehensive information for decision-making about wildfire prevention and mitigation.

The historical listing of wildfires in Baker County includes a description of documented wildfires as reported in the 2020 Oregon State NHMP; it is likely that not all the wildfires that have occurred are included on this list.

During the period from January 2014 through January 2020 a total of 72 fires were reported in Baker County.[26] [27] The majority of those fires consumed less than half an acre of land. The largest fires were few in number but caused the greatest amount of damage.

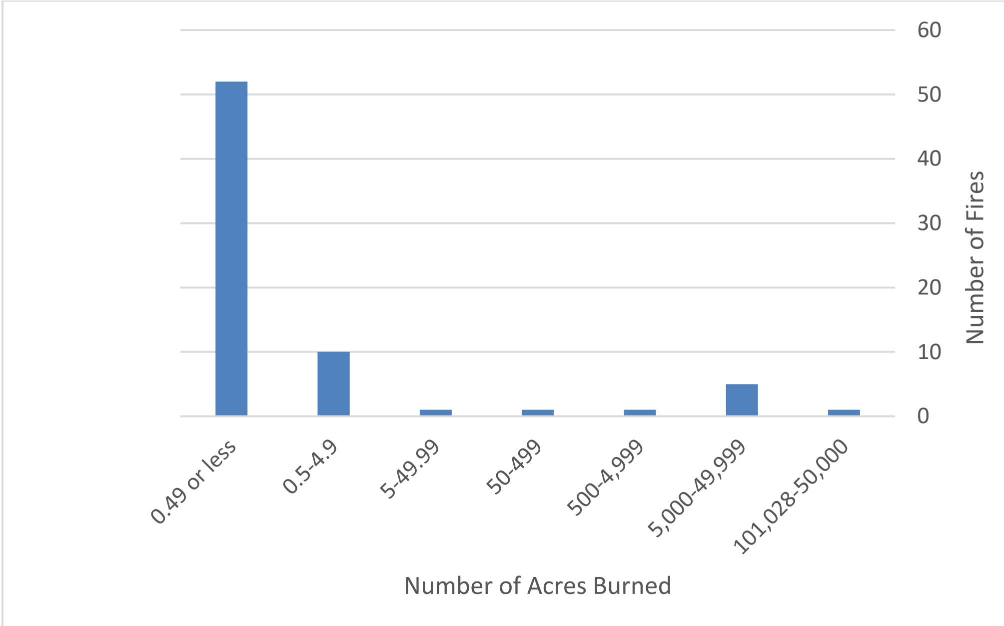
Table 3. Size distribution of fires in Baker County from 1/2014 through 1/2020

Number of fires	Acres burned
1	101,028-50,000
5	5,000-49,999
2	500-4,999
1	50-499
1	5-49
10	0.5-4.9
52	0.49 or less

Source: data from Oregon Department of Forestry Fire Database, consulted January 2020

[26] ODF Fire List, https://apps.odf.oregon.gov/DIVISIONS/protection/fire_protection/fires/FIRESlist.asp consulted June 2020
[27] Joel McCraw, AFMO for USFS Region 6, personal communication, June 2020.

Figure 4. Fire Incidents in Baker County 2014-2020



Source: data from Oregon Department of Forestry Fire Database, consulted January 2020, and personal communication with Joel McCraw, USFS, June 2020, data graphed by author

Community Wildfire Protection Plan[28]

The Healthy Forests Restoration Act of 2003 (HFRA) provides the impetus for wildfire risk assessment and planning at the county and community level. The HFRA refers to this level of planning as Community Wildfire Protection Plans (CWPP). The minimum requirements for a CWPP as described in the HFRA are:

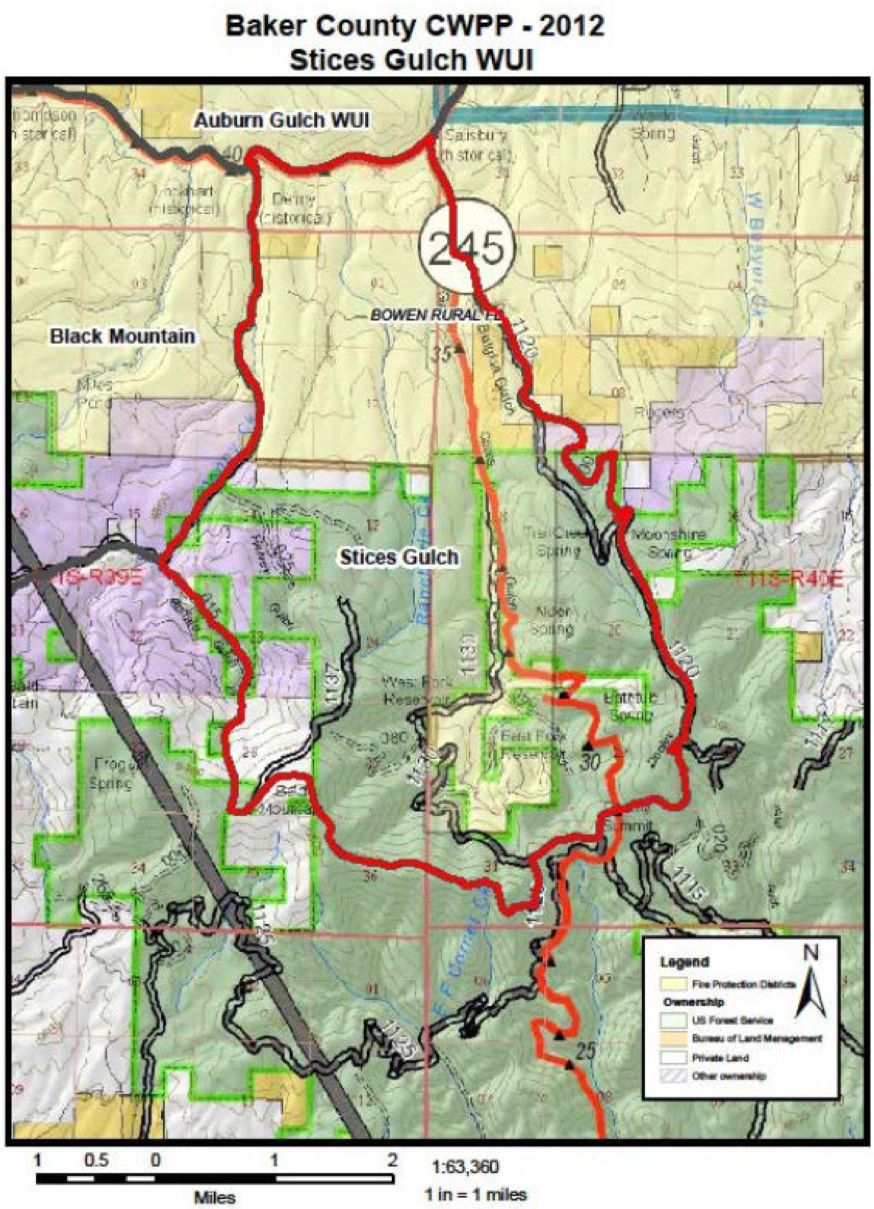
- Collaboration: A CWPP must be collaboratively developed by local and state government representatives, in consultation with federal agencies and other interested parties. Prioritized Fuel Reduction: A CWPP must identify and prioritize areas for hazardous fuel reduction treatments and recommend the types and methods of treatment that will protect one or more at-risk communities and essential infrastructure.
- Treatment of Structural Ignitability: A CWPP must recommend measures that homeowners and communities can take to reduce the ignitability of structures throughout the area addressed by the plan.

The CWPP allows a community to evaluate its current situation with regards to wildfire risk and plan ways to reduce risk for protection of human welfare and other important economic, social or ecological values. The CWPP may address issues such as community wildfire risk, structure flammability, hazardous fuels and non-fuels mitigation, community preparedness, and emergency procedures. The CWPP should be tailored to meet the needs of the community.

[28] This section excerpts the 2015 Baker County Community Wildfire Protection Plan https://www.bakercounty.org/emergency/ccwpp.html

Baker County developed and adopted one of the earliest CWPPs completed in Oregon in 2003. The 2015 revision included a detailed wildfire hazard assessment (*Communities At Risk* or CAR) that ranked risk for each of 28 identified Wildland Urban Interface (WUI) areas using a range of factors (Likelihood of Fire Occurring (historical fire starts per 1,000 acres), Topographic Hazard (slope), Total Fuel Hazard (surface and crown fuels), Overall Fire Protection Capability, Weather Factor and Values at Risk). Each of the 28 WUI areas has a detailed assessment of capacity and mitigation actions along with maps of the multiple jurisdictions for both structural and wildland fire control as shown in Figure X below. The plan is currently undergoing a further update headed by the Emergency Management Fire Division of Baker County.

Figure 5. Example of WUI maps in Baker County CWPP



Source: 2015 Baker County Community Wildfire Protection Plan

The 2015 Baker County CWPP leverages cooperation among state, federal and local firefighting to provide education of the citizens of Baker County through public outreach and school programs. The county formed an Interagency Fire Prevention Team that joins Rural Fire Protection Departments with federal and state firefighting agencies in increasing fire education and reducing human-caused fires. Among the practices promoted by firefighters in Baker County are landscaping and defensible space practices, installation of fire resistant roof material and good access for fire fighters' equipment and vehicles. The promotion of fire-resistant plants and notification of free home inspections for homeowners are among the other mitigation programs promoted in Baker County through the Baker County CWPP.

The Baker County CWPP addresses fuel reduction as it relates to wildfire mitigation and to forest health. The plan seeks to meet both fire risk reduction objectives and objectives for maintenances of health forest stands that are resistant to pests such as bark beetles. The CWPP addresses maintenance of forest stands that have been treated through fuels reduction programs that both thin and use prescribed burning to reduce fuels. The plan recognizes that forest succession can be managed through re-treatment of forest stands. The plan also addresses the potential of this woody biomass for use in alternative energy production and recognizes the potential for negative environmental effects from prescribed burns. It connects the services of Forestry Extension agents on forest stand health, the expertise of the Oregon Department of Environmental Quality with respect to air quality effects of prescribed burning to the mitigation actions in the plan. It also recognizes the potential for economic use of wood biomass thinned from forest stands for use in alternative energy production to offset the cost of thinning operations.

The extensive set of mitigation actions for each of the 28 WUI areas is not reproduced in this 2020 NHMP update, but stands on its own as a companion to the 2020 NHMP update.

FLOOD HAZARD ANNEX

Flooding results when rain and snowmelt creates water flow that exceed the carrying capacity of rivers, streams, channels, ditches, and other watercourses. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean bring intense rainfall. Most of Oregon's most destructive natural disasters have been floods. Flooding can be aggravated when rain is accompanied by snowmelt and frozen ground; the spring cycle of melting snow is the most common source of flood in the region.

Countywide exposure to 100-year flood:

- Number of buildings damaged: **125**
- Loss Estimate: **$986,000**
- Loss Ratio: **0.3%**
- Damaged critical facilities: **0**
- Potentially Displaced Population: **359**

Causes and Characteristics of Flooding

Statewide the most damaging floods have occurred during the winter months, when warm rains from tropical latitudes melt mountain snow packs. Such conditions were especially noteworthy in February 1957, February 1963, December 1964 and January 1965. Somewhat lesser flooding has been associated with ice jams, normal spring run-off, and summer thunderstorms. Heavily vegetated stream banks, low stream gradients, and breeched dikes have contributed to past flooding at considerable economic cost. Northeast Oregon counties also have experienced flooding associated with low bridge clearances, over-topped irrigation ditches, and natural stream constrictions

The Oregon Climate Change Research Institute prepared an analysis of the potential future impact of changing climate on the natural hazards experienced in Baker County. By the 2050's rainfall events are expected to result in more rain. With respect to heavy rains and river flooding the report summarizes the likely effects as follows:

- The intensity of extreme precipitation events is expected to increase slightly in the future as the atmosphere warms and is able to hold more water vapor.
- The frequency of days with at least ¾" of precipitation is projected to increase by the 2050's only by one day per year by above the historic baseline of three days per year with precipitation over ¾".
- The amount of precipitation on the wettest day is projected to increase on average by about 16.9% (with a range of 5.4% to 25.9%) from the historical baseline of nearly 1 inch.
- The amount of precipitation on the wettest consecutive five days of the year is projected to increase by 11.4% (with a range of -3.4% to 22.7%) by the 2050s under the higher emissions scenario relative to the historical baseline of 2.3 inches over the wettest five days of the year.
- In Baker County, the frequency of days exceeding a threshold for landslide risk, based on 3-day and 15-day precipitation accumulation, is not projected to change substantially.

However, landslide risk depends on a variety of factors and this metric may not reflect all aspects of the hazard.[29]

Warming temperatures are predicted to result in changes in winter precipitation. The OCCRI report predicts the following:

- Mid- to low-elevation areas in Baker County's Blue Mountains that are near the freezing level in winter, receiving a mix of rain and snow, are projected to experience an increase in winter flood risk due to warmer winter temperatures causing precipitation to fall more as rain and less as snow.[30]

The principal types of floods that occur in Baker County include:

Riverine Flooding

Riverine floods occur when water levels in rivers and streams overflow their banks. Most communities located along such water bodies have the potential to experience this type of flooding after spring rains, heavy thunderstorms or rapid runoff from snow melt. Riverine floods can be slow or fast-rising, but usually develop over a period of days. The danger of riverine flooding occurs mainly during the winter months, with the onset of persistent, heavy rainfall, and during the spring, with melting of snow. Figure 6 below shows the principle watersheds in Baker County draining to the Powder River, the Burnt River and Pine Creek. Other principle rivers in the county include Old Settler's Slough, Eagle Creek, Mill Creek, Marble Creek, and Stices Gulch.

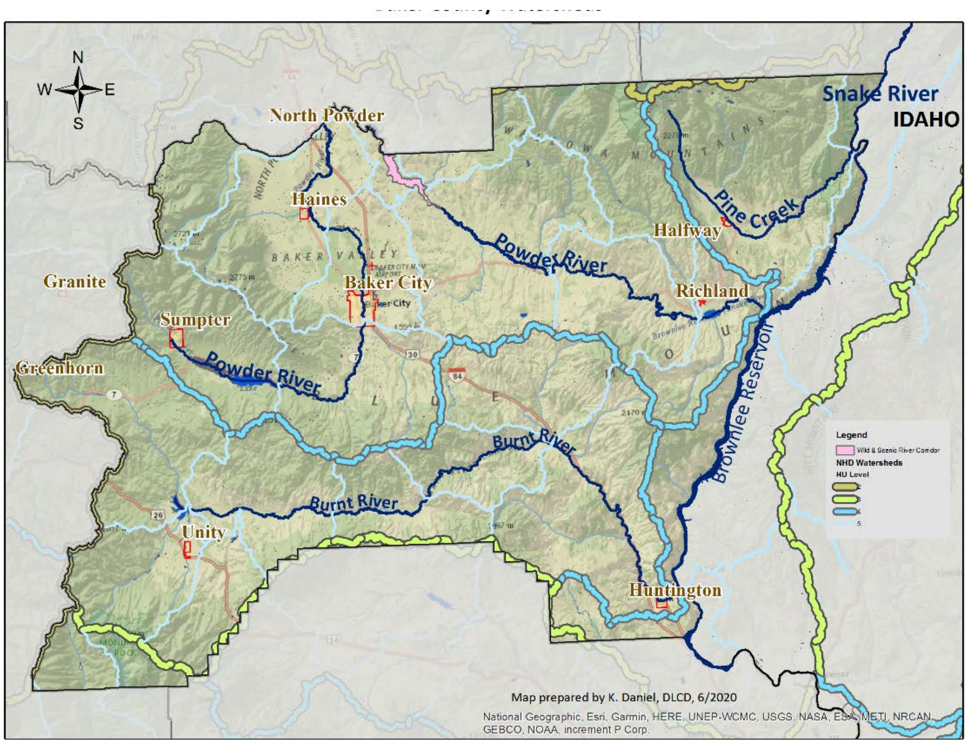
Snow-melt Flooding

Flooding throughout the region is most commonly linked to the spring cycle of melting snow. The weather pattern that produces these floods occurs during the winter months and has come to be associated with La Nina events, a three to seven year cycle of cool, wet weather. In brief, cool, moist weather conditions are followed by a system of warm, moist air from tropical latitudes. The intense warm air associated with this system quickly melts foothill and mountain snow. Above-freezing temperatures may occur well above pass levels (4,000-5,000 feet). Such conditions were especially noteworthy with low bridge clearances which have particularly damaged Northeast Oregon areas as seen in the 2011 flooding in Pine Valley.

[29] Future Climate Projections Grant County, Oregon Climate Change Research Institute, Oregon State University, February 2020

[30] Ibid

Figure 6. Baker County Watershed Boundaries



Source: K. Daniel, June 2020

Flash Floods

Flash floods usually result from intense storms dropping large amounts of rain within a brief period. Flash floods usually occur in the summer during thunderstorm season, appear with little or no warning and can reach full peak in a few minutes. They are most common in the arid and semi-arid central and eastern areas of the state where there is steep topography, little vegetation and intense but short duration rainfall. Flash floods can occur in both urban and rural settings, often along smaller rivers and drainage ways. In flash flood situations, waters not only rise rapidly, but also generally move at high velocities and often carry large amounts of debris. In these instances a flash flood may arrive as a fast moving wall of debris, mud, water or ice. Such material can accumulate at a natural or man-made obstruction and restrict the flow of water. Water held back in such a manner can cause flooding both up stream and then later downstream if the obstruction is removed or breaks free.

Terms related to Flooding

Floodplain

A floodplain is land adjacent to a river, stream, lake, estuary or other water body that is subject to flooding. These areas, if left undisturbed, act to store excess floodwater. The floodplain is made up of two areas: the flood fringe and the floodway:

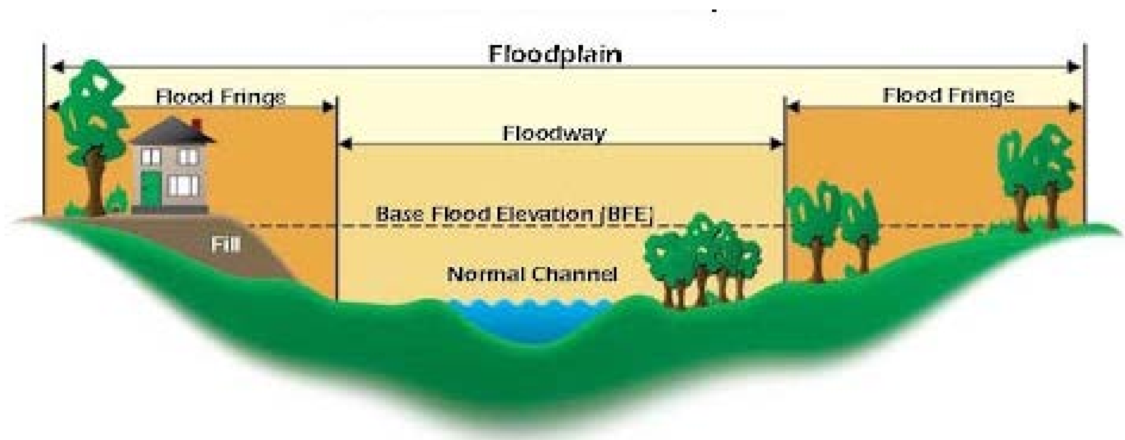
Floodway

The floodway is the portion of the floodplain that is closer to the river or stream. For National Flood Insurance Program (NFIP) and regulatory purposes, floodways are defined as the channel of a river or stream, and the over-bank areas adjacent to the channel. Unlike floodplains, floodways do not reflect a recognizable geologic feature. The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures, so that flood flows are not obstructed or diverted onto other properties. The NFIP floodway definition is "the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot (See Figures FL-3 and FL-4)." Floodways are not mapped for all rivers and streams but are typically mapped in developed areas.

The Flood Fringe

The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken (See Figure FL-3).

Figure 7. Characteristics of a Floodplain



Source: Oregon Department of Geology and Mineral Industries

Base Flood Elevation

Base Flood Elevation (BFE) means the water surface elevation during the base flood in relation to a specified datum or benchmark. The Base Flood Elevation (BFE) is depicted on the FEMA Flood Insurance Rate Map (FIRM) to the nearest foot and in the Flood Insurance Study to the nearest 0.1 foot. The Base Flood Elevation is a baseline pulled together from historic weather data, local topography, and the best science available at the time. It's a reasonable standard to insure against, but it is not a guarantee that it will flood only 1 time every 100 years.

Factors that Affect Flooding in Baker County

Precipitation

In Oregon, observed precipitation is characterized by high year-to-year variability and future precipitation trends are expected to continue to be dominated by this large natural variability. On average, summers in Oregon are projected to become drier and other seasons to become wetter resulting in a slight increase in annual precipitation by the 2050's.[31] Locations surrounded by mountains receive barely 10 inches per year, a portion of which falls as snow. This is in sharp contrast to the 37 to 50 inches normally seen in other parts of the Pacific Northwest. Low levels of precipitation are due in part by the rain shadow effect caused by the Cascade Mountains. Summer precipitation is very low, increasing the risk of wildfire and requiring irrigation for crops.

Projections for future changes in climate suggest that there is greater uncertainty in future projections of precipitation-related metrics than temperature-related metrics. Future streamflow magnitude and timing in the Pacific Northwest is projected to shift toward higher winter runoff, lower summer and fall runoff, and an earlier peak runoff, particularly in snow-dominated regions. These changes are expected to result from warmer temperatures causing precipitation to fall more as rain and less as snow, in turn causing snow to melt earlier in the spring; and in combination with increasing winter precipitation and decreasing summer precipitation.

Warming temperatures and increased winter precipitation are expected to increase flood risk for many basins in the Pacific Northwest, particularly mid-to low-elevation mixed rain-snow basins with near freezing winter temperatures. The greatest changes in peak streamflow magnitudes are projected to occur at intermediate elevations in the Cascade Range and the Blue Mountains.[32]

Surface Permeability

In urbanized areas, increased pavement leads to an increase in volume and velocity of runoff after a rainfall event, exacerbating potential flood hazards. Storm water systems collect and concentrate rainwater and then rapidly deliver it into the local waterway. Traditional storm water systems are a benefit to urban areas, by quickly removing captured rainwater. However, they can be detrimental to areas downstream because they cause increased stream flows due to the rapid influx of captured storm water into the waterway. It is very important to evaluate storm water systems in conjunction with development in the floodplain to prevent unnecessary flooding to downstream properties. Frozen ground and burn scars are other contributors to rapid runoff in the urban and rural environment.

Location of Development

When development is located in the floodplain, it may cause floodwaters to rise higher than before the development was located in the hazard areas. This is particularly true if the development is located within the floodway. When structures or fill are placed in the floodplain, water is displaced.

[31] Future Climate Projections Grant County, Dalton, February 2020, p. 17
[32] Ibid p. 21

Development raises the base-flood elevation by forcing the river to compensate for the flow space obstructed by the inserted structures. Over time, when structures or materials are added to the floodplain and no fill is removed to compensate, serious problems can arise.

Displacement of a few inches of water can mean the difference between no structural damage occurring in a given flood event and the inundation of many homes, businesses, and other facilities. Careful attention must be paid to development that occurs within the floodplain and floodway of a river system to ensure that structures are prepared to withstand base flood events.

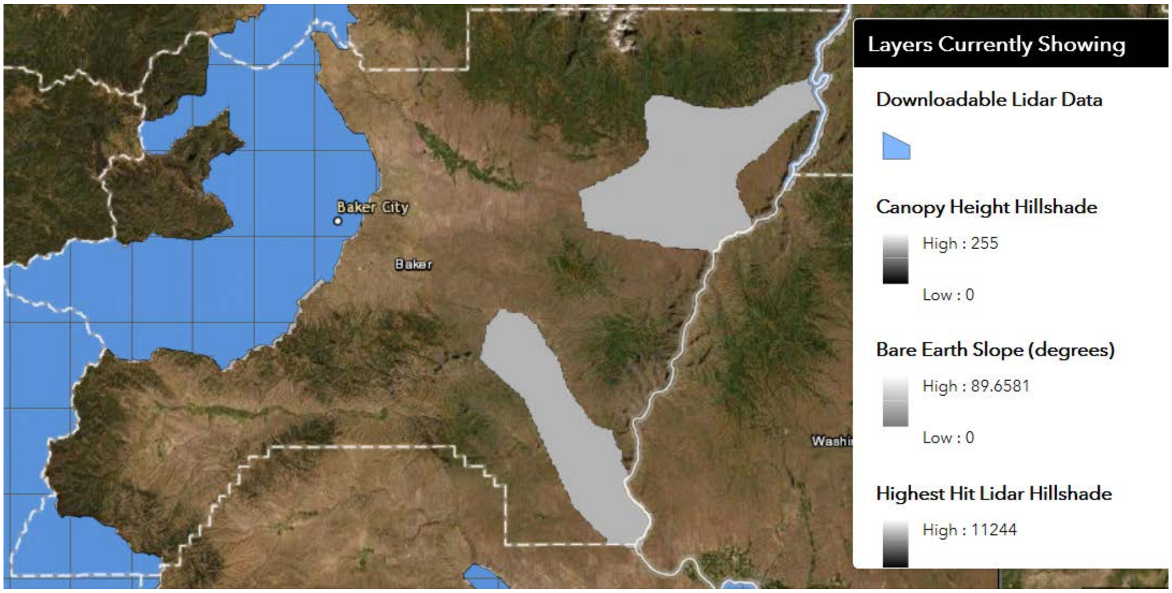
How is Flooding Hazard Identified?

Flood hazard in some areas of Baker County are identified through FEMA issued Flood Insurance Rate Maps (FIRMs), in conjunction with their Flood Insurance Studies (FIS). Flood records in areas without FIRMs are often not well documented, particularly in unincorporated areas because their floodplains are sparsely developed and risk to life and property are low. The Baker County's Flood Insurance Rate Maps (FIRMs), like much of eastern Oregon are not modernized.

Following from the Risk MAP Discovery meetings, FEMA has started the initial planning for acquisition of new lidar datasets over areas of Baker County that were not previously collected. Figures 3 and 4 below show the areas DOGAMIs database of lidar represent existing lidar and the areas where FEMA recognizes additional lidar is needed to complete coverage of the county. For areas where lidar is currently available, FEMA has started the initial flood study work to develop Base Level Engineering to model approximate A zones flood sources (Figure 5). This BLE work is anticipated for completion in the summer of 2020 according to the FEMA Region X Risk Analyst at the time the Discovery Report was completed in February 2020. As the BLE results become available, FEMA will engage with the community to discuss needs for future risk assessment and additional flood study work including a potential Flood Insurance Study update. Depending on funding and data availability, the detailed flood study work could start in late 2021.[33]

[33] Personal communication with Rynn Lamb, Risk Analyst FEMA Region X, March 2020

Figure 8. Existing lidar datasets in Baker County



Source: DOGAMI LiDAR Viewer

Figure 9. FEMA Region X Existing (purple) and Proposed (yellow) Lidar collection areas

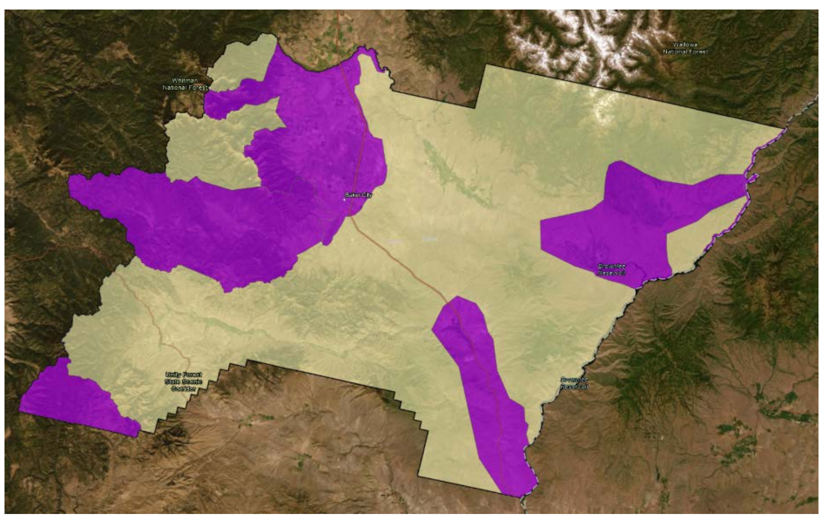
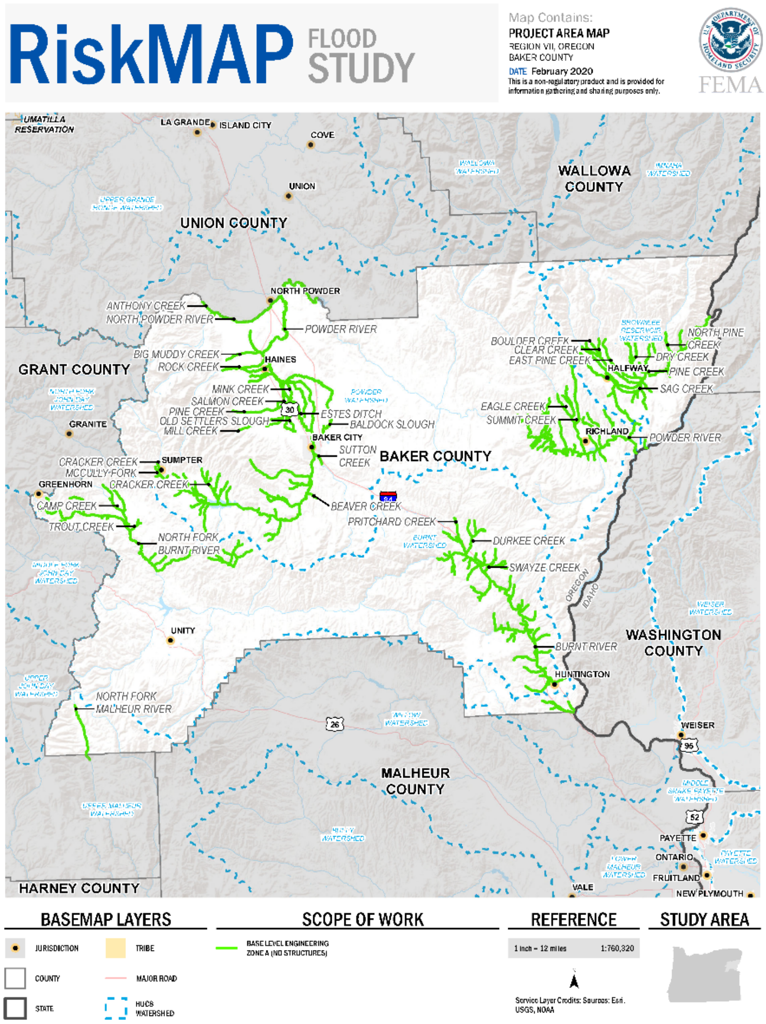


Figure 10. Base Level Engineering being developed using existing lidar



Source: FEMA Risk MAP Discovery, February 2020

The table below shows that as of June 2020, Baker County (including the cities of Baker City, Haines, Halfway, Huntington and Sumpter) has 95 National Flood Insurance Program (NFIP) policies in force, 5 total paid claims and no repetitive loss buildings. The repetitive flood loss claims in Baker County and Baker City resulted in $29,769 in payments over five losses. The tables below display the number of policies by building type and show that the majority of residential structures that have flood insurance policies are single-family homes and that there are 3 non-residential structures with flood insurance policies. Baker County, Baker City, Halfway, and Huntington have participated in Community Assistance Contacts in 2019 or 2020. The cities of Haines and Sumpter have not received a Community Assistance Visit or Community Assistance Contact in the past 18 or 19 years. The county is not a member of the Community Rating System (CRS) and neither are any of the incorporated cities within Baker County.

Table 4. Baker County Flood Insurance Policy Detail

Jurisdiction	Current FIRM effective date	Policies	Pre-FIRM	Policies by Building Type			
				Single Family	2 to 4 Family	Other Residential	Non-Residential
Baker County	06/03/1988	18	12	17	-	-	1
Baker City	06/03/1988	73	46	63	-	3	7
Haines	06/03/1988	0	-	-	-	-	-
Halfway	06/03/1988	3	2	2	-	-	1
Huntington	2/17/1988	0	-	-	-	-	-
Sumpter	06/03/1988	1	0	1	-	-	-
Totals		95	60	83	0	3	9

Table 5. Baker County Flood Insurance Claim and Substantial Damage Detail

Jurisdiction	Insurance in Force	Total Paid Claims	Substantial Damage Claims	Repetitive Loss Buildings	Total Paid Amount	Last CAV	Last CAC
Baker County	$3,962,300	2	0	0	$4,278	10/12/2001	4/23/2020
Baker City	$11,931,200	3	0	0	$25,491	10/12/2001	08/26/2019
Haines	$0	0	0	0	$0	07/01/1991	09/10/1990
Halfway	$492,200	0	0	0	$0	never	04/09/2020
Huntington	$0	0	0	0	$0	never	04/07/2020
Sumpter	$60,000	0	0	0	$0	never	08/24/1992
Totals	16,445,700	5	0	0	$29,769		

Source: Information compiled by Department of Land Conservation and Development, FEMA Community Information System consulted June 2020.

The cities of Greenhorn, Richland, and Unity do not participate in the NFIP.

History of Flooding in Baker County

Table 5 below shows the history of major flood events within Baker County. Staff at the Oregon Department of Land Conservation and Development (DLCD) compiled a list of all recorded floods in Oregon across 146 years of available data, as part of a 2020 update to the 2015 State NHMP table of flooding events. Data for this list had two sources: the Table 1 in the DLCD “Flood Technical

Resource Guide" (Andre and others, 2001)[34] which was used to record events that occurred prior to 2000 and the NOAA Storm Event Database [35] which captured events from 2000 to the present.

There are limitations to this listing in that information from the DLCD Flood Technical Resource Guide's represents a list of 'Historic Flooding' which typically records only at most 12 events in a single region across a decade. In comparison, the NOAA database records storm-driven flooding events that result in damage, injury, loss of life or events that have unusual conditions that may generate media attention. This shows as many as 45 events occurring in one region within a decade. By compiling data from two different sources, neither of which have a quantitative metric for defining a flood, has resulted in a list that is inconsistent and likely incomplete. This table differs somewhat from the list of historic floods in the 2014 NHMP because this plan relates to only a portion of the area covered in the 2014 NHMP.

Table 6. History of flooding in Baker County

Date	Location	Description
1894	NE Oregon	Widespread flooding
1910	Powder River and Malheur River	Widespread flooding
1917	NE Oregon	Widespread flooding
March 1932	NE Oregon	Widespread flooding
1935	NE Oregon	Widespread flooding
Dec. 1964–Jan. 1965	Pacific Northwest	rain on snow; record flood on many rivers
February 1996	Nearly statewide	Damages statewide totaled over $28 million
June 2002	Baker and Malheur Counties	Slow-moving thunderstorms dropped very heavy rainfall over the Rye Valley area near the Baker-Malheur County line.
2011	Pine Creek	
May 2016	Baker County	A strong thunderstorm dumped up to a quarter of an inch of rain over a 15 minute period over terrain scorched by wild fire in August of 2015 causing flash flooding and debris flows.
September 2017	Baker County	Thunderstorms producing heavy rain over the 2016 Rail Fire burned area on the Wallowa-Whitman National Forest resulted in flash flooding and debris flows.
June 2018	Baker County	Thunderstorms with heavy rainfall developed over southwest Baker County, Oregon on June 20th, leading to flash flooding and debris flow on the Rail and Cornet-Windy Ridge fires burn scar areas.

Sources: DLCD "Flood Technical Resource Guide" (Andre and others, 2001) and National Climate Data Center Storm events Database http://www.ncdc.noaa.gov/stormevents

[34] https://oregonexplorer.info/data_files/OE_topic/hazards/documents/04_flood.pdf
[35] https://www.ncdc.noaa.gov/stormevents/

LANDSLIDE HAZARD ANNEX

Countywide exposure:
- Number of buildings: **463**
- Exposure Value: **$53,399,000**
- Ratio of Exposure Value: **1.7%**
- Critical facilities exposed: **1**
- Potentially Displaced Population: **254**

Landslides are a chronic problem in our state, affecting both infrastructure and private property. Approximately 13,048 documented landslides have occurred in Oregon in the last 150 years. The combination of geology, precipitation, topography, and seismic activity makes portions of Oregon especially prone to landslides[36]. In Baker County, a landslide known as the Rock Creek Slide occurred one night in 1862 when miners on Rock Creek and vicinity were awakened by a terrible rumbling sound. Thinking it was an earthquake they returned to bed, but upon rising the next morning they discovered the peak of Hunt Mountain had slid into Rock Creek. The massive scar is still visible today.

Landslides are a geologic hazard in almost every state in America. Nationally, landslides cause 25 to 50 deaths each year.[37] In Oregon, economic losses due to landslides for a typical year are estimated to be over $10 million.[38] In years with heavy storms, such as in 1996, losses can be an order of magnitude higher and exceed $100 million.[39]

While not all landslides result in private property damage, many landslides impact transportation corridors, fuel and energy conduits, and communication facilities. They can also pose a serious threat to human life. Increasing population in Oregon and the resultant growth in home ownership has caused the siting of more development in or near landslide areas. Often these areas are highly desirable owing to their location along the coast, rivers, and on hillsides.

Although landslides are propelled by gravity, they can be triggered by other natural geologic events or human activity. Volcanic eruptions and earthquakes can initiate earth movement on a grand scale. Although earthquakes can initiate debris flows, the major causes of landslides in the northwest are continuous rains that saturate soils.

[36] Sears, Lahav, Burns and McCarley. 2019. Preparing for Landslide Hazards: A Land Use Guide for Oregon Communities https://www.oregon.gov/lcd/Publications/Landslide_Hazards_Land_Use_Guide_2019.pdf

[37] Mileti, Dennis. 1999. Disasters by Design: A Reassessment of Natural Hazards in the United States. Washington D.C.: Joseph Henry Press.

[38] Wang, Yumei, Renee D. Summers, R. Jon Hofmeister, and Oregon Department of Geology and Mineral Industries. 2002. "Open-File Report O-02-05: Landslide Loss Estimation Pilot Project in Oregon." http://www.oregon.gov/LCD/docs/rulemaking/012308/item_1_Kehoe_att_b.pdf, accessed February 14, 2010

[39] Ibid.

Landslides can also be the direct consequence of human activity. Seemingly insignificant modifications of surface flow and drainage may induce landslides. In an urban setting, improper drainage is most often the factor when a landslide occurs.

Many unstable, landslide prone areas can be recognized. Tip-offs include scarps, tilted and bent ("gun-stocked") trees, wetlands and standing water, irregular and hummocky ground topography, and over steepened slopes with a thick soil cover. The technology of spotting landslides by use of aerial photography and new laser based terrain mapping called lidar is helping DOGAMI develop much more accurate and detailed maps of areas with existing landslides and they are now able to create landslide susceptibility maps, that is, maps that that show where staff geologists estimate that different types of landslides may occur in the future.[40]

All landslides can be classified into one of the following six types of movements: (1) slides, (2) flows, (3) spreads, (4) topples, (5) falls, or (6) complex. In addition, landslides may be broken down into the following two categories: (1) rapidly moving; and (2) slow moving. Rapidly moving landslides are typically "off-site" (debris flows and earth flows) and present the greatest risk to human life. Rapidly moving landslides have caused most of the recent landslide-related injuries and deaths in Oregon, including eight deaths in 1996 following La Niña storms. Slow moving landslides tend to be "on-site" (slumps, earthflows, and block slides) and can cause significant property damage, but are less likely to result in serious human injuries.

Landslides vary greatly in the volumes of rock and soil involved, the length, width, and depth of the area affected, frequency of occurrence, and speed of movement. Some characteristics that determine the type of landslide are slope of the hillside, moisture content, and the nature of the underlying materials.

In general, areas at risk to landslides have steep slopes (25 percent or greater,) or a history of nearby landslides. In otherwise gently sloped areas, landslides can occur along steep river and creek banks, and along ocean bluff faces. At natural slopes under 30 percent, most landslide hazards are related to excavation and drainage practices, or the reactivation of preexisting landslide hazards.[41]The severity or extent of landslides is typically a function of geology and the landslide triggering mechanism. Rainfall initiated landslides tend to be smaller, and earthquake induced landslides may be very large. Even small slides can cause property damage, result in injuries, or take lives. Natural conditions and human activities can both play a role in causing landslides. The incidence of landslides and their impact on people and property can be accelerated by development.[42]

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[40] Ibid

[41] Interagency Hazard Mitigation Team.2012- Oregon Natural Hazards Mitigation Plan. Salem, OR: Oregon Military Department – Office of Emergency Management

[42] DLCD, CPW, Planning for Natural Hazards: Oregon Technical Resource Guide, 1999

Causes and Characteristics of Landslides

In simplest terms, a landslide is any detached mass of soil, rock, or debris that falls, slides or flows down a slope or a stream channel. Landslides are classified according to the type and rate of movement and the type of materials that are transported.

In understanding a landslide, two forces are at work: 1) the driving forces that cause the material to move down slope, and 2) the friction forces and strength of materials that act to retard the movement and stabilize the slope. When the driving forces exceed the resisting forces, a landslide occurs.

Landslides can be broken down into two categories: (1) rapidly moving; and (2) slow moving, in addition to "on-site" or "off-site" hazards. Rapidly moving landslides are typically "off-site" (debris flows and earth flows) and present the greatest risk to human life, and persons living in or traveling through areas prone to rapidly moving landslides are at increased risk of serious injury. Rapidly moving landslides have also caused most of the recent landslide-related injuries and deaths in Oregon. Slow moving landslides tend to be "on-site" (slumps, earthflows, and block slides) and can cause significant property damage, but are less likely to result in serious human injuries.

Debris flows or mudflows are a hybrid possessing some characteristics of landslide and some characteristics of flooding. As water runs downhill through burned areas, it can create major erosion and pick up large amounts of ash, rocks, boulders, and burned trees, generating a debris flow (also commonly termed "mudflow")1. Fast-moving, highly destructive debris flows are one of the most dangerous post-fire hazards, since they occur with little warning. High rainfall rates are the trigger for debris flows, rather than the total amount of rain. Their mass and speed make them particularly destructive. Debris flows can strip vegetation, block drainages, damage structures, and endanger human life. The force of the rushing water and debris can threaten life and property miles away from the burned area. Survivors of debris flows describe sounds of cracking, breaking, roaring, or a freight train.[43]

The staff from Oregon Department of Geology and Mineral Industries teamed up with staff from Oregon Department of Land Conservation and Development to develop an updated guide on land use issues for landslide hazards. This Landslide Guide both describes landslides and the methods used to map them more accurately using lidar (Light Detection and Ranging) methods, as well as the types of site specific reporting and the professionals qualified to produce them, mitigation planning topics and the implementation of mitigation actions including a guide to examples of landslide codes for local planners. This document is excerpted below and a reference to the full document is available through the following link:
https://www.oregon.gov/lcd/Publications/Landslide_Hazards_Land_Use_Guide_2019.pdf

Types of Landslides

All landslides can be classified into six types of movement: 1) falls, 2) topples, 3) slides, 4) spreads, 5) flows, and 6) complex (Figure 11). Most slope failures are complex combinations of these six distinct types, but the generalized groupings provide a useful means for framing discussion of the type of

[43] Oregon Post-Wildfire Flood Playbook, 2018, USACE Silver Jackets

hazard and potential mitigation actions. Movement type should be combined with other landslide characteristics such as type of material, rate of movement, depth of failure, and water content to understand more fully the landslide behavior. For a more complete description of the different types of landslides, see *U.S. Transportation Research Board Special Report 247, Landslides: Investigation and Mitigation* (Turner & Schuster, 199610), which has an extensive chapter on landslide types and processes.

One type of landslide that is commonly life threatening is channelized debris flow, sometimes referred to as a *rapidly moving landslide* or RML. They are more prevalent and impactful than most people recognize. Channelized debris flows normally initiate on a steep slope, move into a steep channel (or drainage), increase in volume by incorporating channel materials, and then deposit material, usually at the mouth of the channel on existing fans. Debris flows can be mobilized by other types of landslides that occur on slopes near a channel. Debris flows can also initiate within channels from accelerated erosion during heavy rainfall or snowmelt. These debris flows move fast enough that they are difficult to outrun. Slopes that have failed in the past often remain in a weakened state, and many of these areas tend to fail repeatedly over time. For example, a channel with a debris flow fan at its mouth indicates a history of debris flows in that channel. The formation of talus slopes indicates that numerous rock falls have occurred above the slope. Talus is "[a]n outward sloping and accumulated heap or mass of rock fragments of any size or shape (usually coarse and angular) derived from and lying at the base of a cliff or very steep, rocky slope, and formed chiefly by gravitational falling, rolling, or sliding" (USGS).

The tendency for failures to reoccur is true for all types of landslide movements and over periods much longer than human recorded history. Large landslide complexes may have moved dozens of times over thousands of years, with long periods of stability punctuated by episodes of movement. In some cases, areas that have previously failed have subtle topographic morphology now, making them difficult to identify. However, technological advances such as lidar have greatly helped in the process of identifying and mapping older landslides. Identifying and mapping both historical and ancient landslide areas – many of which will move again – is of great importance for mitigating the risk these natural hazards pose.

Potential slope instability is not limited to past landslide sites. Areas near previous landslides and of similar geology and topography are also at higher risk for slope failure. This makes it even more important to locate previous landslides and study them: Mapping landslide locations can identify nearby or similar areas susceptible to slope instability.[44]

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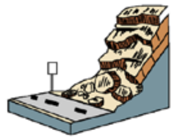
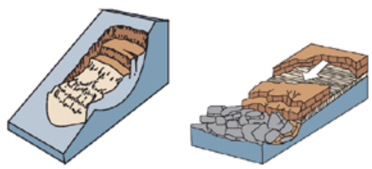
[44] Preparing for Landslide Hazards: A Land Use Guide for Oregon Communities (October 2019)

Figure 11. Types of Common Landslides in Oregon



Falls are near-vertical, rapid movements of masses of materials, such as rocks or boulders. The rock debris sometimes accumulates as talus at the base of a cliff.

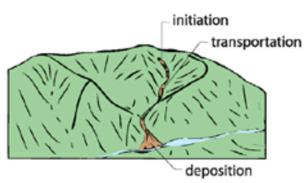
Topples are distinguished by forward rotation about some pivotal point, below or low in the mass.



Slides are downslope movement of soil or rock on a surface of rupture (failure plane or shear-zone).

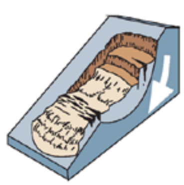
- **Rotational** slides move along a surface of rupture that is curved and concave.
- **Translational** slides displace along a planar or undulating surface of rupture, sliding out over the original ground surface.

Spreads are commonly triggered by earthquakes, which can cause liquefaction of an underlying layer and extension and subsidence of commonly cohesive materials overlying liquefied layers.



Channelized Debris Flows commonly start on a steep, concave slope as a small slide or earth flow into a channel. As this mixture of landslide debris and water flows down the channel, it pick ups more debris, water, and speed, and deposits in a fan at the outlet of the channel.

Earth Flows commonly have a characteristic "hourglass" shape. The slope material liquefies and runs out, forming a bowl or depression at the head.



Complex landslides are combinations of two or more types. A common complex landslide is a slump-earth flow, which usually exhibit slump features in the upper region and earth flow features near the toe.

Source: Preparing for Landslide Hazards: A Land Use Guide for Oregon Communities (October 2019)

Conditions Affecting Landslides

Depending upon the type, location, severity and area affected, severe property damage, injuries and loss of life can be caused by landslides. Landslides can damage or temporarily disrupt utility services, roads and other transportation systems and critical lifeline services such as police, fire, medical, utility and communication systems, and emergency response. In addition to the immediate damage and loss of services, serious disruption of roads, infrastructure and critical facilities and services may also have longer term impacts on the economy of the community and surrounding area.

Natural conditions and human activities can both play a role in causing landslides. Certain geologic formations are more susceptible to landslides than others. Locations with steep slopes are at the greatest risk of slides. However, the incidence of landslides and their impact on people and property can be accelerated by development. Developers who are uninformed about geologic conditions and processes may create conditions that can increase the risk of or even trigger landslides.

The following are principal factors that affect or increase the likelihood of landslides:

Natural conditions and processes including the geology of the site, rainfall, wave and water action, seismic tremors and earthquakes and volcanic activity.

Excavation and grading on sloping ground for homes, roads and other structures. Improper excavation practices, sometimes aggravated by drainage issues, can reduce the stability of otherwise stable slopes.

Drainage and groundwater alterations that are natural or human-caused can trigger landslides. Human activities that may cause slides include broken or leaking water or sewer lines, water retention facilities, irrigation and stream alterations, ineffective storm water management and excess runoff due to increased impervious surfaces.

High rainfall accumulation in a short period of time increases the probability of landslide. An extreme winter storm can produce inches of rainfall in a 24 hour period; if the storm occurs well into the winter season, when the ground is already saturated, the hydraulic overload effect is heightened.

Change or removal of vegetation on very steep slopes due to timber harvesting, land clearing and wildfire.

Allowing development on or adjacent to existing landslides or known landslide-prone areas raises the risk of future slides regardless of excavation and drainage practices. Homeowners and developers should understand that in many potential landslide settings there are no development practices that can completely assure slope stability from future slide events.

Building on fairly gentle slopes can still be subject to landslides that begin a long distance away from the development. Sites at greatest risk are those situated against the base of very steep slopes, in confined stream channels (small canyons), and on fans (rises) at the mouth of these confined channels. Home siting practices do not cause these landslides, but rather put residents and property at risk of landslide impacts. In these cases, the simplest way to avoid such potential effects is to locate development out of the impact area, or construct debris flow diversions for the structures that are at risk.

Certain forest practices can contribute to increased risk of landslides. Forest practices may alter the physical landscape and its vegetation, which can affect the stability of steep slopes. Physical alterations can include slope steepening, slope-water effects, and changes in soil strength. Of all forest management activities, roads have the greatest effects on slope stability, although changing road construction and maintenance practices are reducing the effects of forest roads on landslides.

History of Landslides in Baker County and Oregon

In recent events, particularly noteworthy landslides accompanied storms in 1964, 1982, 1966, 1996, and 2005. Most of Oregon's landslide damage has been associated with severe winter storms where landslide losses can exceed $100 million in direct damage such as the February 1996 event. More winter storm induced landslides occurred in Oregon during November 1996. Intense rainfall on recently past logged land as well as previously unlogged areas triggered over 9,500 landslides and debris flows that resulted directly or indirectly in eight fatalities Highways were closed and a number of homes were lost. The fatalities and losses resulting from the 1996 landslide events brought about the passage of Oregon Senate Bill 12, which set site development standards, authorized the mapping of areas subject to rapidly moving landslides and the development of model landslide (steep slope) ordinances.

Annual average maintenance and repair costs for landslides in Oregon are over $10 million.[45]

In 2017 in southwestern Baker County intense rainfall resulted in debris flows along the South Fork of the Burnt River near Unity. The Baker City Herald reported that multiple torrents of water, carrying hundreds of tons of mud and rock and thousands of trees, many of them burned during the 2016 Rail fire, transformed the landscape in the southwest corner of Baker County in just a few hours. No one was hurt during the flooding. Sections of several roads, including the main route along the South Fork, Forest Road 6005, are buried under jackstrawed piles of trees 15 to 20 feet deep. Floodwaters and debris flows plugged multiple metal culverts, some of them 5 feet in diameter, causing mud, rocks and trees to clog the South Fork's channel for hundreds of yards upstream from the culvert.[46]

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[45] Wang and Chaker, 2004. Geological Hazards Study for the Columbia River Transportation Corridor. Oregon Department of Geology and Mineral Industries Open File Report OFR 0-4-08

[46] Baker City Herald, September 14, 2017

Figure 12. Debris flow September 2017 along South Fork of the Burnt River

Source: Ray Rau, as submitted to and published by the Baker City Herald on September 14, 2017

Preparing for Landslide Hazards: A Land Use Guide for Oregon

DOGAMI and DLCD prepared a comprehensive guide on landslide hazard reduction entitled *Preparing for Landslide Hazards: A Land Use Guide for Oregon* (referred to as the Landslide Guide) that addresses what landslides are and the nature of the risk that they pose to people and property along with specific details on the methodology for mapping landslide susceptibility. The Landslide Guide goes beyond the identification of the hazard and description of the risk to mitigation actions that local jurisdictions can to reduce risk from landslides. The Landslide Guide contents will be summarized here and will serve as a key reference to consult when considering mitigation of the risk of landslides in Oregon communities.

The Landslide Guide identifies planning tools and mitigation strategies to reducing landslide hazard risk. Improved mapping is the first step in better identifying areas where landslides have occurred in the past, a landslide inventory map, and susceptible to landslides. This improved mapping based on lidar (Light Detection and Ranging) technology has significantly improved DOGAMI's ability to identify and map landslide features. Lidar is a relatively new technology that allows mappers to see the earth's surface beneath vegetation and trees, as if the earth had been stripped bare. Lidar gives geologists the ability to identify and map landslide features that may have previously been unrecognized or overlooked. DOGAMI has published the landslide inventory maps in a database called SLIDO. Currently SLIDO is at release 3.4 and has been updated to contain 13,048 historic landslide points and 44,929 landslide polygons. So far, 2,986 square miles of Oregon have been mapped. Oregon is 95,988 square miles.[47]

Further analysis that combines geologic information with the landslide inventory can be used to develop landslide susceptibility maps. Once a landslide feature has been recognized and mapped

[47] https://www.indexmundi.com/facts/united-states/quick-facts/oregon/land-area#map

using lidar, several attributes about the slide, such as type of movement and material, depth of failure, direction of movement, volume of material, and initial slope angle are recorded to aid in the creation of landslide susceptibility maps for the local area. The estimated depth of failure or landslide thickness is used to classify some of the landslides as shallow (less than 15 feet depth) or deep (greater than 15 feet depth). The deep and shallow susceptibility maps are produced using the landslide inventory data combined with models and highlight the relative risk of a landslide occurring at any given point within the mapped area. These susceptibility maps work in conjunction with landslide inventory maps to provide jurisdictional staff, community leaders, and residents information necessary to reduce the risk of landslides impacting people, property, and the environment.

The Landslide Guide answers questions local planners and property owners may have regarding the type of professionals who are qualified to perform engineering geologic reports or geotechnical engineering reports. Engineering geologic reports and geotechnical engineering reports refer to different but related services performed by geoprofessionals with different professional certifications. Engineering geologic reports focus on how the earth (e.g., landforms, water table, soil, and bedrock) and earth processes (e.g., landslides and earthquakes) impact structures or potential structures and describe the degree of risk, while geotechnical engineering reports focus on the design of building products (e.g., structures, retaining walls, pavements) that can withstand or mitigate for subsurface and geologic conditions.

The primary purpose of the Landslide Guide is to provide a range of tools and strategies for using the information provided by landslide inventory and susceptibility maps and the information in geotechnical engineering or engineering geologic reports.

The Landslide Guide addresses how landslide hazard can be incorporated into comprehensive plans. In Oregon the required components of a comprehensive plan are: an inventory of existing conditions (factual base); goals and objectives; plan policies; and implementation measures and ordinances. The inventory of existing conditions (factual base) provides the basis and justification for plan policies. The plan policies provide general guidance in review of land use proposals. The implementing measures and ordinances provide the specific standards and criteria against which development proposals are reviewed. The Cities of Medford, Astoria and Portland provide examples of incorporation of landslide hazard mapping into comprehensive planning.

The Landslide Guide goes further to address the implementation of comprehensive plans through zoning codes. Zoning for natural hazards is often accomplished through zoning overlays, with other related maps, and with corresponding text in the zoning code. A better understanding of the causes and characteristics of landslides, as well as recognizing the locations, types, and extents of landslides leads to more effective plans, policies, and implementing measures. Identifying hazard areas and evaluating proposed development in these areas reduces risk and better protects a community. Zoning ordinances can be a powerful tool for protecting community and private assets against landslides and other hazards.

Finally the Landslide Guide reviews the codes of thirty-four Oregon communities with respect to landslide hazard and summarizes what makes a strong regulatory framework for reducing hazards from landslide. The Landslide Guide summarizes key ways that communities can reduce risk from landslide as follows:

• **Identify the hazard** – Know what the hazard is, where it is located, what causes it, what are its characteristics, when and where has it occurred historically, and when and where might it happen again.

• **Assess the vulnerabilities** – Inventory and analyze the existing and planned property and populations exposed to a hazard, and estimate how they will be affected by the hazard.

• **Assess the level of risk** – Risk is the expression of the potential magnitude of a disaster's impact. A natural hazards risk assessment involves *Landslide Hazards Land Use Guide for Oregon Communities* characterizing the natural hazards, assessing the vulnerabilities, and describing the risk either quantitatively or qualitatively or both.

• **Avoid the hazard** – Stay away from the hazard area if possible.

• **Reduce the level of risk** - Minimize development, reduce density, and implement mitigation measures. Manage the water on the site. Coordinate land use planning efforts with other planning efforts such as emergency operations plans, transportation plans, economic development plans, stormwater management plans, and so forth.

• **Evaluate development in landslide-prone areas** – Use technical information such as maps and reports, including site specific studies as well as broader scale information.

• **Require geotechnical investigations** – When development is proposed for locations that have landslide hazards, require site specific reports by a certified engineering geologist engineer (geotechnical assessment) or a certified engineering geologist and a geotechnical engineer (geotechnical report).

• **Adopt land use policies and enact regulations** – Regulatory tools such as overlay zones, incentive zoning, grading and erosion control provisions, stormwater management, restrictions on the types of uses and development in landslide-prone areas, size and weight of structures, management of vegetation, and other means can reduce risk of landslides. Incentive zoning requires developers to exceed limitations imposed upon them by regulations, in exchange for specific concessions. For example, if the developer avoids building on a landslide-prone area of the property then they could build on another portion of the land at a higher density than is allowed by the zoning.

• **Consider non-regulatory strategies** – Sharing information, incentives, and purchasing high hazard lands to keep them as open space are examples of strategies that can reduce risk.

• **Provide public outreach and education** – Information about the landslide hazards should be available to all inhabitants of the jurisdiction. Post it on the website, have handouts, and raise awareness of the hazard with the public at large.

SEVERE WEATHER HAZARD ANNEX

Causes and Characteristics of Severe Weather

The purpose of this annex is to summarize four different hazards dust storm, extreme heat, windstorm, and winter storm; provide their hazards history; and list the rankings that each county provided for each hazard.

Dust Storm

A dust storm is a strong, violent wind that carries fine particles such as silt, sand, clay, and other materials, often for long distances. A dust storm can spread over hundreds of miles and rise over 10,000 feet. They have wind speeds of at least 25 miles per hour. Dust storms usually arrive with little warning and advance in the form of a big wall of dust and debris. The dust is blinding, making driving safely a challenge. A dust storm may last only a few minutes at any given location, but often leave serious car accidents in their wake, occasionally massive pileups. The arid regions of Central and Eastern Oregon can experience sudden dust storms on windy days. These are produced by the interaction of strong winds, fine-grained surface material, and landscapes with little vegetation. The winds involved can be as small as "dust devils" or as large as fast moving regional air masses.[48]

Extreme Temperatures

Northeast Oregon can also be a place of extreme temperatures events. From extreme cold spells to extreme heat waves, extreme temperatures events have the potential to inflict serious health damage. In extreme heat environments the body must work harder to maintain a normal temperature, these conditions can induce heath related illnesses, particularly among vulnerable population types.[49] Extreme cold events can be defined similarly -- where conditions get so severe that health related illnesses occur.[50]

Windstorm

Extreme winds occur throughout Oregon. The most persistent high winds take place along the Oregon Coast and in the Columbia River Gorge. However, extreme weather events occur in all regions of Oregon.[51] Prevailing winds in Oregon vary with the seasons. In summer, the most common wind directions are from the west or northwest; in winter, they are from the south and east. Local topography, however, plays a major role in affecting wind direction.[52]

48 State of Oregon NHMP 2012

49 FEMA “Extreme Heat” http://www.ready.gov/heat

50Taylor, George H. and Chris Hannan. The Oregon Weather Book. Corvallis, OR: Oregon State University Press. 1999

51Oregon State Natural Hazard Mitigation Plan 2012

52Statesman Journal. February 8, 2002.

Although rare, tornados can and do occur in Oregon. Tornadoes are the most concentrated and violent storms produced by the earth's atmosphere. They are created by a vortex of rotating winds and strong vertical motion, which possess remarkable strength and cause widespread damage. Wind speeds in excess of 300 mph have been observed within tornadoes, and it is suspected that some tornado winds exceed 400 mph. The low pressure at the center of a tornado can destroy buildings and other structures it passes over. Tornadoes are most common in the Midwest, and are more infrequent and generally small west of the Rockies. Nonetheless, Oregon and other western states have experienced tornadoes on occasion, many of which have produced significant damage and occasionally injury or death. Oregon'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.[53]

Winter Storm

Severe winter storms can consist of rain, freezing rain, ice, snow, cold temperatures, and wind. Winter storms occur over eastern Oregon regularly during December through February.[54] Northeast Oregon is known for cold, snowy winters. This is advantageous in at least one respect: in general, the region is prepared, and those visiting the region during the winter, usually come prepared. However, there are occasions when preparation cannot meet the challenge. Drifting, blowing snow has often brought highway traffic to a standstill. Also, windy, icy conditions have often closed mountain passes and canyons to certain classes of truck traffic. In these situations, travelers must seek accommodations, sometimes in communities where lodging is very limited. And local residents also experience problems. During the winter, heating, food, and the care of livestock and farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers.[55]

Ice storms can occur anywhere in Oregon. Like snow, ice storms are comprised of cold temperatures and moisture, but subtle changes can result in varying types of ice formation, including freezing rain, sleet, and hail. Freezing rain can be the most damaging of ice formations. While sleet and hail can create hazards for motorists when it accumulates, freezing rain can cause the most dangerous conditions within a community. Ice buildup can bring down trees, communication towers, and wires creating hazards for property owners, motorists, and pedestrians alike. The most common freezing rain occurs near the Columbia Gorge, but it also poses a hazard to Northeast Oregon.[56]Snow storms are common to central and eastern Oregon because the air can get cold enough and the only necessary ingredient is sufficient moisture. Relative to western Oregon, Northeast Oregon receives a large amount of annual snowfall.

History of Severe Weather in Northeast Oregon

Severe weather incidents have historically been a threat to Northeast Oregon. Table 7 below lists the most significant severe weather storms to impact Northeast Oregon.

53Taylor, George H., Holly Bohman, and Luke Foster. August 1996. A History of Tornadoes in Oregon.Oregon Climate Service. Corvallis, OR: Oregon State University. http://www.ocs.orst.edu/pub_ftp/reports/book/tornado.html

54Oregon State Natural Hazards Mitigation Plan "Winter Storms Chapter". 2012

55 Ibid

[56] Taylor, George H. and Chris Hannan. The Oregon Weather Book. Corvallis, OR: Oregon State University Press. 1999

Table 7. Partial History of Significant Severe Weather Events

Date	Location	Comments
December 22, 1861	Pacific Northwest	**Snowstorm:** Very snowy winter; temperatures ranged from 0°F to -30° F. Over 10,000 cattle starved in eastern Oregon.
December 1892	Northern Counties	**Snowstorm:** Between 15 and 30 inches of snow fell throughout the northern counties
August 5-11, 1898	Eastern Oregon	**Heat wave**: record breaking heat east of the Cascades; Pendleton reached 119° F
April 1931	NE Oregon	**Windstorm:** Unofficial wind speeds reported at 78 mph. Damage to fruit orchards and timber.
February 1933	Statewide	**Cold Spell**: Coldest February to date for eastern Oregon. Seneca reached -54°F, all time record for Oregon.
June, 1937	Baker County	**Tornado:** A barn was destroyed, as well as other structural building damage; damage was category 4
January 9-18, 1950	Statewide	**Ice / Snow Storm**: Heaviest snowfalls on record for January; lots of snow from January 9 to 18; extreme low temperatures
November 10-11, 1951	Statewide	**Windstorm:** Widespread damage, transmission and utility lines, wind speeds 40-60 mph, gust 75-80 mph
December 4, 1951	Statewide	**Windstorm:** Wind Speed up to 60 mph in Willamette Valley, 75 mph gusts; damage to building and utility lines.
December 21-23, 1955	Statewide	**Windstorm:** Wind speeds 55-65 mph, with 69 mph gusts. Considerable damage to buildings and utility lines.
January 25-31, 1957	Statewide	**Cold Spell:** included a -43°F minimum temperature in Seneca on January 26th
November 3, 1958	Statewide	**Windstorm:** Wind speeds up to 51 mph, with 71 mph gusts. Major highways blocked by fallen trees.
March 1-2, 1960	Statewide	**Snowstorm:** Heavy snow throughout state
October 12, 1962	Almost all of Oregon	**Windstorm:** Oregon's most famous and most destructive windstorm, the Columbus Day Storm, produced a barometric pressure low of 960 mb. Total damage estimated at $170 million
January 30-31, 1963	Northern Oregon	**Ice Storm:** Large number of downed power lines, many injuries, one reported death.
June 11, 1968	Wallowa County	**Tornado:** Category 7 damage -- possibly the strongest tornado to strike the Northwest.
January 25-30, 1969	Statewide	**Snowstorm:** Heavy snow throughout state; $3-4 million in property damage

Sources: Oregon State Natural Hazard Mitigation Plan 2012; George and Ray Hatton, 1999, The Oregon Weather Book; NOAA Storm Events Database, http://www.ncdc.noaa.gov/stormevents/. Accessed March 27, 2013.

Date	Location	Comments
March 25-26, 1971	Most of Oregon	**Windstorm:** Storm center moved into NW Washington, bringing cold front heading east and damaging winds on March 26.
July, August 1971	Eastern Oregon	**Heat Wave:** temperatures were high in Eastern Oregon for four consecutive weeks. Ontario had 32 consecutive days of 100°F or more.
January 9-11, 1980	Statewide	**Snowstorm/Windstorm:** Series of snow storms, extreme winds across state. Many injuries and power outages. One death in Baker along with 5 others across the state
November 13-15, 1981	Pacific Northwest	**Snowstorm:** Back-to-back storms on the 13th and 15th of November
February 1985	Statewide	**Snowstorm:** Heavy snow throuhgout the state.
January 7, 1986	Northeast Oregon	**Windstorm:** Elgin High School gymnasium received damage; sustained winds of 80 to 90 mph in La Grande.
February 1986	Central/Eastern Oregon	**Snowstorm**: Heavy snow. Traffic accidents; broken power lines; 6 to 12 inches of snow in the basins and valleys of northeastern Oregon
December 26 1988 - January 22, 1989	Northeastern Oregon	**Snowstorm:** Summerville was (the most) affected, with three blizzards during a four week period.
February 1-8, 1989	Statewide	**Snowstorm/Cold Spell:** Heavy snow and cold temperatures throughout state. Max temperature in Baker City was -2°F; Seneca's minimum temperature was -48°F.
December 1990	Wallowa County	**Severe Windstorm:** wind damage to City of Joseph Elementary School and post office.
February 11-16, 1990	Statewide	**Snowstorm:** Heavy snow throughout state
January 6-7, 1991	All of eastern Oregon	**Snowstorm:** The higher lands of eastern Oregon accumulated between 1 and 6 inches of new snow.
March 1991	NE Oregon	**Severe windstorm**
December 12, 1991	NE Oregon	**Severe windstorm**
December 1992	Northeastern Mtns.	**Severe Windstorm**
December 1993	NE Oregon	**Windstorm:** High winds ranged between 70 and 80 mph with gusts of up to 103 mph. No significant damage was repotred.
January 1994	Northeastern Mtns.	**Snowstorm:** Heavy snow throughout the region
May 15, 1994	Eastern Oregon	**Windstorm:** Severe windstorm, blowing dust, Winds 55 to 65 mph. Particularly damaging in Baker County ($25,000 in property damage)
December 12, 1995	Statewide	**Windstorm:** Strongest windstorm since Nov. 1981; barometric pressure of 966.1 mb at Astoria, and an Oregon record low 953 mb off the coast; major disaster declaration FEMA-1107-DR-OR
Winter 1998-99	Statewide	**Winter Storm:** One of the snowiest winters in Oregon history (Snowfall at Crater Lake: 586 inches)
May 2003	Baker City	**Windstorm:** 60 mph winds in Baker City caused property damage and power outages

Sources: Oregon State Natural Hazard Mitigation Plan 2012; George and Ray Hatton, 1999, The Oregon Weather Book; NOAA Storm Events Database, http://www.ncdc.noaa.gov/stormevents/. Accessed March 27, 2013.

Date	Location	Comments
June, 2003	Baker and Wallowa County	**Windstorm:** 65 mph winds in Baker City caused property damage and power outages. $1,000 in property damage in Wallowa County
July, 2003	Union County	**Windstorm:** $30,000 in property damage
December 2003 - January 2004	Statewide	**Winter Storm:** Public assistance to state and local governments for the repair or replacement of disaster damaged public facilities was available to Baker, Grant, Union, and Wallowa Counties among others. Counties eligible for HMGP funding.
July, 2004	Union County	**Windstorm:** $300,000 in property damage
March 31, 2004	Grande Ronde Valley	**Dust Storm:** Dust storm required closure of roads due to visibility, reported car crashes.
December 2006	Statewide	**Windstorm:** severed tree limbs were strewn about Baker City streets. Peak wind gusts in Baker City of 47 mph. 475 Baker City residents were without power for two hours
November, 2007	Wallowa County	**Windstorm:** $500,000 in damages from a windstorm near Wallowa Lake State Park
January 2008	Union County	**Winter / Windstorm:** extreme winter storm caused extensive damage to structures, businesses, public buildings, and infrastructure in Union County prompting a governor's disaster declaration EO NO. 08 - 02
February 2011	Grant and Union Counties	**Winter / Windstorm:** severe winter weather prompted a governor's disaster declaration for Grant / Union County. EO NO. 11 -01

Sources: Oregon State Natural Hazard Mitigation Plan 2012; George and Ray Hatton, 1999, The Oregon Weather Book; NOAA Storm Events Database, http://www.ncdc.noaa.gov/stormevents/. Accessed October, 2013.

How are Severe Weather Hazards Identified?

Windstorms in Northeast Oregon usually occur from October to March, and their extent is determined by their track, intensity (the air pressure gradient they generate), and local terrain. The National Weather Service uses weather forecast models to predict oncoming windstorms, while monitoring storms with weather stations in protected valley locations throughout Oregon.[57]

Extreme weather events are experienced in all regions of Oregon. The regions that experience the highest wind speeds are in the Central and North Coast of Region 1. Table 8 below shows the wind speed probability intervals that structures 33 feet above the ground would expect to be exposed to within a 25, 50, and 100 year period. The table shows that structures in Northeast Oregon, within Region 7, can expect to be exposed to lower wind speeds than most regions within the state.

Figure 13 below shows the maximum wind speed that structures 33 feet above the ground would expect to be exposed to; for the four counties in Northeast Oregon that expected wind speed is less than for much of the rest of the state at 85 mph.

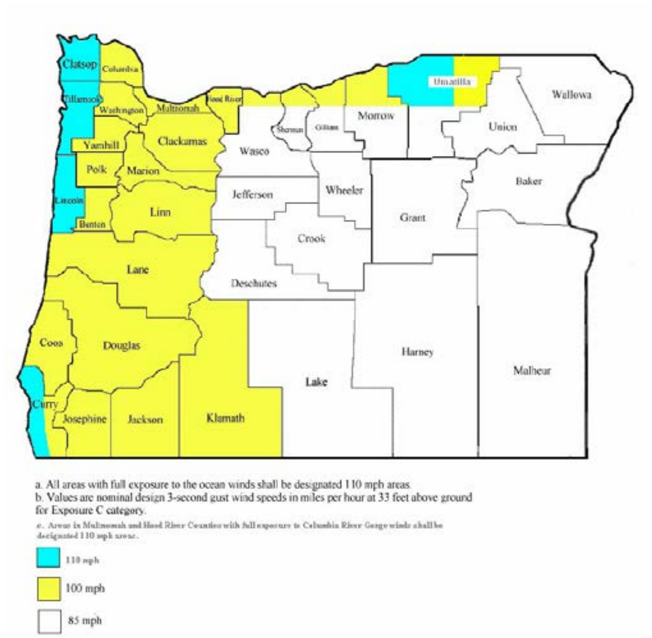
57"Some of the Area's Windstorms." National Weather Service, Portland. http://www.wrh.noaa.gov/pqr/paststorms/wind.php

Table 8. Probability of Severe Wind Events by NHMP Region

	25-Year Event (4% annual probability)	50-Year Event (2% annual probability)	100-Year Event (1% annual probability)
Region 1: Oregon Coast	75 mph	80 mph	90 mph
Region 2: North Willamette Valley	65 mph	72 mph	80 mph
Region 3: Mid/Southern Willamette Valley	60 mph	68 mph	75 mph
Region 4: Southwest Oregon	60 mph	70 mph	80 mph
Region 5: Mid-Columbia	75 mph	80 mph	90 mph
Region 6: Central Oregon	60 mph	65 mph	75 mph
Region 7: Northeast Oregon	70 mph	80 mph	90 mph
Region 8: Southeast Oregon	55 mph	65 mph	75 mph

Source: Oregon State Natural Hazard Mitigation Plan, 2012

Figure 13. Oregon Building Codes Wind Speed Map



Source: State of Oregon Natural Hazards Mitigation Plan. 2012.

The magnitude or severity of severe winter storms is determined by a number of meteorological factors including the amount and extent of snow or ice, air temperature, wind speed, and event duration.

Community Severe Weather Issues and Damage Susceptibility

The damaging effects of windstorms may extend for distances of 100 to 300 miles from the center of storm activity. Positive wind pressure is a direct and frontal assault on a structure, pushing walls, doors, and windows inward. Debris carried by extreme winds can contribute directly to injury and loss of life and indirectly through the failure of protective structures (i.e. buildings) and infrastructure. High winds can topple trees and break limbs which in turn can result in power outages and disrupt telephone, computer, and TV and radio services.

Negative pressure also affects the sides and roof: passing currents create lift and suction forces that act to pull building components and surfaces outward. The effects of winds are magnified in the upper levels of multi-story structures. As positive and negative forces impact and remove the building protective envelope (doors, windows, and walls), internal pressures rise and result in roof or leeward building component failures and considerable structural damage. The effects of winds are magnified in the upper levels of multi-story structures. Manufactured homes, multi-story retirement homes, and buildings in need of roof repair are structures that may be most vulnerable to wind storms. Buildings adjacent to open fields or adjacent to trees are also more vulnerable to wind storms than more protected structures. The effects of wind speed are shown in Table 9 (Note, wind speeds in Northeast Oregon rarely exceed 85 mph).

Windstorms can result in collapsed or damaged buildings, damaged or blocked roads and bridges, damaged traffic signals, streetlights, and parks, among others. Roads blocked by fallen trees during a windstorm may have severe consequences to people who need access to emergency services. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. Windstorms can cause flying debris which can also damage utility lines. Overhead power lines can be damaged even in relatively minor windstorm events. Industry and commerce can suffer losses from interruptions in electric service and from extended road closures. They can also sustain direct losses to buildings, personnel, and other vital equipment. There are direct consequences to the local economy resulting from windstorms related to both physical damages and interrupted services.

Severe winter weather can be a deceptive killer. Winter storms which bring snow, ice and high winds can cause significant impacts on life and property. Many severe winter storm deaths occur as a result of traffic accidents on icy roads, heart attacks which shoveling snow, and hypothermia from prolonged exposure to the cold. The temporary loss of home heating can be particularly hard on the elderly, young children and other vulnerable individuals.

Property is at risk due to flooding and landslides that may result if there is a heavy snowmelt. Additionally, ice, wind and snow can affect the stability of trees, power and telephone lines and TV and radio antennas. Down trees and limbs can become major hazards for houses, cars, utilities and other property. Such damage in turn can become major obstacles to providing critical emergency response, police, fire and other disaster recovery services.

Table 9. Effects of Wind Speed

Wind Speed (mph)	Wind Effects
25-31	Large branches will be in motion.
32-38	Whole trees in motion; inconvenience felt walking against the wind.
39-54	Twigs and small branches may break off trees; wind generally impedes progress when walking; high profile vehicles such as trucks and motor homes may be difficult to control.
55-74	Potential damage to TV antennae; may push over shallow rooted trees, especially if the soil is saturated.
75-95	Potential for minimal structural damge, particularly to unanchored mobile homes; power lines, and signs; and tree branches may be blown down.
96-110	Moderate structural damage to walls, roofs, and windows; large signs and tree branches blown down; moving vehicles pushed off roads.
111-130	Extensive structural damage to walls, roofs, and windows; trees blow down; mobile homes may be destroyed.
131-155	Extreme damage to structures and roofs; trees uprooted or snapped.
Greater than 155	Catastrophic damage; structures destroyed.

Source: Washington County, Office of Consolidated Emergency Management, Wind Effects.

In Northeast Oregon, ice storms occur on a frequent basis and cause significant damage, especially to local utilities. The older lines have wider spans between poles, and when ice accumulates on them, they are heavily weighed down. When the ice melts, the lines snap up and wrap around other overhead lines, causing a short and significant structural damage.

Severe winter weather also can cause the temporary closure of key roads and highways, air and train operations, businesses, schools, government offices and other important community services. Below freezing temperatures can also lead to breaks in un-insulated water lines serving schools, businesses, and industry and individual homes. All of these effects if lasting more than several days can create significant economic impacts for the communities affected as well for the surrounding region, and even outside of Oregon. In the rural areas of Oregon severe winter storms can isolate small communities, farms and ranches and create serious problems for open range cattle operations such as those in southeastern Oregon.

Winter storms can have significant impacts to the local economy. Early and late season extreme cold can damage agricultural crops, while snow and ice can block access for the distribution of crops and provision of agricultural services.

Existing Severe Weather Mitigation Activities

Dust Storm

Soil Water and Conservation Districts have been actively promoting, through education and incentives, direct seeding methods. Direct seeding (or no-till cropping systems) results in minimal soil disturbance and reduced potential for wind and water erosion. The Cooperative State Research, Education, and Extension Service (CRSEES) funded research on a no-till crop project found here: http://www.csrees.usda.gov/nea/nre/sri/air_sri_dust.html.

The Conservation Reserve Program (CRP) retires eligible cropland from agricultural production and plants the land with permanent grass cover to reduce erosion and therefore dust storm events.

Extreme Temperatures

FEMA has recommendations for extreme temperature mitigation activities. In order to help vulnerable population types from extreme cold events, which was of concern by the city working groups, measures should be taken to ensure that they are protected. These can include: organizing outreach to vulnerable populations by establishing and promoting accessible heating centers within the communities; requiring minimum temperatures in housing codes; encouraging utility companies to offer special arrangement for paying heating bills; and creating a database to track vulnerable populations (e.g. elderly and homeless). Baker City noted that they already engage in activities to educate property owners about freezing pipes. These activities can include locating water pipes on the inside of the building insulation or keeping them out of attics, crawl spaces and vulnerable outside walls.[58]

Windstorm

Oregon Building Codes (both residential and other code) set standards to withstand 80 mph winds. It is based on the 2003 edition of the International Residential Code and the International Building Code. FEMA has recommended having a safe room in homes or small businesses to prevent residents and workers from "dangerous forces" of extreme winds to avoid injury or death. This recommendation is provided through FEMA's resources manual: Taking Shelter from the Storm.[59]

Existing strategies and programs at the state level are usually performed by Public Utility Commission (OPUC), Building Code Division (BCD), Oregon Department of Forestry (ODF), Oregon Emergency Management (OEM), Oregon Department of Transportation (ODOT), and the Oregon Emergency Response System (OERS), who all have vital roles in providing windstorm warnings statewide.

The Public Utility Commission ensures operators manage, construct and maintain their utility lines and equipment in a safe and reliable manner. These standards are listed on the following website: http://www.puc.state.or.us/PUC/safety/index.shtml.

OPUC promotes public education and requires utilities to maintain adequate tree and vegetation clearances from high voltage utility lines and equipment.

Winter Storm

Studded tires can be used in Oregon from November 1 to April 1. They are defined under Oregon law as a type of traction tire. Research shows that studded tires are more effective than all-weather tires on icy roads, but can be less effective in most other conditions.

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[58] FEMA "Mitigation Ideas – A Resource for Reducing Risk to Natural Hazards" http://www.fema.gov/media-library-data/20130726-1904-25045-0186/fema_mitigation_ideas_final508.pdf

[59] http://www.fema.gov/safe-room-resources/fema-p-320-taking-shelter-storm-building-safe-room-yourhome-or-small-business

Street/ Road/ Highway Maintenance

Highway maintenance operations are guided by local level service (LOS) requirements. In general, classifications of highways receive more attention. Routes on the National Highway System network, primary interstate expressways and primary roads, will be cleared more quickly and completely.

The Oregon Department of Transportation is responsible for performing precautionary measures to maintain the safety and operability of roads during winter storm conditions. The road maintenance programs redesigned to provide the best use of limited resources to maximize the movement of traffic within the community during winter weather. During storm events, they focus on clearing major arterial and collector streets first, and then respond to residential connector streets, school zones, transit routes, and steep residential streets as resources become available. The cities also have mutual aid agreements with county and the maintenance section of ODOT that allow the city to swap portions of routes adjoining areas already served by other agencies. ODOT spends roughly $16 million per year on snow and ice removal from the state highway system through winter maintenance practices.

Through the educational collaboration between the Oregon Department of Forestry and the Pacific Northwest Chapter, International Society of Arboriculture (ISA) the *How to Recognize and Prevent Tree Hazards* activity brochure was create in February 2002.

Earthquake Hazard Annex

Causes and Characteristics of Earthquake

Earthquakes occur in Oregon every day; every few years an earthquake is large enough for people to feel; and every few decades there is an earthquake that causes damage. Each year, the Pacific Northwest Seismic Network locates more than 1,000 earthquakes greater than magnitude 1.0 in Washington and Oregon. Of these, approximately two dozen are large enough to feel. These noticeable events offer a subtle reminder that the Pacific Northwest is an earthquake-prone region.

Seismic hazards pose a real and serious threat to many communities in Oregon, including Northeast Oregon, requiring local governments, planners, and engineers to consider their community's safety. Currently, no reliable scientific means exists to predict earthquakes. Identifying seismic-prone locations, adopting strong policies and implementing measures, and using other mitigation techniques are essential to reducing risk from seismic hazards in Northeast Oregon.[60]

Oregon and the Pacific Northwest in general are susceptible to earthquakes from three sources: 1) shallow crustal fault – slippage events within the North American Plate; 2) deep intra-plate events within the subducting Juan de Fuca Plate; and 3) the off-shore Cascadian Subduction Zone.[61]

Northeast Oregon contains high mountains and broad inter-mountain valleys. Although there is abundant evidence of crustal faulting, seismic activity is low when compared with other areas of the state. There are a few identified faults in the region that have been active in the last 20,000 years. The region has been shaken historically by crustal earthquakes and prehistorically by subduction zone earthquakes centered outside the area. All considered, there is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region.

Baker County has the most recorded seismic activity in the region. Earthquake activity occurs in the vicinity of Hells Canyon, an area with a complex geologic history. Several significant earthquakes have occurred in the region; the 1913 Hells Canyon, the 1927 and 1942 Pine Valley - Cuddy Mountain, the 1965 John Day (M4.4), and the 1965 and 1966 Halfway (M4.3 and 4.2).[62]

Types of Earthquakes

Crustal Fault Earthquakes

These are the most common earthquakes and occur at relatively shallow depths of 6-12 miles below the surface.[63] When crustal faults slip, they can produce earthquakes of magnitudes up to 7.0. Although most crustal fault earthquakes are smaller than 4.0 and generally create little or no

[60] Interagency Hazard Mitigation Team. 2012. Oregon Natural Hazards Mitigation Plan. Salem, OR: Oregon Military Department – Office of Emergency Management

[61] Planning for Natural Hazards: Oregon Technical Resource Guide, Community Planning Workshop, (July 2000), p. 8-8.

[62] University of Washington. List of Magnitude 4.0 or Larger Earthquakes in Washington and Oregon 1872-2002; and Wong and Bott, November 1995. A look Back at Oregon's Earthquake History, 1841-1994, *Oregon Geology.*

[63] Madin, Ian P. and Zhenming Wang, Relative Earthquake Hazard Maps Report, DOGAMI, 1999.

damage, some of them can cause extensive damage. Earthquakes related to volcanic activity can also affect the region.

Deep Intraplate Earthquakes

Occurring at depths from 18 to 60 miles below the earth's surface in the subducting oceanic crust, deep intraplate earthquakes can reach magnitude 7.5.[64] This type of earthquake is more common in the Puget Sound; in Oregon these earthquakes occur at lower rates and none have occurred at a damaging magnitude.[65] The February 28, 2001 earthquake in Washington State was a deep intraplate earthquake. It produced a rolling motion that was felt from Vancouver, British Columbia to Coos Bay, Oregon and east to Salt Lake City, Utah.[66]

Subduction Zone Earthquakes

The Pacific Northwest is located at a convergent continental plate boundary, where the Juan de Fuca and North American tectonic plates meet. The two plates are converging at a rate of about 1.5 inches per year.[67] This boundary is called the Cascadia Subduction Zone (CSZ, see Figure EQ-1). It extends from British Columbia to northern California. Earthquakes are caused by the abrupt release of this slowly accumulated stress.

Although there have been no large recorded earthquakes along the offshore Cascadia Subduction Zone, similar subduction zones worldwide do produce "great" earthquakes with magnitudes of 8 or larger. They occur because the oceanic crust "sticks" as it is being pushed beneath the continent, rather than sliding smoothly. Over hundreds of years, large stresses build which are released suddenly in great earthquakes. Such earthquakes typically have a minute or more of strong ground shaking, and are quickly followed by numerous large aftershocks.

Subduction zones similar to the Cascadia Subduction Zone have produced earthquakes with magnitudes of 8.0 or larger. Historic subduction zone earthquakes include the 1960 Chile earthquake (magnitude 9.5), the 1964 southern Alaska earthquakes (magnitude 9.2), the 2004 Indian Ocean earthquake (magnitude 9.0) and the 2011 Tohoku earthquake (magnitude 9.0).

Geologic evidence shows that the Cascadia Subduction Zone has also generated great earthquakes, and that the most recent one was about 300 years ago. Large earthquakes also occur at the southern end of the Cascadia Subduction Zone (in northern California near the Oregon border) where it meets the San Andreas Fault system.

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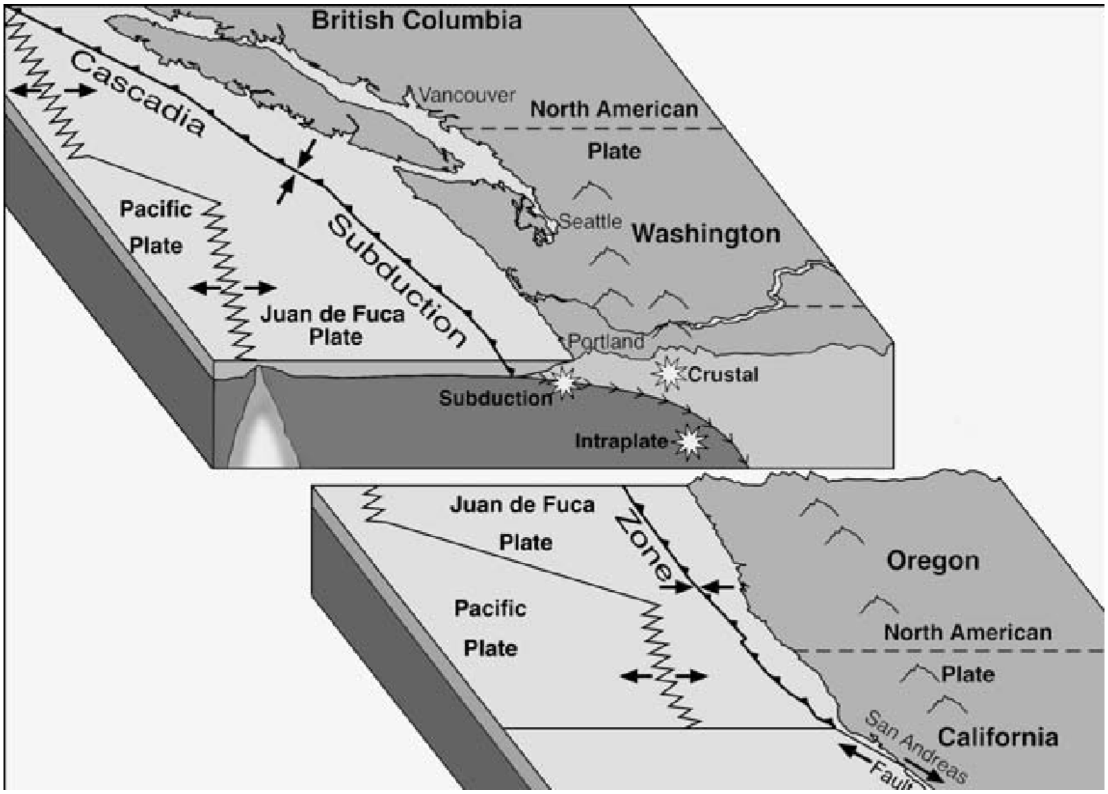
[64] Planning for Natural Hazards: Oregon Technical Resource Guide, Community Planning Workshop, (July 2000), p. 8-8.

[65] Interagency Hazard Mitigation Team. 2012. Oregon Natural Hazards Mitigation Plan. Salem, OR: Oregon Military Department – Office of Emergency Management

[66] Hill, Richard. "Geo Watch Warning Quake Shook Portland 40 Years Ago." The Oregonian. October 30, 2002.

[67] Interagency Hazard Mitigation Team. 2012. Oregon Natural Hazards Mitigation Plan. Salem, OR: Oregon Military Department – Office of Emergency Management

Figure 14. Cascadia Subduction Zone



Source: Shoreland Solutions. Chronic Coastal Natural Hazards Model Overlay Zone. Salem, OR: Oregon Department of Land Conservation and Development (1998) Technical Guide-3.

While all three types of earthquakes have the potential to cause major damage, subduction zone earthquakes pose the greatest danger. A major CSZ event could generate an earthquake with a magnitude of 9.0 or greater resulting in devastating damage and loss of life. Such earthquakes may cause great damage to the coastal area of Oregon as well as inland areas in western Oregon. Northeast Oregon is unlikely to be directly affected by a subduction zone earthquake; however, the county could be affected as populations of refugees flee eastward, and as streams of commerce are interrupted. It is estimated that shaking from a large subduction zone earthquake could last up to five minutes.[68]

[68]*Planning for Natural Hazards: Oregon Technical Resource Guide, Community Planning Workshop, (July 2000), p. 8-9.*

Characteristics of Earthquakes

Ground Shaking

> *"Due to the amount of faulting in the area, [the 1999 Klamath Falls earthquake] is just business as usual for such a geologically active region. Historic evidence, combined with geologic evidence for large numbers of earthquakes in the prehistoric past, suggest that one or more earthquakes capable of damage (magnitude 4 – 6) hit south-central Oregon every few decades, so it pays to be prepared."*
>
> James Roddey, DOGAMI

Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. Ground shaking is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault that is slipping, and distance from the epicenter (where the earthquake originates). Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

Ground Shaking Amplification

Ground shaking amplification refers to the soils and soft sedimentary rocks near the surface that can modify ground shaking from an earthquake. Such factors can increase or decrease the amplification (i.e., strength) as well as the frequency of the shaking. The thickness of the geologic materials and their physical properties determine how much amplification will occur. Ground motion amplification increases the risk for buildings and structures built on soft and unconsolidated soils.

Surface Faulting

Surface faulting are planes or surfaces in Earth materials along which failure occurs. Such faults can be found deep within the earth or on the surface. Earthquakes occurring from deep lying faults usually create only ground shaking.

Liquefaction and Subsidence

Liquefaction occurs when ground shaking causes wet, granular soils to change from a solid state into a liquid state. This results in the loss of soil strength and the soil's ability to support weight. When the ground can no longer support buildings and structures (subsidence), buildings and their occupants are at risk.

The severity of an earthquake is dependent upon a number of factors including: 1) the distance from the earthquake's source (or epicenter); 2) the ability of the soil and rock to conduct the earthquake's seismic energy; 3) the degree (i.e., angle) of slope materials; 4) the composition of slope materials; 5) the magnitude of the earthquake; and 6) the type of earthquake.

Earthquake-Induced Landslides and Rockfalls

Earthquake-induced landslides are secondary hazards that occur from ground shaking and can destroy roads, buildings, utilities and critical facilities necessary to recovery efforts after an earthquake. These areas often have a higher risk of landslides and rockfalls triggered by earthquakes.

The severity of an earthquake is dependent upon a number of factors including: 1) the distance from the earthquake's source (or epicenter); 2) the ability of the soil and rock to conduct the earthquake's seismic energy; 3) the degree (i.e., angle) of slope materials; 4) the composition of slope materials; 5) the magnitude of the earthquake; and 6) the type of earthquake.

History of Earthquakes in Northeast Oregon

All of Oregon west of the Cascades is at risk from the three earthquake types and associated hazards. East of the Cascades the earthquake hazard is predominately of the crustal type. The amount of earthquake damage at any place will depend on its distance from the epicenter, local soil conditions, and types of construction. Due to Oregon's relatively short written history and the infrequent occurrence of severe earthquakes, few Oregon earthquakes have been recorded in writing. Moreover, in the past century, there have been no reported damage or injuries in the Northeast Region due to earthquakes. However, several significant earthquake events have occurred in southeastern Washington in the past 150 years. Details concerning these events are highlighted below.

Image of damage from the 2001 Nisqually earthquake near Seattle

The Pacific Northwest has experienced major earthquakes in 1949 (magnitude 7.1), 1962 (magnitude 5.2), and 2001 (magnitude 6.8). Table 10 shows the location of selected Pacific Northwest earthquakes.

The Northeast Oregon region has been historically shaken by crustal and intraplate earthquakes centered on the area. Historically there have been few earthquakes in Northeast Oregon, and even fewer earthquakes that have caused structural damage to buildings. In the last 42 years, the region around Northeast Oregon has been affected by several earthquakes of estimated magnitudes of three and greater. Table 11 shows the location of selected Northeast Oregon region earthquakes since 1900. This data relies on the Pacific Northwest Seismic Networks database. Among the three earthquakes whose magnitudes exceeded four, none of them had epicenters in any of the Northeast Oregon counties. For more regional earthquakes of magnitude 3.0 or less see table 12.

Table 10. Earthquake History in Pacific Northwest

Date	Location	Magnitude	Comments
Approximate years: 1400 BCE, 1050, BCE 600 BCE 400, 750, 900	Offshore, Cascadia subduction zone	Probably 8.0-9.0	Researchers Brian Atwater and Eileen Hemphill-Haley have dated earthquakes and tsunamis at Willapa Bay, Washington; these are the midpoints of the age ranges for these six events.
January 26, 1700	Offshore, Cascadia Subduction zone	Approximately 9.0	Generated a tsunami that struck Oregon, Washington and Japan; destroyed Native American villages along the coast.
November 23, 1873	Oregon/California border, near Brookings	6.8	Felt as far away as Portland and San Francisco; may have been an intraplate event because of lack of aftershocks.
March, 1893	Umatilla	VI-VII (Modified Mercalli Intensity)	Damage unknown
July 15, 1936	Milton-Freewater	6.4	Two foreshocks and many aftershocks felt; $100,000 damage (in 1936 dollars).
April 13, 1949	Olympia, Washington	7.1	Eight deaths and $25 million damage (in 1949 dollars); cracked plaster, other minor damage in northwest Oregon.
January, 1951	Hermiston	V (Modified Mercalli Intensity)	Damage unknown
November 5, 1962	Portland/Vancouver	5.5	Shaking lasted up to 30 seconds; chimneys cracked, windows broke, furniture moved.
1968	Adel	5.1	Swarm lasted May through July, decreasing in intensity; increased flow at a hot spring was reported.
April 12, 1976	Near Maupin	4.8	Sounds described as distant thunder, sonic booms, and strong wind.
April 25, 1992	Cape Mendocino, California	7.0	Subduction earthquake at the triple-junction of the Cascadia subduction zone and the San Andreas and Mendocino faults.
March 25, 1993	Scotts Mill	5.6	On Mount Angel-Gates Creek fault; $30 million damage, including Molalla High School and Mount Angel church.
September 20, 1993	Klamath Falls	5.9 and 6.0	Two deaths, $10 million damage, including county courthouse; rockfalls induced by ground motion.

Source: Ivan Wong and Jacqueline D.J. Bolt, November 1995, A Look Back at Oregon's Earthquake History, 1841-1994, Oregon Geology, pp. 125-139 and Niewendorp, C.A., Neuhaus, M.E., 2003. Map of Selected Earthquakes for Oregon, 1841 through 2002. Oregon Department of Geology and Mineral Industries Open File Report 03-02

Table 11. Earthquakes Greater than 4.0 in Northeastern Oregon (1900 to 2013)

Date	Location	Magnitude	Comments
October, 1913	Hells Canyon	6.0	
April, 1927	Pine Valley-Cuddy Mountain	5.0	
June, 1942	Pine Valley-Cuddy Mountain	5.0	Minor Damage
August 1, 1965	John Day	4.4	
November, 1965	Halfway	4.3	
December, 1966	Halfway	4.2	

Source: University of Washington. List of Magnitude 4.0 or Larger Earthquakes in Washington and Oregon 1872-2002; and Wong and Bott, November 1995. A look Back at Oregon's Earthquake History, 1841-1994, *Oregon Geology.*

Table 12. Earthquakes Greater than 3.0 in Northeastern Oregon (1991-2013)

Magnitude	Date	Location
3.3	9/20/91	11.3 mi ESE from Christmas Valley, OR
3.1	10/16/93	27.3 mi ESE from John Day, OR
3.1	4/1/98	10.8 mi SSW from Prineville, OR
3.0	4/27/99	14.6 mi ESE from Christmas Valley, OR
3.0	4/28/99	15.4 mi ESE from Christmas Valley, OR
3.8	4/28/99	15.8 mi ESE from Christmas Valley, OR
3.1	2/28/03	2.2 mi NNW from Millican, OR
3.0	6/24/04	11.0 mi SSE from Lakeview, OR
3.2	6/26/04	9.7 mi SSE from Lakeview, OR
3.0	6/27/04	9.5 mi SE from Lakeview, OR
3.2	6/27/04	9.8 mi SSE from Lakeview, OR
3.9	6/27/04	8.7 mi SE from Lakeview, OR
4.4	6/30/04	9.6 mi SE from Lakeview, OR
3.2	7/4/04	10.4 mi SSE from Lakeview, OR
3.3	7/13/04	9.2 mi SSE from Lakeview, OR
4.3	7/22/04	8.9 mi SE from Lakeview, OR
3.1	7/22/04	9.6 mi SE from Lakeview, OR
3.0	9/1/04	10.2 mi SE from Lakeview, OR
3.5	10/7/04	10.1 mi SSE from Lakeview, OR
3.1	10/29/04	9.3 mi SSE from Lakeview, OR
3.5	11/16/04	9.7 mi SSE from Lakeview, OR
3.4	8/12/05	24.6 mi S from Adel, OR
3.1	4/19/07	45.6 mi ENE from Christmas Valley, OR
3.1	5/30/07	7.4 mi SE from Lakeview, OR

Source: Pacific Northwest Seismic Network "Earthquake Map" http://www.pnsn.org/earthquakes/recent*taken from latitude coordinates: 43.921-46.031; longitude coordinates: -119.649—116.486*

How are Earthquake Hazards Identified?

The Oregon Department of Geology and Mineral Industries (DOGAMI), in partnership with other state and federal agencies, has undertaken a rigorous program in Oregon to identify seismic hazards, including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction, and earthquake induced landslides.

The extent of the damage to structures and injury and death to people will depend upon the type of earthquake, proximity to the epicenter and the magnitude and duration of the event. In Northeast Oregon the predominant risks for the region, in terms of concentration of population and assets are the City of La Grande and Baker City, which lie near the Grande Ronde Valley Fault Zone and Baker Valley Faults respectively.

Community Earthquake Issues and Damage Susceptibility

Earthquake damage occurs because humans have built structures that cannot withstand severe shaking. Buildings, airports, schools, and lifelines (highways, phone lines, gas, water, etc.) suffer damage in earthquakes and can ultimately result in death or injury to humans.

Death and Injury

Death and injury can occur both inside and outside of buildings due to falling equipment, furniture, debris, and structural materials. Likewise, downed power lines or broken water and gas lines endanger human life. Death and injury are highest in the afternoon when damage occurs to commercial and residential buildings and during the evening hours in residential settings.[69]

Building and Home Damage

Wood structures tend to withstand earthquakes better than structures made of brick or unreinforced masonry buildings.[70] Building construction and design play a vital role in the survival of a structure during earthquakes. Damage can be quite severe if structures are not designed with seismic reinforcements or if structures are located atop soils that liquefy or amplify shaking. Whole buildings can collapse or be displaced.

Bridge Damage

All bridges can sustain damage during earthquakes, leaving them unsafe for use. More rarely, some bridges have failed completely due to strong ground motion. Bridges are a vital transportation link – damage to them can make some areas inaccessible.

Because bridges vary in size, materials, siting, and design, earthquakes will affect each bridge differently. Bridges built before the mid 1970's often do not have proper seismic reinforcements. These bridges have a significantly higher risk of suffering structural damage during a moderate to

[69] Planning for Natural Hazards: Oregon Technical Resource Guide, Community Planning Workshop, and (July 2000).

[70] Wolfe, Myer, et al. Land Use Planning for Earthquake Hazard Mitigation: A Handbook for Planners, Special Publication 14, Natural Hazards Research and Applications Information Center.

large earthquake. Bridges built in the 1980's and after are more likely to have the structural components necessary to withstand a large earthquake.[71]

Damage to Lifelines

Lifelines are the connections between communities and critical services. They include water and gas lines, transportation systems, electricity, and communication networks. Ground shaking and amplification can cause pipes to break open, power lines to fall, roads and railways to crack or move, and radio or telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. All lifelines need to be usable after an earthquake to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public.

> **2001 Nisqually Earthquake**
>
> A 6.8 magnitude earthquake centered southwest of Seattle struck on February 28, 2001, followed by a mild aftershock the next morning, and caused more than $1 billion worth of damage. Despite this significant loss, the region escaped with relatively little damage for two reasons: the depth of the quake center and preparations by its residents. Washington initiated a retrofitting program in 1990 to strengthen bridges, while regional building codes mandated new structures withstand certain amounts of movement. Likewise, historic buildings have been voluntarily retrofitted with earthquake-protection reinforcements.
>
> Source: "Luck and planning reduced Seattle quake damage", CNN Report, March 1, 2001

Disruption of Critical Facilities

Critical facilities are police stations, fire stations, hospitals, and shelters. These are facilities that provide services to the community and need to be functional after an earthquake event. The earthquake effects outlined above can all cause emergency response to be disrupted after a significant event.[72]

Economic Loss: Equipment and Inventory Damage, Lost Income

Seismic activity can cause great loss to businesses, either a large-scale corporation or a small retail shop. Losses not only result in rebuilding cost, but fragile inventory and equipment can be destroyed. When a company is forced to stop production for just a day, business loss can be tremendous. Residents, businesses, and industry all suffer temporary loss of income when their source of finances are damaged or disrupted.

Fire

Downed power lines or broken gas mains can trigger fires. When fire stations suffer building or lifeline damage, quick response to quench fires is less likely.

Debris

After damage occurs to a variety of structures, much time is spent cleaning up brick, glass, wood, steel or concrete building elements, office and home contents, and other materials.

[71] University of Washington website: www.geophys.washington.edu/SEIS/PNSN/INFO_GENERAL/faq.html#3.
[72] *Earthquake Damage in Oregon: Preliminary Estimates of Future Earthquake Losses.*

Existing Hazard Mitigation Activities

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of an earthquake.[73]

Individual Preparedness

At an individual level, preparedness for an earthquake is minimal as perception and awareness of earthquake hazards are low.[74] Strapping down heavy furniture, water heaters and expensive personal property as well as having earthquake insurance, is a step towards earthquake mitigation.

Earthquake Awareness Month

April is Earthquake Awareness Month. Oregon Military Department – Office of Emergency Management coordinates activities such as earthquake drills and encourages individuals to strap down computers, heavy furniture and bookshelves in homes and offices.

School Education

Schools conduct earthquake drills regularly throughout Oregon and teach students how to respond when an earthquake event occurs.

Building Codes

The Oregon State Building Codes Division adopts statewide standards for building construction that are administered by the state, cities and counties throughout Oregon. The codes apply to new construction and to the alteration of, or addition to, existing structures. Within these standards are six levels of design and engineering specifications that are applied to areas according to the expected degree of ground motion and site conditions that a given area could experience during an earthquake. The Structural Code requires a site-specific seismic hazard report for projects including critical facilities such as hospitals, fire and police stations, emergency response facilities, and special occupancy structures, such as large schools and prisons.

The seismic hazard report required by the Structural Code for essential facilities and special occupancy structures considers factors such as the seismic zone, soil characteristics including amplification and liquefaction potential, any known faults, and potential landslides. The findings of the seismic hazard report must be considered in the design of the building. The Dwelling Code incorporates prescriptive requirements for foundation reinforcement and framing connections based on the applicable seismic zone for the area. The cost of these requirements is rarely more than a small percentage of the overall cost for a new building.

Requirements for existing buildings vary depending on the type and size of the alteration and whether there is a change in the use of the building that is considered more hazardous. Oregon State Building Codes recognize the difficulty of meeting new construction standards in existing buildings and allow some exception to the general seismic standards. Upgrading existing buildings to resist earthquake forces is more expensive than meeting code requirements for new construction. The state code only requires seismic upgrades when there is significant structural alteration to the

[73] Planning for Natural Hazards: Oregon Technical Resource Guide, Community Planning Workshop, (July 2000), p. 8-20.

[74] Darienzo, Mark, Oregon Military Department – Office of Emergency Management, Personal Interview, (February 22, 2001).

building or where there is a change in use that puts building occupants and the community at greater risk.

Local building officials are responsible for enforcing these codes. Although there is no statewide building code for substandard structures, local communities have the option of adopting a local building code to mitigate hazards in existing buildings. Oregon Revised Statutes allow municipalities to create local programs to require seismic retrofitting of existing buildings within their communities. The building codes do not regulate public utilities or facilities constructed in public right-of-way, such as bridges.

Volcanic Event Hazard Annex

Volcanoes are present in Washington, Oregon, and California where volcanic activity is generated by continental plates moving against each other (Cascadia Subduction Zone movement). Because the population of the Pacific Northwest is rapidly expanding, volcanoes of the Cascades Range are now considered some of the most dangerous in the United States.[75]

Volcanoes, however, provide benefits to humans living on or near them. They produce fertile soil, and provide valuable minerals, geothermal resources, and scenic beauty. Volcanic products are used as building or road-building materials, as abrasive and cleaning agents, and as raw materials for many chemical and industrial uses. Volcanic ash makes soil rich in mineral nutrients thus encouraging human settlement.[76]

Causes and Characteristics of Volcanic Eruption

Northeast Oregon and the Pacific Northwest, lie within the "ring of fire," an area of very active volcanic activity surrounding the Pacific Basin. Volcanic eruptions occur regularly along the ring of fire, in part because of the movement of the Earth's tectonic plates. The Earth's outermost shell, the lithosphere, is broken into a series of slabs known as tectonic plates. These plates are rigid, but they float on a hotter, softer layer in the Earth's mantle. As the plates move about on the layer beneath them, they spread apart, collide, or slide past each other. Volcanoes occur most frequently at the boundaries of these plates and volcanic eruptions occur when the hotter, molten materials, or magma, rise to the surface.

The primary threat to lives and property from active volcanoes is from violent eruptions that unleash tremendous blast forces, generate mud and debris flows, and produce flying debris and ash clouds. The immediate danger area in a volcanic eruption generally lies within a 20-mile radius of the blast site. The following section outlines the specific hazards posed by volcanoes.

Volcanoes are commonly conical hills or mountains built around a vent that connect with reservoirs of molten rock below the surface of the earth.[77] Some younger volcanoes may connect directly with reservoirs of molten rock, while most volcanoes connect to empty chambers. Unlike most mountains, which are pushed up from below, volcanoes are built up by an accumulation of their own eruptive products: lava or ash flows and airborne ash and dust. When pressure from gases or molten rock becomes strong enough to cause an upsurge, eruptions occur. Gases and rocks are pushed through the opening and spill over, or fill the air with lava fragments. Figure VE-1 diagrams the basic features of a volcano.

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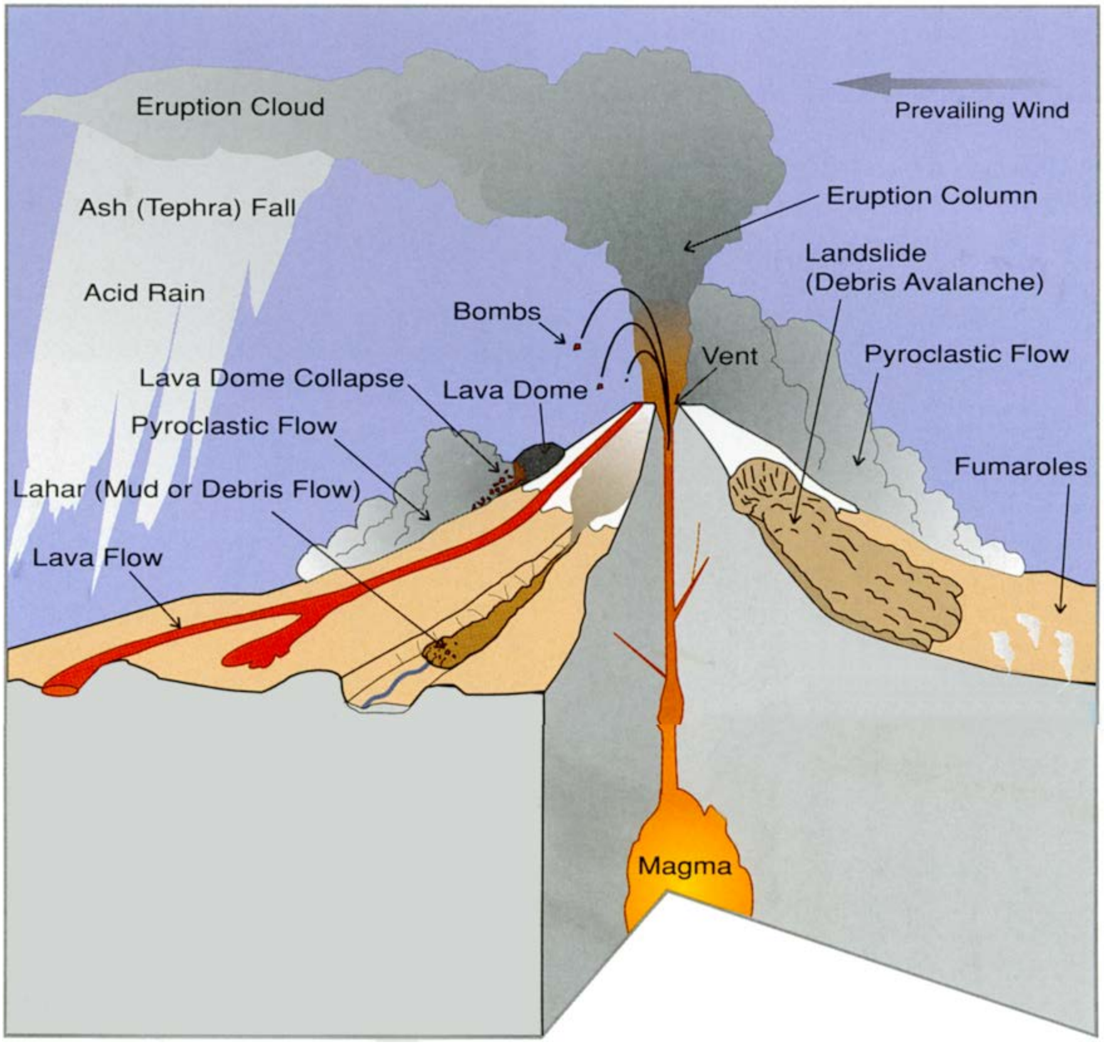
[75]Dzurisin, Dan, Peter H. Stauffer, and James W. Hendley II, Living With Volcanic Risk in the Cascades, USGS Fact Sheet 165-97, (2000).
[76] FEMA Library: Volcanoes at http://www.fema.gov/library/volcano.htm.
[77] Tilling, Robert I., Volcanoes, USGS General Interest Publication, (1985).

Figure 15. Volcanic Hazard from a Composite Type Volcano



Source: Walder et al, "Volcano Hazards in the Mount Jefferson Region," 1999; W.E. Scott, R.M. Iverson, S.P. Schilling, and B.J. Fischer, Volcano Hazards in the Three Sisters Region, Oregon: U.S. Geological Survey Open-File Report 99-437, 14p,200.

Ash / Tephra

Tephra consists of volcanic ash (sand-sized or finer particles of volcanic rock) and larger fragments. During explosive eruptions, tephra together with a mixture of hot volcanic gas are ejected rapidly into the air from volcanic vents. Larger fragments fall down near the volcanic vent while finer particles drift downwind as a large cloud. When ash particles fall to the ground, they can form a blanket-like deposit, with finer grains carried further away from the volcano. In general, the thickness of ash fall deposits decreases in the downwind direction. Tephra hazards include impact of falling fragments, suspension of abrasive fineparticles in the air and water, and burial of structures, transportation routes and vegetation.

During an eruption that emits ash, the ash fall deposition is controlled by the prevailing wind direction.[78] The predominant wind pattern over the Cascades is from the west, and previous eruptions seen in the geologic record have resulted in most ash fall drifting to the east of the volcanoes.[79]

Earthquakes

Volcanic eruptions can be triggered by seismic activity or earthquakes can occur during or after a volcanic eruption. Earthquakes produced by stress changes are called volcano-tectonic earthquakes. These earthquakes, typically small to moderate in magnitude, occur as rock is moving to fill in spaces where magma is no longer present and can cause land to subside or produce large ground cracks.[80] In addition to being generated after an eruption and magma withdrawal, these earthquakes also occur as magma is intruding upward into a volcano, opening cracks and pressurizing systems.[81] Volcano-tectonic earthquakes do not indicate that the volcano will be erupting but can occur at anytime and cause damage to manmade structures or provoke volcanic events.

Lava flows

Lava flows are streams of molten rock that erupt relatively non-explosively from a volcano and move down slope, causing extensive damage or total destruction by burning, crushing, or burying everything in their paths. Secondary effects can include forest fires, flooding, and permanent reconfiguration of stream channels.[82]

Pyroclastic flows and surges

Pyroclastic flows are avalanches of rock and gas at temperatures of 600 to 1500 degrees Fahrenheit. They typically sweep down the flanks of volcanoes at speeds of up to 150 miles per hour. Pyroclastic surges are a more dilute mixture of gas and rock. They can move even more rapidly than a pyroclastic flow and are more mobile. Both generally follow valleys, but surges sometimes have enough momentum to overtop hills or ridges in their paths. Because of their high speed, pyroclastic flows and surges are difficult or impossible to escape. If, it is expected that they will occur, evacuation orders should be issued as soon as possible for the hazardous areas. Objects and structures in the path of a pyroclastic flow are generally destroyed or swept away by the impact of debris or by accompanying hurricane-force winds. Wood and other combustible materials are commonly burned. People and animals may also be burned or killed by inhaling hot ash and gases. The deposit that results from pyroclastic flows is a combination of rock bombs and ash and is termed *ignimbrite.* These deposits may accumulate to hundreds of feet thick and can harden to resistant rock.[83]

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[78]Oregon State Natural Hazard Mitigation Plan. 2012." Volcanic Hazards Chapter,"
[79] Ibid.
[80]Riley, Colleen M., A Basic Guide to Volcanic Hazards, Michigan Technological University: http://www.geo.mtu.edu/volcanoes/hazards/primer.
[81]Scott, W. E., USGS Cascades Volcano Observatory, Personal Correspondence, (July 5, 2001).
[82]Oregon State Natural Hazard Mitigation Plan. 2012." Volcanic Hazards Chapter,"
[83] Ibid.

Lahars and debris flows

Lahar is an Indonesian term that describes a hot or cold mixture of water and rock fragments flowing down the slopes of a volcano or river valley.[84] Lahars typically begin when floods related to volcanism are produced by melting snow and ice during eruptions of ice-clad volcanoes like Mount Shasta, and by heavy rains that may accompany eruptions. Floods can also be generated by eruption-caused waves that could overtop dams or move down outlet streams from lakes.

Lahars react much like flash flood events in that a rapidly moving mass moves downstream, picking up more sediment and debris as it scours out a channel. This initial flow can also incorporate water from rivers, melting snow and ice. By eroding rock debris and incorporating additional water, lahars can easily grow to more than ten times their initial size. But as a lahar moves farther away from a volcano, it will eventually begin to lose its heavy load of sediment and decrease in size.[85]

Lahars often cause serious economic and environmental damage. The direct impact of a lahar's turbulent flow front or from the boulders and logs carried by the lahar can easily crush, abrade, or shear off at ground level just about anything in the path of a lahar. Even if not crushed or carried away by the force of a lahar, buildings and valuable land may become partially or completely buried by one or more cement-like layers of rock debris. By destroying bridges and key roads, lahars can also trap people in areas vulnerable to other hazardous volcanic activity, especially if the lahars leave deposits that are too deep, too soft, or too hot to cross.[86]

Volcanic Landslides (debris avalanches)

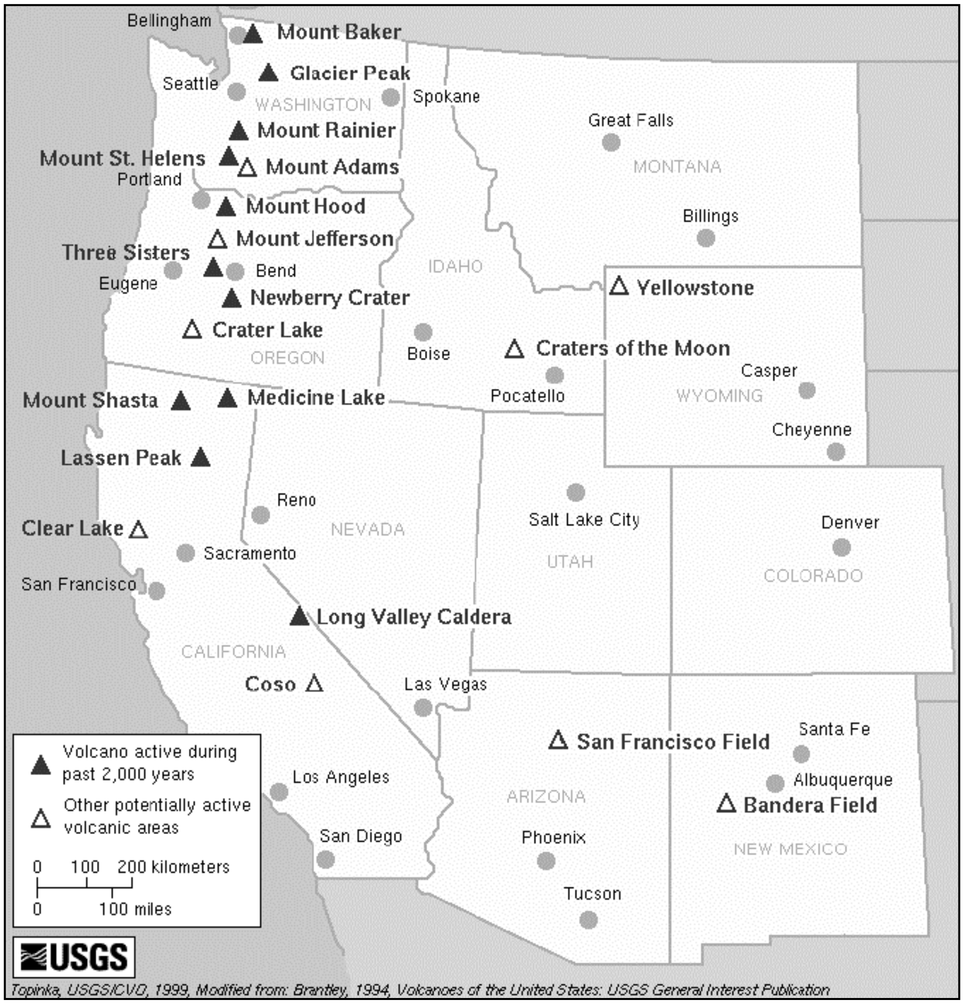
Landslides – or debris avalanches – are a rapid downhill movement of rocky material, snow, and (or) ice. Volcanic landslides range in size from small movements of loose debris on the surface of a volcano to massive collapses of the entire summit or sides of a volcano. Steep volcanoes are susceptible to landslides because they are built up partly of layers of loose volcanic rock fragments. Landslides on volcano slopes are triggered not only by eruptions, but also by heavy rainfall or large earthquakes that can cause materials to break free and move downhill.[87]

History of Volcanic Events in Northeast Oregon

Although there have been no recent volcanic events in the Northeast Oregon region, it is important to note the area is active and susceptible to eruptive events since the region is near the volcanic Cascades Range. Figure VE-2 displays volcanoes of the western United States.

[84]USGS website: http://volcanoes.usgs.gov/Hazards/What/Lahars/lahars.html
[85]Ibid.
[86]Ibid.
[87]Wright and Pierson, Living With Volcanoes, USGS Volcano Hazards Program Circular 1973, (1992).

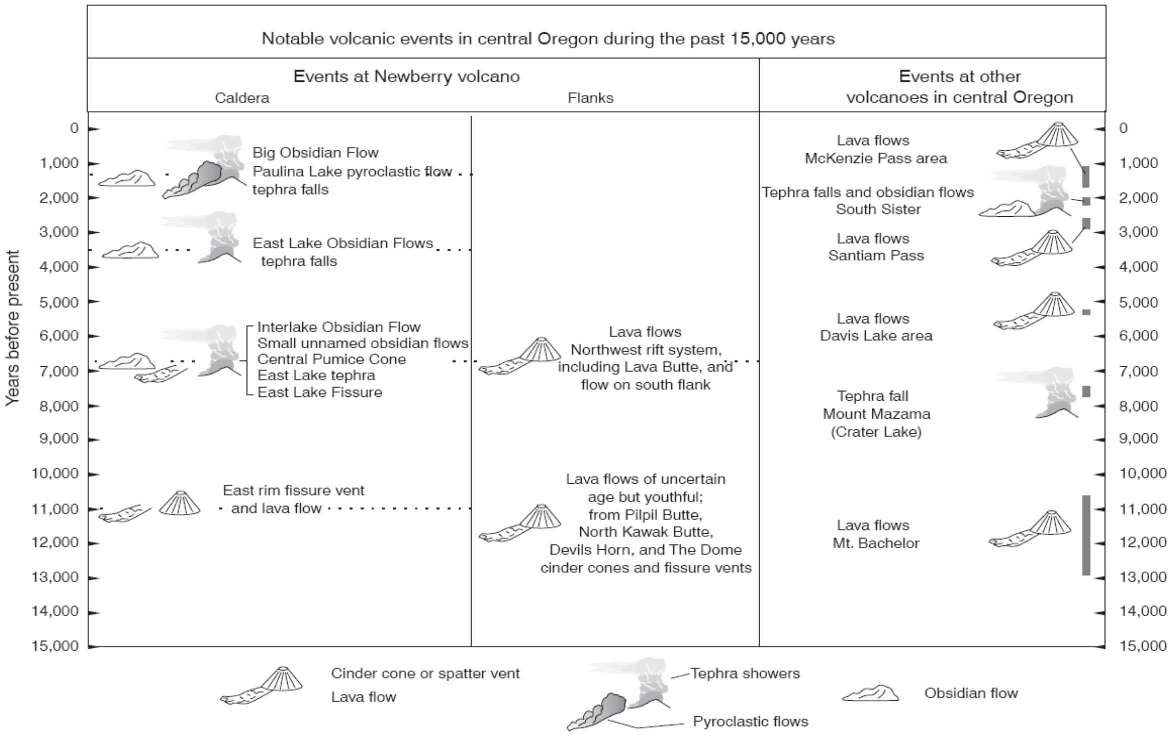
Figure 16. Potentially Active Volcanoes of the Western United States



Source: USGS. http://www.volcano.si.edu/reports/usgs/maps.cfm#usa

Volcanoes in the Cascade Range have been erupting for hundreds of thousands of years. Newberry Volcano, for example, has had many events in the last 15,000 years as shown in the table below. The Three Sisters region has also had some activity during this time while the last major eruptive activity at Mt. Mazama occurred approximately 7,700 years ago, forming Crater Lake in its wake. Some of the most recent events include Big Obsidian Flow at Newberry Volcano. All of the Cascade volcanoes are characterized by long periods of quiescence and intermittent activity. And these characteristics make predictions, recurrence intervals, or probability very difficult to ascertain.

Figure 17. Notable Volcanic Events in Central Oregon during the Past 15,000 Years



Source: D.R. Sherrod, L.G. Mastin, W.E. Scott, and S.P. Schilling, 1997, Volcano Hazards at Newberry Volcano, Oregon: U.S. Geological Survey Open-File Report 97-513

Mount St. Helen's Case Study

On May 18, 1980, following two months of earthquakes and minor eruptions and a century of dormancy, Mount St. Helens in Washington, exploded in one of the most devastating volcanic eruptions of the 20th century. Although less than 0.1 cubic mile of magma was erupted, 58 people died, and damage exceeded 1.2 billion dollars. Fortunately, most people in the area were able to evacuate safely before the eruption because the U.S. Geological Survey (USGS) and other scientists had alerted public officials to the danger. As early as 1975, USGS researchers had warned that Mount St. Helens might soon erupt. Coming more than 60 years after the last major eruption in the Cascades (Lassen Peak), the explosion of St. Helens was a spectacular reminder that the millions of residents of the Pacific Northwest share the region with live volcanoes.[88]

How are Volcanic Hazards Identified?

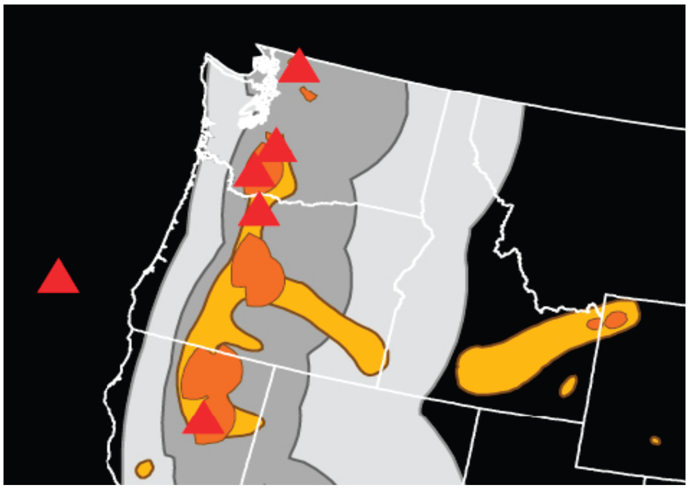
Communities that are closer to volcanoes may be at risk to the proximal hazards, as well as the distal hazards, such as lahars, lava flows, and ash fall. The communities that are farther away, such as Baker City and La Grande, are only at risk from the distal hazards, (mainly ash fall). The image below shows the locations of some of the Cascade volcanoes (red triangles) with relative volcanic hazard zones. In the figure below dark orange areas have a higher volcanic hazard; light-orange

[88] Dzurisin, Dan, Peter H. Stauffer, and James W. Hendley II, Living With Volcanic Risk in the Cascades, USGS Fact Sheet 165-97, (2000).

areas have a lower volcanic hazard. Dark-grey areas have a higher ash fall hazard; light-grey areas have a lower ash fall hazard.

Geologic hazard maps have been created for most of the volcanoes in the Cascade Range by the USGS Volcano Program at the Cascade Volcano Observatory in Vancouver, WA and are available at http://vulcan.wr.usgs.gov/Publications/hazards_reports.html.

Figure 18. National Volcanic Hazard Map

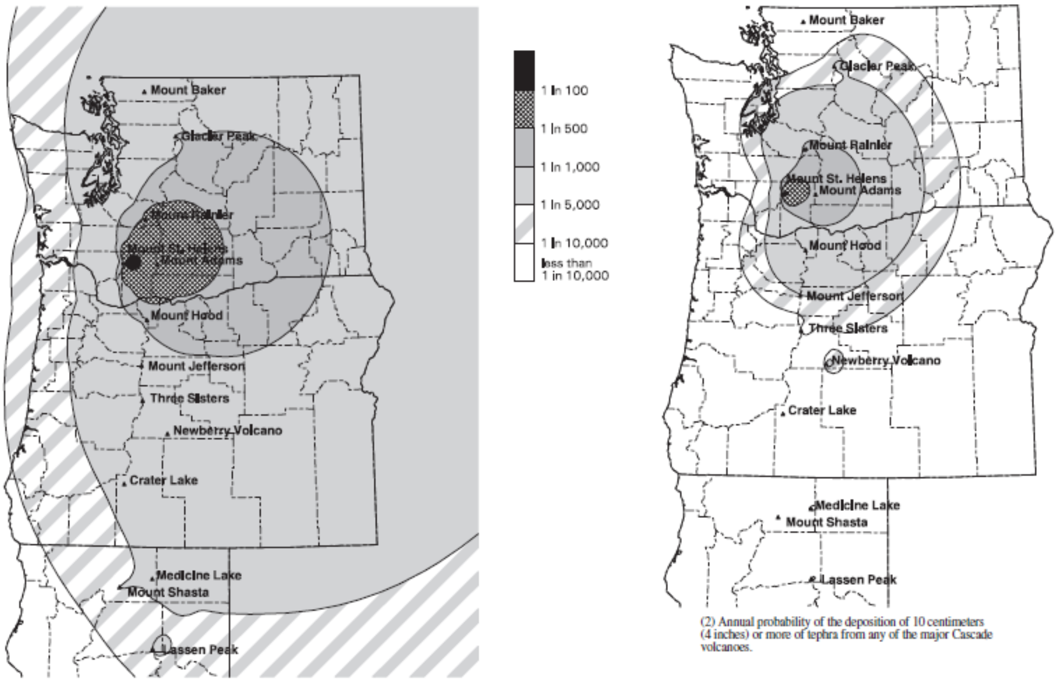


Note: The red triangles are volcano locations. Dark-orange areas have a higher volcanic hazard; light-orange areas have a lower volcanic hazard. Dark-gray areas have a higher ash fall hazard; light-gray areas have a lower ash fall hazard. Information is based on data during the past 10,000 years.

Source: Image modified from USGS Fact Sheet 2006-3014

Scientists also use wind direction to predict areas that might be affected by volcanic ash; during an eruption that emits ash, the ash fall deposition is controlled by the prevailing wind direction. The predominant wind pattern over the Cascades originates from the west, and previous eruptions seen in the geologic record have resulted in most ash fall drifting to the east of the volcanoes. Figure VE-5 depicts the potential and geographical extent of volcanic ash fall in excess of ten centimeters from a large eruption within the Cascade Range (Mt. St. Helens). The image on the left shows the annual probability of the deposition of one-centimeter or more of tephra; the figure on the right shows the annual probability of the deposition of ten-centimeters or more of tephra.

Figure 19. Regional Tephra-fall Maps



(1) Annual probability of the deposition of 1 centimeter (0.4 inches) or more of tephra from any of the major Cascade volcanoes.

(2) Annual probability of the deposition of 10 centimeters (4 inches) or more of tephra from any of the major Cascade volcanoes.

Source: USGS "Volcano Hazards in the Mount Jefferson Region, Oregon"

Cascadia: Living On Fire

A detailed report of the Pacific Northwest's catastrophic hazards and history written by Rick Gore appears in the May 1998 National Geographic, Vol. 193, No. 5. For more information or to request a back copy of this article, write to: National Geographic Society, P.O. Box 98199, Washington, D.C. 20090-8199 or visit www.nationalgeographic.comon the Internet.

Community Hazard Issues and Damage Susceptibility

Volcanic eruptions can send ash airborne, spreading the ash for hundreds or even thousands of miles. An erupting volcano can also trigger flash floods, earthquakes, rockfalls, and mudflows. Volcanic ash can contaminate water supplies, cause electrical storms, and collapse roofs.[89]

Businesses and individuals can make plans to respond to volcano emergencies. Planning is prudent because once an emergency begins, public resources can often be overwhelmed, and citizens may need to provide for themselves and make informed decisions. Knowledge of volcano hazards can

[89]Dzurisin, Dan, Peter H. Stauffer, and James W. Hendley II, Living With Volcanic Risk in the Cascades, USGS Fact Sheet 165-97, (2000).

help citizens make a plan of action based on the relative safety of areas around home, school, and work.[90]

Building and Infrastructure Damage

Buildings and other property in the path of a flash flood, debris flow, or tephra fall can be damaged. Thick layers of ash can weaken roofs and cause collapse, especially if wet. Clouds of ash often cause electrical storms that start fires or damp ash can short-circuit electrical systems and disrupt radio communication.

Pollution and Visibility

Tephra fallout from an eruption column can blanket areas within a few miles of the vent with a thick layer of pumice. High-altitude winds may carry finer ash tens to hundreds of miles from the volcano, posing a hazard to flying aircraft, particularly those with jet engines. In an extreme situation, the airports would need to close to prevent the detrimental effect of fine ash on jet engines and for pilots to avoid total impaired visibility. Fine ash in water supplies will cause brief muddiness and chemical contamination.

Economic Impacts

Volcanic eruptions can disrupt the normal flow of commerce and daily human activity without causing severe physical harm or damage. Ash a few millimeters thick can halt traffic, possibly up to one week, and cause rapid wear of machinery, clog air filters, block drains and water intakes, and can kill or damage agriculture.

Transportation of goods between Northeast Oregon and nearby communities and trade centers could be deterred or halted. Subsequent airport closures can disrupt airline schedules for travelers. Ash can cause short circuits in electrical transformers, which in turn cause electrical blackouts. Volcanic activity can also force nearby recreation areas to close for safety precautions long before the activity ever culminates into an eruption.

Death and Injury

Inhalation of volcanic ash can cause respiratory discomfort, damage or result in death for sensitive individuals miles away from the cone of a volcano. Likewise, emitted volcanic gases such as fluorine and sulfur dioxide can kill vegetation for livestock or cause a burning discomfort in the lungs. Hazards to human life from debris flows are burial or impact by boulders and other debris.

[90] Scott, W.E. et al, Volcano Hazards in the Three Sisters Region, Oregon, USGS Open-File Report 99-437, (2001).

Volume III: Resources

Photo credits: Vista, Baker County Website; Snow covered roof, Salli Hysell

Volume III: Resources

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Community Profile

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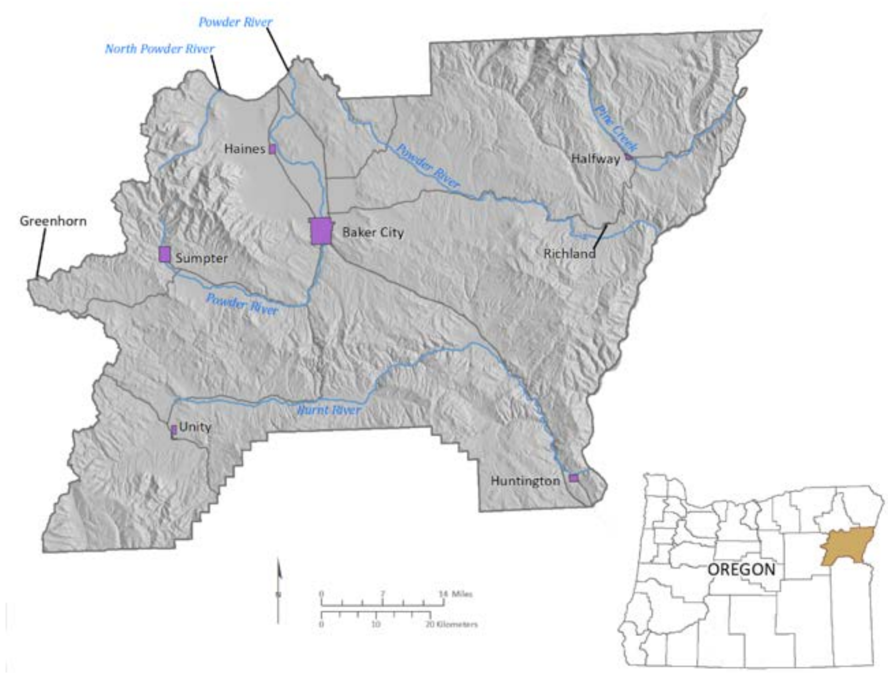
Community Profile

Baker County was created from part of Wasco County in 1862. It was named for Edward Baker, one of Oregon's first senators and a colonel in the Union Army. Baker was killed at the Battle of Balls Bluff in Virginia in 1861. [1]

Baker County was established on September 22, 1862. In 1864 Union County was created from the northern portion of the county. In 1887 Malheur County was created from the southern portion of the county. The boundaries were adjusted for the last time in 1901 when the area between the Powder River and the Wallowa Mountains, known as the Panhandle, was returned to Baker County.[2]

The county consists of 3,089 square miles and is bounded to the north by Union and Wallowa Counties, to the west by Grant County, to the south by Malheur County, and to the east by the State of Idaho. The original county seat was established at Auburn. Originally a booming mining town with 5,000 inhabitants, the population dwindled and there was agitation to move the county seat. In 1868 an election confirmed Baker City as the new county seat.[3]

Figure 1. Map of Baker County Oregon and its incorporated cities



Source: Department of Geology and Mineral Industries

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[1] Sec of State County Records Guide https://sos.oregon.gov/archives/records/county/Pages/baker-history.aspx#:~:text=Baker%20County%20was%20created%20from,northern%20portion%20of%20the%20county

[2] ibid

[3] ibid

Gold mining was the original drive for settlement in the area. At one time the county was the largest gold producer in the Northwest. [4] Approximately 20 mining operations in Baker County are large enough that they are administered by the Oregon Department of Geology and Mineral Industries (DOGAMI). Currently, there are over 1,200 mining claims filed in Baker County on U.S. Forest Service (USFS) and Bureau of Land Management (BLM) managed lands.[5]

The first mineable mineral was discovered October 23, 1861, by Henry Griffin. That material was a gold nugget and the place was named "Griffin Gulch" in honor of the discoverer. One night in the year 1862, the miners on Rock Creek and vicinity were awakened by a terrible rumbling sound. Thinking it was an earthquake they returned to bed, but upon rising the next morning they discovered the peak of Hunt Mountain had slid into Rock Creek. This is known as the Rock Creek Slide. The massive scar is still visible today. [6]

A major boost for Baker City's fortunes occurred on August 19, 1884, when the Oregon Railway and Navigation Company arrived in Baker City. The railroad joined the Union Pacific at Huntington, giving Baker City direct Rail service to the East and West.[7]

At the turn of the century, Baker City was known as the "Queen City of the Inland Empire", and boasted a population of approximately 6,700, larger than Spokane or Boise City at the time. [8] After 1900, agriculture, mining and the lumber business were mainstays of the local economy. Water was a vital commodity and the early miners and settlers stored and moved water throughout the County. After the end of World War II, mining labor and material costs increased, few mines were reactivated and the price of gold remained fixed for more than 40 years. The result was a rapid decrease in the mining industry.[9]

As the large mining operations began to close, logging and agriculture continued to thrive in the county. Baker Livestock Auction brought people from all over Eastern Oregon to market their livestock and the retail businesses were strong and vital. Changes in forest policy in the 1980's and 1990's led to a decline in the logging industry and the livestock auction closed in 1985. Agriculture remains the mainstay of the economy, but a focus on tourism helped to stabilize the impact of the loss of mining and timber.

The Oregon Trail Interpretative Center has drawn large numbers of visitors since it opened in 1993 on Flagstaff Hill northeast of Baker City. The Eagle Cap Wilderness Area, Hells Canyon Recreation Area, Sumpter Gold Dredge Park, Baker City Restored Historic District, and Anthony Lakes Ski Resort, along with fishing and hunting, also draw visitors to the area.[10] Among the cultural institutions active in Baker City today is the Crossroads Creative and Performing Arts Center, now called the Crossroads Carnegie Arts Center. This not for profit art center was created in the early 1970's when The American Association of University Woman outgrew the small art group's capacity because it became so successful.

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[4] ibid
[5] Baker County, Oregon Natural Resources Plan (2016)
[6] ibid
[7] ibid
[8] ibid
[9] Baker County, Oregon Natural Resource Plan (2016)
[10] ibid

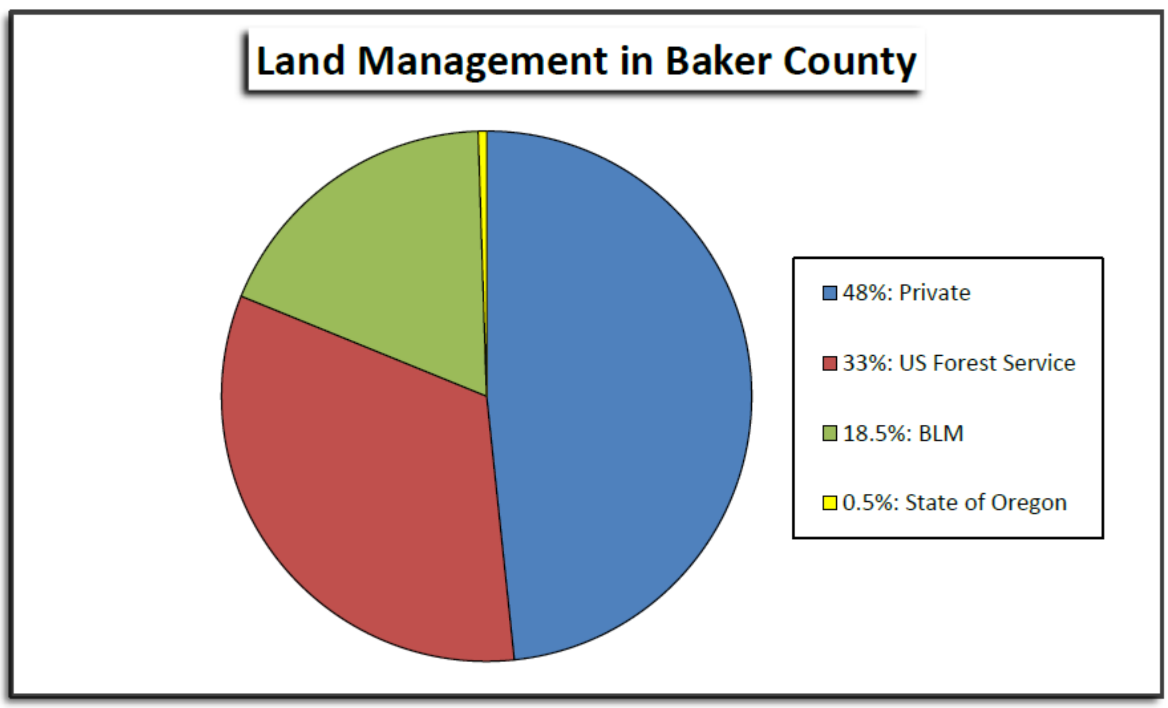
The county's population has fluctuated due in part to the boom and bust nature of mining. The population in 2008 of 16,455 represented a 1.7% decrease from 2000 and was down from a high of 17,295 in 1960.[11]

Environmental, Demographic and Socio-economic Profile

Baker County contains the headwaters of the Powder River, the Burnt River and Pine Creek. The Powder River basin compromises more than 2 million acres, including almost all of Baker County and a small part of Union County.

Federal agencies manage approximately 51.5% of the land in Baker County, comprising a total of 1,016,511 acres. Approximately 33% of the County is managed by the US Forest Service (USFS), 18.5% is managed by the Bureau of Land Management (BLM), and an additional 10,067 acres, or 0.5% of Baker County, is managed by the State of Oregon. The remaining 48% of the land in the county, approximately 950,382 acres, is privately owned.[12] The U.S. Forest Service administers two Wilderness Areas totaling over 37,650 acres in Baker County. The Monument Rock Wilderness Area covers approximately 18,650 acres, while the Eagle Cap Wilderness Area covers approximately 19,000 acres. The Bureau of Land Management manages 14,846 acres designated as a Wilderness Study Area and is also responsible for managing 23,817 acres of Areas of Critical Environmental Concern (ACEC) in Baker County.

Figure 2. Land Management in Baker County



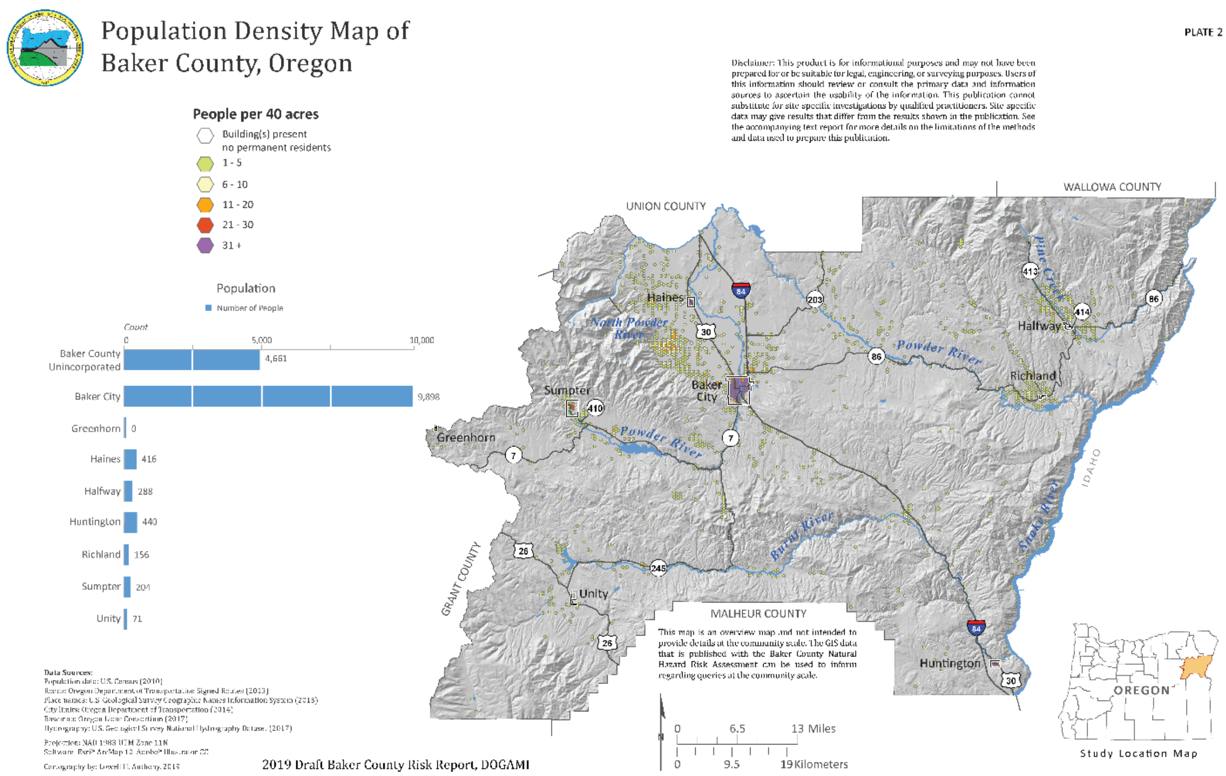
Source: Baker County, Oregon Natural Resource Plan (2016)

[11] ibid
[12] Baker County, Oregon Natural Resources Plan (2016)

Agriculture and forest production are the predominant land uses in Baker County. According to Baker County Assessor's records, there are approximately 146,386 irrigated acres and 1,129,662 non-irrigated acres that are, or could be, used for agricultural production. Of those acres, 377 irrigated acres and 399,097 non-irrigated acres are publicly owned. There are an additional 673,681 acres of timber, 628,681 acres of which are publicly managed.[13]

The county's population has fluctuated due in part to the natural resource base of the county's economy and earlier in history to the boom and bust nature of mining. From a high in 1960 of 17,295 residents[14], the county population has steadily decreased from to 15,984 in 2018[15]. The population in 2008 of 16,455 represented a 1.7% decrease from 2000 and was down from a high of 17,295 in 1960. The county's largest community and the county seat is the City of Baker City. Most of the residents in the county reside along one of the principal rivers in the county (Figure 3).

Figure 3. Population Density of Baker County, Oregon



Source: DOGAMI Risk Report (2019)

[13] Ibid

[14] Oregon Secretary of State website, Baker County history https://sos.oregon.gov/archives/records/county/Pages/baker-history.aspx

[15] US Census, American Community Survey 5-year estimates

Natural Environment

Natural environment capacity is recognized as the geography, climate, and land cover of the area such as, urban, water and forested lands that maintain clean water, air and a stable climate.[16] Natural resources such as wetlands and forested hill slopes play significant roles in protecting communities and the environment from weather-related hazards, such as flooding and landslides. However, natural systems are often impacted or depleted by human activities adversely affecting community resilience.

Geography

Baker County is comprised of 3,089 square miles. Columbia River Basalt lava flows formed the high plateaus of the region; the two major mountain ranges are the Blue and Wallowa Ranges. Major rivers include the Powder River, the Burnt River, Pine Creek, and the Snake.[17]

Blue Mountains

The Blue Mountains are not a single cohesive range, but rather a complex of ranges and inter-mountain basins and valleys that extend from southeast Washington into central Oregon, ending near Prineville. The Blue Mountains extend from the northeast corner of the state into the John Day Valley. It extends east to the Snake River Canyon, northwest to the Columbia Plateau and south to the High Lava Plains and Owyhee Plateau.[18] Western Baker County includes the Elkhorn Mountains sub-range of the Blue Mountains. The highest point in the range is Rock Creek Butte, in Baker County which is 9,106 feet (2,776 m) above sea level. The county line runs along the crest of the range dividing Baker and Grant Counties.

The Baker Valley located in the rain shadow to the east of the Elkhorn Mountains, and to the west of the Wallowa Mountains, is drier and has areas of alkaline soil. The Powder Basin runs through the Baker Valley and compromises more than 2 million acres, including the central and northern portions of Baker County and a small part of Union County. The large floodplain north of Baker City is primarily land managed for agriculture. The native vegetation of the Baker Valley features sagebrush steppe composed of Wyoming big sagebrush, bluebunch wheatgrass, and Idaho fescue.

Wallowa Mountains

The Wallowa Mountains are located between the Blue Mountains to the west and the Snake River and Idaho to the east. A large portion of the range belongs to the Wallowa-Whitman National Forest. The mountains can receive over 100 inches of precipitation, primarily in the form of snow, as opposed to the valley which generally receives less than 20 inches.

Rising precipitously from the flatlands in Oregon's far-northeastern corner, the Wallowas extend into Wallowa County and have 19 peaks over 9,000 feet in elevation. Ice-age glaciers carved sharp crags and deep canyons into the mountains. Much of the high country, including the only remaining glacier (Benson Glacier, whose status these days is debated) and Eastern Oregon's highest peak (the 9,838 foot

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[16] Mayunga, J. 2007. Understanding and Applying the Concept of Community Disaster Resilience: A capital-based approach. Summer Academy for Social Vulnerability and Resilience Building.

[17] Loy, W.G., ed. 2001. *Atlas of Oregon*, 2nd Edition. Eugene: University of Oregon Press.

[18] Idaho Power Boardman to Hemingway Transmission Line Project; Exhibit H

Sacajawea), is part of the Eagle Cap Wilderness, a 715 square mile natural area studded with alpine meadows and lakes, just over the northern county line.[19]

Surface Water Resources

Baker County contains the headwaters of all three of its principal rivers: the Powder River, the Burnt River and Pine Creek. Other primary rivers in Baker County include Eagle Creek that flows from Eagle Cap south to Richland and into the Powder River. The North Powder River watershed that flows out of the Elkhorn Mountains in the northwestern corner of the county and traces a portion of the Union Baker county line. The McCulley Forks watershed is a principal tributary to the Powder River flowing from the western county boundary into Sumpter where the Powder River originates. There are a number of dams and impoundments that also comprise important features of the surface water resources in Baker County. These include Phillips Lake that is impounded by Mason Dam, Unity Reservoir that is impounded by Unity Dam, and the Thief Valley Reservoir on the northern county line. The Brownlee Dam on the Snake River forms the Brownlee Reservoir which reaches back up the Powder River to Richland.

Powder River

The Powder River is tributary of the Snake River and is more than 150 miles in length. It lies almost entirely in Baker County but also extends to a portion of Union County. The watershed drains 1,750 square miles of northeastern Oregon. The Powder River watershed drains 1,603 square miles of northeastern Oregon. There are three man-made reservoirs on the Powder River: Phillips Reservoir (behind Mason Dam), Thief Valley Reservoir, and also the Powder arm of Brownlee Reservoir at the Oregon–Idaho border at the confluence of the Powder and Snake Rivers.

In 1988, 11.7 miles of the Powder River was designated Wild and Scenic. Between the Thief Valley Dam and the Oregon Route 203 bridge, this stretch flows through a rugged canyon with spectacular geologic formations.

Burnt River

The Burnt River is a 98-mile-long tributary of the Snake River. It enters the Snake near Huntington, Oregon, draining 1,090 square miles, it flows predominantly west to east.

The river begins at Unity Reservoir at the confluence of the North, West, Middle, and South forks of the river. The reservoir is slightly east of the Wallowa-Whitman National Forest in the Blue Mountains and slightly north of Unity. Unity Lake State Recreation Site adjoins the reservoir. As it leaves the lake, the river flows under Oregon Route 245, then runs east through the upper Burnt River Valley past Hereford and Bridgeport and, through the Burnt River Canyon, to Durkee. Turning generally south at Durkee, the river runs along Interstate 84 past Weatherby, Dixie, and Lime before flowing under the Interstate and turning east again. Shortly thereafter, it passes Huntington and reaches the Snake.

[19] https://www.lonelyplanet.com/usa/oregon/wallowa-mountains

Pine Creek

Pine Creek is a 35-mile long tributary of the Snake River that itself picks up a seven or more principal tributaries that drain the forested slopes of the Eagle Cap Wilderness. Pine Creek, which flows through the city of Halfway, provides critical bull trout habitat in the Hells Canyon Complex Recovery Unit.

The nearby McMullen Slough conveys irrigation and stock water and return flow for area ranchers. During high flow events, Pine Creek over tops its banks and flows into McMullen Slough, threatening the stability of the slough and increasing flood risks for Halfway. The Halfway Wastewater Treatment Plant is located adjacent to Pine Creek south of Halfway and has also been impacted by flood waters in the past.

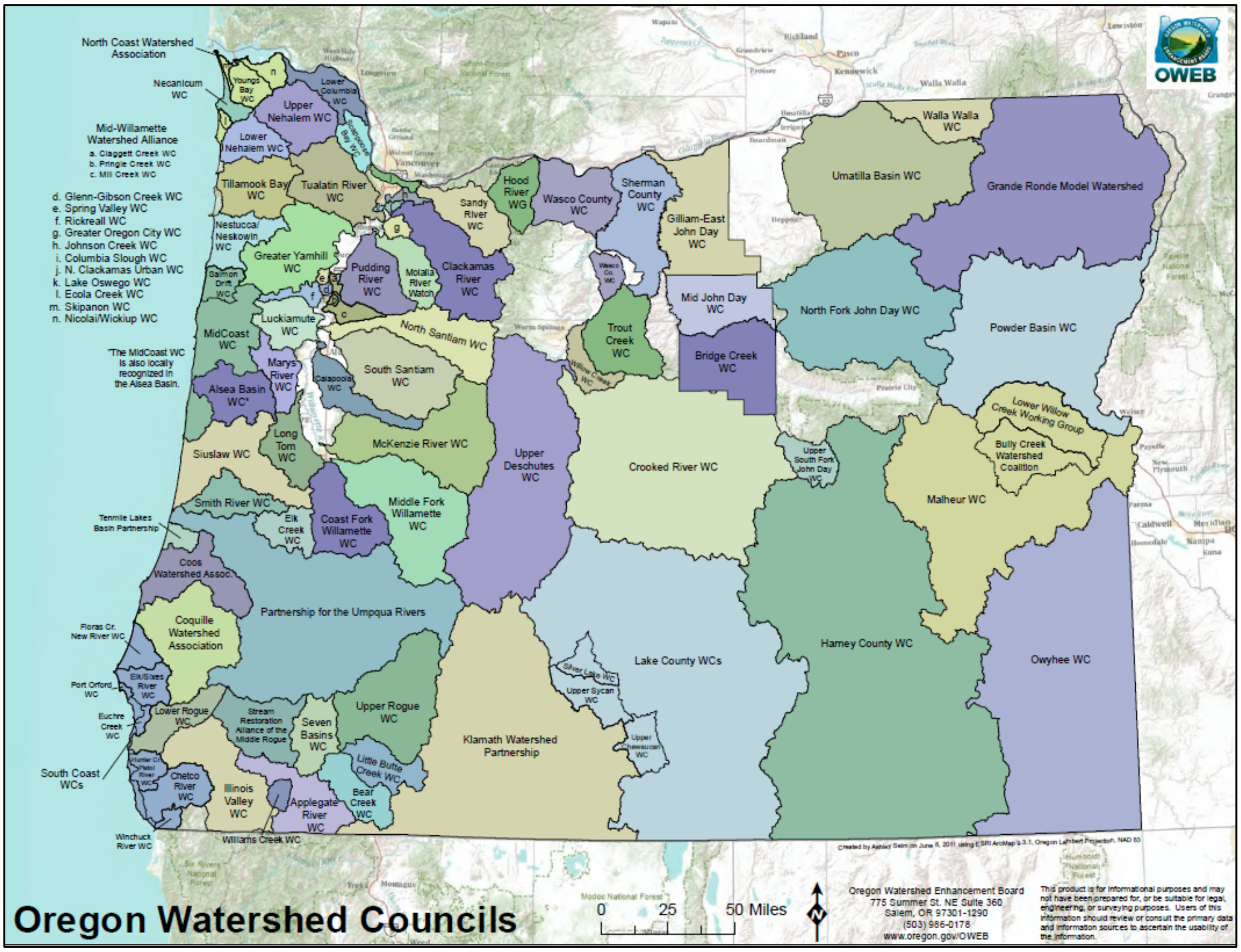
Following flood damage that caused a portion of Pine Creek north of Halfway to erode almost to the point of breaking through to the McMullen Slough. The Powder River Watershed Council engaged in a bank stabilization project funded by OWEB. The goal of the project was to improve stream corridor stability, lessen flood risk, and improve habitat by promoting riparian and floodplain recovery. By encouraging a dense riparian plant community, over bank flows will be slowed, fine sediment deposition will be encouraged, and the floodplain will become more resilient to flood scour.[20]

Watershed Councils

A watershed council is a community-based, voluntary, non-regulatory group that meets regularly in their local communities to assess conditions in a given watershed (usually a river or creek and the lands that drain into them) and to conduct projects to restore or enhance the waters and lands for fish and native plants in their areas. Oregon is one of the few states to have this community-based model – supported by the state and recognized by local governments – to focus on restoring land and water from "ridgetop to ridgetop." The Powder Basin Watershed Council represents the entire county covering the Powder River, Burnt River and the Pine Creek watersheds.

[20] Powder River Watershed Council website https://www.powderbasinwatershhedcouncil.org/our-projects

Figure 4. Location of Oregon Watershed Councils



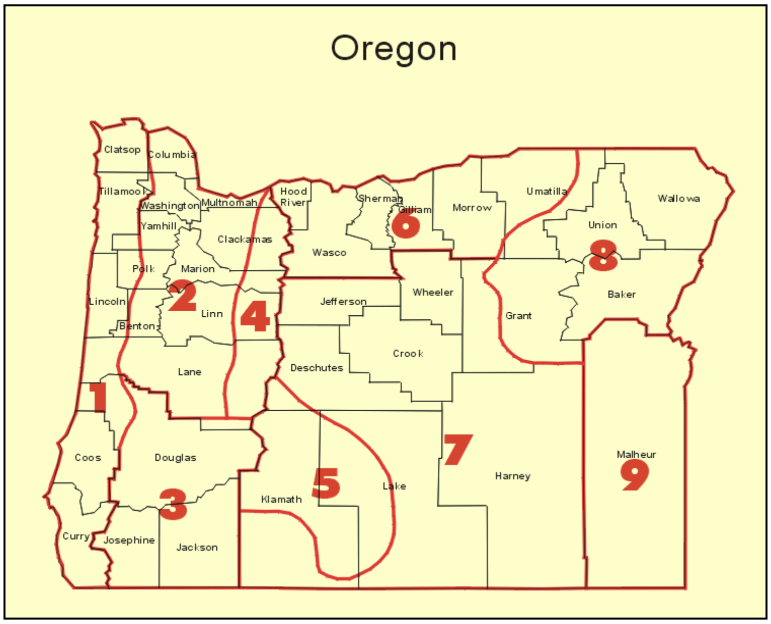
Source: Oregon Watershed Enhancement Board "Watershed Councils in Oregon" https://www.oregon.gov/oweb/resources/Pages/Watershed-Councils.aspx

Climate

Baker County lies within NOAA's Climate Division 8– Northeast Oregon. This Division is characterized by a semi-arid, low precipitation climate with warm summers and cool winters. The region is generally dry and there are large seasonal variations in temperature ranging from high temperatures of 80 to 90 degrees F from June to September to average highs of low teens in the winter months. In most winters, there are frequent and severe winter storms characterized by temperature, wind velocity, ground saturation, and snow pack. Winter storms can slow or halt traffic, damage power lines, and kill livestock.[21]

[21] Climate divisions are created by the National Oceanic Oregon and Atmospheric Administration to separate regions that have similar climates.

Figure 5. Map of Climatic Divisions



Source: National Oceanic and Atmospheric Administration, National Weather Service "Climate Divisions within Counties"

Precipitation: Rainfall and Snowfall

Figure 5 below shows the thirty year average precipitation and snow fall for NOAA stations at Mason Dam, Baker City, Halfway and in Richland. The locations on the valley floor receive less than 20 inches of precipitation per year, particularly those surrounded by high mountains which may receive less than 10 inches. The higher elevation locations receive higher annual precipitation totals, generally in the form of snowfall. Precipitation tends to spike in spring and again in the late fall with dry months in July, August and September.

Snowfall similarly varies by elevation, ranging from approximately 27 inches at the Baker City station to nearly 76 inches at the Halfway station.[22]

Temperature and Climate Change Variability

Baker County usually experiences freezing winters and hot dry summer days. Figure 7 below shows monthly average temperatures averaged over a 30 year period from 1981 to 2010. The historical baseline number of days during the year when temperatures rise to 90 °F is 13.5. Historically, the hottest day of the year sees 94.2 °F with the warmest night reaching 61.8 °F [23]

Extreme heat events are expected to increase in frequency, duration, and intensity due to continued warming temperatures. [24]

[22] NOAA Climate Data Online, accessed June 2020
[23] Future Climate Projection for Baker County, Oregon Center for Climate Change Research, M. Dalton (2020)
[24] Future Climate Projection Baker County, OCCRI, February 2020

In Baker County, the frequency of hot days per year with temperatures at or above 90°F is projected to increase on average by 30 days (ranging from 12 to 40 days), by the 2050s under the higher emissions scenario relative to the historical baselines. This average increase represents a more than tripling of hot days relative to the average historical baseline.[25]

In Baker County, the temperature of the hottest day of the year is projected to increase on average by nearly 7.8°F, (ranging from 3 to 10.7°F), by the 2050s under the higher emissions scenario relative to the historical baselines. Temperature increases will occur throughout all seasons, with the greatest differences in summer months.[26]

Increasing temperatures affects hydrology. Spring snowpack has substantially decreased throughout the Western part of the United States, particularly in areas with milder winter temperatures, such as the Cascade Mountains. In other areas of the West, such as east of the Cascades Mountains, snowfall is affected less by the increasing temperature because the temperatures are already cold and more by precipitation patterns. Spring flooding could be affected by warming climate. Mid- to low-elevation areas in Baker County's Blue Mountain and Wallowa Mountain ranges that are near the freezing level in winter, receiving a mix of rain and snow, are projected to experience an increase in winter flood risk due to warmer winter temperatures causing precipitation to fall more as rain and less as snow. [27]

[25] Ibid.

[26] Ibid

[27] Ibid.

Figure 6. 30 Year Temperature Averages in Baker County (1981-2010 averages)

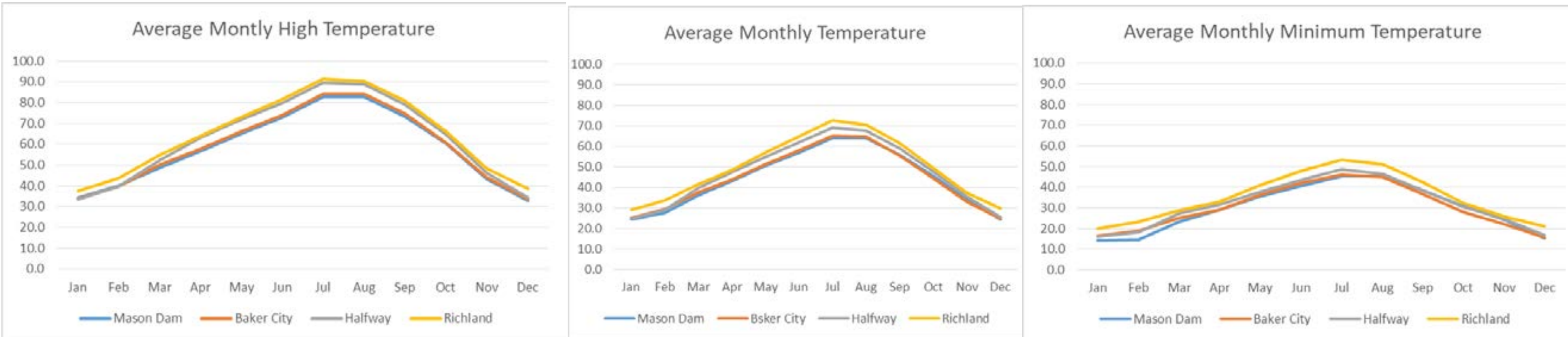
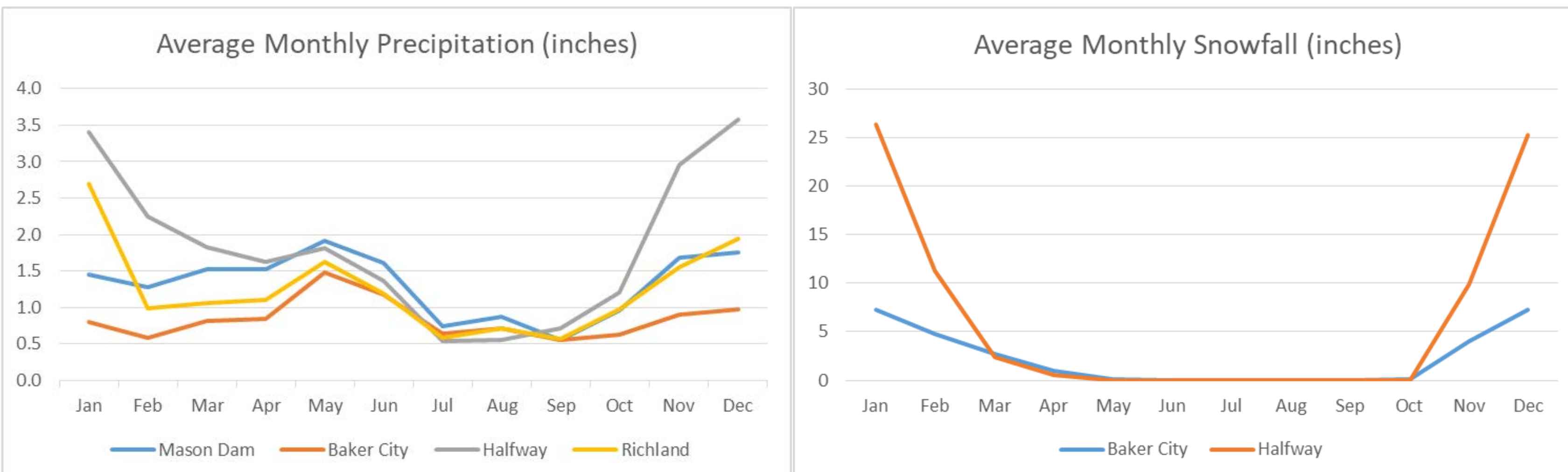


Figure 7. 30 Year Average Monthly Precipitation and Snowfall in Baker County (1981-2010 averages)



Source: NOAA National Centers for Environmental Information 1981-2010 Normals, https://www.ncdc.noaa.gov/cdo-web/datatools/normals data for the following NOAA stations: Mason Dam, Baker City, Halfway, and Richland.

Demographics

Baker County Residents

Baker County is the second most populated county in Northeastern Oregon and has the second most populated city in the region in Baker City. Baker City is home to about 60% of the people who live in Baker County (Table 2). A significant portion of the population in Baker County lives in the farmland floodplain areas west of State Route 30 and near the Powder River outside of Richland and along Pine Creek north and south of Halfway (Figure X). The cities of Unity, Sumpter, Haines, Huntington, Richland and Halfway together are home to about 9.5% of the county's population. The American Community Survey, a product of the US Census, provides population estimates for 2018, the most recent year reported by the US Census. Those estimates represent a decline in population for most cities in Baker County with the exception of Halfway and Richland which each are estimated to have gained population during the eight years since the 2010 census was taken.

Table 1. Population of Baker County and its cities 2010 and 2018

Community	2010 Census Population	2018 Population Estimate	Change since 2010	Percent change since 2010
Baker City	9,828	9,738	-90	-0.9%
Huntington	440	361	-79	-18.0%
Haines	416	357	-59	-14.2%
Halfway	288	319	31	10.8%
Sumpter	204	187	-17	-8.3%
Richland	156	228	72	46.2%
Unity	71	67	-4	-5.6%
Subtotal of Cities	11,403	11,257	-146	-1.3%
Unincorporated Baker County	4,731	4,727	-4	-0.1%
Total	16,134	15,984	-150	-0.9%

Source: US Census and American Community Survey, Demographic and Housing Estimates, Table DP05 consulted June 2020

Table 2 shows that between the years 2010 and 2018, the total population of Baker County is estimated to have decreased by less than 1%. However, Eastern Oregon's[28] population as a whole increased by 8,048 people during this eight year time period. Natural increase (+4,508) combined with net in migration (+3,540) pushed the total number of residents in the region to 190,180 people.

However, even with the increases, population growth rate in Eastern Oregon (4.4%) was less than half the overall growth rate in the State of Oregon (9.5%) for the period. While natural increase (births minus deaths) and net migration (in-migrants minus out-migrants) were both positive for the region, the two

[28] Eastern Oregon is comprised of the following counties: Wallowa, Umatilla, Union, Morrow, Grant, Baker, Harney and Malheur.

components varied among individual counties, creating notable differences in population shifts over time.

Vulnerable Population Groups

People of certain population groups may be more vulnerable to natural hazards by virtue of age, both the youngest and the oldest; language, non-native English speakers, for example; educational background and household characteristics. Combinations of these factors may further exacerbate vulnerability. Elderly residents living alone are among the most vulnerable during natural disasters.

Age

Both children and the elderly are more vulnerable than are others to the risks posed by natural hazards.

Many seniors are sensitive to heat and cold, reliant upon public transportation or other people to transport them to obtain medication and access medical facilities, and have comparatively more difficulty in making home modifications that reduce risks to hazards. In addition, seniors may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to seniors.[29] Seniors living alone may have more challenges knowing about and responding to a disaster than those living with other people.

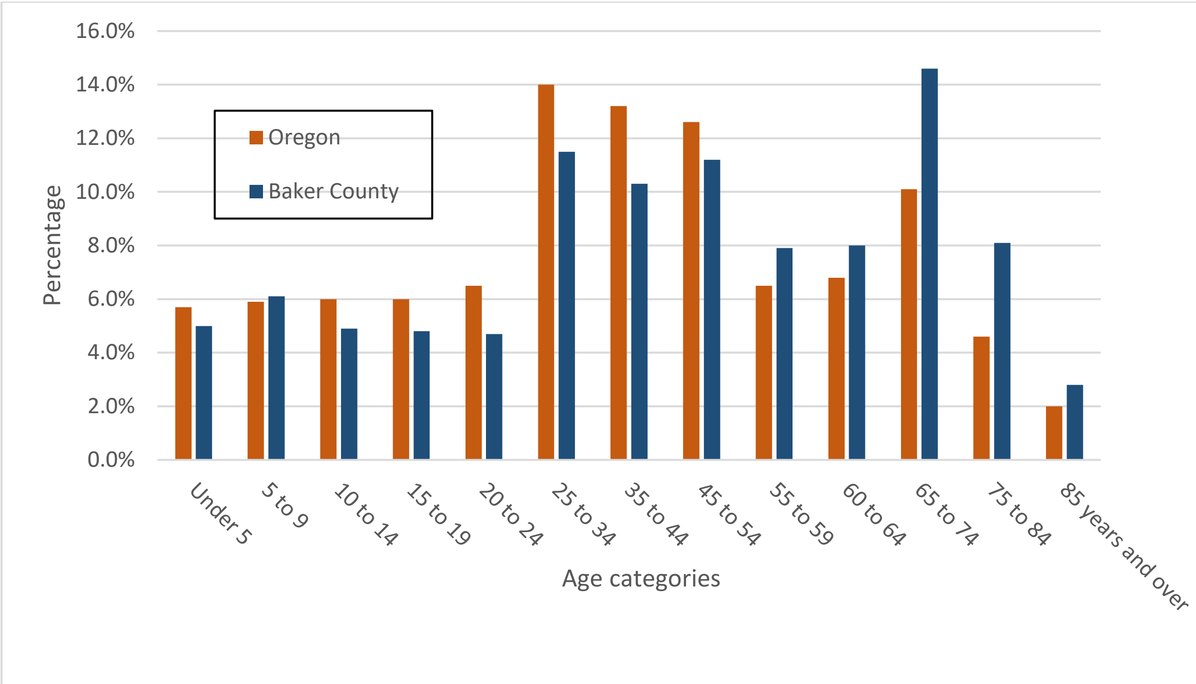
Young children are also more vulnerable to heat and cold, have fewer transportation options, and require assistance to obtain medication and access medical facilities. In addition, parents may lose time and money when childcare facilities and schools are impacted by disasters. Therefore, special consideration should also be afforded young children, schools, and parents during the natural hazards mitigation process.[30]

Figure 8 below shows Baker County's population by age group. Like many rural areas, the percentage of the population over 55 is relatively high in Baker County, especially compared to the State of Oregon as a whole. Baker County has an aging population that makes a distinct point of variation from Oregon starting from the age cohort from 45-49 and up. Conversely, every five-year age bracket below 45 years old had relatively smaller representation in Baker County than in Oregon. More than one of every five Baker County residents was 65 or older in 2010. By contrast, fewer than one in seven Oregonians was at least 65.

Another measure of vulnerability for people is the age dependency ratio. The age dependency ratio expresses the number of people 65 or older and 15 or younger for every 100 working aged adults. There are three types of age dependency ratio. The youth dependency ratio is the population ages 0-15 divided by the population ages 16-64. The old-age dependency ratio is the population ages 65-plus divided by the population ages 16-64. The total age dependency ratio is the sum of the youth and old-age ratios.

[29] Oregon NHMP: Oregon Department of Land Conservation and Development, 2015
[30] Ibid.

Figure 8. Population by Age Group in Baker County and the State of Oregon



Source: U.S. Census Bureau, 2018 American Community Survey.

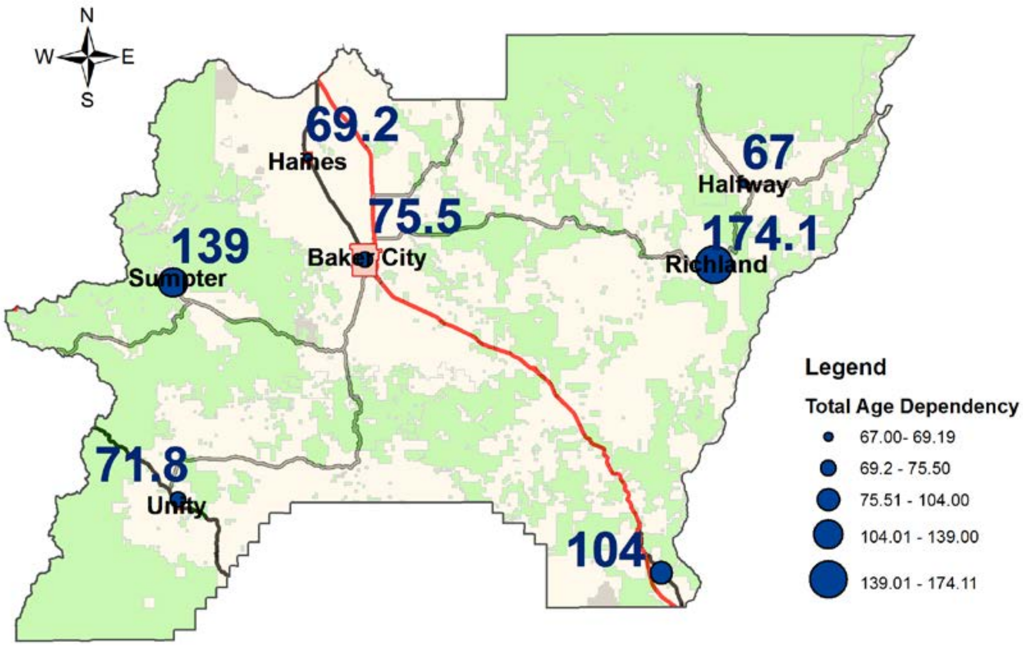
In Baker County the age dependency ratio is 61.4 comprised of a child dependency ratio of 36.8 and an old-age dependency ratio of 24.6. The age dependency ratio for Oregon is 62.5 representing 62.5 elders and children for every 100 working aged individuals. Several Baker County communities have age dependency ratios greater than 100. These data are provided below in Table 2. Dependency ratios reveal the population breakdown of a place and broadly represents how well dependents can be taken care of.

Table 2. Age Dependency ratios for Baker County and its cities

Jurisdiction	Total Age Dependency	Old-age Dependency	Child Dependency
United States	52.7		
Oregon	62.5	28.7	33.8
Baker County	61.4	24.6	36.8
Baker City	75.5	38.4	37.1
Huntington	104.0	72.9	31.1
Haines	69.2	50.7	18.5
Halfway	67.0	45.0	22.0
Richland	174.1	100.0	74.7
Sumpter	139.0	139.0	0
Unity	71.8	66.7	5.1

Source: US Census 2018 American Community Survey 5-year estimates

Figure 9. Total Age Dependency Ratio



Source: US Census American Community Survey 5-year estimates, mapped by author

By this measure, the communities of Richland, Sumpter and Huntington may be particularly vulnerable to the impact of natural hazard events due to the higher proportion of older and younger people as compared to the portion of the population between 15 and 64, the assumed wage earners. The age dependency of these communities is dominated by the impact of a cohort of those 65 and older as compared to the cohort between the ages of 15 and 64.

Language

Special consideration should be given to populations who do not speak English as their primary language. Language barriers can be a challenge when disseminating hazard planning and mitigation resources to the general public, and it is less likely they will be prepared if special attention is not given to language and culturally appropriate outreach techniques. A small proportion of Baker County's population speaks a language other than English at home. While the vast majority of residents speak only English at home (96.2%), there are approximately 365 county residents who speak languages other than English at home. Spanish speakers comprise the majority of those. [31]

[31] US Census, 2018 American Community Survey, consulted June 2020

Education

Educational attainment of community residents is also identified as an influencing factor in socio-demographic capacity. Educational attainment often reflects higher income and, therefore, higher self-reliance. Widespread educational attainment is also beneficial for the regional economy and employment sectors supporting potential employment in the professional, governmental and service sectors. An oversaturation of either highly educated residents or low educational attainment can have negative effects on the resiliency of the community.

According to the U.S. Census, 32.9% of the Baker County population over 25 years of age has graduated from high school or received a high school equivalency, with approximately 15% going on to earn a Bachelor's Degree.[32] In 2018-19 the Oregon Department of Education reported that Baker High School had an on time graduation rate of 84%. The total enrollment at Baker High School was 408 students in the 2018-19 school year. 89% of students earned their high school diploma or GED within five years.[33] Baker County has three other options for study in the high school grades. Eagle Cap Innovative High School is the smallest with 16 students who engage in a blend of asynchronous online learning and face-to-face classes, primarily located on the North Baker School campus. Many of the school's students attend college courses at Blue Mountain Community College or work from home after demonstrating successful progress on campus.[34] On time graduation rate at Eagle Cap Innovative High School was 85% in the 2018-19 school year. Two charter schools operate in Baker County including Baker Early College and Baker Web Academy. Baker Early College has an enrollment of 336 with an on time graduation rate of 96% in the 2018-19 school year and 69% of its students enrolled in a 2-year or 4-year college program within a year of graduation from high school. Baker Web Academy serves students from Kindergarten through 12th grade. It has a 2018-19 graduation rate of 63%.[35]

Living Arrangements

As described in Volume I as part of the Vulnerability Assessment the 2020 Baker County NHMP Steering Committee identified people living in poverty as a vulnerable population. The US Census American Community Survey 5-year estimates show that there were a total of 6,927 households (family and non-family households) in Baker County in 2018. Of this total, 4,319 households are family households with at least one parent. The remaining 2,609 households are non-family households, either individuals living alone or groups of people who live together, but who are not related.

Among the most vulnerable people are people living below the poverty line whether they live in families or not. Of all families in Baker County, 10.9% or 471 families (out of the total 4,319 families) are families whose income in the preceding 12 months was below the poverty level. For people who live in families, poverty is highest among single parent households with children under 18 years old. There are 1699 families with children under 18 years old in Baker County, of which 519 families are headed by single female householders. Of these 519 single female parent families, 53.4% or 326 of these are families

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[32] Ibid
[33] Oregon Department of Education school report cards https://www.ode.state.or.us/data/reportcard/reports.aspx
[34] https://eaglecap.baker5j.org/
[35] Oregon Department of Education website https://www.ode.state.or.us/data/reportcard/reports.aspx

living in poverty. Of people living alone, 21% (547 people) of the 2,068 single person households in Baker County are people living below the poverty line. [36]

Seniors living alone may have more challenges knowing about and responding to a disaster than those living with other people. Based on the US Census 2018 American Community Survey 5-year estimates out of the 6,927 households in Baker County, 2,197 were single person households. Of these 1-person households, 53% or 1,167 households are people over 65 years old living alone.[37]

Home Ownership

Housing occupancy data may relate to factors that influence resilience to natural hazards, both positively and negatively. On the positive side, length of occupancy in the same residence may reflect how strongly people are tied to their community. Strong community ties may support community resilience in the face of a flood or fire. In addition, those who own their homes may be more likely to prepare their homes to be more resistant to natural hazards, such as maintenance of defensible space to combat the threat of wildfires.

In Baker County, there are 8,996 housing units, of which 4,850 (53.9%) are owner occupied. This is slightly lower the Oregon statewide average of 61% owner occupied housing.[38] Of the owner occupied housing in Baker County 48.4% are not burdened by a mortgage.[39] This statistic may indicate a high degree of community stability. On the other hand, insurance requirements may be place on borrowers by mortgage lenders, such as obligatory flood insurance purchase for structures located in the FEMA floodplain. Those home owners who do not hold mortgages, may drop flood insurance policies after the mortgage is paid off, particularly if household income is limited.

Economics

Income and Poverty

Household income and poverty status are indicators and the stability of the local economy. Household income can be used to compare economic areas as a whole, but does not reflect how the income is divided among the area residents.

Household income and poverty rates are indicators of socio demographic capacity and the broader community resilience to natural hazards. People living in poverty suffer a disproportionate burden from disasters. They are more likely to be isolated and less likely to have the assets to withstand economic setback. When a disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the disaster. [40]

The median household income of Baker County residents in 2018 was $43,921. Between 2010 and 2018 median income rose significantly in some cities within Baker County. Table 3 below shows the change in

[36] US Census, consulted June 2020
[37] Ibid.
[38] Ibid.
[39] Ibid.
[40] FEMA Local Mitigation Planning Handbook, 2013

median household income for the state, the county and the cities in Baker County from 2010 to 2018, as well as the household poverty rate for those jurisdictions.

Table 3. Median Household Income and Households below the Poverty Level

Community	Median Household Income 2010	Median Household Income 2018	% Change	2010 % of Families in Poverty	2018 % of Families in Poverty
Oregon	$46,560	$63,426	36.22%	15.8%	12.6%
Baker County	$39,704	$43,921	10.62%	12.7%	15.7%
Baker City	$38,442	$42,881	11.55%	14.2%	15.7%
Huntington	$20,855	$42,500	103.79%	26.1%	18.4%
Haines	$37,778	$38,182	1.07%	6.6%	20.5%
Halfway	$23,646	$38,533	62.96%	27.2%	10.3%
Sumpter	$34,028	$19,167	-43.67%	-	29.4%
Richland	$24,250	$43,333	78.69%	-	4.5%
Unity	$23,750	$36,000	51.58%	28.6%	35.8%

Source: US Census Bureau (https://www.census.gov/), Tables S1901 and S1702 consulted June 2020.

Within the wider region of Eastern Oregon, in 2017 the combined personal income of the residents of Baker, Grant, Harney, Malheur, Morrow, Umatilla, Union, and Wallowa counties) totaled about $6.8 billion in 2017, up from $5.1 billion in 2008, a growth rate of 33 percent. Baker County had the highest rate of personal income growth in the area (41%), followed by Grant (39%), Harney (34%), Wallowa (34%), Umatilla (33%), Morrow (32%), Malheur (30%), and Union (29%). Eastern Oregon's rate of growth was well below Oregon's statewide growth of 43%.

Those communities with higher poverty rates bear a disproportionate burden during recovery from disasters. Those families in poverty are more likely to be isolated and, when work is interrupted by a disaster, families in poverty may experience the most difficulty in providing housing, food, and basic necessities for their families.

By this measure the communities of Sumpter and Unity may be the communities that are the most vulnerable to natural hazards. These cities suffer from the highest overall poverty level in the county, with 29.4% and 35.8% respectively of families living below the poverty line.

Employment and Wages

According to the Oregon Employment Department and shown in Table 3 below, unemployment declined from 2009 to 2018 reflecting recovery from the Great Recession of 2008. However, unemployment in northeastern Oregon, remains higher than the State unemployment rate.

The understanding of the impact on unemployment by the COVID-19 pandemic in 2020 remains incomplete at the time of this writing. An April 21, 2020 Press Release from the Oregon Employment Department reported that statewide the department received 53,800 initial claims for unemployment benefits from April 5-11. That's in addition to a revised total of 243,000 initial claims filed during the prior three weeks, March 15 to April 4. In comparison, the Employment Department received just 14,820 initial claims during the comparable four-week period in 2019 (March 17 to April 13). This surge in claims is unprecedented.[41]

In Eastern Oregon, initial claims had surged as well, with 2,473 processed initial unemployment insurance claims for the four-week period, March 15 to April 11. This represents a significant increase over the 379 claims during the comparable four-week period in 2019. All Eastern Oregon counties have seen a relatively large upswing in unemployment insurance claims. The majority of claims have come from four industries: accommodation and food services, health care and social assistance, manufacturing, and retail trade. [42]

Table 4. Unemployment Rates in Northeast Oregon (Region 7)

Community	Employment 2009	Employment 2018	Unemployment Rate 2009 (%)	Unemployment Rate 2018 (%)	% Change in Unempl. Rate
Oregon	1,608,760	1,920,804	11.3%	4.2%	-62.8%
Grant County	2,319	2,482	13.7%	7.3%	-46.7%
Baker County	5,286	5,544	10.4%	5.5%	-47.1%
Union County	9,447	10,173	11.6%	5.4%	-53.4%
Wallowa County	2,362	2,572	12.0%	6.1%	-49.1%

Source: Oregon Employment Department, Local Area Unemployment Statistics, accessed August 29, 2019.

NHMP Plan Holders

Baker County

Baker County is situated in the northeastern quadrant of the state and consists of 3,089 square miles of forest and farmland. Baker County is bounded to the north by Union and Wallowa Counties, to the west by Grant County, to the south by Malheur County, and to the east by the State of Idaho. The original county seat was established at Auburn. Originally a booming mining town with 5,000 inhabitants. In

[41] Oregon Employment Department, April 21, 2020 Press Release
[42] Ibid.

1868 an election confirmed Baker City as the new county seat and once known as the "Queen City of the Inland Empire". Gold mining was the original drive for settlement in the area. At one time the county was the largest gold producer in the Northwest.

After the end of World War II, mining labor and material costs increased, few mines were reactivated and the price of gold remained fixed for more than 40 years resulting in a rapid decrease in the mining industry. Logging and agriculture continued to thrive in the county. Baker Livestock Auction brought people from all over Eastern Oregon to market their livestock and the retail businesses were strong and vital. Changes in forest policy in the 1980's and 1990's led to a decline in the logging industry and the livestock auction closed in 1985. Agriculture remains the mainstay of the economy, but a focus on tourism helped to stabilize the impact of the loss of mining and timber.

Baker County contains the headwaters of the Powder River, the Burnt River and Pine Creek. The 2016 Baker County Natural Resource Plan states that there are approximately 146,386 irrigated acres and 1,129,662 non-irrigated acres that are, or could be, used for agricultural production. Much of this land is located in the wide floodplain of the Powder River in the Baker Valley.

The county is bisected by the valley which gives way to the Wallowa Mountains to the east and the Elkhorn Range of the Blue Mountains to the west. These are the timber lands of the county. The Natural Resource Plan states that there are 673,681 acres of timber, 628,681 acres of which are publicly managed. Federal agencies manage approximately 51.5% of the land in Baker County, comprising a total of 1,016,511 acres. Approximately 33% of the County is managed by the US Forest Service (USFS), 18.5% is managed by the Bureau of Land Management (BLM), and an additional 10,067 acres, or 0.5% of Baker County, is managed by the State of Oregon.

City of Baker City

Baker City sits at the southern end of the Baker Valley along the Powder River. The town wasn't platted until 1865, but quickly established itself as a regional center of commerce, backed by productive gold mines, timber and the arrival of the railroads. In the 1890s and early 20th century, it was known as the "Queen City of the Inland Empire," using its wealth to replace the wooden structures of the Old West with modern buildings made of brick and stone.[43]

Locals fashioned Baker into a Victorian-style city in the high desert, complete with an opera and a grand hotel. By 1900 it was the largest city between Portland and Salt Lake City, and a popular stop among those traveling west. Better yet: All the growth came just ahead of the Great Depression, so while the city struggled along with the rest of the country, the opulent façade remained intact.[44]

Baker City continues to serve as an influential hub of activity in Eastern Oregon. Annual events such as the Hells Canyon Motorcycle Rally, breweries and distilleries along with historic museums, a restored historic downtown and a focus on the importance of the environment provide context for identification and mitigation of natural hazards that can impact agricultural, timber and tourism economies.

[43] OregonLive May 17, 2019 https://www.oregonlive.com/travel/2017/09/20_reasons_to_love_baker_city.html
[44] Ibid

Drought, Winter Storm, Wildfire, and Flood were the top rated natural hazards named by Baker County Working Group members in 2013. The 2014 NHMP describes a range of conditions and actions intended to mitigate the impact of these hazards.

With respect to drought, Baker City completed and implementing their water curtailment plan by ordinance in 2008 that outlines conditions under which water volumes available for industrial, commercial and landscaping use are restricted. [45] On a broader scale the city was interested in gaining a better understanding of the valley's aquifer capacities in order to drill a secondary well. Baker City hired a consultant to perform a study on the aquifer that supports the city's drinking water well. This was done in the early 2000's as the city developed its Aquifer Storage and Recovery (ARS) well. The city was granted a permit on the ASR well in 2009.

In 2013 the Baker City Working Group noted that the city capable of managing the effects of winter storms by clearing snow quickly, nonetheless the *2014 NHMP* Baker City Working Group determined that the city's vulnerability to a winter storm is High. This hazard remains among the high hazard events for the residents of Baker City as well as for those in the county.

Regarding the risk of wildfire, Baker City utilizes surface water for its municipal water supply so, the city's watershed is an area vulnerable to hazards such as wildfire and erosion. The 2015 revision of the Baker County Community Wildfire Protection Plan (CWPP) continues to rank the Baker City watershed as a 'High Priority.' A mitigation action originating in the *2008 Northeast Oregon Multi-Jurisdictional NHMP* identifies an expansion of fuels reduction in the watershed as one way to implement actions identified in the CWPP. The mitigation action WF 1: *Advocate for the implementation of the actions identified the most current Baker County Community Wildfire Protection Plan* was carried through to the *2014 NHMP* and continues to be included in the *2020 Baker County NHMP.*

Flooding also ranks high among natural hazard concerns in Baker City. Mason Dam was constructed in 1968 and contains Phillips Lake on the Powder River, 19 miles upstream from Baker City. The dam has served for irrigation purposes and flood control against the Powder River. The 2013 Working Group considered a breach in the dam as a worst-case-scenario type flood event. By contrast the accuracy of FEMA Flood Insurance Rate Maps has been raised in 2013 and again in 2019 as a concern for floodplain management in Baker City as well as land in the county that is depicted as a Special Flood Hazard Area.

City of Halfway

The City of Halfway is located 54 miles east of Baker City, along Oregon Route 86, halfway between Pine and Cornucopia. The city's location halfway between these two cities gave the town its name. The city's geographic coordinates of 44°52′42″N 117°6′38″W (making it close to the midpoint between the equator and the North Pole) was part of the reason for an internet company (Half.com) to choose the town for an advertising gimmick that had the city unofficially renaming itself Half.com for one year in exchange for $110,000, 20 computers for the school, and other financial subsidies.[46]

[45] Baker City Code of Ordinances § 53.25
[46] Wikipedia entry for Halfway, Oregon, https://en.wikipedia.org/wiki/Halfway,_Oregon consulted June 2020

In 2017, the three largest employers in Halfway were the Pine Eagle School District, the Idaho Power Company, and the U.S. Forest Service, which combined to employ over 125 people.

Tourism also forms a portion of the city's economic base. Halfway is located near the Hells Canyon National Recreation Area where visitors can hike, raft, camp, fish, and snow mobiling in the winter. The Pine Valley Community Museum tells of the area's mining, ranching and recreation history.

The Halfway Addendum to the 2014 NHMP describes the city's exposure to natural hazards as distinct from the concerns of Baker County and other cities in the county. The residents of Halfway conducted a separate Risk Assessment during the development of the addendum to the *2014 NHMP*. In this exercise participants ranked flood as the number one natural hazard faced in Halfway. Landslide was ranked second with earthquake, windstorm, wildfire and winter storms occupying a second tier moderate risk hazards. Drought and Volcanic Event occupied the lowest ranked tier.

The *2014 NHMP* notes that the Pine Valley and City of Halfway flood due to spring runoff, rain on snow, and summer thunderstorms. The movement of sediment in Pine Creek also is a significant contributor to flooding in Halfway. A mitigation action that had been carried forward from the *2008 Northeast Oregon Multi-Jurisdictional NHMP* regarding flooding in Halfway was item MH#15 (renumbered to MH 7 in the *2020 NHMP*) that calls for implementation of the Pine Creek Floodplain Management Plan. A new action has been added to the *2020 NHMP* as action FL 1.1. It identifies floodplain restoration in the headwaters of Pine Creek as a method to reduce flooding downstream near Halfway.

Infrastructure that is at risk of damage by flooding includes the Halfway Wastewater Treatment Plant. The City of Halfway operates this wastewater treatment facility where wastewater is treated and discharged to a holding pond and is then used for surface application to agricultural fields. Discharge was previously directly into Pine Creek. In June 2010, a large infiltration of flood water climbed above the banks of Eagle Creek, Pine Creek, and their tributaries and caused damage to the City of Halfway, specifically threatening the city's wastewater treatment facility. A similar future event is possible and could be devastating to the facility.[47] Among the hazard mitigation actions included in the 2014 NHMP is mitigation action FL#6 (renumbered to FL 5 in the 2020 Baker County NHMP) to seek Silver Jackets[48] assistance to investigate opportunities to prevent large infiltration of flood waters into the Halfway wastewater treatment facility.

There is little history of landslide in Baker County and few steep slopes or historic landslides identified by DOGAMI's mapping included in the Risk Report that would directly affect the City of Halfway. However, the 1984 'Hole in the Wall' landslide dammed the Powder River in October and temporarily isolated Halfway from the west. The blockage of Highway 86 caused a variety of indirect impacts including preventing travel for several months. The Hole in the Wall landslide required a 21 mile detour through Sparta for the City of Halfway as well as Richland, Oxbow, and Homestead, but this route was unsafe for traffic during winter months.

[47] 2014 Northeast Oregon Multi-Jurisdictional Natural Hazard Mitigation Plan

[48] Silver Jackets is a state-led interagency team of multiple state and federal agencies that can leverage support to bring cohesive solutions to flood issues.

Built Environment

Settlement Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is the 19 Statewide Land Use Planning Goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards.[49]

Baker County, the cities of Baker City and Halfway and the other incorporated cities in the county have acknowledged comprehensive plans and implementing ordinances. Each city in the county also has identified an urban growth boundary intended to identify lands needed to accommodate population and employment growth for a 20-year period.

Most of the residents in the county reside in the central part of county in or near Baker City. The county is characterized by river canyons and high plateaus, which are interspersed with wide grasslands. These grasslands are generally developed for agricultural production.

While 38% of the building inventory in Baker County is located in Baker City, this building stock represents 46% of the total building value in the county. There are 16,108 buildings in Baker County. Of these, 50% or 8,107 buildings are located in unincorporated areas (Table 5). These structures account for 45% of the estimated total building value in the county. Much of the value of the structures in the unincorporated area is in agriculture facilities, whereas in the incorporated areas, the majority of the building stock is devoted to residential use.

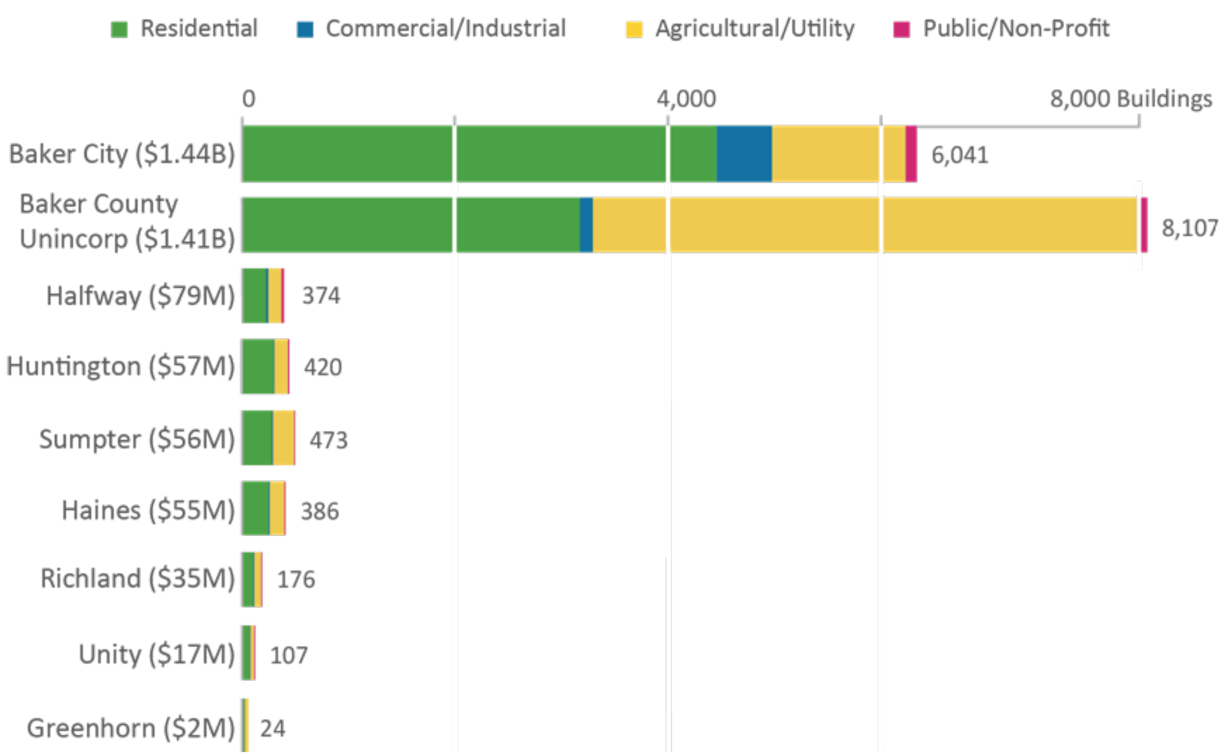
[49] Department of Land Conservation and Development, http://www.oregon.gov/LCD/docs/goals/ goal7.pdf

Table 5. Building Inventory in Baker County

Community	Total # of Buildings	% of Total Buildings	Est. Total Building Value ($)	% of Total Building Value
Unincorporated Baker County	8,107	50%	1,408,882,000	45%
Baker City	6,041	38%	1,437,408,000	46%
Greenhorn	24	0.1%	1,876,000	0.1%
Haines	386	2.4%	55,066,000	1.7%
Halfway	374	2.3%	78,700,000	2.5%
Huntington	420	2.6%	57,259,000	1.8%
Richland	176	1.1%	34,987,000	1.1%
Sumpter	473	2.9%	55,531,000	1.8%
Unity	107	0.7%	16,938,000	0.5%
Total Baker County	**16,108**	**100%**	**3,146,647,000**	**100%**

Source: Natural Hazard Risk Report for Baker County, 2019. Oregon Department of Geology and Mineral Industries.

Figure 10. Buildings by Occupancy Class (ranked by Value)



Source: Natural Hazard Risk Report for Baker County, 2019. Oregon Department of Geology and Mineral Industries

Critical or Essential Facilities

Critical facilities are structures and institutions necessary for a community's response to and recovery from emergencies. Critical facilities must continue to operate during and following a disaster to reduce the severity of impacts and accelerate recovery. When identifying vulnerabilities, consider both the structural integrity and content value of critical facilities and the effects of interrupting their services to the community.[50]

DOGAMI, in their risk assessment for Baker County, identified a number of critical facilities with data that came from the DOGAMI Statewide Seismic Needs Assessment (SSNA).[51] DOGAMI updated the SSNA data by reviewing Google Maps™ data. The critical facilities DOGAMI attributed include hospitals, schools, fire stations, police stations, emergency operations, and military facilities. In addition to these standard building types, we considered other building types based on local input or special considerations that are specific to Baker County that would be essential during a natural hazard event, such as public works and water treatment facilities. Critical facilities are important to note because these facilities play a crucial role in emergency response efforts. Communities that have critical facilities that can function during and immediately after a natural disaster are more resilient than those with critical facilities that are inoperable after a disaster.

Table 6. Critical Facilities by Community

		Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Community**	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**
Baker City Municipal Airport	County		X		
Baker RFPD	County		X		
Greater Bowen Valley RFPD	County		X	X	
Keating RFPD	County		X		
Mosquito Flat North RFPD	County				
Oregon State Police	County				
Baker City Armory	Baker City				
Baker City Fire Department	Baker City		X		
Baker City Hall	Baker City				
Baker City Police Department	Baker City				
Baker City Warehouse and Shop	Baker City		X		
Baker County Road Department	Baker City		X		
Baker County Sheriff's Office	Baker City				
Baker High School	Baker City				
Baker Middle School	Baker City				
Brooklyn Elementary School	Baker City				
North Baker Elementary School	Baker City				
South Baker Elementary School	Baker City		X		
St. Alphonsus Baker Clinic	Baker City				

[50] FEMA Local Mitigation Planning Handbook, 2013
[51] Statewide Seismic Needs Assessment; Lewis, 2007

St. Elizabeth Hospital	Baker City		X		
St. Luke's Clinic	Baker City				
Haines Elementary School	Haines				
Halfway Elementary School	Halfway				
Pine Eagle Clinic	Halfway				
Pine Eagle High School	Halfway		X		
Pine Valley VFD	Halfway		X		
Huntington City Hall	Huntington				
Huntington Fire Station	Huntington				
Eagle Valley Fire Department	Richland		X		
Sumpter Fire Department	Sumpter				
Burnt River School	Unity				
Unity Community Hall	Unity				
Unity Fire Department	Unity				

Source: Baker County Natural Hazard Risk Assessment, DOGAMI, 2019

Other facilities not listed above, but which are relevant to planning for natural disaster resilience.

Mass Congregate Facilities

There are four assisted living facilities in Baker City, one with a memory care unit. These facilities have capacity to care for 176 seniors.[52]

There is one correctional facility located in Baker County. The Powder River Correctional Facility in Baker City has an inmate capacity of 286. Inmates provide a variety of work related services to the communities in Baker and surrounding counties. One of the primary reasons for this work is to reduce the costs of government, particularly to rural governments, who could not successfully complete needed work projects by other means. The Baker County Jail in Baker City is one of three county jails in northeast Oregon.

Cultural and Historic Resources

Historic Resources

The Oregon Historic Sites Database lists a number of structures, historic districts and sites in Baker County. Among those that may be impacted by natural hazards include the Sumpter Valley Dredge State Historic Area and the Sumpter Valley Railway Historic District in Sumpter and along the Powder River upstream from Phillips Reservoir.

Libraries and Museums

Libraries and museums develop cultural capacity and community connectivity as they are places of knowledge and recognition, they are common spaces for the community to gather, and can serve critical functions in maintaining the sense of community during a disaster. They are recognized as safe places

[52] SeniorGuidance.org https://www.seniorguidance.org/assisted-living/oregon/baker-city.html

and reflect normalcy in times of distress. The Baker County Library District operates six community libraries in Baker County. The main library is located in Baker City with branches in Haines, Halfway, Huntington, Richland, and Sumpter. There are approximately three museums in Baker County: Baker Heritage Museum, Alder House Museum, and the Eastern Oregon Museum.

Cultural Events

Other such institutions that can strengthen community connectivity are the presence of festivals and organizations that engage diverse cultural interests. Examples of events and institutions include Sumpter Flea Markets, Memorial Day Weekend & Labor Day Weekend events; Haines Days, the 4th of July Celebrations, Rodeos, County Fair, Baker City – 4H Fair, the Elkhorn Bicycle Ride, Hells Canyon Motorcycle Rally, the Huntington Catfish Derby, and other local events. Not only do these events bring revenue into the community, they have potential to improve cultural competence and enhance the sense of place. Cultural connectivity is important to community resilience.

Infrastructure

Roads & Bridges

Baker County has approximately 187 miles of paved roads, 495 miles of gravel roads, and 2,278 miles of dirt roads. The principal routes through the county are Interstate 84, US Highways 26 and 30 and State Highways 7 and 86. These highways are used predominantly by through traffic traveling across the state. Local traffic volumes are higher in the urban areas of cities.

Interstate 84 runs northwest to southeast, bisecting the county and connecting travelers to La Grande, Pendleton and Hermiston on the Columbia River to the north and to Ontario to the south. Haines and Huntington access Baker City via US Highway 30 and Interstate 84. Halfway and Richland access Baker City by east-west running State Highway 86. Sumpter accesses Baker City by east-west running State Highway 7. Unity lies along the east-west running US Highway 26 that provides access out of the county to the larger cities of John Day, Prineville, Madras and Bend to the west and the city of Ontario to the east.[53]

In addition to the state highways, a network of county roads runs throughout the study area. County roads serve many purposes. They provide access to residences in rural areas around the incorporated cities. They also serve other smaller rural communities. County roads often connect to agricultural areas, recreational areas, and national forests.

The Oregon Department of Transportation (ODOT) inventories and assesses the condition of bridges in Oregon. According to the 2019 Interactive Bridge Condition Report[54] provided by ODOT, one bridge in Baker County is in Poor Condition (Figure 11). This bridge is located on Bridge Street (Highway 66) and crosses the Powder River. It was constructed in 1933 is 54 feet long and carries 2600 vehicle trips per day (Figure 12).

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[53] Baker County Transportation System Plan (2005)

[54] 2019 ODOT Bridge Condition Report, https://www.oregon.gov/ODOT/Bridge/Pages/BCR.aspx, consulted May 2020

Figure 11. Report on Baker County bridge conditions from Oregon Department of Transportation

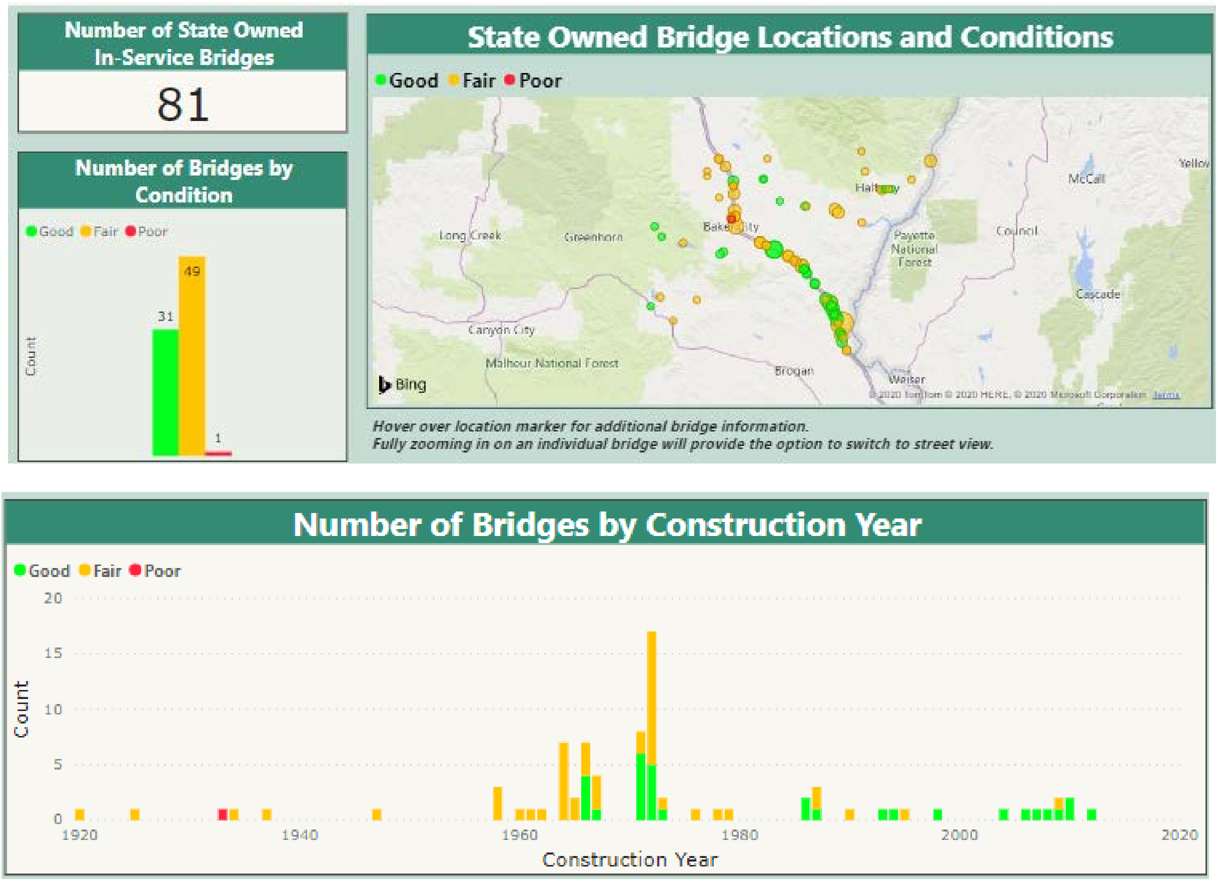
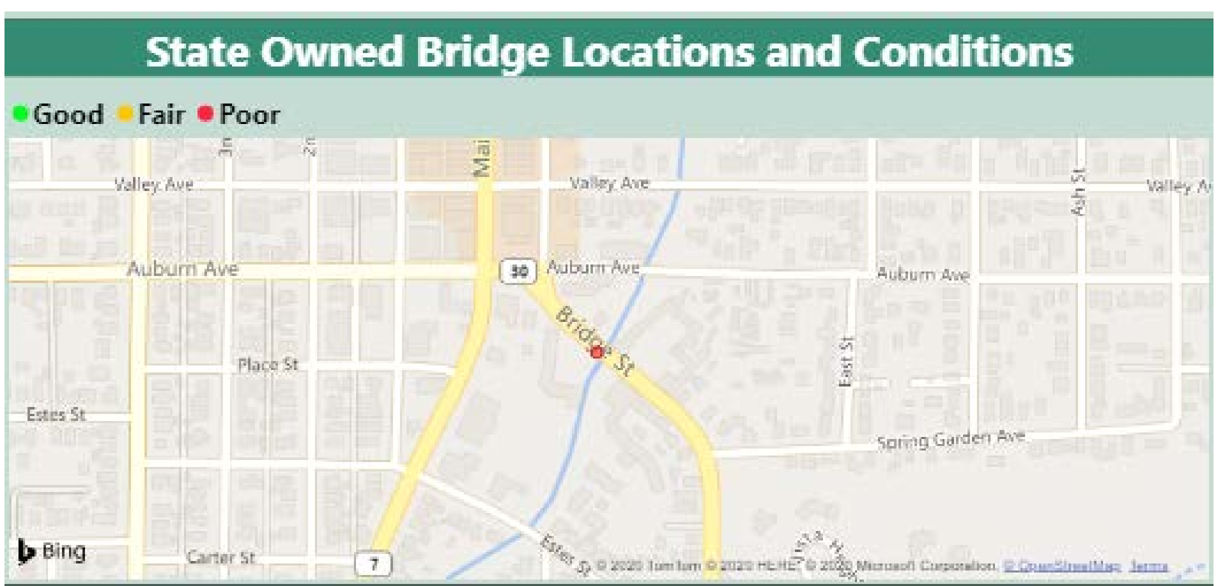


Figure 12. Location of state owned bridge in poor condition



Source: Oregon Department of Transportation 2019 Interactive Bridge Conditions Report

Public Transportation

Community Connections of Northeast Oregon runs public transportation between Baker City Haines and North Powder in Union County. A fixed route also runs weekly in the morning from Halfway, through New Bridge and Richland to Baker City and return in the evening and a Demand Response route operates weekly from Halfway to Richland and back.

A fixed route trolley is operated by Community Connections of Northeast Oregon in downtown Baker City.

Railroads

Railroads are major providers of regional and national cargo and trade flows. Railroads that run through the Northeast Region provide vital transportation links from the Pacific to the rest of the country. The Union Pacific Railroad runs north and south paralleling Interstate 84 through Baker County. There are a few abandoned railroad lines in the county and one historic rail line, the Sumpter Valley Railroad line.

Rails are sensitive to icing from winter storms that can occur in the Region. For industries in the region that utilize rail transport, these disruptions in service can result in economic losses. The potential for rail accidents caused by natural hazards can also have serious implications for the local communities if hazardous materials are involved.

Airports & Emergency Rotary Landing Zones

Baker's Municipal Airport is owned by the City of Baker and is classified as a General Aviation Facility. The first airline flights were Empire Airlines Boeing 247Ds in late 1946; successors West Coast, Air West and Hughes Airwest served Baker until 1973.

Airfield support is provided by a fixed base operator, Baker Aircraft, commenced operation in August of 2003. It presently provides a full line of aeronautical services.

Other private use airstrips in Baker County include locations in Halfway, Unity, Haines, Muddy Creek, Oxbow and Richland.

There are companies offering helicopter evacuation or ambulance service in Baker County. Requests for helicopter service from the U.S. Forest Service for emergencies must be routed through the Baker County Sheriff's office. Apart from the Baker City Airport, other recognized landing sites in Baker County include St. Elizabeth Hospital in Baker City, Unity Airport, Halfway Airport, the old fairgrounds in Sumpter, Boulder Park Resort, Idaho Power in Oxbow, and the Boundary Guard Station 3 miles east of Granite.

Dams

There have been floods, damage and even death caused by dam failures in Baker County.

Table 7. Historic Significant Dam Failures in Region 7

Year	Location	Description
1896	Goodrich dam west of Baker City in Baker Co.	Flood wave killed entire family of 7
1917	Killamacue dam west of Haines in Baker Co.	Property damaged
1937	Spaulding Vaughn dam in Baker Co.	Property damaged
1956	Goodrich dam west of Baker City in Baker Co.	Property damaged in the second failure of a dam at this site

Source: Oregon Water Resources Department Dam Safety Program records

Dams are now regulated by the Oregon Water Resources Department (OWRD). Oregon's statutory size threshold for dams to be regulated by OWRD is at least 10 feet high and storing at least 3 million gallons. Many dams that fall below this threshold have water right permits for storage from OWRD.

Under normal loading conditions dams are generally at very low risk of failure. Specific events are associated with most dam failures. Events that might cause dams to fail include:

- An extreme flood that exceeds spillway capacity and causes an earthen dam to fail;
- Extended high water levels in a dam that has no protection against internal erosion;
- Movement of the dam in an earthquake; and
- A large rapidly moving landslide impacting the dam or reservoir.

Most of the largest dams, especially those owned or regulated by the Federal Government are designed to safely withstand these events and have been analyzed to show that they will. However, there are a number of dams where observations, and sometimes analysis indicates a deficiency that may make those dams susceptible to one or more of the events.[55]

Oregon follows national guidance for assigning hazard ratings to dams and for the contents of Emergency Action Plans, which are now required for all dams rated as "high hazard." Each dam is rated according to the anticipated impacts of its potential failure. The state has adopted these definitions (ORS 540.443–491) for state-regulated dams:

- "High Hazard" means loss of life is expected if the dam fails.
- "Significant Hazard" means loss of life is not expected if the dam fails, but extensive damage to property or public infrastructure is.

There are five high hazard federally regulated dams in Baker County and eight State of Oregon owned dams that are rated "significant" hazard. The following table lists the condition of the dams of concern in Baker County.

[55] 2020 Oregon State NHMP draft

Figure 13. High and Significant Hazard Dams in Baker County

Name	Rating	Regulator
Brownlee Dam	High	Federal
Mason Dam	High	Federal
Oxbow Hydro Dam	High	Federal
Thief Valley Reservoir	High	Federal
Unity Reservoir	High	Federal
Balm Creek Reservoir	Significant	State
Camp Creek Reservoir (Baker)	Significant	State
Clear Creek Reservoir-West Fork	Significant	State
Goodrich Reservoir	Significant	State
Killamacue Reservoir	Significant	State
Love Reservoir (Baker)	Significant	State
Salmon Creek Reservoir	Significant	State
Whited Reservoir (Baker)	Significant	State

Source: 2020 Oregon State NHMP draft

Utilities

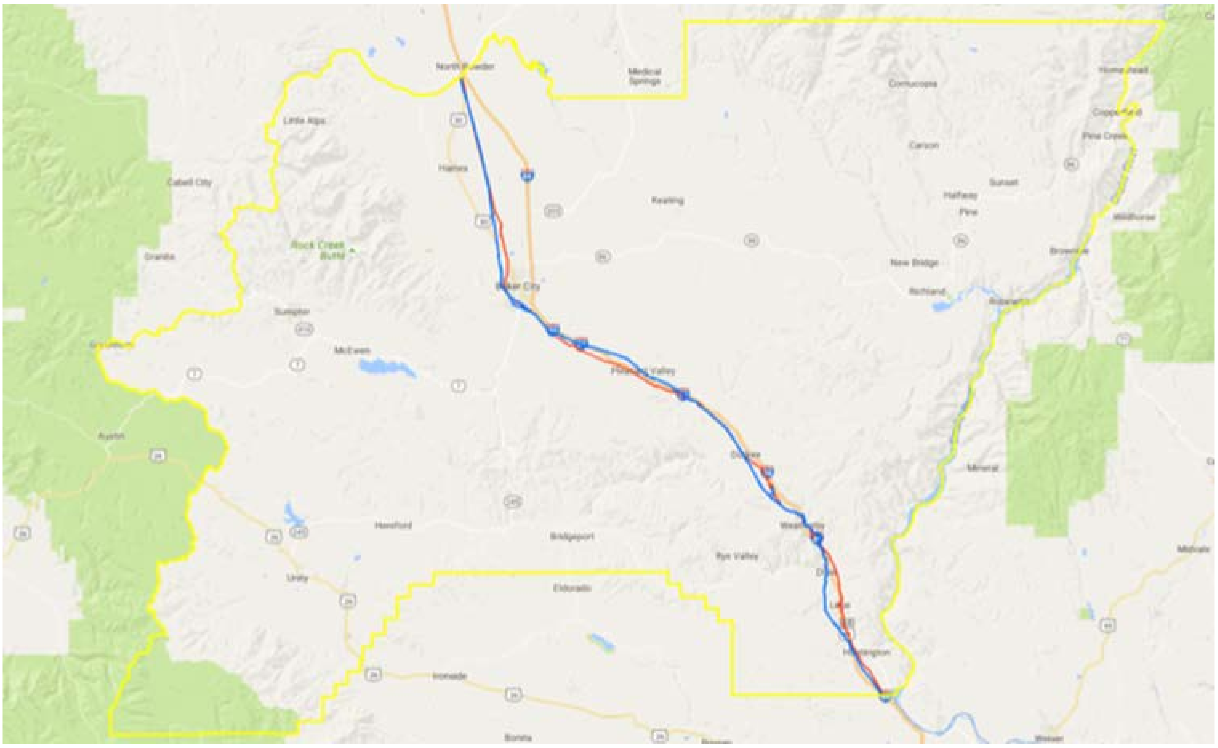
Transmission Lines and Pipelines

The Brownlee Dam and the Bonneville Dam generate hydropower which is the main source of electricity in Baker County. Both the Oregon Trail Electric Cooperative and Idaho Power use the system of dams on the Columbia and Snake rivers produce electricity. These rivers produce more than 22,000 megawatts of clean, carbon-free electricity every year. Wind, biomass, geothermal and solar power also produce electricity for Baker County and Oregon as a whole. Transmission lines are often above ground and subject to winter storm and windstorm damage.

Both gas and hazardous material pipelines run through Baker County, roughly following Highway 84 on a north-south route through Baker City. The figure below shows gas lines in blue and hazardous material lines in red.[56] These lines may be subject to damage by earthquake or landslide.

[56] The Oregonian, OregonLive, May 17, 2019, https://www.oregonlive.com/environment/2016/11/post_50.html

Figure 14. Gas and hazardous material pipe lines in Baker County, Oregon



Source: The Oregonian, OregonLive, May 17, 2019

Electricity is provided to northern Baker County by the Oregon Trail Electric Cooperative and to the southern part of the county by Idaho Power.

Oregon Trail Electric Cooperative

Oregon Trail Electric Cooperative (OTEC) is one of Oregon's largest distribution cooperatives. Headquartered in Baker City, Oregon, with district offices in La Grande, John Day, and Burns, OTEC serves approximately 31,000 customers in Baker, Grant, Harney and Union counties with a network of overhead and underground lines over 3,000 miles long. OTEC's distribution system represents an investment of more than $153 million[57] (Oregon Trail Cooperative website).

Idaho Power

Idaho Power uses 17 hydroelectric projects as the core source of its electricity. The company serves more than 570,000 customers in a 24,000 square mile service area predominantly in Idaho. Idaho Power has set a goal of providing 100% clean energy by 2045.

Although just under 30% of Baker County residents use electricity to heat their homes, natural gas is the source of heat for 39% of Baker County residents with 20% of residents using wood for heating.

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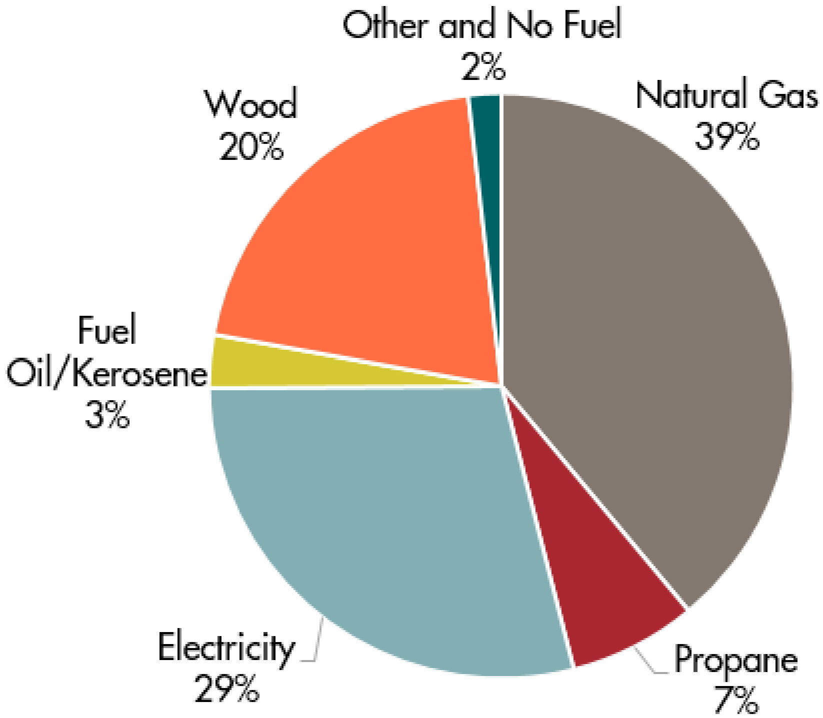
[57] Oregon Trail Electric Cooperative, https://otec.coop/

Figure 15. Home Heating Fuel Use in Baker County.



Source: Oregon Department of Energy, 2018 Biennial Energy Report.

Communications

Blue Mountain Translator District

The Blue Mountain Translator District is a special district that provides television signals to portions of Baker and Union Counties. BMTD's translators broadcast signals to Baker City, Cove, Elgin, Haines, Imbler, Island City, Keating, La Grande, Medical Springs, North Powder, Summerville, Sumpter, and Union. BMTD broadcasts additionally relay signals through a network that ensures OTA access in Morrow County, Umatilla County, and the Walla Walla area, as well as cable TV access in Joseph. [58] Currently, the Blue Mountain Translator District (BMTD) is Oregon's only translator district. BMTD is advised by a five member board and operates with a single employee assisted by several contractors and a summer intern. BMTD benefited from recent legislation that allows it to finance operations by operating its own noncommercial TV station.

Translator districts or non-profit entities are often created when a community is too far away from urban transmitter sites to receive over-the-air TV signals, or when cable TV is impractical to introduce. Translator towers are pretty common throughout the western US, operating as companies, nonprofits, and government agencies. Peer institutions in the West are either translator districts funded directly by property taxes, or subunits of county governments (and Parks & Recs District in Colorado) funded by

[58] Personal communication with Alex McHaddad, BMTD Executive Director, June 2020

property tax-based general fund revenue. Other translators in Oregon have operated in Maupin until 2008 and in Hood River.

Cellular, Internet and Phone services

Coverage maps provided by four major cellular service providers show service to some extent in Baker County by Verizon Wireless, AT&T, Sprint, T-Mobile and US Cellular.[59] There are approximately 11 cellular towers in Baker County several of which are owned by the Eagle Telephone System, a local company that provides telephone, mobile broadband service and DSL internet to the Richland area including New Bridge, Sparta, Eagle Creek and the Connor Creek area in the Snake River Corridor between Huntington and Richland. Also in Pine Valley OTC Connections, another local telephone company provides internet, cable and phone service.

The primary internet providers in the Baker City area are Spectrum providing cable internet service and CenturyLink that provides DSL internet service to a wider area of the county.[60] In Hines and Huntington several fixed wireless internet providers advertise service that utilizes an antenna to pick up radio signals from the closest cell tower and route it into the user.

Water and Waste Water Systems

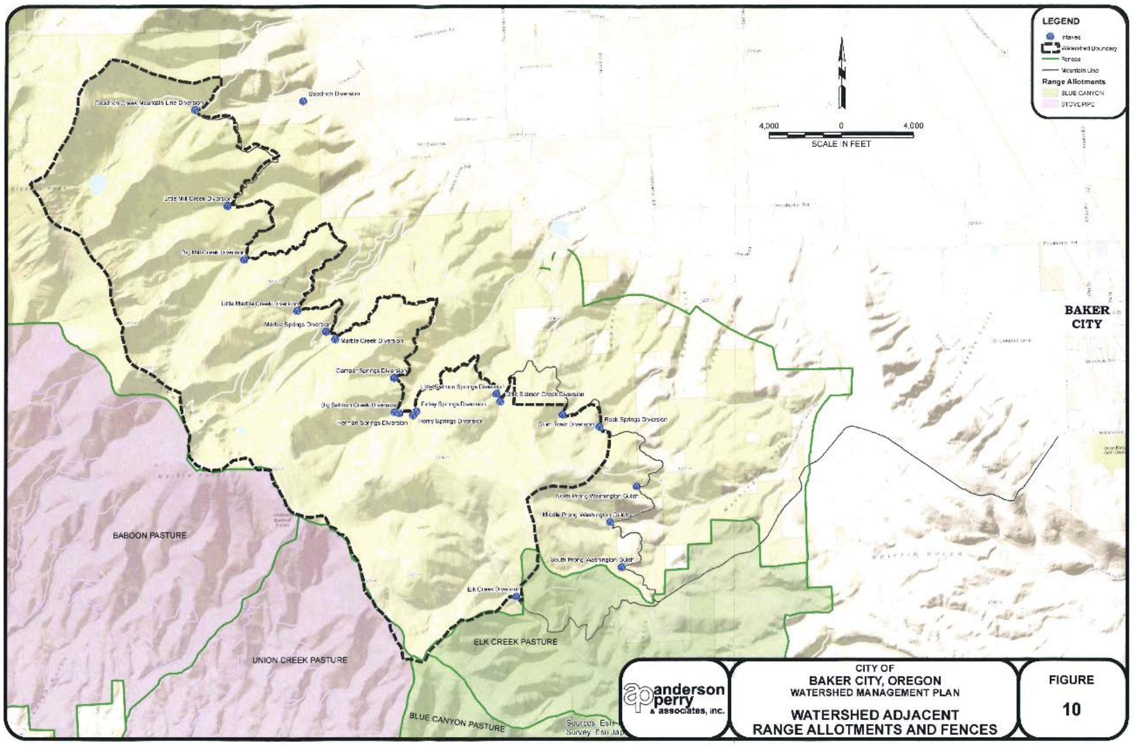
Baker City:

Water: The Baker City Watershed comprised of approximately 10,000 acres supplies nearly 90% of the water for Baker City. There are 11 primary streams/diversions that collect the surface water which gravity flows to Baker City. There is one municipal well and a second well being drilled in 2020 to supply peak day demand and provide redundancy in supply. The Water Treatment Plant uses chlorine and ultra violet light treatment to prepare potable water for the city. The plant has a capacity of 12 million gallons per day. There is 7.5 million gallons of above ground stored treated water and up to 240 million gallons stored underground via the Aquifer Storage and Recovery well(s). Average winter production is 1.5 million gallons per day and average summer production is 6 million gallons per day. There is an onsite generator providing backup power for the full treatment facility including the UV plant.

Wastewater: Baker City wastewater is gravity flow through town to the Wastewater Treatment Plant (WWTP) with the exception of one lift station for one neighborhood. The WWTP has a 2 million gallon per day design capacity through the 100 acre 4-cell lagoon. Currently discharge is to the Powder River and occurs during the spring, summer and fall with storage in the lagoon during winter. The plant currently runs at capacity. The WWTP is undergoing upgrades during 2020/2021 to eliminate discharge to the Powder River and instead use treated effluent for land application. This includes construction of a new storage pond and the removal of biosolids to increase the capacity of the existing 4-cell lagoon. There are dual pumps and generator back-up at the WWTP. The lift station has an alarm when the power is out but there is no backup power. There is a two day storage capacity prior to any overflow at the lift station.

[59] https://www.wirefly.com/content/phone-plans/oregon/baker-city
[60] https://broadbandnow.com/Oregon/Baker-City

Figure 16. Baker City Municipal Watershed



Source: Baker City Watershed Management Plan (2014)

Halfway:

Water: Halfway residents are served by a well located north of the community of Carson.

Wastewater: The Halfway wastewater treatment plant (WWTP) is located adjacent to Pine Creek and has been subject to flooding. The city secured CDBG funding and loan funds to develop a secondary holding pond for effluent from the WWTP and subsequent discharge to fields as surface application. Water from Pine Creek making its way into the treatment lagoons during times of high spring runoff continues to be a concern and the channel upstream from the WWTP is kept clear of vegetation and debris to avoid that problem. This is the area where Pine Creek intersects with Hwy 414, an area of concern noted in the FEMA Risk MAP Discovery meetings.

Appendix B: Planning and Public Process

Table of Contents

List of Figures and Tables

Planning and Public Process

Purpose

This Appendix describes the process of updating the plan, how the plan was prepared, who was involved and specific changes made to the *2014 Northeast Oregon Multi-jurisdictional Natural Hazards Mitigation Plan (2014 NHMP)* during the plan update process.

Background

The Disaster Mitigation Act of 2000 requires communities to update their mitigation plans every five years to remain eligible for Pre-Disaster Mitigation (PDM) program funding, Flood Mitigation Assistance (FMA) program funding, and Hazard Grant Mitigation Program (HMGP) funding. Baker County was a participant in the *2014 NHMP* that expired during the update process. In 2018 the Department of Land Conservation and Development was awarded an HMGP grant by FEMA to assist Baker County with its NHMP update. Baker County partnered with the Oregon Department of Land Conservation and Development (DLCD staff over the next year and a half to update the *NHMP* producing this document, the *2020 Baker County Multi-Jurisdictional Natural Hazard Mitigation Plan.*

DLCD staff worked with Baker County's Emergency Manager, Jason Yencopal, to form the Baker County 2020 NHMP Steering Committee (SC) representative of the whole community. Initially the DLCD Natural Hazard Planner, Jason Gately, managed the project and met with members of the SC three times and conducted individual phone conversations and email conversation to guide SC work on the plan update. From late July through mid-September, FEMA was concurrently conducting a Risk MAP process that involved risk assessment and mitigation strategy development. These meetings are included in the NHMP update process. In January 2020 Katherine Daniel took up the project management and writing of the NHMP update and met with the Steering Committee one addition time.

The Steering Committee included steady representation from Baker County and from the Cities of Baker City and Halfway, the Baker County Library District. Meetings were also periodically attended by individuals representing the Baker City Fire Department, Baker Rural Fire Protection District, North Powder Fire Department, Greater Bowen Valley Rural Fire Protection District, Baker School District, the Pine Eagle School District, the Baker Soil and Water Conservation District, the Powder Valley Water Control District, the Powder River Watershed Council, Oregon Department of Forestry, Oregon Department of Transportation, Natural Resource Conservation Service, the US Forest Service, the Bureau of Land Management and the Blue Mountain Translator District. Below is a list of the Steering Committee members and other representatives who participated in steering committee meetings, and in the case of the representatives of Oregon Department of Transportation, The Powder Valley Water Control District, and the Powder Basin Watershed Council, attended the FEMA Risk MAP Discovery meetings or webinars held during the NHMP update process.

2020 NHMP Public Participation Process

Baker County is dedicated to directly involving the public in the review and update of the natural hazard mitigation plan. Although members of the 2020 Baker County NHMP Steering Committee represent the public to some extent, the residents of Baker County, the Cities of Baker City, Halfway, Huntington, Haines, Richland, Sumpter, and Greenhorn were notified about opportunities to provide feedback about the NHMP through personal communication, public notices, Facebook posts and meetings. As described in Volume I: Section 4 - Plan Implementation and Maintenance, the NHMP will undergo formal review twice per year in concert with the requirements of the Emergency Management Program Grant utilized by the county to support its emergency management services.

Baker County Emergency Manager posted notification of steering committee meetings through flyers distributed to the Baker County Library District main and branch libraries. Notification of meetings was also posted on the Emergency Management Department Facebook page. Participation by the public and feedback on the NHMP update process was solicited by Steering Committee members between meetings.

The project manager reached out to the Baker City Herald in early August 2019 offering an interview with the newspaper regarding the NHMP update process. An article was published August 14th on the front page of the Baker City Herald. Later in the drafting process the Emergency Manager, Jason Yencopal, made the completed draft *2020 Baker County NHMP* available via their websites prior to the final submission of the NHMP to FEMA Region X and Office of Emergency Management reviewers. The Blue Mountain Translator District broadcast the fourth steering committee meeting on its frequencies for two hours in a mid-morning time slot on May 21, 2020.

Public Involvement Summary

Keeping in mind the importance of representing the whole community, the 2020 Grant County NHMP Steering Committee (the Steering Committee) was assembled by Jason Yencopal, Baker County Emergency Manager, and Jason Gately, DLCD Natural Hazard Planner. A broad range of jurisdictions and agencies were solicited for potential participation. Opportunity to participate as a member of the steering committee was extended to representatives of all the incorporated cities in the county, local and regional agencies involved in hazard mitigation and agencies that have the authority to regulate development. Emails soliciting participation were sent to representatives from the county and cities, such as the County Commissioners, City Mayors, City Recorders, Planning Directors, Public Works Department Directors; Soil and Water Conservation and the Blue Mountain Translator District Managers, School District Superintendents; representatives of local fire districts, US and Oregon agencies, such as the Oregon Department of Forestry, Oregon Water Resource Department, the Army Corps of Engineers, the Bureau of Land Management; owners of local businesses; local non-profits and involved citizen leaders.

The members of the Steering Committee volunteered their time to provided edits and updates to the NHMP during publicly advertised meetings and on an individual basis such comments being vetted in a public forum before inclusion in the document. Opportunities for the public to comment were provided at each meeting and through the Emergency Management Facebook page.

Not all those who were invited were able to participate in the NHMP Steering Committee, however, the FEMA Risk MAP webinar meeting and the Discovery meeting were well attended.

Project Steering Committee Members:

These representatives served as Steering Committee members for the Baker County Natural Hazards Mitigation Plan update process. Jason Yencopal, Director of Baker County Emergency Services was the convener of the committee.

Baker County

Jason Yencopal — Emergency Management
Holly Kerns — Planning Department
Jeff Smith — Road Department

Baker County Library District

Ed Adamson — Facilities Manager

City of Baker City

Michelle Owen — Director of Public Works

City of Halfway

Salli Hysell — City Recorder

Baker School District 5J

Lance Woodward — Superintendent
Christi Settles — Maintenance

Pine Eagle School District

Cammie DeCastro — Superintendent

Blue Mountain Translator District

Alex McHaddad — Director

Baker Soil and Water Conservation District

Whitney Collins — District Manager

Baker Rural Fire Protection District

Sean Lee — Fire Chief

North Powder Rural Fire Protection District

Colby Thompson — Fire Chief

Greater Bowen Valley Rural Fire Protection District

Chris Galiszewski — Fire Chief

Oregon Department of Forestry

Steve Meyer — Protection Supervisor

Natural Resource Conservation Service

Misty Beals — District Conservationist

Oregon Department of Land Conservation & Development Project Managers

Jason Gately — Natural Hazard Planner
Katherine Daniel — Natural Hazards Planner

Other Participants:

United States Forest Service
Steve Hawkins, Deputy Fire Staff
Joel McCraw, Assistant Fire Management Officer

Powder Basin Watershed Council
Christo Morris, Executive Director

Powder Valley Water Control District
Lyle Umpleby, District Manager

Oregon Department of Transportation
David Dethloff, Asst. District Manager
Ken Patterson, Region 5 Area Manager

The following pages include copies of meeting agendas and sign-in sheets from NHMP Steering Committee meetings, website screenshots, flyers, and other information that demonstrates the outreach that has been done during this NHMP update process.

Summary of Outreach

Table 1. Baker County NHMP Outreach Efforts

Date	Description of Event/Activity
March 12, 2019	Jason Yencopal, Baker County Emergency Manager and the Project Manager met to discuss the composition of the steering committee and the role of members of the 2020 Baker County NHMP Steering Committee.
May 21, 2019	Jason Yencopal convened the first Steering Committee meeting. The responsibilities of all parties were reconfirmed with IGA's to be signed in the near future. The Steering Committee members accepted the lead on public engagement during the NHMP update process.
June, 2019	Flyer distributed to the public in the Baker County Library and the five branch libraries promoting a survey mounted by the Project Manager and the Steering Committee.
July 16, 2019	Jason Yencopal convened the second Steering Committee meeting to consider the Risk Assessment phase of the NHMP update and to complete a Hazard Vulnerability Analysis. This meeting was advertised to the public with flyers distributed through the Baker County Library system.
August 14, 2019	Baker City Herald published an article on the NHMP update process.
July 31 – August 22, 2019	FEMA Risk MAP project initiated the Discovery process through Community Information Exchange webinars with communities in Baker County.
September 10, 2019	Jason Yencopal convened the third Steering Committee meeting to begin discussing the Mitigation Strategy. This meeting was advertised to the public with flyers distributed through the Baker County Library system.
September 12, 2019	FEMA Risk MAP project held the Discovery Meeting with communities in Baker County to learn from residents and stakeholders about the county's vulnerabilities to natural hazard events.
January 2020	DLCD Project Manager position was filled by Katherine Daniel.
May 19, 2020	Jason Yencopal convened fifth Steering Committee meeting to allow K. Daniel to confirm with the Steering Committee the work completed to date with DLCD staff member Jason Gately, who resigned his position in December 2019 including work as Grant County NHMP Project Manager.

Steering Committee Meeting Agendas and Sign-in Sheets

Figure 1. March 12, 2019 County organizational meeting agenda

Baker County NHMP Update
County/DLCD Coordination Meeting

Date: 03/12/2019	1995 3rd St.
Time: 10:00am – 12:00am	Baker City, OR 97814

A.	Project Overview	10 min
B.	Discuss the Intergovernmental Agreement	10 min
C.	Discuss the Scope of Work and revise as necessary, this will include: a) Project Schedule b) Discuss Table 1: Allocation of Basic Responsibilities and Tasks c) Deliverables	30 min
D.	Discuss the current NHMP's strengths and opportunities for improvement;	10 min
E.	Review Steering Committee member list	10 min
F.	Review draft Public Engagement Program	20 min
G.	Review Communication Protocol	10 min
H.	Next Steps/Action Items	5min

Figure 2. May 21, 2019 Steering Committee meeting agenda

Baker County NHMP Update
County/DLCD Coordination Meeting

Date: 03/12/2019
Time: 10:00am – 12:00am

1995 3rd St.
Baker City, OR
97814

A.	Project Overview	10 min
B.	Discuss the Intergovernmental Agreement	10 min
C.	Discuss the Scope of Work and revise as necessary, this will include: a) Project Schedule b) Discuss Table 1: Allocation of Basic Responsibilities and Tasks c) Deliverables	30 min
D.	Discuss the current NHMP's strengths and opportunities for improvement;	10 min
E.	Review Steering Committee member list	10 min
F.	Review draft Public Engagement Program	20 min
G.	Review Communication Protocol	10 min
H.	Next Steps/Action Items	5min

Figure 3. May 21, 2019 Sign-in Sheet

Baker County Natural Hazards Mitigation Plan
Steering Committee Meeting # 1
May 21th, 9am-11pm
1995 3rd St.
Baker City, OR 97814

Full Signature	Organization	Name	Email
	County Emergency Manager	Jason Yencopal	**jyencopal@bakercounty.org**
	County Road Department	Jeff Smith	bcroad@bakercounty.org
	County Commissioner	Mark Bennett	mbennett@bakercounty.org
	County Planning	Holly Kerns	hkerns@bakercounty.org
	City of Greenhorn	Dale McClouth	dalemclouth@molalla.net
	City of Halfway	Sally Hysell	halfwaycity@gmail.com
	City of Huntington	Wendy Gargan	huntingtoncityof@gmail.com
	City of Haines	Valerie Russell	haines@cascadeaccess.com
	City of Richland	Patty Crews	richcity@eagletelephone.com
	City of Sumpter	Julie McKinney	cityofsumpter@qwestoffice.net
	Baker City Police	Dustin Newman, Chief	dnewman@bakercity.com
	Baker City Fire	John Clark, Chief	jclark@bakercity.com
	Baker City Public Works	Michelle Owen	mowen@bakercity.com

Baker County Natural Hazards Mitigation Plan
Steering Committee Meeting # 1
May 21th, 9am-11pm
1995 3rd St.
Baker City, OR 97814

LANCE WOODWARD	Baker School District	Mark Witty, Superintendent	Mark.witty@bakersd.org
Cammie DeCastro	Pine Eagle School District	Cammie DeCastro	cadecastro@pineeaglesd.org
	Huntington School District	Scott Bullock	Scott.Bullock@huntingtonsd.org
	Burnt River School District	Lorrie Andrews	lorrieandrews@burntriver.k12.or.us
	Medical Springs RFPD	Phil Whitley, Chief	whitleyranch@gmail.com
	Haines FPD	Jerry Hampton, Chief	Jerryhampton61@gmail.com
	Keating FPD	Buzz Harper, Chief	Sandyharper13@gmail.com
	Pine Valley RFPD	Todd Robinett, Chief	training@pinetel.com
	Eagle Valley RFPD	Dave Kingsbury, Chief	dkingsbury@pinetel.com
	Powder River RFPD	Wes Morgan, Chief	morganwc@q.com
	Baker County Library District	~~Perry Stokes~~ ED ADAMSON	~~director@bakerlib.org~~ Facilities@bakerlib.org
	Greater Bowen Valley RFPD	Chris Galiszewski	gbvrfpd@gmail.com
	Army Corp	Jeff Stidham	Jeffery.l.stidham@usace.army.mil
	USFS	Willy Crippen	wcrippen@fs.fed.us

Figure 4. July 16, 2019 Steering Committee Agenda

Baker County Natural Hazard Mitigation Plan Update
Steering Committee Meeting #1

May 21, 2019, 9:00 to 11:00 AM
1995 3rd St.
Baker City, OR 97814

AGENDA

Introduction and Background	**9:00 – 9:15**
▪ Introductions ▪ Meeting Goals and Objectives ▪ Goals of the Plan	
Natural Hazards Mitigation Planning Overview	**9:15 - 9:25**
▪ What is Natural Hazards Mitigation Planning?	
Review and Discuss the (IGA) and Scope of Work (SOW)	**9:25 – 10:30**
Review and Discuss Public Engagement Program and Communication Protocol	**10:30 -10:45**
▪ Events, venues, formats (fairs, farmer's markets, senior centers, rodeos, etc.)? ▪ Internet ▪ News media ▪ Online Survey	
Natural Hazard / Community Assets Worksheet	**10:45 -10:50**
▪ Homework! Email completed form to: Jason.gately@state.or.us by Friday, May 31st	
Next Steps / Adjourn	**10:50 - 11:00**
▪ Steering Committee Mtg. #2: Risk Assessment – need a date and location. ▪ Action Items	

Pg. 1

Figure 5. July 16, 2019 meeting sign-in sheet

Baker County Natural Hazards Mitigation Plan
Steering Committee Meeting # 2
July 16th, 9am-11pm
1995 3rd St.
Baker City, OR 97814

	BLM	Lori Wood	lwood@blm.gov
	ODF	Steve Meyer	Steve.meyer@state.os.us
	OWRD	Rick Lusk	Rick.m.lusk@wrd.state.or.us
	Baker City Municipal Airport	Troy Woydziak	troy@bakercityairport.com
	Baker Valley RFPD	Sean Lee	slee@bakerruralfire.org
	Sumpter Fire	Kurt Clarke	Kclarke97702@yahoo.com
	NRCS	Misty Bennett	Misty.bennett@or.usda.gov
	FSA	Trent Luschen	Trent.luschen@or.usda.gov
	Baker SWCD	Whitney Collins	Whitney.collins@bakercountyswcd s.com
	Huntington Fire	Eric Bronson	ebbronson@yahoo.com
	DOGAMI	Jason McClaughry	Jason.mcclaughry@dogami.state.o r.us
	North Powder Fire	Colby Thompson	tlazytfarm@gmail.com
	Blue Mountain Translator District	Alex McHaddad	Bmtd.org@gmail.com
[signature]	Baker County Library	Ed Admanson	facilities@bakerlib.org

Baker County Natural Hazards Mitigation Plan
Steering Committee Meeting # 2
July 16th, 9am-11pm
1995 3rd St.
Baker City, OR 97814

Full Signature	Organization	Name	Email
	County Emergency Manager	Jason Yencopal	**jyencopal@bakercounty.org**
	County Road Department	Jeff Smith	bcroad@bakercounty.org
	County Commissioner	Mark Bennett	mbennett@bakercounty.org
	County Planning	Holly Kerns	hkerns@bakercounty.org
	City of Greenhorn	Dale McClouth	dalemclouth@molalla.net
	City of Halfway	Sally Hysell	halfwaycity@gmail.com
	City of Huntington	Wendy Gargan	huntingtoncityof@gmail.com
	City of Haines	Valerie Russell	haines@cascadeaccess.com
	City of Richland	Patty Crews	richcity@eagletelephone.com
	City of Sumpter	Julie McKinney	cityofsumpter@qwestoffice.net
	Baker City Police	Dustin Newman, Chief	dnewman@bakercity.com
	Baker City Fire	John Clark, Chief	jclark@bakercity.com
[signature]	Baker City Public Works	Michelle Owen	mowen@bakercity.com

Figure 6. September 12, 2019 FEMA Risk MAP Discovery meeting

BAKER COUNTY | OREGON

LOCAL PARTICIPATION

The Baker County Information Exchange webinars were held in July and August 2019 with Baker County and the cities of Baker City, Greenhorn, Haines, Huntington, and Unity, and the Town of Halfway.

Staff from Baker County and the cities of Baker City, and Haines and the Town of Halfway attended the in-person Baker County Discovery Meeting on September 12, 2019.

DISCOVERY MEETING LOCATION: Oregon Trail Electric Cooperative Office in Baker City, OR

COMMUNITY	NAME	TITLE	INFORMATION EXCHANGE WEBINAR	IN-PERSON DISCOVERY MEETING
BAKER COUNTY	HOLLY KERNS	Planning Department Director	X	X
	EVA HENES	Planner	X	
	CHRISTO MORRIS	Executive Director - Powder Basin Watershed Council		X
	NOODLE PERKINS	Roadmaster	X	
	LYLE UMPLEBY	District Manager - Power Valley Irrigation District		X
	JASON YENCOPAL	Emergency Manager	X	X
BAKER CITY	CHRISTY SETTLES	School District Maintenance Supervisor	X	X
	MICHELLE OWEN	Public Works Director	X	
	FRED WARNER, JR.	City Manager	X	
GREENHORN	DALE MCLOUTH	Mayor	X	
HAINES	JIM BROWN	Mayor	X	
	RICHARD HOWE	Planning Director	X	
	ANDI WALSH	Planner		X
HALFWAY	SALLI HYSELL	City Recorder	X	X
HUNTINGTON	JENNIFER PETERSON	City Recorder	X	
UNITY	MARK BENNETT	General Manager	X	

FEMA

REGION X — DISCOVERY REPORT | 24

BAKER COUNTY | OREGON

LOCAL PARTICIPATION

COMMUNITY	NAME	TITLE	INFORMATION EXCHANGE WEBINAR	IN-PERSON DISCOVERY MEETING
OREGON DEPARTMENT OF TRANSPORTATION	DAVE DETHLOFF	Region 5 - Assistant District Manager		X
	KENNETH PATTERSON	Region 5 - District Manager		X
WALLOWA-WHITMAN NATIONAL FOREST	STEVE HAWKINS	Deputy Fire Staff, Fuels Program Manager		X

Figure 7. May 19, 2020 Steering Committee meeting agenda

Baker County Natural Hazard Mitigation Plan Update
Steering Committee Meeting

Risk Assessment and Mitigation Strategy
draft chapter review

OREGON
Department of Land Conservation & Development

May 19, 2020
10:00 am to 12:00 noon
Via Zoom
https://us02web.zoom.us/j/2501233496?pwd=SGVMMGVHTzZQUmNGSU93WU9XVlV3dz09
Meeting ID: 250 123 3496 Password: 577369

Or for audio only by phone: (669) 900-6833 or (253) 215-8782

AGENDA

Introduction and Background	**10:00 – 10:25**
▪ Introductions ▪ Updates (schedule review and cost share reporting) ▪ Meeting Goals and Objectives · Review and revise Risk Assessment chapter · Review and revise Mitigation Strategy chapter	
Risk Assessment and Mitigation Strategy chapter reviews	**10:25 - 11:25**
Both Steering Committee members and other invitees are welcome to make comments on the chapters.	
Public Engagement	**11:25 – 11:40**
Develop community engagement strategy for remainder of NHMP update process Discuss means for providing access to draft documents on agency websites.	
Next Steps	**11:40 - 11:45**
▪ Remaining sections of Volume I: Basic Plan ▪ Volumes II and III	

Figure 8. May 19, 2020 Steering Committee Meeting Minutes

Baker County Natural Hazard Mitigation Plan Update
Steering Committee Meeting

Risk Assessment and Mitigation Strategy
draft chapter review

May 19, 2020
10:00 am to 12:00 noon
Via Zoom
https://us02web.zoom.us/j/2501233496?pwd=SGVMMGVHTzZQUmNGSU93WU9XVlV3dz09
Meeting ID: 250 123 3496 Password: 577369

Or for audio only by phone: (669) 900-6833 or (253) 215-8782

Minutes

Attendees: Jason Yencopal, Baker County Emergency Manager;
Michelle Owen, Baker County Public Works Director;
Ed Adamson, Facilities Specialist Baker County Library District;
Holly Kerns, Baker County Planning Director;
Tamra Mabbot, DLCD Regional Representative;
Misty Beals, District Conservationist for NRCS;
Alex McHaddad, Exec. Director of Blue Mountain Translator District;
Joel McGraw, District Fire Management Officer for USFS;
Steve Hawkins Deputy Fire Staff, Wallowa Whitman NF;
Christy Settles, Baker School District 5J Maintenance

Introductions: The meeting convened at 10:04 am with brief introductions and a review of the purpose of the meeting. Although the project is at a later stage than was anticipated, it is still on track to be completed within the period of performance of the FEMA grant under which the Baker County NHMP is being updated through a partnership between Baker County and Oregon Department of Land Conservation and Development (DLCD)

Risk Assessment and Mitigation Strategy chapter reviews:

Jason Yencopal suggested a revision to the order of importance of the natural hazards. He made the observation that Drought has historically been the Baker County's worst hazard in terms of economic impacts as compared to Wildfire. He and Ed Adamson agreed that Winter Storms are also among the most important natural hazards faced by residents in Baker County.

The Hazard Vulnerability Assessment (HVA) was completed questionnaire- style by several members of the steering committee individually; however, Jason observed that it is better completed as a group exercise. Katherine Daniel agreed and noted that the HVA is qualitative in nature. The group agreed that she should adjustment in the relative importance of Drought over Wildfire.

Regarding the Risk Report prepared by Oregon Department of Geology and Mineral Industries (DOGAMI), Jason mentioned the need to follow up with Matt Williams of that agency to finalize the comments made following Matt's presentation to a few of the steering committee members on September 10, 2020. Katherine will follow up with Jason and Matt.

Ed Adamson stated that Baker County's biggest natural hazard issue in the recent past was the damage from winter storm events 2016-17. He noted structural failures at the library and other damage in the county. He suggested mitigation of this damage by conducting structural assessment of critical facilities. He referred to teams of FEMA structural specialists who conducted such assessments following hurricane events in the southeastern US.

Regarding the historical listing of wildfires, the source of the Dry Gulch fire was a vehicle accident, not lightning. The Rail fire was not listed. The Bear Butte fire was not listed. Katherine will make these corrections. The group agreed that December 31, 2019 would be the cut off for listing of historical hazard events.

Gary Tim, Grant County Emergency Management Fire Division staff is heading up the update to the Community Wildfire Protection Plan. Gary also reviewed these draft NHMP chapters and had participated in the 2014 NE Oregon NHMP that is being updated with this process.

Multi Hazard mitigation actions MH1-MH 9.1 were reviewed and the following revisions or additions were made:
MH 2 changed from High to Low priority,
MH 3 is Low Priority because it is easiest to do in conversation to inform public officials and a routine action when new officials come on board;
MH4 – the Library was added as a lead agency for this action as public engagement falls squarely in its wheelhouse; the Translator District was added as a partner (MH 4.1 and MH 4.2) and ideas of a kiosk with materials, an informational "Disasters and Donuts" type of event and the creation of long or short form videos to air via the Translator District were discussed;
MH 5 - COVID-19 has raised awareness of the essential role played by local businesses; the priority level was raised from Low to Medium and the status of Deferred was removed
MH 9 – Steve Hawkins noted that the evacuation routes covered in the CWPP was the basis for USFS assistance in developing an alternative route for Stises Gulch (spelling?); Alex McHaddad offered for the Translator District to broadcast evacuation routes and development of PSAs for radio outside of the Translator District's current reach; maps of evacuation routes were not identified. Specific cities and communities with only a single route of access, such as Halfway and Sumpter, were of concern. Mass notification and follow up by law enforcement and fire personnel were the principle means of notification of the need for evacuation.

Regarding LiDAR collection, Holly noted that part of the discussion on this topic was to consolidate resources and get wider coverage; Katherine will verify Jason's report out at the meeting that a summer 2021 project would complete LiDAR in the county. Steve reported that the USFS has some LiDAR from flights last summer.

Wildfire Mitigation actions were reviewed and revised shortening the WF 1 description.

Steve offered that Baker County is writing a smoke mitigation plan with DEQ funds. It addresses health concerns of smoke for at-risk populations as well as planning for proscribed fire to reduce fuel loads. Doni Bruland from Baker County is writing this plan.

Regarding Sage Grouse habitat and wildfire mitigation actions, Holly Kern offered to provide some more detail strategies for preserving sage grouse habitat as relates to wildfire protection measures in order to preserve the possibility of NHMP supporting additional funding for those efforts.

Drought mitigation actions were reviewed. Jason offered to communicate with the watermasters to look over the drought mitigation actions.

Ed suggested adding an action under Severe Weather: Structural Assessments of critical facilities. This would serve to mitigate both earthquake damage and winter storm damage. For example, installing cross strapping as a mitigation strategy to prevent collapse of walls whether from earthquake or from snow load.

Public Engagement: Katherine noted that the representatives of jurisdictions that will be plan holders (Baker County, Baker City and City of Halfway) have agreed in the IGAs that were signed to conduct public engagement activities, so that the NHMP can benefit from the whole community perspective. Jason noted that he has provided notice of meetings on the Emergency Management Facebook page.

The NHMP update process will follow the EMPG requirements for updating twice annually. Jason schedules these for just after fire season (late fall) and just before fire season (late winter).

Katherine thanked everyone for attending and for their contributions.

The next (and potentially final) meeting date was not set at this time. Katherine will be composing and sending additional chapters of the NHMP for review by the steering committee members over the next several weeks.

Baker County Outreach Materials and Media

A public engagement strategy was developed early in the process as illustrated in the 2020 Baker County Public Engagement Strategy document below. Flyers were prepared and utilized to educate Steering Committee members to promote public engagement. These flyers were posted on the Emergency Management Department Facebook page. An interview by Jason Gately, DLCD, with the Baker City Herald was used in an article published in the newspaper on August 14, 2019 that stimulated interest in the NHMP process. In the final months of the process, Baker County and Baker City posted the draft NHMP on their websites. The final steering committee meetings were held via video conference. The links to these video conference meetings were provided in email communications to all those who had participated to date.

Figure 9. Public Engagement Strategy

2020 Baker County NHMP Public Engagement Strategy

Public engagement is a cornerstone of the NHMP Update. It may include such things as: scheduling, preparing for and staffing public outreach events, posting documents online and gathering comments, organizing mailers, meeting one on one with key stakeholders, or delivering a presentation to stakeholders. Public engagement for the update of the Baker County NHMP will consist of engaging three tiers (groups) of people at various times during the planning process. Baker County will be the lead for this task.

Public Engagement Objectives

Provide an opportunity for all citizens – the whole community - of Baker County to be involved in the planning process, to educate the citizens of Baker County on the risks of natural hazards in their community, to give the planning team a solid understanding of community concerns and values so that they can be reflected in the plan, and to ensure that the whole community clearly understands that their thoughts and concerns will be listened and responded to.

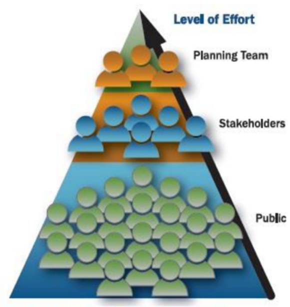


Figure 3.1: Outreach strategy framework

Tier One: The Planning Team

The Planning Team consists of the Baker County Project Conveyor, the Steering Committee and the DLCD Project Manager.

When to provide information and seek input

- At Steering Committee Meetings;
- When a draft of the Risk Assessment has been completed;
- When a draft of the Mitigation Strategy has been completed; and
- When a draft plan and a final have been completed.

How to provide information and seek input

- See the Communication Protocol for the Steering Committee (attached).

Tier Two: Stakeholders

Stakeholders, as defined by FEMA, are individuals or groups that can affect or can be affected by a mitigation action or policy. This may include: elected officials, business leaders, government agencies, cultural institutions, non-profit organizations, neighborhood groups, and academic institutions.

When to provide information and seek input

- At the beginning of the project to let people know what is happening and why;
- When a draft of the Risk Assessment has been completed;
- When a draft of the Mitigation Strategy has been completed; and
- When a draft plan has been completed.

How to provide information and seek input

- Via an internet based county wide opinion survey;
- Through presentations to specific groups;
- In one on one briefings and interviews;

2020 Baker County NHMP Update 1
Public Engagement Strategy

Figure 10. Initial NHMP Public Engagement flyer

2020 Baker County
Natural Hazards Mitigation Plan Update

Baker County is collaborating with the Oregon Department of Land Conservation and Development (DLCD) to update the counties plan for natural hazards. A Steering Committee, chaired by Baker County Emergency Management, is convening now. The Natural Hazards Mitigation Plan (NHMP) is targeted for completion by Fall 2020.

Please see the back of this flyer for how to get involved.

Project Contact:
Jason Gately, Project Manager | DLCD
#503-934-0043
Email: Jason.Gately@state.or.us

Why engage in natural hazard mitigation planning?

To avoid disasters by reducing or eliminating long-term risk to people, property, and the environment from natural hazards.

To maintain eligibility for federal disaster related funding.

To increase safety and resiliency by integrating hazard mitigation into the plans, programs, and policies

Baker County's Natural Hazards

Hazard	Risk Score	Risk Level (H-M-L)
Wildfire	240	High
Winter Storms	202	High
Drought	199	High
Wind Storms	149	Medium
Flood	135	Medium
Earthquake	131	Medium
Landslide	24	Low
Volcanic Events	17	Low

How to Get Involved:

Check the Baker County Website and Facebook pages for meeting dates and times, documents to review and an online survey to complete; and

Call or email the Project Manager for more information at 503-934-0043 or Jason.Gately@state.or.us

Take the Natural Hazards Community Survey at this link: forms.gle/kAsU6kFtb5eQzAnR7

Figure 11. Baker City Herald Article

WEDNESDAY — MARINERS' PENCE HITS THREE HOME RUNS IN SEATTLE WIN: PAGE 5A

Baker City Herald

August 14, 2019

Serving Baker County since 1870 • bakercityherald.com

IN THIS EDITION: Local • Business & AgLife • Go! magazine $1.50

GO! Magazine
Your guide to upcoming arts and entertainment happening around Northeast Oregon

QUICK HITS

Good Day Wish To A Subscriber

A special good day to Herald subscriber Al Hausotter of Baker City.

Local, 2A

Danni Huck has an ambitious goal in her campaign to collect unused greeting cards to send to hospitalized veterans and retired veterans homes.

BRIEFING

Class on safe use of medication for seniors set Aug. 19

A free class, "Safe Medication Use In Older Adults" is set for Aug. 19 in Baker City. The half-day class is free thanks to funding from the state and nonprofits including the Alzheimer's Association and Oregon Health Care Association. The class will run from 1 p.m. to 5 p.m. at the Sunridge Inn Conference Center, 1 Sunridge Lane. To register for the class, call 1-800-930-6581 or go to www.Oregon-CarePartners.com

WEATHER

Today
88 / 50
Mostly sunny

Thursday
85 / 46
Mostly sunny

Full forecast on the back of the B section.

Correction: In a story about a new paid family leave law in Oregon that was published in the Aug. 12 issue of the Baker City Herald, The Associated Press reported erroneously that a person needed to work 1,000 hours a year to qualify. A person needs to earn $1,000 a year to qualify.

The space below will be blank on issues delivered or sold from boxes. The space is for a postage label for issues that are mailed.

Lexie Flanagan Has Acted In All 20 Missoula Children's Theater Plays In Baker

A Decade On Stage

S. John Collins/Baker City Herald file photo

Lexie Flanagan, right, appears in song and dance with Henry Wood during "Jack and the Beanstalk" rehearsals in June.

By Lisa Britton
For the Baker City Herald

Lexie Flanagan will don a costume Friday night and put her all into bringing her character to life.

Flanagan, 17, has auditioned for every show Missoula Children's Theatre has brought to Baker City over the past decade.

"I look forward to doing it every year," she said.

MCT has helped her "get comfortable acting in front of people."

But that doesn't mean it's easy.

"I still get nervous — I look at the exit sign," Flanagan said.

"Pinocchio," presented this weekend at Baker High School, is the 20th play to cast local youth.

"Little did I imagine when we started our journey with Missoula Children's Theatre 10 years ago that we would be doing three shows a year," said Ginger Savage, executive director of Crossroads Carnegie Art Center. "This program has had such a powerful impact on the children. We want the whole community to come and celebrate this remarkable milestone."

"I still get nervous — I look at the exit sign."

— Lexie Flanagan, 17, who has had a role in all 20 of the Missoula Children's Theater performances over the past 10 years

Performances for the community are at 6 p.m. Friday and 3 p.m. Saturday at Baker High School. Admission is $5, or free for ages 12 and younger.

This show is sponsored by Soroptimist of Baker County.

An ice cream social is planned for Friday after the show, sponsored by the Baker County Cultural Coalition and Ash Grove Cement Co.

'Pinocchio'

- Performances at Baker High School auditorium, 2500 E St.
- Friday, 6 p.m.
- Saturday, 3 p.m.
- Admission: $5 for adults, free for ages 12 and younger

About MCT

Missoula Children's Theatre is located in Missoula, Montana. Throughout the year the company sends tour directors on the road with everything to put on a full musical production.

"We're a miniature theater on the road," Shiana Tyler said.

Tyler and Kourtney Ellis have toured "Pinocchio" for nine weeks.

See **Theater** / *Page 6A*

Council OKs bid for sewer station

By Samantha O'Conner
soconner@bakercityherald.com

The Baker City Council on Tuesday awarded the bid for constructing a wastewater lift station on H St.

The bid, for $231,780, was submitted by M2 Construction LLC.

There were no other bidders.

In a report to councilors, Michelle Owen, the city's public works director, wrote that the city's 2017 Wastewater Facilities Plan, previously adopted by the Council, calls for replacing the lift station, which is on H Street near Ninth Drive.

Most of the city's wastewater system is gravity-fed, but there is a single lift station where pumps push wastewater to the city's treatment lagoons about a mile north of town.

The existing station, which is several decades old, has had problems with failing pumps and has required "continual maintenance," according to Owen's report.

The city's budget for the fiscal year that started July 1 includes money for the lift station replacement.

The Council approved the bid award by a 5-0 vote.

Councilors Arvid Andersen and Doni Bruland were absent.

In other business Tuesday, the Council approved a resolution removing one ADA parking space, on Court Avenue just west of Main Street, as requested by Ryan Chaves of Glacier 45 Distillery.

Another ADA parking space was recently added on that same block.

See **Council** / *Page 2A*

County updating hazards plan

By Samantha O'Conner
soconner@bakercityherald.com

Baker County's Natural Hazards Mitigation Plan is being updated and is anticipated to be complete by the fall of 2020, and local and state officials are inviting local residents to participate.

Jason Gately, the project manager who works for the Oregon Department of Land Conservation and Development in Salem, said the county's plan, which is updated every five years, is funded through the Federal Emergency Management Agency (FEMA).

Although county plans are not required by law, they can ensure counties qualify to receive federal dollars for work designed to mitigate natural hazards such as wildfire and drought.

"Most communities, counties, throughout the United States have these mitigation plans," Gately said. "They are not required but if you want to have FEMA mitigation grants, you have to have one."

A steering committee for the plan update, chaired by Baker County Emergency Management, will have its next meeting Sept. 10 at 9 a.m. at the Baker County Courthouse, 1995 Third St. The public is welcome.

See **Hazards** / *Page 6A*

Fire tactics evolve on the W-W

Officials explore new ways to allow flames to perform historic role

By Jayson Jacoby
jjacoby@bakercityherald.com

Fire officials from the Wallowa-Whitman National Forest have pulled a new tool from their belts in their campaign to construct a wider strategy that allows flames to play their historic, and sometimes beneficial, role on public lands.

For the first time on the Wallowa-Whitman, officials are giving a lightning-sparked fire an incendiary assist.

But there's a major difference between that fire, called Hollow Log, burning in the Alder Spring area about 24 miles northeast of Joseph, and the Granite Gulch fire that's been burning in the Eagle Cap Wilderness since mid July, said Nathan Goodrich, fire management officer for the northern part of the Wallowa-Whitman.

The Hollow Log fire, ignited by lightning during last weekend's storm spree that pummeled the region with several thousand bolts, is not in a wilderness area.

See **Fires** / *Page 3A*

Man arrested on gun charges

By Chris Collins
ccollins@bakercityherald.com

A man who returned to Baker City a month and a half ago after serving a two-year prison term for being a felon in possession of a firearm, and who served another prison term for shooting a man in the face in 2009, was arrested Monday afternoon after allegedly providing shooting lessons for his mother.

Persicke

Zachary Charles Persicke, 32, is being held at the Baker County Jail on multiple charges.

See **Charges** / *Page 2A*

FRIDAY — TWO PEAKS, TWO QUITE DIFFERENT PERSPECTIVES

Figure 12. Baker County Emergency Management Facebook Post

2020 Plan Update Changes

The entire *2014 Northeast Oregon Multi-Jurisdictional NHMP* has been revised and updated. While the basic format of the existing NHMP was retained, substantial changes have been made. Generally, the *2020 Baker County Multi-Jurisdictional Natural Hazard Mitigation Plan* provides updated statistics and attempts to make the document more readable by removing repetition and focusing on the most salient aspects of hazard identification, risk assessment and mitigation actions. The document style has been revised to match other NHMPs prepared by DLCD beginning with the Tillamook County NHMP so as to make this work recognizable as such.

Cover and Front Pages

The cover and the front pages orient the reader of the NHMP to what the NHMP contains.

- A new NHMP cover was created in the style noted above. The photos for the cover were taken by Baker County Steering Committee members and Baker City Herald reporters. Photos were also added to the Volume II, and III covers.
- The FEMA Approval Pending Adoption (APA) and final approval letter as well as the County and Cities resolutions of adoption are included in the final document (when available).
- The Acknowledgements have been updated to include the 2019-2020 Steering Committee members.

Volume I: Basic Plan

Volume I includes the cover, approval letters, jurisdictional resolutions, and Table of Contents. It provides the overall plan framework for the *2020 Baker County NHMP*. It also contains Section 1: Introduction; Section 2: Risk Assessment; Section 3: Mitigation Strategy; and Section 4: Plan Implementation and Maintenance.

Section 1: Introduction

Section 1 introduces the concept of natural hazards mitigation planning and answers the question, "Why develop a mitigation plan?" Additionally, Section 1 summarizes the 2020 plan update process, and provides an overview of how the plan is organized.

The principle change to this section, as with the entire NHMP, is that information from the focus on Baker County alone has allowed the plan to drill down to focus on the incorporated cities in Baker County allowing a more granular view of hazard mitigation in the county. Rather than having separate addenda for the Cities, the Cities are included in the main body of the NHMP. Where applicable, the Cities are specifically called out for their unique situations.

Section 2: Risk Assessment

Section 2, Risk Assessment, consists of three phases: natural hazard identification, vulnerability assessment, and risk analysis. Hazard identification involves the identification of hazard geographic extent, its intensity, and probability of occurrence. The second phase combines the information from the hazard identification with an inventory of the existing (or planned) property and population exposed to a hazard, then attempts to predict how different types of property and population groups will be affected by the hazard. The third phase involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time.

Changes to Section 2 include:

- Format changes to the document to match the style referenced above.
- The incorporation of the information from the cities along with the information concerning Baker County to create a cohesive Risk Assessment section.
- Hazard identification, characteristics, history, probability, vulnerability, and hazard specific mitigation activities were updated. Discussion of the community Hazard Vulnerability Analysis was moved up to Volume I: Section 2 – Risk Assessment. More detailed information about each hazard was moved back to Volume II: Hazard Annexes
- NFIP information was updated.
- The Baker County NHMP Steering Committee performed a new Hazard Vulnerability Analysis/Assessment (HVA), resulting in new scores for the identified hazards of drought, earthquake, flood, landslide, winter storms, wind storms, volcanic events, and wildfire.

Section 3: Mitigation Strategy

This section provides the basis and justification for the mission, goals, and mitigation actions identified in the NHMP. Changes to Section 3 include the following:

- The NHMP Steering Committee opted to prioritize mitigation actions as described in the section above, using the HVA risk levels. All the multi-hazard mitigation actions were identified as high priority while hazard specific mitigation actions are high, medium, and low.
- The mission statement and the goals were reviewed and re-confirmed by the 2020 Steering Committee without any changes.
- The mitigation actions from the *2014 Northeast Oregon Multi-Jurisdictional NHMP* were reviewed. Actions were deleted, retained as is, or retained in a modified fashion. New mitigation actions were established.

Section 4: Plan Implementation and Maintenance

The Baker County NHMP convener is the Emergency Manager; this person will form and facilitate an Implementation Committee for maintaining, updating, and implementing the NHMP. The Implementation Committee will be composed of members of the NHMP Steering Committee and other members of the community. The Implementation Committee plans to meet formally at least twice per year based on the framework set out in Section 4 Plan Implementation and Maintenance to implement the Mitigation Strategy contained in Section 3 of the Basic Plan.

Volume II: Hazard Annexes

All hazard specific annexes were reformatted and updated to include new history, data, maps, vulnerability information, and resources as available. Cross references to other information in the NHMP has been updated. Information about climate change has been integrated into the hazard specific annexes and added as Appendix D: Future Climate Projections Reports.

Volume III: Mitigation Resources

All of the appendices have been revised and updated to focus uniquely on Baker County and its incorporated cities. The appendices have been reorganized slightly placing the Community Profile in

Appendix A and the Action Items in Appendix C to follow a more logical progression. Data contained in the Community Profile has been updated with the most recent census information. Appendix D now contains the Future Climate Projection Baker County report prepared by OCCRI while the Appendix previously titled Economic Analysis of Natural Hazards has been located in Appendix E and covers a method of evaluating mitigation actions based on benefit/cost analysis. The remaining appendix includes resources for hazard mitigation grants and program resources. The appendix containing the Regional Household Preparedness Survey was deleted because it was no longer relevant.

Appendix C: Mitigation Action Worksheets

Mitigation Actions from the *2014 NE Oregon Multi-Jurisdictional Natural Hazard Mitigation Plan* were carried over into the 2020 Grant County *Multi-Jurisdictional Natural Hazard Mitigation Plan* as illustrated below in Table 1. This table also tracks the jurisdictions within Grant County to which the mitigation actions apply.

Of the thirty-two actions that were carried over from the 2014 Plan, two of those actions were removed, two actions were completed, and six of those actions were consolidated into two actions. Seventeen new actions were added. These new actions were refinements or more specific actions based on existing action descriptions many of which were identified through the Risk MAP Discovery process conducted by FEMA during the course of the plan update process.

This plan identifies 41 mitigation actions. These actions are prioritized into High Priority (20 actions), Medium Priority (14 actions) and Low Priority (7 actions). Within each priority ranking, the actions are further divided primarily into Long Term, Medium Term and Short Term time frames for action. Some actions are in progress and this is also noted under the Timeline column.

Table 1. Relationship between 2014 NHMP actions and 2020 actions; 2020 timeline, status and jurisdictions concerned

Action number in 2014 NE Oregon NHMP	Action number in 2020 Baker County NHMP	Priority	Description	2020 Timeline	2020 Status	Baker County	Baker City	Haines	Halfway	Huntington	Richland	Sumpter	Unity
MH #1	**MH 1**	Medium	Complete Continuity of Operations Plans (COOPs) within all interested municipalities and the county.	Short Term	In Progress	X							
MH #2	**MH 2**	Low	Incorporate the Natural Hazards Mitigation Plan into the Comprehensive Plan (in particular Goal 7)	Long Term	Deferred	X	X	X	X	X	X	X	X
MH #3	**MH 3**	Low	Inform public officials about mitigation awareness and the Natural Hazards Mitigation Plan	Short Term	Routine	X	X	X	X	X	X	X	X
MH #4	**MH 4**	High	Develop and implement education and outreach programs to increase public awareness of the risk associated with natural hazards. Specifically target vulnerable populations	Short Term	Routine	X	X	X	X	X	X	X	X
	MH 4.1	Medium	Improve outreach for the local mass notification system. The county would like to increase the number of registered participants in the program.	Short Term	Routine Action, new listing	X	X	X	X	X	X	X	X
	MH 4.2	High	Requesting multi-hazard outreach materials and messaging strategies for earthquake. At this time all questions about earthquake risk are re-directed to county officials.	Short Term	New Action				X				

Action number in 2014 NE Oregon NHMP	Action number in 2020 Baker County NHMP	Priority	Description	2020 Timeline	2020 Status	Baker County	Baker City	Haines	Halfway	Huntington	Richland	Sumpter	Unity
MH #5	**MH 5**	Medium	Increase the resilience of small businesses to natural hazards	Short term		X	X	X	X	X	X	X	X
MH #6	**MH 6**	High	Enhance communication and response coordination between all of the incorporated areas in each county	Routine	Routine	X	X	X	X	X	X	X	X
MH #7		**Removed; no longer relevant to new NHMP**	Develop a Memorandum of Understanding to establish a regional committee responsible for oversight and implementation of the regional plan, and to oversee reviewing and updating of the NE Natural Hazards.										
MH #8		**Removed due to low likelihood of funding**	Create a position for a Countywide Hazards Mitigation Project Coordinator										
	MH 8	High	Collect lidar data for the locations specified in Volume I, Table 4.	Short Term	New Action in progress	X							

Action number in 2014 NE Oregon NHMP	Action number in 2020 Baker County NHMP	Priority	Description	2020 Timeline	2020 Status	Baker County	Baker City	Haines	Halfway	Huntington	Richland	Sumpter	Unity
MH #9	**MH 9**	Medium	Develop a warning and evacuation protocol for vulnerable populations	Medium Term	In process, part of CWPP	X	X	X	X	X	X	X	X
	MH 9.1	Medium	Address a city-wide evacuation plan that would gain consensus on how best to communicate evacuation routes to residents. The plan would internally clarify evacuation plans and account for contingencies.	Short Term	New Action				X				
MH #10-14	**Do not apply to Baker County**												
MH #15	**MH 7**	High	Complete and implement the Pine Creek Floodplain Management Plan	Long Term	In Process	X			X				
MH #16 & #17	**Do not apply to Baker County**												
DR #1 & DR #2	**DR 1**	High	Identify incentive programs to increase water efficiency among both agricultural and municipal water users	Routine	Actions completed by Baker City and by the Powder River Watershed Council	X	X	X	X	X	X	X	X

Action number in 2014 NE Oregon NHMP	Action number in 2020 Baker County NHMP	Priority	Description	2020 Timeline	2020 Status	Baker County	Baker City	Haines	Halfway	Huntington	Richland	Sumpter	Unity
DR #3	**DR 2**	High	Develop community drought emergency plans and policies	Routine	Routine	X	X	X	X	X	X	X	X
DR #4	**DR 3**	High	Conduct aquifer studies for the Pine and Baker Valleys. Baker Valley well data study funded for work by the Powder River Watershed Council.	Long Term	Completed by Baker City	X	X	X	X				
DR #5	**Does not apply to Baker County**												
EQ #1	**EQ 1**	Low	Perform an earthquake risk evaluation in critical buildings not listed in the DOGAMI RVS report	Long Term	Deferred	X	X	X	X	X	X	X	X
	EQ 1.1	Medium	Seismic analysis of critical infrastructure is requested in Baker City. The old buildings downtown are vulnerable to earthquakes and there are concerns about city hall and emergency operation centers. The city would like to retrofit their city hall and fire station.	Short Term	New Action		X						
	EQ 1.2	Medium	Complete ongoing seismic retrofits.	Medium Term	New Action		X						
	EQ 1.3	High	Prioritize and complete remaining seismic retrofits to critical facilities.	Long Term	New Action	X	X	X	X	X	X	X	X

Action number in 2014 NE Oregon NHMP	Action number in 2020 Baker County NHMP	Priority	Description	2020 Timeline	2020 Status	Baker County	Baker City	Haines	Halfway	Huntington	Richland	Sumpter	Unity
EQ #2	**EQ 2**	Low	Seismically retrofit The Unity Fire Department to reduce the building's vulnerability to seismic hazards.	Long Term	Deferred								X
EQ #3, #4, #6, and #8	**EQ 3**	Low	Seismically retrofit primary school buildings to reduce their vulnerability to seismic hazards.	Long Term	Deferred / Modified		X		X				X
EQ #5		**Complete**	Seismically retrofit Baker High School to reduce vulnerability to seismic hazards.				X						
EQ #7		**Complete**	Seismically retrofit Brooklyn Elementary School to reduce the building's vulnerability to seismic hazards.				X						
EQ #9-28	**Do not apply to Baker County**												
FL #1	**FL 1**	High	Explore flood mitigation opportunities for homes and critical facilities subject to flooding.	Routine	Routine	X	X	X	X	X	X	X	X

Action number in 2014 NE Oregon NHMP	Action number in 2020 Baker County NHMP	Priority	Description	2020 Timeline	2020 Status	Baker County	Baker City	Haines	Halfway	Huntington	Richland	Sumpter	Unity
	FL 1.1	Medium	Floodplain restoration on the headwaters of Pine Creek is needed to reduce flooding downstream near Halfway.	Medium Term	New Action	X			X				
	FL 1.2	High	Develop strategy for management of standing water that may accumulate on 4th Street during seasonal irrigation or rain events.	Long Term	New Action	X		X					
	FL 1.3	Medium	Characterize source of flooding hazards for the two local schools on Bell Street. Develop a mitigation strategy to reduce flooding	Medium Term	New Action				X				
FL #2	**FL 2**	High	Explore the costs and benefits for participation in the NFIP's Community Rating System	Routine	Deferred	X	X	X	X	X		X	
FL #3	**FL 3**	High	Increase awareness concerning the NFIP program.	Routine	Routine	X	X	X	X	X		X	
FL #4	**FL 4**	High	Update the County and City FEMA Flood Insurance Rate Maps and digitize the updated maps.	Long Term	In Progress	X	X	X	X	X	X	X	X
	FL 4.1	Low	Map along Highway 86 for flooding and washout risk. Highway 86 and the Burnt River Corridor on Pine Creek below Halfway needs maps and assessment of the area.	Short Term	New Action	X			X				

Action number in 2014 NE Oregon NHMP	Action number in 2020 Baker County NHMP	Priority	Description	2020 Timeline	2020 Status	Baker County	Baker City	Haines	Halfway	Huntington	Richland	Sumpter	Unity
	FL 4.2	High	New flood analysis is requested in and around Baker City with details provided in Volume I, Table 4.	Short Term	New Action	X	X						
	FL 4.3	Medium	Develop stream restoration strategies for Rock Creek, which has become clogged with silt.	Medium Term	New Action	X							
	FL 4.4	Low	New flood analysis is requested for Halfway as described in Volume I, Table 4.	Short Term	New Action				X				
FL #5	**Does not relate to Baker County**												
FL #6	**FL 5**	High	Seek Silver Jackets assistance to investigate opportunities to prevent infiltration of flood waters into the wastewater treatment facility in Halfway.	Short Term	In Progress				X				

Action number in 2014 NE Oregon NHMP	Action number in 2020 Baker County NHMP	Priority	Description	2020 Timeline	2020 Status	Baker County	Baker City	Haines	Halfway	Huntington	Richland	Sumpter	Unity
LS #1	**LS 1**	High	Identify, obtain, and evaluate detailed risk assessments in landslide prone areas and develop mitigation strategies to reduce the likelihood of a potential hazardous event.	Long Term	Deferred	X	X	X	X	X	X	X	X
	LS 1.1	High	Conduct an assessment of landslide risk along railroads, highways and roads, and utilities.	Medium Term	New Action	X							
SW #1	**SW 1**	Medium	Participate in the NOAA Storm Ready Program	Short Term	In Progress	X	X	X	X	X	X	X	X
SW #2	**SW 2**	Medium	Shorten spans and anchor poles on utility lines in high wind or heavy icing areas	Routine	Routine	X	X	X	X	X	X	X	X
SW #3	**SW 3**	Medium	Bury overhead power lines in winter storm and windstorm prone areas	Routine	Routine	X	X	X	X	X	X	X	X
	SW 4	Medium	Conduct structural assessment of sample structures to develop recommendations for construction to mitigate heavier snow loads.	Medium	New Action	X	X	X	X	X	X	X	X

Action number in 2014 NE Oregon NHMP	Action number in 2020 Baker County NHMP	Priority	Description	2020 Timeline	2020 Status	Baker County	Baker City	Haines	Halfway	Huntington	Richland	Sumpter	Unity
WF #1	**WF 1**	High	Advocate for the implementation of the actions identified the most current Baker County Community Wildfire Protection Plan.	Ongoing	Ongoing	X	X	X	X	X	X	X	X
	WF 2	High	Develop and implement smoke mitigation plan for Baker County		New Action	X	X	X	X	X	X	X	X
	WF 3	High	Sage Grouse Habitat		New Action	X							

High Priority, Short Term Mitigation Actions

In order to focus on the most important and shortest term mitigation actions for further elaboration, the subset of actions which were both High Priority and Short Term were selected. This selection of six mitigation actions were fleshed out in Mitigation Action Worksheets. The purpose of these worksheets is to provide a jump start for Baker County and the incorporated cities to use in developing funding proposals to implement these most important actions.

The High Priority, Short Term Mitigation Actions are as follows:

MH 4: Develop and implement education and outreach programs to increase public awareness of the risk associated with natural hazards. Specifically target vulnerable populations

MH 4.2: Requesting multi-hazard outreach materials and messaging strategies for earthquake. At this time all questions about earthquake risk are re-directed to county officials.

MH 8: Collect lidar data for locations detailed for this action item in Volume I, Table 4.

FL 4.2: New flood analysis is requested in and around Baker City with the following details:

FL 5: Seek Silver Jackets assistance to investigate opportunities to prevent infiltration of flood waters into the wastewater treatment facility in Halfway.

WF 2: Develop and implement smoke mitigation plan for Baker County

Mitigation Actions Carried Over from *2014 NHMP*

The actions for which Mitigation Action Sheets were prepared in 2014 were carried over to the *2020 Baker NHMP* and the sheets are included here edited to reflect the focus on Baker County. These include the following Mitigation Actions:

MH 1: Complete Continuity of Operations Plans (COOPs) within all interested municipalities and the county.

MH 2: Incorporate the Natural Hazards Mitigation Plan into the Comprehensive Plan.

MH 3: Inform public officials about mitigation awareness and the Natural Hazards Mitigation Plan.

MH 5: Increase the resilience of small businesses to natural hazards.

MH 6: Enhance communication and response coordination among all of the incorporated areas in Baker County.

MH 9: Develop a warning and evacuation protocol for vulnerable populations.

DR 1: Identify incentive programs to increase water efficiency among both agricultural and domestic water users.

DR 2: Develop community drought emergency plans and policies.

DR 3: Conduct aquifer studies for the Pine and Baker Valleys. (Baker Valley well data study funded for work by the Powder River Watershed Council.)

EQ 1: Perform an earthquake risk evaluation in critical buildings not listed in the DOGAMI RVS report.

EQ 2: Seismically retrofit The Unity Fire Department to reduce the building's vulnerability to seismic hazards. Consider both structural and non-structural retrofit options.

EQ 3: Seismically retrofit all School District's primary buildings to reduce their vulnerability to seismic hazards. (This action was modified to include North Baker Elementary School, South Baker Elementary School, Pine Eagle Charter School, and Burnt River School.)

FL 1: Explore flood mitigation opportunities for homes and critical facilities subject to flooding.

FL 2: Explore the costs and benefits for participation in the NFIP's Community Rating System.

FL 3: Increase awareness concerning the NFIP program.

FL 4: Update the County and City FEMA Flood Insurance Rate Maps and digitize the updated maps.

LS 1: Identify, obtain, and evaluate detailed risk assessments in landslide prone areas and develop mitigation strategies to reduce the likelihood of a potential hazardous event.

SW 1: Participate in the NOAA Storm Ready Program.

SW 2: Shorten spans and anchor poles on utility lines in high wind or heavy icing areas.

SW 3: Bury overhead power lines in winter storm and windstorm prone areas.

WF 1: Advocate for the implementation of the actions identified the most current Baker County Community Wildfire Protection Plan.

Other New Mitigation Actions

New Mitigation Actions not prioritized as High Priority, Short Term actions still require evaluation and evaluation in order to develop Mitigation Action Sheets. Most of these actions were identified by Baker County residents during the FEMA Risk MAP Discovery process. The actions are as follows:

MH 4.1: Improve outreach for the local mass notification system. The county would like to increase the number of registered participants in the program.

MH 7: Complete and implement the Pine Creek Floodplain Management Plan.

MH 9.1: Address a city-wide evacuation plan that would gain consensus on how best to communicate evacuation routes to residents. The plan would internally clarify evacuation plans and account for contingencies.

EQ 1.1: Seismic analysis of critical infrastructure is requested in Baker City. The old buildings downtown are vulnerable to earthquakes and there are concerns about city hall and emergency operation centers. The city would like to retrofit their city hall and fire station.

EQ 1.2: Complete ongoing seismic retrofits.

EQ 1.3: Prioritize and complete remaining seismic retrofits to critical facilities. (These facilities include Baker City Municipal Airport, Baker RFPD, Greater Bowen RFPD, Keating RFPD, Baker City Fire Dept, Baker City Warehouse and Shop, Baker County Road Dept, St. Elizabeth Hospital, Pine Valley VFD and Eagle Valley Fire Dept.)

FL 1.1: Floodplain restoration on the headwaters of Pine Creek is needed to reduce flooding downstream near Halfway.

FL 1.2: Develop strategy for management of standing water that may accumulate on 4th Street during seasonal irrigation or rain events.

FL 1.3: Characterize source of flooding hazards for the two local schools on Bell Street. Develop a mitigation strategy to reduce flooding.

FL 4.1: Map along Highway 86 for flooding and washout risk. Highway 86 and the Burnt River Corridor on Pine Creek below Halfway needs maps and assessment of the area.

FL 4.3: Develop stream restoration strategies for Rock Creek, which has become clogged with silt.

FL 4.4: New flood analysis is requested for the west side of Halfway floods, which is not reflected in the current SFHA.

- The current FIRM only maps flooding on the east side of Halfway - in proximity to creeks. Flooding, however, is more observed on the west side of the city, near ditches.
- McMullen Slough is identified in the SFHA; however, not a lot of flooding occurs in this area.
- Flooding occurs at Pine Creek and Highway 414.
- Flooding occurs near West Bell Street.

LS 1.1: Conduct an assessment of landslide risk along railroads, highways and roads, and utilities.

SW 4: Conduct structural assessment of sample structures to develop recommendations for construction to mitigate heavier snow loads.

WF 3: Coordinate with the Sage-grouse Local Implementation Team to support actions reducing the risk and impacts of wildfire in Sage-grouse habitat, including but not limited to invasive weed reduction and prevention or resources for improved firefighting response.

Mitigation Action Sheet Components

Mitigation Action Title

Each mitigation action item includes a title and a brief description of the proposed action.

Alignment with Plan Goals

The plan goals addressed by each mitigation action are identified as a means for monitoring and evaluating how well the mitigation plan is achieving its goals, following implementation.

Affected Jurisdiction

Many of the mitigation actions within this plan apply to all of the participating Cities and Baker County; however, some actions are specific. The list of affected jurisdictions is provided on the right side of the matrix. The action item form in Appendix A provides more detailed information.

Alignment with Existing Plans / Policies

Identify any existing community plans and policies where the mitigation action can be incorporated. Incorporating the mitigation action into existing plans and policies, such as comprehensive plans, will increase the likelihood that it will be implemented.

Rationale or Key Issues Addressed

Mitigation actions should be fact-based and tied directly to issues or needs identified throughout the planning process. Mitigation actions can be developed at any time during the planning process and can come from a number of sources, including participants in the planning process, noted deficiencies in local capability, or issues identified through the risk assessment. The rationale for proposed mitigation actions is based on the information documented in Section 2 Risk Assessment and Volume II Hazard Annexes.

Implementation through Existing Programs

For each mitigation action, the Mitigation Action Item form asks for some ideas for implementation, which serve as the starting point for taking action. This information offers a transition from theory to practice. Ideas for implementation could include: (1) collaboration with relevant organizations, (2) alignment with the community priority areas, and (3) applications to new grant programs.

The ideas for implementation offer a transition from theory to practice and serve as a starting point for this plan. This component of the mitigation action is dynamic, since some ideas may prove to not be feasible, and new ideas may be added during the plan maintenance process. Ideas for implementation include such things as: collaboration with relevant organizations, grant programs, tax incentives, human resources, education and outreach, research, and physical manipulation of buildings and infrastructure. When an action is implemented, more work may be needed to determine the exact course of action.

The *2020 Baker County NHMP* includes a range of mitigation actions that, when implemented, will reduce loss from hazard events in the County. Within the NHMP, FEMA requires the identification of existing programs that might be used to implement these action items. Baker County and the participating cities currently address statewide planning goals and legislative requirements through their comprehensive land use plans, capital improvements plans, mandated standards and building codes. Plans and policies already in existence have support from local residents, businesses, and policy makers. Many land use, comprehensive, and strategic plans are updated regularly, and can adapt easily to changing conditions and needs.[1] Implementing the NHMP's action items through such plans and

[1] Ibid

policies increases their likelihood of being supported and implemented. The jurisdictions will work to incorporate the mitigation actions into existing programs and procedures.

Coordinating Organization

The coordinating organization is the public agency with the regulatory responsibility to address natural hazards, or that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring and evaluation.

The Coordinating Organization and main contact for the Baker County NHMP is the Baker County Emergency Manager, a position that is vacant at the time of this writing. The Implementation Committee for the *2020 Baker County NHMP* has not yet been formed.

Internal and External Partners

The internal and external partner organizations listed in the Mitigation Actions Table and in the Action Item Worksheets are potential partners recommended by the Steering Committee but not necessarily contacted during the development of the plan. The coordinating organization should contact the identified partner organizations to see if they are capable of and interested in participation. This initial contact is also to gain a commitment of time and/or resources toward completion of the action items.

Internal partner organizations are departments within the County or other participating jurisdiction that may be able to assist in the implementation of action items by providing relevant resources to the coordinating organization.

External partner organizations can assist the coordinating organization in implementing the action items in various functions and may include local, regional, state, or federal agencies, as well as local and regional public and private sector organizations.

Potential Funding Sources

Where possible, identify potential funding sources for the mitigation action. Example funding sources can include: the federal Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) Programs; state funding sources such as the Oregon Seismic Rehabilitation Grant Program; or local funding sources such as capital improvement or general funds. A mitigation action may have multiple funding sources. The funding sources are identified general as short- or long-term (see below) and includes an element of funding capacity of the jurisdiction for that action. Appendix A Action Item Forms includes the more detailed description of each mitigation action; funding sources are included there. See Appendix E Grant Programs and Resources for additional information on funding opportunities.

Sample maps or examples

Where possible, examples of the issue to be resolved by the mitigation action or maps of the area of concern are included.

High Priority, Short Term Mitigation Actions

Action Item:	Alignment with Plan Goals:	Priority
MH 4 – Develop and implement education and outreach programs to increase public awareness of the risk associated with natural hazards. Specifically target vulnerable populations	Goals 1 &3	☒ High Priority

Affected Jurisdictions:			
☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- To build and capitalize upon the self-sufficiency and individual capacity of Baker County residents.
- Community organizations that serve elderly or disadvantaged people are concerned with the transportation and services available to special-needs groups
- The high percentage of elderly individuals require special consideration due to their sensitivities to heat, cold, and smoke, their reliance upon transportation for medications, and their comparative difficulty in making home modifications that reduce risk to hazards.
- Young people represent a vulnerable segment of the population.. Special considerations should be given to younger populations and schools, where children spend much of their time, during the natural hazard mitigation process. Children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities.
- The Disaster Mitigation Act of 2000 requires that communities continue to involve the public beyond the original planning process [201.6(c)(4)(iii)]. Developing a public education and outreach strategies to raise awareness of the risk natural hazard pose will help to keep the public informed of, and involved in, awareness of natural hazards and potential mitigation activities the public can implement. Targeting vulnerable populations and organizations that help people with special needs will help to reduce the impact of a natural hazard event on these populations.
- Public education and outreach can be inexpensive and can provide information that result in safer households, work places, and public areas. Some outreach materials include: informational brochures about community seismic risks and mitigation techniques, public forums, newspaper articles, training classes and television advertisements.
- Mitigation is a shared responsibility between local, state, and federal government; citizens; businesses; non-profit organizations; and others. Informing the public of their role in a community's mitigation efforts not only increases the public's awareness of a community's hazard risks, but also helps a community reduce its risk to the hazards addressed by the Natural Hazard Mitigation Plan. Targeting vulnerable populations and organizations that help people with special needs will also help to reduce the impact of a natural hazard event on these populations.

Ideas for Implementation:

- Develop and distribute Natural Hazard Community Resource Maps and risk reduction tips that include instructions about how to prepare and reduce risks posed by natural hazards.
- Institute for Business and Home Safety (IBHS) offers materials that address winter storms, flooding, wind storms, wildfire and earthquake for homes and businesses. Encourage implementation of non-structural earthquake retrofits in homes, businesses, and medical and care facilities. (Distribute the IBHS Homeowners Guide to Non-structural Retrofit)
- Research ways to create and disseminate a message that will cause people to act to reduce individual risk. Target education and outreach actions to reach marginalized populations.
- Bring emergency management and response training to community organizations, such as Head Start and Community Connections.
- Create mailing packet with hazard-specific information on impacts of hazards, mitigation activities and preparedness
- Determine which media avenue is most effective for local outreach; mailings, posters, flyers, radio, local TV, presentations by local officials, etc.
- Print relevant hazard-related articles in local newspaper and other local publications with tips on mitigation actions.
- Have informational brochures and packets available at identified partner's office locations.
- Fire-wise brochures can be used in the spring to address wildfire.
- Baker County uses the Interagency Fire Prevention Team apparatus to carry out education and outreach about various natural hazards to vulnerable populations.

Coordinating Organization:	Emergency Services / Emergency Management; Baker City; City of La Grande, Relevant Public Health Departments

Internal Partners:	**External Partners:**
Eastern Oregon Head Start, Chambers of Commerce, American Red Cross, Oregon Education Association, Families First, Grant - Harney County Casa, Inc., Oregon Rural Action	Baker County Children and Families, County Extension Offices, Eastern Oregon Medical Associates, Elks Lodge, Girl Scouts of the USA, Greater Prairie City Community Association, People Mover, Community Connections of Northeast Oregon

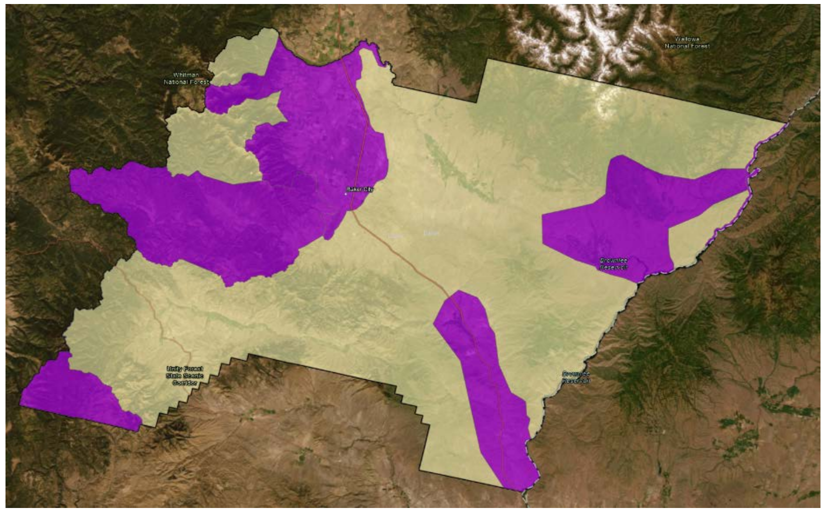
Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Routine

Form Submitted by:	2008 NHMP Steering Committees; revised and confirmed in 2013, revised and confirmed in 2020
Action Item Status:	Routine,

Action Item:			Alignment with Plan Goals:	High Priority Action Item?
MH 4.2: Requesting multi-hazard outreach materials and messaging strategies for earthquake and other natural hazards..			Goals 1 and 3	☒ High Priority
Affected Jurisdictions:				
☒ Baker County	☒ Baker City	☒ Haines		☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter		☒ Unity
Alignment with Existing Plans/Policies:				
Background and Rationale for Proposed Action Item:				
Provide information about multiple hazards to the public through the library system to support the response to questions about earthquake and other hazards directed to county officials. Libraries and museums develop cultural capacity and community connectivity as they are places of knowledge and recognition, they are common spaces for the community to gather, and can serve critical functions in maintaining the sense of community during a disaster. They are recognized as safe places and reflect normalcy in times of distress. The Baker County Library District operates six community libraries in Baker County. The main library is located in Baker City with branches in Haines, Halfway, Huntington, Richland, and Sumpter. The Baker County Library District serves some of the most vulnerable populations in Baker County, the elderly and children.				
Ideas for Implementation:				
Events that highlight natural hazards and preparedness. Handouts that provide useful information such as evacuation routes, how to become part of the mass notification system or 2-day ready kit contents. Public service announcements on preparedness and the mass notification system.				
Coordinating Organization:	Baker County Library District			
Internal Partners:		**External Partners:**		
Emergency Services / Emergency Management; Public Health Department		Blue Mountain Translator District		
Potential Funding Sources:		**Estimated cost:**		**Timeline:**
FEMA Cooperating Technical Partners				Short term (0-3 years)
Form Submitted by:	Submitted by 2020 NHMP Steering Committees			
Action Item Status:	New Action			

<table>
<tr><th colspan="2">Action Item:</th><th>Alignment with Plan Goals:</th><th>High Priority Action Item?</th></tr>
<tr><td colspan="2">MH 8: Collect lidar data for locations detailed for the following locations in particular:
• Main horizontal county and highway routes
• Headwaters of the Powder River
• North of Sumpter (location of mineral extraction)
• Powder River Tributaries that contribute to the high water
• Hole in the Wall - near Halfway
• lidar gaps near Sumpter
• State highway I-84 post fire and flood areas</td><td>Goals 1 and 2</td><td>☒ High Priority</td></tr>
<tr><th colspan="4">Affected Jurisdictions:</th></tr>
<tr><td>☒ Baker County</td><td>☒ Baker City</td><td>☒ Haines</td><td>☒ Halfway</td></tr>
<tr><td>☒ Huntington</td><td>☒ Richland</td><td>☒ Sumpter</td><td>☒ Unity</td></tr>
<tr><th colspan="4">Alignment with Existing Plans/Policies:</th></tr>
<tr><td colspan="4">Flood Hazard Prevention ordinances</td></tr>
<tr><th colspan="4">Rationale for Proposed Action Item:</th></tr>
<tr><td colspan="4">The FEMA Risk MAP Discovery Report identifies the following:
• The county disagrees with the current Special Flood Hazard Area (SFHA); most areas currently identified as in a flood zone do not see flooding. Many discrepancies are related to the Phillips Reservoir and its carrying capacity.
• Snow-melt causes isolated flooding events throughout the county.
• Post-wildfire flooding is also a concern. Burn scars from previous fires have had a small debris flow and are monitored closely.
• The cities of Baker City and Haines, and the Town of Halfway have seen recent impacts from floods.
• Ice jamming on the Powder River has caused flooding in Baker City.

LiDAR is planned to be flown throughout the Baker County project area. LiDAR data can support and enhance flood mapping, multi-hazard risk assessments, grant applications, project prioritization, and multiple local planning efforts.</td></tr>
<tr><th colspan="4">Ideas for Implementation:</th></tr>
<tr><td colspan="4">FEMA's Risk MAP Discovery report notes that LiDAR collection is planned to be completed in 2020 and 2021.</td></tr>
<tr><th>Coordinating Organization:</th><td colspan="3">Baker County and FEMA Region X</td></tr>
<tr><th colspan="2">Internal Partners:</th><th colspan="2">External Partners:</th></tr>
<tr><td colspan="2">FEMA Region X, Baker County</td><td colspan="2">DOGAMI,USFS</td></tr>
<tr><th colspan="2">Potential Funding Sources:</th><th>Estimated cost:</th><th>Timeline:</th></tr>
<tr><td colspan="2">FEMA</td><td></td><td>Short term (0-3 years)</td></tr>
</table>

Form Submitted by:	Submitted by 2020 NHMP Steering Committees
Action Item Status:	New Action
Areas for future lidar collection.	**FEMA Region X Existing (purple) and Proposed (yellow) lidar collection areas** 

Action Item:	Alignment with Plan Goals:	High Priority Action Item?
FL 4.2: New flood analysis is requested in and around Baker City with the following details: •	Goals 1 and 2	☒ High Priority

Affected Jurisdictions:			
☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity

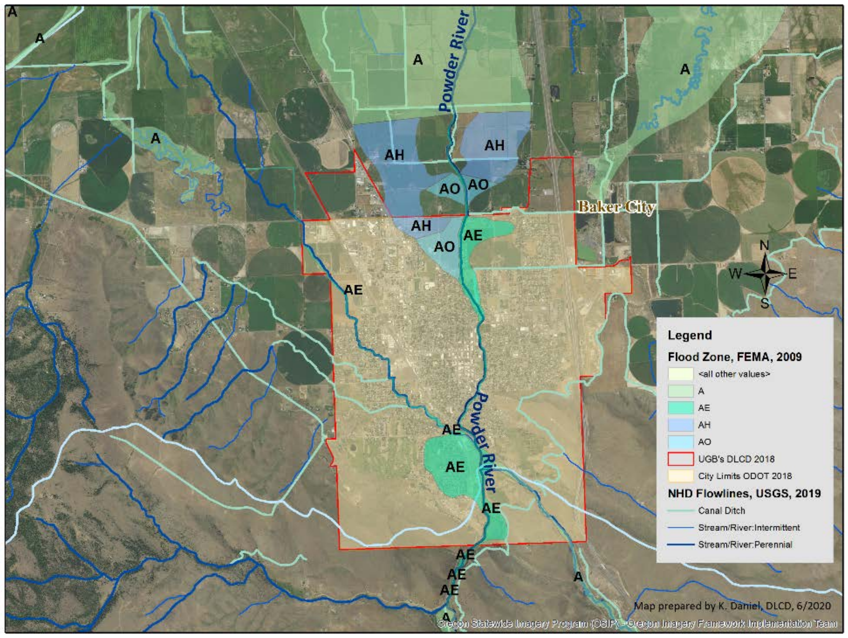
Alignment with Existing Plans/Policies:
Flood Hazard Regulations
Rationale for Proposed Action Item:
The current FIRM has areas in the floodplain that the city believes does not match where the residents experience flooding.. Not a lot of flooding has occurred within the current SFHA. LOMAs are an indicator of inaccuracy (many found in the southern part of Baker City). Specific examples include the following: • The irrigation ditch near the industrial part in the west region of the city floods. • Sheet flow is a problem throughout the city. • Seasonal snow causes flash flooding - if a rain or snow event occurs the city does not have a way to control high water. • Ice jams are common on the north side of the city along the Powder River. • Undeveloped residential land has growth limitations due to flood zones. • The school district purchased land for future development at Hughes Lane and Sports Complex. This area is currently mapped in the floodplain. In addition county staff observe that the FIRM does not seem to take into account the Mason Dam that has a primary use in flood control.
Ideas for Implementation:
Floodplain managers may be the best local source of public information about flood mapping and the impact of flooding on home and business owners. Developing a robust floodplain information and outreach project may assist in preparing the community for the future review and adoption of the new maps.

Coordinating Organization:	Baker County Planning

Internal Partners:	**External Partners:**
Floodplain managers in Baker County, and Baker City,	Oregon NFIP Coordinator, US Army Corps of Engineers, FEMA Region X

Potential Funding Sources:	**Estimated cost:**	**Timeline:**
Cooperating Technical Partners grant from FEMA for outreach and education		Short Term

Form Submitted by:	2020 Baker County NHMP Steering Committee
Action Item Status:	New Action

Current mapping of the Powder River floodplain and associated streams in Baker City.	**Baker City and vicinity Special Flood Hazard Areas** 

Action Item:	Alignment with Plan Goals:	High Priority Action Item?
FL 5: Seek Silver Jackets assistance to investigate opportunities to prevent infiltration of flood waters into the wastewater treatment facility in Halfway.	Goals 4	☒ High Priority ☐ Medium Priority

Affected Jurisdictions:

☒ Baker County	☐ Baker City	☐ Haines	☒ Halfway
☐ Huntington	☐ Richland	☐ Sumpter	☐ Unity

Alignment with Existing Plans/Policies:

City of Halfway Comprehensive Plan

Background and Rationale for Proposed Action Item:

The City of Halfway operates this wastewater treatment facility where wastewater is treated and discharged to a holding pond and is then used for surface application to agricultural fields. Discharge was previously directly into Pine Creek.

In June 2010, a large infiltration of flood water climbed above the banks of Eagle Creek, Pine Creek, and their tributaries and caused damage to the City of Halfway, specifically threatening the city's wastewater treatment facility. A similar future event is possible and could be devastating to the facility.

Flooding is not reported in the FEMA mapped SFHA around McMullen Slough, however flooding in the vicinity of the wastewater treatment plant where Pine Creek intersects Pine Creek Highway (Highway 414).

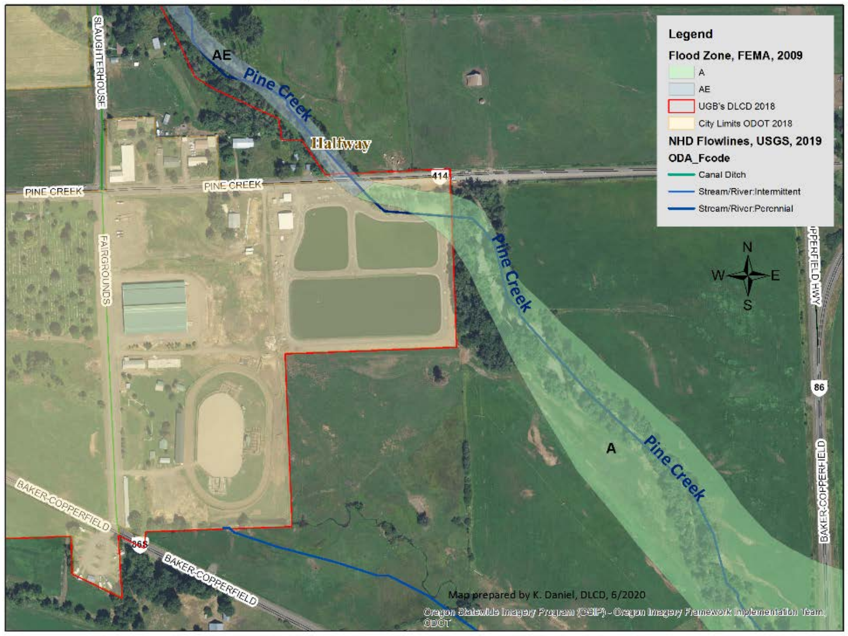
Ideas for Implementation:

Coordinating Organization:	City of Halfway

Internal Partners:	External Partners:
City of Halfway Public Works Department. Adjacent land owners	Oregon Department of Environmental Quality, US Environmental Protection Agency, Silver Jackets, Powder River Watershed Council

Potential Funding Sources:	Estimated cost:	Timeline:
		Short term (0-3 years)

Form Submitted by:	2020 NHMP Steering Committee although the action is carried over from the 2014 NHMP.
Action Item Status:	In progress, diversion of discharge to surface application completed.

Vicinity of Halfway Wastewater Treatment Plant	**Halfway Wastewater Treatment Plant Location** 

<table>
<tr><th colspan="6">Action Item:</th><th>Alignment with Plan Goals:</th><th colspan="2">High Priority Action Item?</th></tr>
<tr><td colspan="6">WF 2: Develop and implement smoke mitigation plan for Baker County</td><td>Goals 1 and 2</td><td colspan="2">☒ High Priority
☐ Medium Priority</td></tr>
<tr><td colspan="9">Affected Jurisdictions:</td></tr>
<tr><td colspan="2">☒ Baker County</td><td colspan="3">☐ Baker City</td><td colspan="2">☐ Haines</td><td colspan="2">☒ Halfway</td></tr>
<tr><td colspan="2">☐ Huntington</td><td colspan="3">☐ Richland</td><td colspan="2">☐ Sumpter</td><td colspan="2">☐ Unity</td></tr>
<tr><td colspan="9">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="9">Community Wildfire Protection Plan</td></tr>
<tr><td colspan="9">Background and Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="9">In support of the continuation of and management of proscribed burning to manage existing fuel loads in WUI areas of Baker County, the county has begun to develop a smoke mitigation plan.

The Natural Resources Coordinator is heading the effort and coordinating with the County Emergency Manager, and US Forest Service staff.</td></tr>
<tr><td colspan="9">Ideas for Implementation:</td></tr>
<tr><td colspan="9">Actions resulting from the Smoke Mitigation Plan may include purchase and installation of smoke monitoring equipment, public information campaigns to alert residents what actions they should take, and equipment to create smoke-free refuges for vulnerable people with compromised respiratory systems.</td></tr>
<tr><td colspan="3">Coordinating Organization:</td><td colspan="6">Baker County Natural Resources Coordinator</td></tr>
<tr><td colspan="4">Internal Partners:</td><td colspan="5">External Partners:</td></tr>
<tr><td colspan="4">Emergency Management/Emergency Services Department</td><td colspan="5">US Forest Service, Oregon Department of Forestry</td></tr>
<tr><td colspan="4">Potential Funding Sources:</td><td colspan="3">Estimated cost:</td><td colspan="2">Timeline:</td></tr>
<tr><td colspan="4"></td><td colspan="3"></td><td colspan="2">Short term (0-3 years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="8">2020 NHMP Steering Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="8">New Action.</td></tr>
</table>

Mitigation Actions Carried Over from *2014 NHMP*

Action Item:	**Alignment with Plan Goals:**	**Priority**
MH 1 – Complete Continuity of Operations Plans (COOPs) within all interested municipalities and counties	Goal 4	☐ High ☒ Medium ☐ Low

Affected Jurisdictions:

☒ Baker County	☐ Baker City	☐ Haines	☐ Halfway
☐ Huntington	☐ Richland	☐ Sumpter	☐ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- Government is one of the largest employers in Baker County
- City and County services in are typically relegated to one central building; should an earthquake or any other natural disaster interrupt the functioning of these buildings, municipal operations would cease to function.
- A Continuity of Operations Plan establishes policy and guidance to ensure the execution of the organization's most essential functions in any event that requires the relocation of selected personnel and functions to an alternate facility.
- Research has shown that staff turnover is likely to occur after a disaster, and veteran staff is critical after a disaster. Developing a continuity of operations plan will help prevent turnover so that existing personnel do not have to take on extra responsibilities during an already stressful time. In addition, continuity planning can help lessen turnover by ensuring competitive salaries and benefits and by reducing the amount of stress that staff will have to endure.

  Source: Oregon Natural Hazards Workgroup (ONHW). Cannon Beach Case Study Report. July 2006. Community Service Center, University of Oregon. Eugene, OR.

Ideas for Implementation:

- Recommend that public sector employees take the FEMA Independent Study Program: Continuity of Operations Course (online). The course provides a fundamental understanding of continuity of operations plans, terms, objectives, and benefits to public sector departments and agencies. It also provides information on how a COOP event might affect employees, the department/agency and an employee's family.
- Distribute the FEMA continuity of operations self-assessment tool to cities throughout the region.
- Review existing COOP plans and begin to establish county benchmarks for increasing recovery potential.

<table>
<tr><td colspan="4">• Seek assistance from the OEM COOP toolkit available on the Oregon Emergency Management website found here: http://www.oregon.gov/omd/oem/pages/plans_train/coop.aspx</td></tr>
<tr><td>Coordinating Organization:</td><td colspan="3">Interested City Managers and/or City Council; County Commissioners, Emergency Management</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="2">External Partners:</td></tr>
<tr><td colspan="2">Relevant Public Works and Emergency Services / Emergency Management, Law Enforcement, Fire Department</td><td colspan="2">FEMA, County Roads Departments, ODOT, relevant private industries, OEM</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td>Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="2"></td><td></td><td>Short Term</td></tr>
<tr><td>Form Submitted by:</td><td colspan="3">2008 NHMP Steering Committees; revised, confirmed in 2013 and confirmed in 2020</td></tr>
<tr><td>Action Item Status 2020:</td><td colspan="3">In Progress.</td></tr>
</table>

Action Item:	Alignment with Plan Goals:	Priority
MH 2 – Incorporate the Natural Hazards Mitigation Plan into the Comprehensive Plan (in particular Goal 7)	Goal 4	☐ High ☐ Medium ☒ Low

Affected Jurisdictions:			
☒ Baker County	☐ Baker City	☐ Haines	☐ Halfway
☐ Huntington	☐ Richland	☐ Sumpter	☐ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- The vision, goals, and policies of the comprehensive plan are routinely implemented through other local planning instruments such as zoning ordinances, subdivision regulations, and capital improvement programs. Integrating hazard mitigation into the local comprehensive plan thereby establishes resilience as an overarching value of a community and provides the opportunity to continuously manage development in a way that does not lead to increased hazard vulnerability.

  Source: FEMA
- The Natural Hazards Mitigation Plan's current actions have no regulatory or statutory requirements for compliance. Requiring the incorporation would give the plan 'teeth.'
- The Disaster Mitigation Act of 2000 requires that mitigation plans provide a comprehensive range of actions and projects to mitigate against natural hazards [201.6(c)(3)(ii)], such as actions that protect natural resources. Encouraging the implementation of existing action items with the Comprehensive Plan will help to ensure that the actions are implemented.

Ideas for Implementation:

- Interested county and city Natural Hazards Mitigation Plans will be adopted as an amendment to their Comprehensive Plan Goal 7 elements.

Coordinating Organization:	County/ City Planning Departments

Internal Partners:	External Partners:
	Department of Land Conservation and Development, Oregon Office of Emergency Management, Federal Emergency Management Agency

Potential Funding Sources:	Estimated cost:	Timeline:
		Long Term

Form Submitted by:	2013 County NHMP Steering Committees, confirmed by 2020 Baker County NHMP Steering Committee
Action Item Status 2020:	Deferred.

Action Item:	Alignment with Plan Goals:	Priority
MH 3 – Inform public officials about hazard mitigation and the Natural Hazards Mitigation Plan	Goal 3	☐ High ☐ Medium ☒ Low

Affected Jurisdictions:			
☒ Baker County	☐ Baker City	☐ Haines	☐ Halfway
☐ Huntington	☐ Richland	☐ Sumpter	☐ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- New public officials in Baker County should be briefed on community capacity, existing plans and policies, and personnel capabilities. Before a crisis occurs, public officials can prepare communities, risk managers, government spokespersons, public health officials, the news media, physicians, and hospital personnel with appropriate messages that can help build public confidence in public officials and the measures they recommend. When public officials are more informed about the mitigation plan, it is more likely that the plan will be implemented and maintained on a regular basis, and that any methods and schedules for monitoring, evaluating, and updating the plan are continued.

Ideas for Implementation:

- Develop public official information kit that can be distributed to elected officials and community decision makers. The kit should include pertinent information regarding the Natural Hazards Mitigation Plan as well as the risk the County faces.
- Publicize the Natural Hazards Mitigation Plan and send a copy to public officials.
- Create a brief memo for public officials that lists pertinent information regarding the Natural Hazards Mitigation Plan. Within the memo, create a list of persons involved in developing and/or implementing the plan, prioritized mitigation actions, and funding source descriptions.
- Bring mitigation awareness training to county planning and public works staff, GIS technicians, and persons responsible for maintaining or implementing the Natural Hazards Mitigation Plan
- Provide a briefing to relevant public officials regarding the specifics of the plan.

Coordinating Organization:	County Steering Committee Convener

Internal Partners:	**External Partners:**
Baker County Library District	

Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Short Term

Form Submitted by:	2008 NHMP Steering Committees; revised and confirmed in 2013, confirmed by 2020 Baker County NHMP Steering Committee
Action Item Status 2020:	Routine

<table>
<tr><th colspan="2">Action Item:</th><th>Alignment with Plan Goals:</th><th>Priority</th></tr>
<tr><td colspan="2">MH 5 – Increase the resilience of small businesses to natural hazards</td><td>Goal 2</td><td>☐ High
☒ Medium
☐ Low</td></tr>
<tr><th colspan="4">Affected Jurisdictions:</th></tr>
<tr><td>☒ Baker County</td><td>☒ Baker City</td><td>☒ Haines</td><td>☒ Halfway</td></tr>
<tr><td>☒ Huntington</td><td>☒ Richland</td><td>☒ Sumpter</td><td>☒ Unity</td></tr>
<tr><th colspan="4">Alignment with Existing Plans/Policies:</th></tr>
<tr><td colspan="4"></td></tr>
<tr><th colspan="4">Rationale for Proposed Action Item:</th></tr>
<tr><td colspan="4">
• To encourage and equip small businesses to rebuild post-disaster.
• As of 2018, there are 522 businesses in Baker County. Of these, 92%, or 481, were small businesses with less than 20 employees. The prevalence of small businesses in the Baker County is an indication of sensitivity to natural hazards because small businesses are more susceptible to financial uncertainty. When a business is financially unstable before a natural disaster occurs, financial losses (resulting from both damage caused and the recovery process) may have a bigger impact than they would for larger and more financially stable businesses.
• The professional and business services sector is sensitive to infrastructure disruptions such as a loss of power or disruptions of physical transmission cables (phone lines, etc.) due to winter storms. There may also be a disruption of employees' ability to work as a result of damage caused by natural hazards. If prepared and organized, however, the business sector has the potential to have moderate resilience to many disasters. Recent effects of COVID-19 have highlighted the essential nature of businesses such as grocery stores.
• Business continuity plans assist businesses in determining appropriate insurance coverage, review lease stipulations, mitigate against potential risks, and plan for future recovery efforts. (Source: Alesh, Daniel J. et al. 2001. "Organizations at Risk: What Happens When Small Businesses and Not-for-Profits Encounter Natural Disasters," The Public Entity Risk Institute).
• The Disaster Mitigation Act of 2000 requires communities to identify a comprehensive range of actions and projects that reduce the effects of hazards on the community [201.6(c)(3)(ii)], such as actions that educate the public and raise awareness. Teaching businesses to be more disaster resilient will help reduce the impact of a natural hazard on local businesses and will help them to bounce back faster after a natural hazard event.
</td></tr>
<tr><th colspan="4">Ideas for Implementation:</th></tr>
<tr><td colspan="4">
• Encourage small businesses to develop business continuity plans.
• Develop a program to provide businesses with post-disaster consult and assistance.
For example, In Union County there is a regional 'Contact Committee' composed of Union County Commissioners, the La Grande City Mayor, UCEDC, NEOEDD, Eastern Oregon University OTEC, and Oregon State Employment. When new businesses enter the region, they may use the contact committee for assistance, help in finding loans, etc. Each person/group on this committee is in a position to offer help, and members are bound to confidentiality.
</td></tr>
</table>

- Provide businesses with the Institute for Business and Home Safety (IBHS) "Getting Back to Business" guide: it contains important steps for business owners to use when reporting losses, assessing damages, and returning to business. It also contains a list of questions to ask your insurer and a resource list of organizations that can assist in business recovery issues.
- Hold community workshops on business hazard preparation and business continuity planning with Oregon Continuity Planners Association (OCPA; http://continuityplanners.org/)

Coordinating Organization:	Northeast Oregon Economic Development District, Baker County Economic Development	
Internal Partners:	**External Partners:**	
Northeast Oregon Counties' Chambers of Commerce, Baker County Economic Development, Baker Enterprise Growth Initiative,	Greater Eastern Oregon Development Corporation, Oregon Rural Alliance, Economic and Community Development Department Regional Development Officer, Oregon Trail Electric Cooperative, Southeast Regional Alliance, Historic Baker Center, Regional Solutions Team	
Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Short
Form Submitted by:	2008 NHMP Steering Committees; revised and confirmed in 2013, confirmed in 2020	
Action Item Status 2020:		

Action Item:	Alignment with Plan Goals:	Priority
MH 6 – Enhance communication and response coordination among all of the incorporated areas in each county	Goal 4	☒ High ☐ Medium ☐ Low

Affected Jurisdictions:

☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- In each county, there are distinct, geographically dispersed populations that do not share a lot of communication or interconnection. If areas need to be warned of an event or need emergency assistance, quick response will be difficult.
- Resources need to be shared; coordination can eliminate gaps and/or duplication of services

Ideas for Implementation:

- Establish resource sharing, interoperable communications, and emergency coordination meetings (to be modeled after those conducted in Baker County)
- Determine appropriate divisions of responsibility and establish a framework for joint planning and strategic decision-making on issues of common concern.
- Once per quarter hold meetings where public works staff can formally discuss issues and communicate. To be modeled after successful fire department mutual aid agreement communications that currently occur among municipalities.

Coordinating Organization:	Emergency Services / Emergency Management; Consolidated Dispatch Center

Internal Partners:	External Partners:
County Planning Departments; Local fire departments and fire districts	Bureau of Land Management, Oregon Department of Forestry, Oregon Department of Transportation, OSU Extension, Amateur Radio Emergency Services, OSP, FBI, Public Works, USFS, local irrigation districts

Potential Funding Sources:	Estimated cost:	Timeline:
		Ongoing

Form Submitted by:	2008 NHMP Steering Committees; revised and confirmed in 2013, confirmed in 2020
Action Item Status 2020:	Routine

Action Item:		Alignment with Plan Goals:	Priority
MH 9 – Develop a warning and emergency evacuation protocol for vulnerable populations; increase registration for the voluntary mass notification system particularly among vulnerable populations.		Goal 4	☐ High ☒ Medium ☐ Low
Affected Jurisdictions:			
☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity
Alignment with Existing Plans/Policies:			
Rationale for Proposed Action Item:			

- Community organizations that serve vulnerable populations are concerned with the transportation and services available to persons with special needs.
- Baker County is projected to maintain a fairly stable population over the next 20 years, but the average age of this region's population will increase. In 2025, 29% of Baker County's residents are expected to be above the age of 65.
- In 2018, nearly 33% of Baker County's population is 65 or older; 16% of the Baker County's population is under the age of 15.
- Impacts, in terms of loss and the ability to recover varies among population groups following a disaster. Historically, 80% of a disaster burden falls on the public. Of this number, a disproportionate burden is placed upon special needs groups, particularly minorities, and the poor.
- Low-income populations may require additional assistance following a disaster because they may not have the savings to withstand economic setbacks, and if work is interrupted, housing, food, and necessities become a greater burden. Additionally, low-income households are more reliant upon public transportation, public food assistance, public housing, and other public programs, all which can be impacted in the event of a natural disaster.
- The high percentage of elderly individuals require special consideration due to their sensitivities to heat, cold and smoke, their reliance upon transportation for medications, and their comparative difficulty in making home modifications that reduce risk to hazards.
- Young people also represent a vulnerable segment of the population. Special considerations should be given to young populations and schools, where children spend much of their time, during the natural hazard mitigation process. Children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities.
- According to the American Red Cross, natural hazards pose special problems for disabled residents in hazard-prone areas. "For the millions of Americans who have physical, medical, sensory or cognitive disabilities, emergencies such as fires, floods and acts of terrorism present a real challenge. The same challenge also applies to the elderly and other special needs populations."
- Three is no current policy/procedure in place, but there are general informal practices/protocols for vulnerable populations.
- According to the National Organization on Disability, in all these emergencies [natural hazards], people with disabilities are especially vulnerable. The N.O.D./Harris Surveys found that people with disabilities

are less prepared and, correspondingly, more anxious than our non-disabled counterparts. A 2004 N.O.D./Harris Survey of emergency managers across the country found a continued need to include people with disabilities in preparedness plans.			
Ideas for Implementation:			
• Create a voluntary registration for vulnerable populations (i.e., senior citizens, persons with wheelchairs or oxygen tanks, etc.) who may need emergency assistance in evacuating. • A mass notification system was successfully implemented in Baker County and helped with the water disease crypto outbreak consider using this in other counties/cities • The county wants to expand this program and has added a mitigation action (MH 4.1) related to public outreach in order to boost registration for the system.			
Coordinating Organization:	Emergency Services / Emergency Management		
Internal Partners:		**External Partners:**	
Baker Public Library District		Blue Mountain Translator District	
Potential Funding Sources:		**Estimated cost:**	**Timeline:**
			Short Term
Form Submitted by:	2008 NHMP Steering Committees; revised and confirmed in 2013, revised and confirmed in 2020		
Action Item Status 2020:	In process as part of revision to CWPP		

Action Item:		Alignment with Plan Goals:	Priority
DR 1 (DR #1 and DR #2 combined)– Identify incentive programs to increase water efficiency among agricultural and municipal water users		Goals 1 & 4	☒ High ☐ Medium ☐ Low
Affected Jurisdictions:			
☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity
Alignment with Existing Plans/Policies:			
Rationale for Proposed Action Item:			

- 1985-1997 was a dry period capped by statewide droughts in 1992 and 1994 (1992 drought emergency declaration). Negative externalities included forest-fires and insect problems.
- 2001, 2003, 2005, 2007, 2013, 2014, 2015 and 2018: Baker County was issued a declaration of a local drought emergency. The probability that Baker County will experience future droughts is high. Projections for future climate conditions as analyzed by the Oregon Climate Change Research Institute predicts hotter days and more of them.
- A strong water conservation incentive program will help to raise public consciousness and participation in water saving habits and lifestyles.
- Drought can affect all segments of a jurisdiction's population, particularly those employed in water-dependent activities (e.g., agriculture, hydroelectric generation, recreation, etc.). Facilities affected by drought conditions include communications facilities, hospitals, and correctional facilities that are subject to power failures. Storage systems for potable water, sewage treatment facilities, water storage for firefighting, and hydroelectric generating plants also are vulnerable.
- Water-efficiency measures can reduce water and sewer costs by up to 30%. Significant savings in energy, chemical and maintenance expenses are also possible. Water conservation measures result in both financial benefits and environmental benefits.
- The Disaster Mitigation Act of 2000 requires communities to identify comprehensive actions and projects that reduce the effects of a hazard on the community [201.6(c)(3)(ii)], such as actions protecting natural resources. Installing water efficient devices can significantly reduce the impact of drought by conserving the critical water resources in the community.

Completed Implementation:

- The Powder River Watershed Council has conducted projects with private landowners to convert flood irrigation to sprinkler irrigation and to convert from ditches to pipelines to transport water for agricultural uses. These methods conserve water by minimizing evaporation during transportation and to minimize wasting of water when irrigating.[2]
- Baker City has enacted regulations (Baker City Code of Ordinances § 53.25 - WATER CURTAILMENT PLAN) to require water conservation measures during periods of water shortage.

[2] Christo Morris, Powder River Watershed Council, personal communication, July 2020

<table>
<tr><th colspan="3">Ideas for Further Implementation:</th></tr>
<tr><td colspan="3">• Create a water-conservation committee within interested counties and/or cities to develop incentive programs, educational programs, and voluntary and/or mandatory restrictions on water use.
• Work with the Powder River Watershed Council to develop additional projects with private landowners that result in water conservation measures for agricultural land.
• Distribute conservation literature along with the regular mailing of bills. Local service organizations can be asked to disseminate water conservation promotional information.
• Investigate water pricing schemes (i.e., peak pricing and excess use charges) that discourage water use.
• Speak to local civic organizations (Boy Scouts, volunteer fire companies, etc.) on water conservation and suggest the sale of water-saving devices as a fund-raising activity.</td></tr>
<tr><td>Coordinating Organization:</td><td colspan="2">Powder River Watershed Council, County Watermasters, Public Works Departments</td></tr>
<tr><td>Internal Partners:</td><td colspan="2">External Partners:</td></tr>
<tr><td>Baker Soil and Water Conservation District, Natural Resources Conservation Service; landowners, irrigation districts</td><td colspan="2">Oregon Watershed Enhancement Board, Oregon Water Resources Department, U.S. Environmental Protection Agency</td></tr>
<tr><td>Potential Funding Sources:</td><td>Estimated cost:</td><td>Timeline:</td></tr>
<tr><td></td><td></td><td>Ongoing</td></tr>
<tr><td>Form Submitted by:</td><td colspan="2">2008 NHMP Steering Committees; revised and confirmed in 2013, revised and confirmed in 2020.</td></tr>
<tr><td>Action Item Status 2020:</td><td colspan="2">Some actions completed since 2014 plan update. See above Completed Implementation section.</td></tr>
</table>

Action Item:		Alignment with Plan Goals:	Priority
DR 2 (formerly DR #3): Develop community drought emergency plans and policies		Goal 4	☒ High ☐ Medium ☐ Low
Affected Jurisdictions:			
☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity
Alignment with Existing Plans/Policies:			
Rationale for Proposed Action Item:			
• 1985-1997 was a dry period capped by statewide droughts in 1992 and 1994 (1992 drought emergency declaration). Negative externalities included forest-fires and insect problems. • 2001, 2003, 2005, 2007, 2013, 2014, 2015 and 2018: Baker County was issued a declaration of a local drought emergency. The probability that Baker County will experience future droughts is high. Projections for future climate conditions as analyzed by the Oregon Climate Change Research Institute predicts hotter days and more of them. • Drought can affect all segments of a jurisdiction's population, particularly those employed in water-dependent activities (e.g., agriculture, hydroelectric generation, recreation, etc.). Facilities affected by drought conditions include communications facilities, hospitals, and correctional facilities that are subject to power failures. Storage systems for potable water, sewage treatment facilities, water storage for firefighting, and hydroelectric generating plants also are vulnerable. • The Disaster Mitigation Act of 2000 requires communities to identify comprehensive actions and projects that reduce the effects of a hazard on the community [201.6(c)(3)(ii)], such as actions protecting natural resources. Installing water efficient devices can significantly reduce the impact of drought by conserving the critical water resources in the community.			
Ideas for Implementation:			
• Review existing plans and look for improvement opportunities • Identify new and/or build upon existing emergency water supplies • Develop emergency water surcharge schedule rules • Adopt orders, rules and regulations for the purpose of implementing and enforcing the provisions of any Executive Orders issued pertaining to a drought emergency. • Impose restrictions upon the non-essential use of water including the use of water conservation devices, as may be necessary. • Encourage cities without a water curtailment plan/and or drought emergency plan to produce one • Inform public of drought conditions via newspaper and/ or local radio advertisement • Develop education strategies regarding conservation for elementary school students			

Coordinating Organization:	County Emergency Services / Emergency Management	
Internal Partners:	**External Partners:**	
Public Works Departments County and City Governments, County and City Planning Departments	Oregon Water Resources Department, Natural Resources Conservation Service, Baker County Cattleman's Association, Relevant Irrigation Districts, OSU Extension Office, US Department of Agriculture	
Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Routine
Form Submitted by:	2008 NHMP Steering Committees; revised and confirmed in 2013, revised and confirmed in 2020.	
Action Item Status 2020:	Routine	

Action Item:	**Alignment with Plan Goals:**	**Priority**
DR 3 (formerly DR #4) – Conduct an aquifer study for the Pine and Baker Valleys.	Goal 1	☒ High ☐ Medium ☐ Low

Affected Jurisdictions:

☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- Over-exploitation of aquifers may exceed the practical sustained yield in the near future; Baker County expects that they've reached full capacity, but would like to make sure.
- According to the 2008 Halfway City Addendum in the last 15-20 years, the City of Halfway's water supply has dropped by 50ft. The City would like to better understand its ability to sustain growth, and the amount of water in the Pine Valley will be a crucial determinant.
- Baker City's backup water supply is dependent on the valley's aquifers. Currently, aquifers are tapped for agricultural use; if Baker City's primary water supply failed, aquifer supply may not be adequate in accommodating the City's needs.
- Baker City used a consultant to perform a study on the aquifer that supports the city's drinking water well. This was done in the early 2000's, maybe 2004 as the city developed its Aquifer Storage and Recovery well. The city was granted a permit on the ASR well in 2009.
- Unknown capacities within aquifers may limit future development.
- A better knowledge of the hydrodynamic conditions and characteristics of the groundwater is essential for the well-being of the population and the economic development of the region
- The Baker Valley has a groundwater study completed and updated in 1965; Pine Valley does not have a completed study through the Oregon Water Resources Department.
- The Disaster Mitigation Act of 2000 requires communities to identify comprehensive actions and projects that reduce the effects of hazards on a community [201.6(c)(3)(ii)], such as actions protecting natural resources. Conducting an aquifer study will help determine the capacity of the Baker and Union aquifers and help these counties to plan for the effects of a potential drought.

Current Implementation Project:

The Powder River Watershed District was awarded grant funding in early 2020 from the Oregon Watershed Enhancement Board (OWEB) and has partnered with the Oregon Water Resources Department (OWRD) and the Department of Geology and Mineral Industries (DOGAMI) to conduct a review of existing data available from well drilling records and yearly flow data already available on Baker Valley wells through OWRD. The study will improve understanding about the aquifer underlying the Baker Valley.

Ideas for Implementation:

- The study is intended to do the following:
  - Improve the understanding of hydrodynamic conditions
  - Estimate recharge trends over past decades to study potential impacts of climate change.
  - Evaluate the vulnerability of water supply
  - Characterize the groundwater quality
- Most issues related to groundwater management are handled by state agencies under the authority of state law. Communication for the aquifer study should begin with the Oregon Water Resources Department or other relevant state agencies.

Coordinating Organization:	Baker County Emergency Management, Powder River Watershed Council	
Internal Partners:	**External Partners:**	
Baker County Water Master, Baker County Planning Department, Baker County Public Works, Baker City, City of Halfway	Oregon Water Resources Department, United States Geological Survey	
Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Long Term
Form Submitted by:	2008 NHMP Steering Committees; revised and confirmed in 2013, revised and confirmed in 2020.	
Action Item Status 2020:	Long Term	

Action Item:	**Alignment with Plan Goals:**	**Priority**
EQ 1 – Perform an earthquake risk evaluation in critical buildings not listed in the DOGAMI RVS report	Goal 1 and 2	☐ High ☐ Medium ☒ Low

Affected Jurisdictions:

☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- Oregon Senate Bill 2 (2005) directed DOGAMI to develop a statewide seismic needs assessment that includes a FEMA 154 Rapid Visual Screening survey of specific critical facilities, including schools. The Steering Committee identified several potentially vulnerable buildings not listed in survey including: Baker City Hall, the Carnegie Library in Baker City, and the Baker County Courthouse.
- Buildings, bridges, highways and utilities that are better able to withstand earthquakes not only save lives but also enable critical activities to continue with less disruption.
- The Disaster Mitigation Act of 2000 requires communities to identify actions and projects that reduce the effects of hazards on the community, particularly to buildings and infrastructure [201.6(c)(3)(ii)]. Implementing structural and non-structural retrofitting programs will reduce the seismic vulnerability of public buildings, historically important structures, and critical facilities and infrastructure, and assist a community in reducing its overall earthquake risk

Ideas for Implementation:

- Inventory existing facilities to determine future demands for maintenance, repair, rehabilitation or replacement; and to determine adequacy of existing facilities to meet future needs.
- Identify historic structures that represent a significant cultural resource for the community, focusing especially on un-reinforced masonry buildings, and identify mitigation measures to protect them from natural hazards.
- Provide both structural and non-structural retrofits to at risk buildings as required by the risk evaluations.

Coordinating Organization:	Emergency Management

Internal Partners:	**External Partners:**
County Public Works Departments, , Interested Cities,	Relevant utility companies, Business Oregon, DOGAMI

Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Long Term

Form Submitted by:	
Action Item Status 2020:	Deferred

<table>
<tr><th colspan="2">Action Item:</th><th colspan="2">Alignment with Plan Goals:</th><th>Priority</th></tr>
<tr><td colspan="2">EQ 2 – Seismically retrofit The Unity Fire Department to reduce the building's vulnerability to seismic hazards. Consider both structural and non-structural retrofit options</td><td colspan="2">Goal 1</td><td>☐ High
☐ Medium
☒ Low</td></tr>
<tr><th colspan="5">Affected Jurisdictions:</th></tr>
<tr><td>☐ Baker County</td><td>☐ Baker City</td><td colspan="2">☐ Haines</td><td>☐ Halfway</td></tr>
<tr><td>☐ Huntington</td><td>☐ Richland</td><td colspan="2">☐ Sumpter</td><td>☒ Unity</td></tr>
<tr><th colspan="5">Alignment with Existing Plans/Policies:</th></tr>
<tr><td colspan="5"></td></tr>
<tr><th colspan="5">Rationale for Proposed Action Item:</th></tr>
<tr><td colspan="5">• DOGAMI estimates the Unity Fire Department was constructed in the1970'sand its building was constructed of reinforced masonry bearing wall building with flexible diaphragms
• The Unity Fire Department has been identified as a critical facility by the Baker County Steering Committee
• Oregon Senate Bill 2 (2005) directed DOGAMI to develop a statewide seismic needs assessment that includes a FEMA 154 Rapid Visual Screening survey of specific critical facilities, including fire departments; this assessment determined that the Unity Fire Department has buildings with a very high collapse potential.
• Retrofitting of vital infrastructure, provides important improvements that reduce hazard exposure and the cost and time associated with recovery (Source: American Planning Advisory Service Report Number 483/484)
• Baker County has moderate vulnerability for seismic hazards. Retrofitting the Unity Fire Department will significantly reduce the building's vulnerability to seismic hazards and improve the safety of fire department employees and community members
• The Disaster Mitigation Act of 2000 requires communities to identify actions and projects that reduce the effects of hazards on the community, particularly to buildings and infrastructure [201.6 (c)(3)(ii)]. Seismically retrofitting the Unity Fire Department will reduce its vulnerability and ensure the viability of this critical facility.</td></tr>
<tr><th colspan="5">Ideas for Implementation:</th></tr>
<tr><td colspan="5">• Conduct a detailed structural evaluation that outlines recommendations for building deficiencies, and provides a cost estimate, incorporate DOGAMI's seismic assessment data to assist in retrofitting Unity Fire Department
• Apply for grant funding through the Oregon Seismic Rehabilitation Grant Program
• Apply for FEMA project grant funding</td></tr>
<tr><th colspan="2">Coordinating Organization:</th><td colspan="3">City of Unity Fire Department</td></tr>
<tr><th colspan="3">Internal Partners:</th><th colspan="2">External Partners:</th></tr>
<tr><td colspan="3">Emergency Management, County/City Public Works Departments,</td><td colspan="2">Business Oregon, Department of Geology and Mineral Industries, FEMA, OEM</td></tr>
</table>

Potential Funding Sources:		Estimated cost:	Timeline:
			Long Term
Form Submitted by:	2013 Baker County NHMP Steering Committee		
Action Item Status 2020:	Deferred		

Action Item:	Alignment with Plan Goals:	Priority
EQ 3 (combining EQ #3, EQ #4, EQ #6 and EQ #8) Seismically retrofit all School District's primary buildings to reduce their vulnerability to seismic hazards. This action was modified to include North Baker Elementary School, South Baker Elementary School, Pine Eagle Charter School, and Burnt River School. Consider both structural and non-structural retrofit options	Goal 1	☐ High ☐ Medium ☒ Low

Affected Jurisdictions:			
☐ Baker County	☒ Baker City	☐ Haines	☒ Halfway
☐ Huntington	☐ Richland	☐ Sumpter	☒ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- North Baker Elementary School was built in 1913 and is constructed of reinforced masonry bearing wall building with flexible diaphragms.
- South Baker Elementary School was built in 1953 and was constructed with a wood frame.
- Pine Eagle High School was built in 1967 and has buildings constructed with precast concrete frames.
- Burnt River School was built in 1968 and was constructed of a wooden frame.
- South Baker Elementary, North Baker Elementary, Pine Eagle Charter and Burnt River School have been identified as a critical facilities by the Baker County Steering Committee
- Oregon Senate Bill 2 (2005) directed DOGAMI to develop a statewide seismic needs assessment that includes a FEMA 154 Rapid Visual Screening survey of specific critical facilities, including schools; this assessment determined that the North Baker Elementary School has buildings with very high collapse potential.
- Retrofitting of vital infrastructure, such as schools and community buildings, provides important improvements that reduce hazard exposure and the cost and time associated with recovery (Source: American Planning Advisory Service Report Number 483/484)
- Baker County has moderate vulnerability for seismic hazards. Retrofitting North Baker Elementary will significantly reduce the school’s vulnerability to seismic hazards and improve the safety of students, teachers, and community members that use the school
- The Disaster Mitigation Act of 2000 requires communities to identify actions and projects that reduce the effects of hazards on the community, particularly to buildings and infrastructure [201.6 (c)(3)(ii)]. Seismically retrofitting the North Baker Elementary School will reduce its vulnerability and ensure the viability of this critical facility.

Ideas for Implementation:		
• Conduct a detailed structural evaluation that outlines recommendations for building deficiencies, and provides a cost estimate, incorporate DOGAMI's seismic assessment data for each of the four schools. • Apply for grant funding through the Oregon Seismic Rehabilitation Grant Program • Apply for FEMA project grant funding • Align project with School District Maintenance Plan		
Coordinating Organization:	Baker 5J School District	
Internal Partners:	**External Partners:**	
Emergency Management, County Public Works Departments, Baker City, City of Halfway, City of Unity	Business Oregon, Department of Geology and Mineral Industries, Federal Emergency Management Agency, Oregon Department of Education, Oregon Office of Emergency Management	
Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Long Term
Form Submitted by:	2013 Baker County NHMP Steering Committee, revised and confirmed in 2020	
Action Item Status 2020:	Deferred	

<table>
<tr><th colspan="2">Action Item:</th><th>Alignment with Plan Goals:</th><th>Priority</th></tr>
<tr><td colspan="2">FL 1 – Explore flood mitigation opportunities for homes and critical facilities subject to flooding.</td><td>Goal 1</td><td>☒ High
☐ Medium
☐ Low</td></tr>
<tr><th colspan="4">Affected Jurisdictions:</th></tr>
<tr><td>☒ Baker County</td><td>☒ Baker City</td><td>☒ Haines</td><td>☒ Halfway</td></tr>
<tr><td>☒ Huntington</td><td>☒ Richland</td><td>☒ Sumpter</td><td>☒ Unity</td></tr>
<tr><th colspan="4">Alignment with Existing Plans/Policies:</th></tr>
<tr><td colspan="4"></td></tr>
<tr><th colspan="4">Rationale for Proposed Action Item:</th></tr>
<tr><td colspan="4">• The City of Halfway has identified Pine Creek as a continual flooding hazard.
• Flooding is a potential hazard for many of the region’s water treatment facilities. The City of Halfway has identified their wastewater treatment plant as being threatened by Pine Creek.
• The Disaster Mitigation Act of 2000 requires communities to identify mitigation actions that address existing buildings and infrastructure [201.6(c)(3)(ii)]. Exploring flood mitigation opportunities for critical infrastructure will reduce the effect of a flood hazard on the community. Eliminating or limiting development in hazard prone areas, such as floodplains, can reduce vulnerability to hazards</td></tr>
<tr><th colspan="4">Ideas for Implementation:</th></tr>
<tr><td colspan="4">• Assess flooding hazards within each jurisdiction to determine where mitigation efforts are most needed. Identify suitable mitigation projects for each scenario.
• Develop acquisition and management strategies to preserve parks, trails, and open space in the floodplain.
• Identify water and wastewater treatment facilities that are in need of flood-proofing (mechanical or structural fixes).
• Assess the necessity of retrofitting the wastewater treatment plant and assess the benefits and costs of retrofitting.
• Implement mechanical and structural fixes during planned upgrades/expansions.
• Seek funding from the Flood Mitigation Assistance Program (FMA) or Oregon Department of Environmental Quality.
• Explore multi-objective stream enhancement projects.
• Seek Silver Jackets assistance in completion of mitigation projects.</td></tr>
<tr><th>Coordinating Organization:</th><td colspan="3">City and County Public Works Departments / Emergency Services and Emergency Management</td></tr>
<tr><th colspan="2">Internal Partners:</th><th colspan="2">External Partners:</th></tr>
<tr><td colspan="2">County Roads Departments, Public Works Departments, County Planning Departments;</td><td colspan="2">Relevant water treatment facilities, Federal Emergency Management Agency, Homeowner, Army Corps of Engineers, Oregon Department of Fish and Wildlife,</td></tr>
</table>

City of Enterprise City of John Day, City of La Grande, Baker City, City of Halfway	Department of State Lands, Oregon Department of Transportation, Silver Jackets	
Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Routine
Form Submitted by:	2013 Baker County NHMP Steering Committee, revised and confirmed in 2020	
Action Item Status 2020:	Routine	

Action Item:	Alignment with Plan Goals:	Priority
FL 2 – Explore the costs and benefits for participation in the NFIP's Community Rating System	Goals 1 and 2	☒ High ☐ Medium ☐ Low

Affected Jurisdictions:

☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, insurance premiums under the NFIP are discounted to reflect the reduced flood risk resulting from the community actions.
- The Community Rating System rewards communities that undertake floodplain activities beyond the requirements of the National Flood Insurance Program. The CRS is a point system program that reduces flood insurance premiums for the citizens of the participating communities.
- The current amount insurance in force for each county is a substantial amount of money. Participating in the CRS program could reduce this amount. The insurance in force for each county is as follows with the total paid amounts in parentheses:

  Baker County: $3,962,300 ($4,278)
  - Baker City: 11,931,200 ($25,491)
  - Halfway: $492,200 ($0.00)
- The Disaster Mitigation Act of 2000 requires communities to identify mitigation actions that address existing buildings and infrastructure [201.6(c)(3)(ii)]. Improving the CRS ratings for communities in Baker County helps decrease vulnerability to floods.

Ideas for Implementation:

- Assess current community activities to determine whether the city or county is already eligible to apply for a CRS classification better than 10.
- Determine the CRS classification your community would like to obtain, and take steps towards reaching that goal.
- Work towards obtaining higher CRS class ratings (1 being the highest rating obtainable; 10 being a non-participating community). Activities that reduce flood insurance premiums fall under four categories: Public Information, Mapping and Regulations, Flood Damage Reduction, and Flood Preparedness.
- Seek Silver Jackets assistance for CRS credit completion

Coordinating Organization:	Interested Cities and Counties
Internal Partners:	**External Partners:**

County and city planning departments, county emergency services / emergency management, county public works	Federal Emergency Management Agency, Department of Land Conservation and Development, Silver Jackets	
Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Short Term
Form Submitted by:	2013 Baker County NHMP Steering Committee, revised and confirmed in 2020	
Action Item Status 2020:	Deferred	

Action Item:	Alignment with Plan Goals:	Priority
FL 3 – Increase awareness of the NFIP program, specifically the Biggert Waters Flood Insurance Reform Act of 2012.	Goals 3 and 4	☒ High ☐ Medium ☐ Low

Affected Jurisdictions:			
☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- The purchase of flood insurance is low within each of the counties and cities participating in this NHMP.
- The Disaster Mitigation Act of 2000 requires communities to include a process for continued public involvement in the maintenance of the plan [201.6(c)(4)(iii)].Increasing public awareness of the National Flood Insurance Program (NFIP) will allow continued public involvement and will inform residents and businesses of the benefits of the NFIP program and how the NFIP can protect their property.
- The Biggert Waters Flood Insurance Reform Act of 2012 removed subsidized rates (pre-FIRM rates) on October 1st, 2013 for many classes of structures and allows rates to increase by 25% per year until actuarial rates are achieved.

Ideas for Implementation:

- Distribute information to current and future homeowners/renters in flood-prone areas.
- Communicate information regarding the Biggert-Waters Flood Insurance Reform Act of 2012 and its implications on (pre-FIRM) NFIP properties. Communicate these changes to NFIP insured property owners, prospective buyers, surveyors, real-estate agents, and the public at large. Seek assistance from Oregon's State Floodplain Coordinator.
- Increase awareness for current homeowners and prospective buyers of property about floodplain issues on their property and actions they can implement to mitigate the impacts of a flood

Coordinating Organization:	Local floodplain managers, County Emergency Manager

Internal Partners:	External Partners:
City Planning Departments, Emergency Services / Emergency Management, NFIP Floodplain Coordinator (DLCD), insurers, realtors	FEMA

Potential Funding Sources:	Estimated cost:	Timeline:
		Routine

Form Submitted by:	2013 Baker County NHMP Steering Committee, revised and confirmed in 2020
Action Item Status 2020:	Deferred

Action Item:	**Alignment with Plan Goals:**	**Priority**
FL 4 –Update the County and City FEMA Flood Insurance Rate Maps and digitize the updated maps.	Goals 1 and 2	☒ High ☐ Medium ☐ Low

Affected Jurisdictions:

☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- Flood Insurance Rate Maps in each of the communities in Baker County that participate in the NFIP are too old to be currently accurate.
- DOGAMI flew LIDAR in Baker County in 2012, near Baker City and part of the Elk Horn Mountains
- FEMA has not updated the Flood Insurance Rate Maps (FIRMS) since they were created in the 1980's. Due to their age, and the technology used to create them, the maps may not accurately represent present flood conditions.

Ideas for Implementation:

- Update the Flood Insurance Rate Maps using lidar.
- Convert then updated maps to digital maps. Using GIS, overlay digital FIRM maps against current property maps. Count and document the number of structures lying within the updated mapping of the floodplain.
- Determine the locations of flood-prone areas not identified by the FIRMs.

Coordinating Organization:	FEMA, DOGAMI

Internal Partners:	**External Partners:**
Baker County, Baker City, and City of Halfway floodplain administrators, Public Works Departments, Emergency Services and Emergency Management,	Army Corps of Engineers

Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Long Term

Form Submitted by:	2013 Baker County NHMP Steering Committee, revised and confirmed in 2020
Action Item Status 2020:	In Progress

Action Item:	**Alignment with Plan Goals:**	**Priority**	
LS 1 – Identify, obtain, and evaluate detailed risk assessments in landslide prone areas and develop mitigation strategies to reduce the likelihood of a potential hazardous event.	Goals 1 & 4	☒ High ☐ Medium ☐ Low	
Affected Jurisdictions:			
☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity
Alignment with Existing Plans/Policies:			
Rationale for Proposed Action Item:			
• The County Steering Committees identified several landslide prone areas that may need a detailed risk assessment. In Baker County Smith Ditch can block the Powder River; Highway 86 near Huntington has frequent landslide issues • The Disaster Mitigation Act of 2000 requires that communities identify actions and projects the reduce the impact of a natural hazard on the community, particularly to new and existing buildings and infrastructure [201.6(c)(3)(ii)]. Identifying areas vulnerable to landslide can reduce the impacts of landslides on new and existing developments and infrastructure.			
Ideas for Implementation:			
• Improve knowledge of debris flow (rapid moving) landslide hazard areas • Map steep slope areas using existing and new lidar imagery. • Research existing community ordinances related to steep slope developments			
Coordinating Organization:	County Emergency Management Department		
Internal Partners:		**External Partners:**	
County Planning Department, Incorporated Cities		ODOT, DOGAMI, USGS, Irrigation Districts	
Potential Funding Sources:		**Estimated cost:**	**Timeline:**
			Long Term
Form Submitted by:	2013 Baker County NHMP Steering Committee, revised and confirmed in 2020		
Action Item Status 2020:	Deferred		

Action Item:	Alignment with Plan Goals:	Priority
SW 1 – Participate in the NOAA Storm Ready Program	Goal 1	☐ High ☒ Medium ☐ Low

Affected Jurisdictions:

☒ Baker County	☐ Baker City	☐ Haines	☐ Halfway
☐ Huntington	☐ Richland	☐ Sumpter	☐ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- Baker County experiences extreme cold, high winds, winter storms, heavy rain, thunderstorms, and occasional tornados.
- Typically, winter weather will close interstate traffic, placing increased demands on lodging, rest stops, and local emergency services.
- Extreme winds are not uncommon in Baker County valleys and canyons.
- Only nine tornados have been recorded in Eastern Oregon since 1888, but they have caused damage to timber resources, personal property, and critical infrastructure.
- Thunderstorms can bring heavy winds, rain, hail, and lightning, which can all lead to mudslides, power outages, and damages to crop-producing fields.
- All structures, particularly those on the valley floor, are subject to severe weather, including ice and snow storms, lightning storms, and hail, heavy rain, and fast winds. Information pertaining to weather-related hazards and mitigation techniques would be helpful for new home-owners and developers in the area.
- The Disaster Mitigation Act of 2000 requires communities to identify a comprehensive range of actions and projects that reduce the effects of hazards on the community [201.6(c)(3)(ii)], such as actions addressing emergency services. Participating in NOAAs Storm Ready Program will reduce the impact of a severe weather event on a community by helping community members strengthen safety programs.
- The benefits for becoming a NOAA Storm Ready Program community include:
    - Enhance available coverage through NOAA weather radio
    - Identify and pursue funding sources for weather alert radio purchases
    - Provide staff support to assist with NOAA Storm Spotter program
- Improve warning dissemination to public.

<table>
<tr><th colspan="4">Ideas for Implementation:</th></tr>
<tr><td colspan="4">The steps for becoming a Storm Ready Community include:
o Contact the local National Weather Service (for Baker County contact the Boise office); contact the local Warning Coordination Meteorologists (WCM)
o Complete a Storm Ready form and send it to the local WCM
o Arrange a verification visit
o Receive Local Advisory Board Approval
o More information can be found at: http://www.stormready.noaa.gov/apply.htm</td></tr>
<tr><th>Coordinating Organization:</th><td colspan="3">Emergency Services / Emergency Management</td></tr>
<tr><th colspan="2">Internal Partners:</th><th colspan="2">External Partners:</th></tr>
<tr><td colspan="2">County Public Works Departments, County Roads Departments, Interested Cities, local fire departments</td><td colspan="2">National Oceanic and Atmospheric Administration, National Weather Service (Boise office), HAMM, Oregon Department of Transportation, American Red Cross, local radio stations, , United States Geological Survey</td></tr>
<tr><th colspan="2">Potential Funding Sources:</th><th>Estimated cost:</th><th>Timeline:</th></tr>
<tr><td colspan="2"></td><td></td><td>Short Term</td></tr>
<tr><th>Form Submitted by:</th><td colspan="3">2013 Baker County NHMP Steering Committee, revised and confirmed in 2020</td></tr>
<tr><th>Action Item Status 2020:</th><td colspan="3">In Progress</td></tr>
</table>

Action Item:	Alignment with Plan Goals:	Priority
SW 2 – Shorten spans and anchor poles on utility lines in high wind or heavy icing areas	Goal 1	☐ High ☒ Medium ☐ Low

Affected Jurisdictions:			
☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- High windstorms or winter icing storms can cause damage to long spans between power poles and create power outages during storms. If poles are inserted between spans this reduces the risk of outages. Also by anchoring certain poles this can reduce the amount of line, which would go down in a storm. Both items reduce the cost of repair and replacement.
- The Disaster Mitigation Act of 2000 requires communities to develop comprehensive actions to reduce the impacts of natural hazards, with an emphasis on new and existing buildings and infrastructure [206.6(c)(3)(ii)]. Shortening the spans between long lines and anchoring poles will reduce the likelihood of lines breaking during wind and winter icing storms.
- Windstorm and winter storm events were given a high probability ranking and high vulnerability score in the risk assessment for Baker County.
- Non-profit electric cooperatives are eligible to receive grant funding through the Hazard Mitigation Grant Program (HMGP)

Ideas for Implementation:

- The utility company would be responsible for identifying high wind and icing areas from previous outages and apply for grants to strengthen the areas by pole inserts and anchoring.

Coordinating Organization:	Oregon Trail Electric Cooperative

Internal Partners:	**External Partners:**
County Emergency Management, County Public Works	Other relevant utility companies

Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Routine

Form Submitted by:	2013 Baker County NHMP Steering Committee, revised and confirmed in 2020
Action Item Status 2020:	Routine

Action Item:	Alignment with Plan Goals:	Priority
SW 3 - Bury overhead power lines in winter storm and windstorm prone areas	Goal 1	☐ High ☒ Medium ☐ Low

Affected Jurisdictions:			
☒ Baker County	☒ Baker City	☒ Haines	☒ Halfway
☒ Huntington	☒ Richland	☒ Sumpter	☒ Unity

Alignment with Existing Plans/Policies:

Rationale for Proposed Action Item:

- Overhead electrical lines are subject to high winds and winter storm damage. During winter storms access to the line by the utility can be difficult and this delays the time for restoration of power to the services. Bury overhead power lines would remove the risk of damage from wind and winter storm events.
- The Disaster Mitigation Act of 2000 requires communities to develop comprehensive actions to reduce the impacts of natural hazards, with an emphasis on new and existing buildings and infrastructure [206.6(c)(3)(ii)]. Burying overhead lines in winter storm and windstorm prone areas will reduce the impact of severe weather on power lines, and will continue power service to rural customers as well as ODOT, State Police, county sheriff, emergency services, telephone utilities, and cell phone companies.
- Windstorm and winter storm events were given a high probability ranking and high vulnerability score in the risk assessment for Baker County.
- Non-profit electric cooperatives are eligible to receive grant funding through the Hazard Mitigation Grant Program (HMGP)

Ideas for Implementation:

- The utility company would be responsible to identifying high wind and icing areas from previous outages and apply for grants to bury overhead power lines.

Coordinating Organization:	Oregon Trail Electric Cooperative

Internal Partners:	**External Partners:**
County Emergency Management, County Public Works	Other relevant utility companies

Potential Funding Sources:	**Estimated cost:**	**Timeline:**
		Ongoing

Form Submitted by:	2013 Baker County NHMP Steering Committee, revised and confirmed in 2020
Action Item Status 2020:	Routine

<table>
<tr><th colspan="3">Action Item:</th><th colspan="2">Alignment with Plan Goals:</th><th colspan="2">Priority</th></tr>
<tr><td colspan="3">WF 1 – Implement wildfire mitigation action items as identified in each county's Community Wildfire Protection Plan.</td><td colspan="2">Goals 1 & 4</td><td colspan="2">☒ High
☐ Medium
☐ Low</td></tr>
<tr><th colspan="7">Affected Jurisdictions:</th></tr>
<tr><td>☒ Baker County</td><td colspan="2">☒ Baker City</td><td colspan="2">☒ Haines</td><td colspan="2">☒ Halfway</td></tr>
<tr><td>☒ Huntington</td><td colspan="2">☒ Richland</td><td colspan="2">☒ Sumpter</td><td colspan="2">☒ Unity</td></tr>
<tr><th colspan="7">Alignment with Existing Plans/Policies:</th></tr>
<tr><td colspan="7">Baker County CWPP 2014</td></tr>
<tr><th colspan="7">Rationale for Proposed Action Item:</th></tr>
<tr><td colspan="7">• The Disaster Mitigation Act of 2000 requires that mitigation plans provide a comprehensive range of actions and projects to mitigate against natural hazards [201.6(c)(3)(ii)], such as actions that protect natural resources. Encouraging the implementation of existing action items with the Counties' Community Wildfire Protection Plans will help to ensure that wildfire mitigation remains a cooperative priority in Northeast Oregon
• The Baker County CWPP developed extensive risk assessments and identified mitigation actions. The CWPP should be considered the guiding plan with the Wildfire section of this NHMP as a supplementary and supporting document. The CWPP contains accurate, updated and extensive information about the vulnerability, risk, and mitigation actions to mitigate the risk of wildfire.
• Action items included within the CWPPs should be referred to and coordinated as a component of this NHMP</td></tr>
<tr><th colspan="7">Ideas for Implementation:</th></tr>
<tr><td colspan="7">• Include persons who created and/or maintain the CWPP at semi-annual meetings. Incorporate CWPP actions into the project prioritization process.
• Continue fuels protection activities within the Baker City watershed and surrounding areas</td></tr>
<tr><th colspan="2">Coordinating Organization:</th><td colspan="5">County Steering Committee Convener, Emergency Management</td></tr>
<tr><th colspan="3">Internal Partners:</th><th colspan="4">External Partners:</th></tr>
<tr><td colspan="3">County Emergency Services / Emergency Management, County Planning Departments, City of Baker City, City of Halfway, Local Public Safety Coordinating Council (LPSCC), local fire departments,</td><td colspan="4">Oregon Department of Forestry, Bureau of Land Management, OSU Extension Services, US Forest Service, Soil and Water Conservation Districts, Oregon Department of Fish and Wildlife; Homeowners in Wildland/Urban Interface zones; Hells Canyon Preservation Council</td></tr>
<tr><th colspan="3">Potential Funding Sources:</th><th colspan="3">Estimated cost:</th><th>Timeline:</th></tr>
<tr><td colspan="3"></td><td colspan="3"></td><td>Routine</td></tr>
<tr><th>Form Submitted by:</th><td colspan="6">2013 Baker County NHMP Steering Committee, revised and confirmed in 2020</td></tr>
<tr><th>Action Item Status 2020:</th><td colspan="6">Routine</td></tr>
</table>

Appendix D:
Future Climate Projection, Baker County

Future Climate Projections
Baker County

February 2020

A Report to the Oregon Department of Land Conservation and Development

Prepared by
The Oregon Climate Change Research Institute

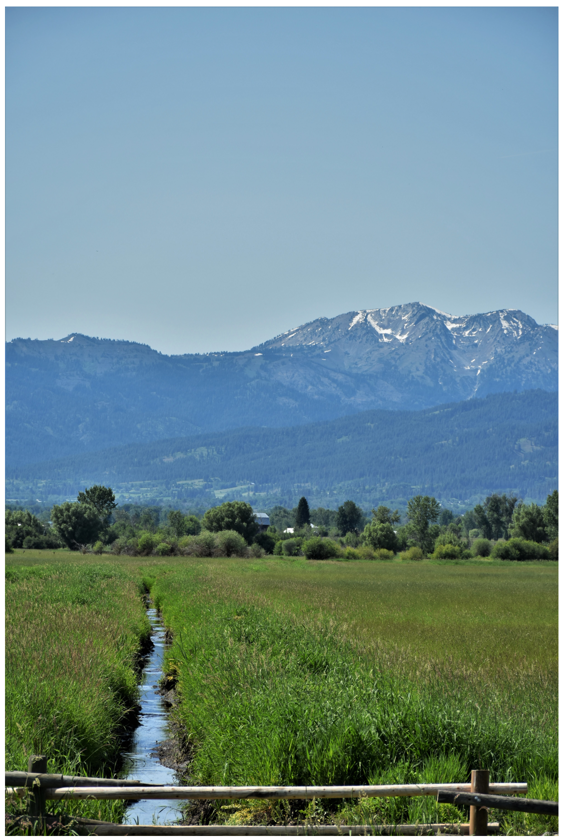


Photo credit: Halfway Oregon, Along Hells Canyon Scenic Byway, by Baker County Tourism, https://flic.kr/p/KS3aWT, Creative Commons License (CC BY-ND 2.0)

OCCRI DLCD

Future Climate Projections: Baker County

A report to the Oregon Department of Land Conservation and Development

Prepared by:
Meghan Dalton
Oregon Climate Change Research Institute
College of Earth, Ocean, and Atmospheric Sciences
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Guidance and review provided by:
Marian Lahav, Oregon Department of Land Conservation and Development

February 2020

Table of Contents

Executive Summary

Climate change is expected to increase the occurrence of most climate-related risks considered in this report. The risks of heat waves are projected to increase with very high confidence due to strong evidence in published literature, model consensus, and robust theoretical principles for continued increasing temperatures. The majority of risks expected to increase with climate change have high or medium confidence due to moderate to strong evidence and consensus yet they are influenced by multiple secondary factors in addition to increasing temperatures. Risks with low confidence, while important, show relatively little to no changes due to climate change or the level of evidence is limited. The projected direction of change along with the level of confidence in the direction of change for each climate change-related risk is summarized in Table 1.

Table 1 Summary of projected direction of change along with the level of confidence in climate change-related risk of natural hazard occurrence. Very high confidence means all models agree on the direction of change and there is strong evidence in the published literature. High confidence means most models agree on the direction of change and there is strong to medium evidence in the published literature. Medium confidence means that there is medium evidence and consensus on the direction of change with some caveats. Low confidence means the direction of change is small compared to the range of model responses or there is limited evidence in the published literature.

	Low Confidence	Medium Confidence	High Confidence	Very High Confidence
Risk Increasing ↑	Poor Air Quality	Drought Increased Invasive Species Risk	Heavy Rains Flooding Wildfire Loss of Wetland Ecosystems	Heat Waves
Risk Unchanging =	Windstorms			
Risk Decreasing ↓	Dust Storms			Cold Waves

This report presents future climate projections for Baker County relevant to specific natural hazards for the 2020s (2010–2039 average) and 2050s (2040–2069 average) relative to the 1971–2000 average historical baseline. The projections were analyzed for a lower greenhouse gas emissions scenario as well as a higher greenhouse gas emissions scenario, using multiple global climate models. This summary lists only the projections for the 2050s under the higher emissions scenario. Projections for both time periods and both emissions scenarios can be found within relevant sections of the main report.

Heat Waves

Extreme heat events are expected to increase in frequency, duration, and intensity due to continued warming temperatures.

In Baker County, the frequency of hot days per year with temperatures at or above 90°F is projected to increase on average by 30 days, with a range of about 12 to 40 days, by the 2050s under the higher emissions scenario relative to the historical baselines. This average increase represents a more than tripling of hot days relative to the average historical baseline.

In Baker County, the temperature of the hottest day of the year is projected to increase on average by nearly 8°F, with a range of about 3 to 11°F, by the 2050s under the higher emissions scenario relative to the historical baselines.

Cold Waves

Cold extremes are still expected to occur from time to time, but with much less frequency and intensity as the climate warms.

In Baker County, the frequency of cold days per year at or below freezing is projected to decrease on average by 19 days, with a range of about 10 to 28 days, by the 2050s under the higher emissions scenario relative to the historical baselines. This average decrease represents a future with less than half as many cold days per year as in the average historical baseline.

In Baker County, the temperature of the coldest night of the year is projected to increase on average by nearly 10°F, with a range of about 1 to 17°F, by the 2050s under the higher emissions scenario relative to the historical baselines.

Heavy Rains

The intensity of extreme precipitation events is expected to increase in the future as the atmosphere warms and is able to hold more water vapor.

In Baker County, the frequency of days with at least ¾" of precipitation is not projected to change substantially. However, the magnitude of precipitation on the wettest day and wettest consecutive five days per year is projected to increase on average by about 16% (with a range of 1% to 27%) and 11% (with a range of -4% to 29%), respectively, by the 2050s under the higher emissions scenario relative to the historical baselines.

In Baker County, the frequency of days exceeding a threshold for landslide risk, based on 3-day and 15-day precipitation accumulation, is not projected to change substantially. However, landslide risk depends on a variety of factors and this metric may not reflect all aspects of the hazard.

River Flooding

Mid- to low-elevation areas in Baker County's Blue Mountains that are near the freezing level in winter, receiving a mix of rain and snow, are projected to experience an increase in winter flood risk due to warmer winter temperatures causing precipitation to fall more as rain and less as snow.

Drought

Drought conditions, as represented by low summer soil moisture, low spring snowpack, low summer runoff, and low summer precipitation are projected to become more frequent in Baker County by the 2050s relative to the historical baseline.

By the end of the 21st century, summer low flows are projected to decrease in the Blue Mountains region putting some sub-basins at high risk for summer water shortage associated with low streamflow.

Wildfire

Wildfire risk, as expressed through the frequency of very high fire danger days, is projected to increase under future climate change. In Baker County, the frequency of very high fire danger days per year is projected to increase on average by about 42% (with a range of -7 to +98%) by the 2050s under the higher emissions scenario compared to the historical baseline.

Air Quality

Under future climate change, the risk of wildfire smoke exposure is projected to increase in Baker County. The number of "smoke wave" days—days with high concentrations of wildfire-specific particulate matter—is projected to increase by 100% and the intensity of "smoke waves" is projected to increase by 52% by 2046–2051 under a medium emissions scenario compared with 2004–2009.

Windstorms

Limited research suggests very little, if any, change in the frequency and intensity of windstorms in the Pacific Northwest as a result of climate change.

Dust Storms

Limited research suggests that the risk of dust storms in summer would decrease in eastern Oregon under climate change in areas that experience an increase in vegetation cover from the carbon dioxide fertilization effect.

Increased Invasive Species Risk

Warming temperatures, altered precipitation patterns, and increasing atmospheric carbon dioxide levels increase the risk for invasive species, insect and plant pests for forest and rangeland vegetation, and cropping systems.

Loss of Wetland Ecosystems

Freshwater wetland ecosystems are sensitive to warming temperatures and altered hydrological patterns, such as changes in precipitation seasonality and reduction of snowpack.

Introduction

Industrialization has given rise to increasing amounts of greenhouse gas emissions worldwide, which is causing the Earth's climate to warm (IPCC, 2013). The effects of which are already apparent here in Oregon (Dalton *et al.*, 2017; Mote *et al.*, 2019). Climate change is expected to influence the likelihood of occurrence of existing natural hazard events such as heavy rains, river flooding, drought, heat waves, cold waves, wildfire, air quality, and coastal erosion and flooding.

Oregon's Department of Land Conservation and Development (DLCD) contracted with the Oregon Climate Change Research Institute (OCCRI) to perform and provide analysis of the influence of climate change on natural hazards. The scope of this analysis is limited to the geographic area encompassed by the four Oregon counties that are part of the Pre-Disaster Mitigation (PDM) 17 grants DLCD received from FEMA. Those counties include: Lincoln, Clatsop, Baker, and Grant. Outcomes of this analysis include county-specific data, graphics, and text summarizing climate change projections for climate metrics related to each of the natural hazards listed in Table 2. This information will be integrated into the Natural Hazards Mitigation Plan (NHMP) updates for the four counties, and can be used in other county plans, policies, and programs. In addition to the county reports, sharing of data, and other technical assistance will be provided to the counties. This report covers climate change projections related to natural hazards relevant to Baker County.

Table 2 Natural hazards and related climate metrics evaluated in this project.

Heavy Rains Wettest Day ◆ Wettest Five Days Landslide Threshold Exceedance	**Heat Waves** Hottest Day ◆ Warmest Night "Hot" Days ◆ "Warm" Nights
River Flooding Annual maximum daily flows Atmospheric Rivers Rain-on-Snow Events	**Cold Waves** Coldest Day ◆ Coldest Night "Cold" Days ◆ "Cold" Nights
Drought Summer Flow ◆ Spring Snow Summer Soil Moisture Summer Precipitation	**Air Quality** Unhealthy Smoke Days
Wildfire Fire Danger Days	**Dust Storms**
Windstorms	**Loss of Wetland Ecosystems**
Increased Invasive Species Risk	

Future Climate Projections Background

Introduction

The county-specific future climate projections prepared by OCCRI are derived from 10–20 global climate models (GCM) and two scenarios of future global greenhouse gas emissions. Future climate projections have been “downscaled”—that is, made locally relevant—and summaries of projected changes in the climate metrics in Table 2 are presented for an early 21st century period and a mid 21st century period relative to a historical baseline. (Read more about the data sources in the Appendix.)

Global Climate Models

Global climate models are sophisticated computer models of the Earth’s atmosphere, water, and land and how these components interact over time and space according to the fundamental laws of physics (Figure 1). GCMs are the most sophisticated tools for understanding the climate system, but while highly complex and built on solid physical principles, they are still simplifications of the actual climate system. There are several ways to implement such simplifications into a GCM, which results in each one giving a slightly different answer. As such, it is best practice to use at least ten GCMs and look at the average and range of projections across all of them. (Read more about GCMs and uncertainty in the Appendix.)

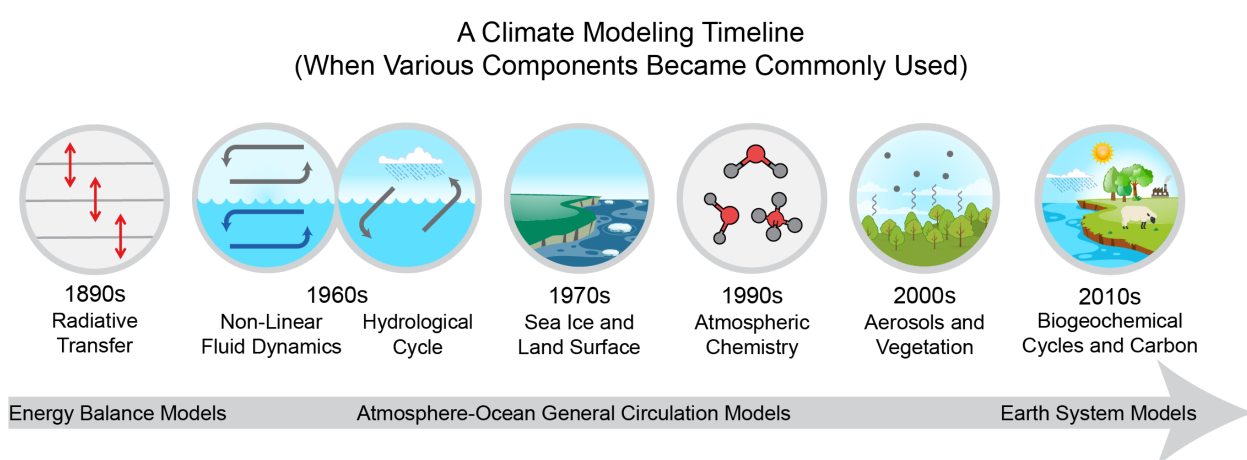

Figure 1 As scientific understanding of climate has evolved over the last 120 years, increasing amounts of physics, chemistry, and biology have been incorporated into calculations and, eventually, models. This figure shows when various processes and components of the climate system became regularly included in scientific understanding of global climate calculations and, over the second half of the century as computing resources became available, formalized in global climate models. (Source: science2017.globalchange.gov)

Greenhouse Gas Emissions

When used to project future climate, scientists give the GCMs information about the quantity of greenhouse gases that the world would emit, then the GCMs run simulations of what would happen to the air, water, and land over the next century. Since the precise amount of greenhouse gases the world will emit over the next century is unknown, scientists use several scenarios of different amounts of greenhouse gas emissions based on plausible societal trajectories. The future climate projections prepared by OCCRI uses emissions pathways called Representative Concentration Pathways (RCPs). There are several RCPs and the higher global emissions are, the greater the expected increase in global temperature (Figure 2). OCCRI considers a lower emissions scenario (RCP 4.5) and a higher emissions scenario (RCP 8.5) because they are the most commonly used scenarios in published literature and the downscaled data is available for these scenarios. (Read more about emissions scenarios in the Appendix.)

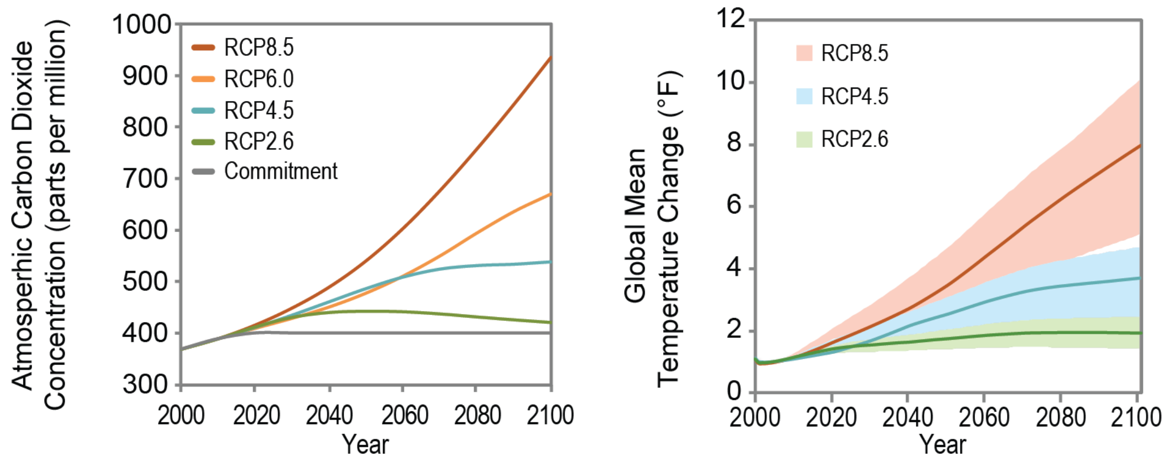

Figure 2 Future scenarios of atmospheric carbon dioxide concentrations (left) and global temperature change (right) resulting from several different emissions pathways, called Representative Concentration Pathways (RCPs), which are considered in the fourth and most recent National Climate Assessment. (Source: science2017.globalchange.gov)

Downscaling

Global climate models simulate the climate across adjacent grid boxes the size of about 60 by 60 miles. To make this coarse resolution information locally relevant, GCM outputs have been combined with historical observations to translate large-scale patterns into high-resolution projections. This process is called statistical downscaling. The future climate projections produced by OCCRI were statistically downscaled to a resolution with grid boxes the size of about 2.5 by 2.5 miles (Abatzoglou and Brown, 2012). (Read more about downscaling in the Appendix.)

Future Time Periods

When analyzing global climate model projections of future climate, it is best practice to compare the average across at least a 30-year period in the future simulations to an average across at least a 30-year period in the historical simulations. The average over a 30-year period in the historical simulations is called the *historical baseline*. For the future climate projections in this report, two 30-year future periods are analyzed in comparison with a 30-year historical baseline (Table 3).

Each of the twenty global climate models simulates historical and future climate slightly differently. Thus, each global climate model has a different historical baseline from which future projections are compared. Because each climate model's historical baseline is slightly different, this report presents the average and range of projected *changes* in the variables relative to each model's own historical baseline (rather than the average and range of future projected absolute values). The average of the twenty historical baselines, called the *average historical baseline*, is also presented to aid in understanding the relative magnitude of projected changes. The average historical baseline can be combined with the average projected future change to infer the average projected future absolute value of a given variable. However, the average historical baseline cannot be combined with the range of projected future changes to infer the range of projected future absolute values.

Table 3 Historical and future time periods for presentation of future climate projections

Historical Baseline	Early 21st Century "2020s"	Mid 21st Century "2050s"
1971–2000	2010–2039	2040–2069

How to Use the Information in this Report

Given the changing climate, anticipating future outcomes by considering only past trends may become increasingly unreliable. Future projections from GCMs provide an opportunity to explore a range of plausible outcomes taking into consideration the climate system's complex response to increasing concentrations of greenhouse gases. It is important to be aware that GCM projections should not be thought of as predictions of what the weather will be like at some specified date in the future, but rather viewed as projections of the long-term statistical aggregate of weather, in other words, "climate", if greenhouse gas concentrations follow some specified trajectory.[1]

The projections of climate variables in this report, both in the direction and magnitude of change, are best used in reference to the historical climate conditions under which a particular asset or system is designed to operate. For this reason, considering the projected changes between the historical and future periods allows one to envision how current systems of interest would respond to climate conditions that are different from what they have been. In some cases, the projected change may be small enough to be accommodated within the existing system. In other cases, the projected change may be large enough to require adjustments, or adaptations, to the existing system. However, engineering or design projects would require a more detailed analysis than what is available in this report.

The information in this report can be used to:

- Explore a range of plausible future outcomes taking into considering the climate system's complex response to increasing greenhouse gases
- Envision how current systems may respond under climate conditions different from those the systems were designed to operate under
- Evaluate potential mitigation actions to accommodate future conditions
- Influence the risk assessment in terms of the likelihood of a particular climate-related hazard occurring.

[1] Read more: https://nca2014.globalchange.gov/report/appendices/faqs#narrative-page-38784

Average Temperature

Oregon's average temperature warmed at a rate of 2.2°F per century during 1895–2015. Average temperature is expected to continue warming during the 21st century under scenarios of continued global greenhouse gas emissions; the rate of warming depends on the particular emissions scenario (Dalton *et al.*, 2017). By the 2050s (2040–2069) relative to the 1970–1999 historical baseline, Oregon's average temperature is projected to increase by 3.6 °F with a range of 1.8°–5.4°F under a lower emissions scenario (RCP 4.5) and by 5.0°F with a range of 2.9°F–6.9°F under a higher emissions scenario (RCP 8.5) (Dalton *et al.*, 2017). Furthermore, summers are projected to warm more than other seasons (Dalton *et al.*, 2017).

Average temperature in Baker County is projected to warm during the 21st century at a similar rate to Oregon as a whole (Figure 3). Projected increases in average temperature in Baker County relative to each global climate model's 1971–2000 historical baseline range from 1.2–4.1°F by the 2020s (2010–2039) and 2.1–7.9°F by the 2050s (2040–2069), depending on emissions scenario and climate model (Table 4).

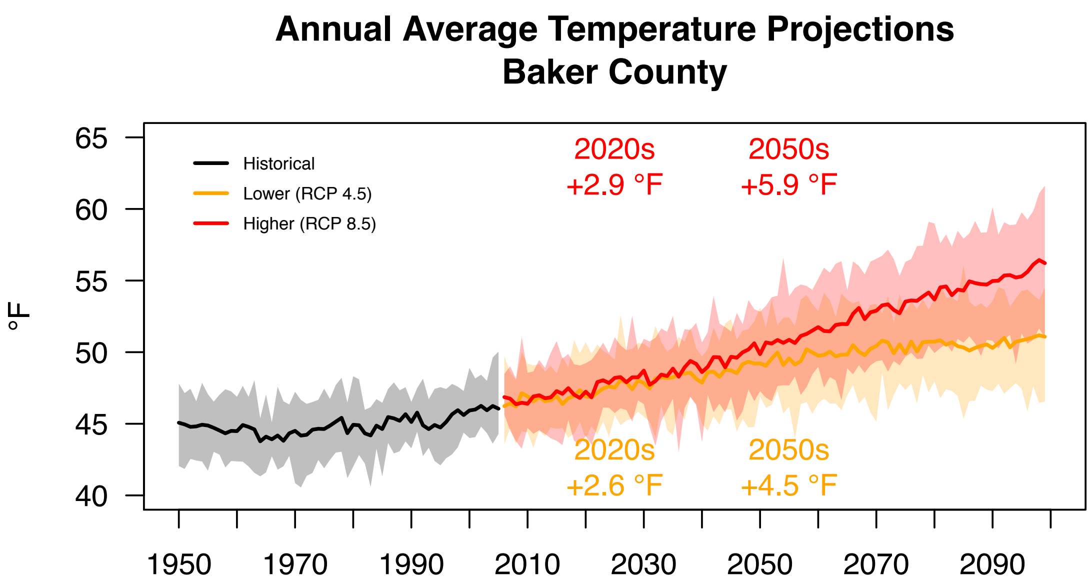

Figure 3 Annual average temperature projections for Baker County as simulated by 20 downscaled global climate models under a lower (RCP 4.5) and a higher (RCP 8.5) greenhouse gas emissions scenario. Solid line and shading depicts the 20-model mean and range, respectively. The multi-model mean differences for the 2020s (2010–2039 average) and the 2050s (2040–2069 average) relative to the average historical baseline (1971–2000 average) are shown.

Table 4 Average and range of projected future changes in Baker County's average temperature relative to each global climate model's (GCM) historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 GCMs.

	Change by Early 21st Century "2020s"	Change by Mid 21st Century "2050s"
Higher (RCP 8.5)	+2.9°F (1.6 to 4.1)	+5.9°F (3.2 to 7.9)
Lower (RCP 4.5)	+2.6°F (1.2 to 4.0)	+4.5°F (2.1 to 6.3)

Heat Waves

Extreme heat events are expected to increase in frequency, duration, and intensity in Oregon due to continued warming temperatures. In fact, the hottest days in summer are projected to warm more than the change in mean temperature over the Pacific Northwest (Dalton *et al.*, 2017). This report presents projected changes for three metrics of heat extremes for both daytime (maximum temperature) and nighttime (minimum temperature) (Table 5).

Table 5 Heat extreme metrics and definitions

Metric	Definition
Hot Days	Number of days per year maximum temperature is greater than or equal to 90°F
Warm Nights	Number of days per year minimum temperature is greater than or equal to 65°F
Hottest Day	Annual maximum of maximum temperature
Warmest Night	Annual maximum of minimum temperature
Daytime Heat Waves	Number of events per year with at least 3 consecutive days with maximum temperature greater than or equal to 90°F
Nighttime Heat Waves	Number of events per year with at least 3 consecutive days with minimum temperature greater than or equal to 65°F

In Baker County, all the extreme heat metrics in Table 5 are projected to increase by the 2020s (2010–2039) and 2050s (2040–2069) under both the lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios (Table 6). For example, for the 2050s under the higher emissions scenario climate models project that the number of hot days greater than or equal to 90°F per year, relative to each model's 1971–2000 historical baseline, would increase by as little as 12 days to as much as 40 days. The average projected increase in the number of hot days per year is 30 days above the average historical baseline of 14 days. This represents a projected more than tripling in the frequency of hot days by the 2050s under the higher emissions scenario.

Likewise, the temperature of the hottest day of the year is projected to increase by as little as 3.0°F to as much as 10.7°F by the 2050s under the higher emissions scenario relative to the models' historical baselines. The average projected increase is 7.8°F above the average historical baseline of 94.2°F. The frequency of daytime heat waves is projected to increase by nearly three events per year on average relative to the average historical baseline of about two events. In other words, hot days are projected to become more frequent and the hottest days are projected to become even hotter.

Projected changes in the frequency of extreme heat days (i.e., Hot Days and Warm Nights) are shown in Figure 4. Projected changes in the magnitude of heat records (i.e., Hottest Day and Warmest Night) are shown in Figure 5. Projected changes in the frequency of extreme heat events (i.e., Daytime Heat Waves and Nighttime Heat Waves) are shown in Figure 6.

Table 6 Mean and range of projected future changes in extreme heat metrics for Baker County relative to each global climate model's (GCM) historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 GCMs. The average historical baseline across the 20 GCMs is also presented and can be combined with the average projected future change to infer the average projected future absolute value of a given variable. However, the average historical baseline cannot be combined with the range of projected future changes to infer the range of projected future absolute values.

		Change by Early 21st Century "2020s"		Change by Mid 21st Century "2050s"	
	Average Historical Baseline	**Lower**	**Higher**	**Lower**	**Higher**
Hot Days	13.5 days	+10.9 days (3.8–16.2)	+12.9 days (5.4–17.6)	+21.0 days (7.7–30.2)	+29.7 days (11.6–40.4)
Warm Nights	1.2 days	+2.1 days (0.5–4.1)	+2.4 days (1.1–4.2)	+5.2 days (1.2–10.6)	+9.8 days (2.9–19.2)
Hottest Day	94.2°F	+3.3°F (1.2–4.9)	+3.8°F (1.7–5.4)	+5.7°F (2.3–8.0)	+7.8°F (3.0–10.7)
Warmest Night	61.8°F	+2.7°F (1.2–4.5)	+3.0°F (1.7–4.2)	+4.6°F (1.6–7.6)	+6.6°F (3.8–9.7)
Daytime Heat Waves	1.8 events	+1.2 events (0.6–1.9)	+1.4 events (0.8–1.8)	+2.1 events (1.2–3.4)	+2.7 events (1.5–4.0)
Nighttime Heat Waves	0.1 events	+0.3 events (0.0–0.4)	+0.3 events (0.1–0.5)	+0.6 events (0.1–1.3)	+1.2 events (0.2–2.2)

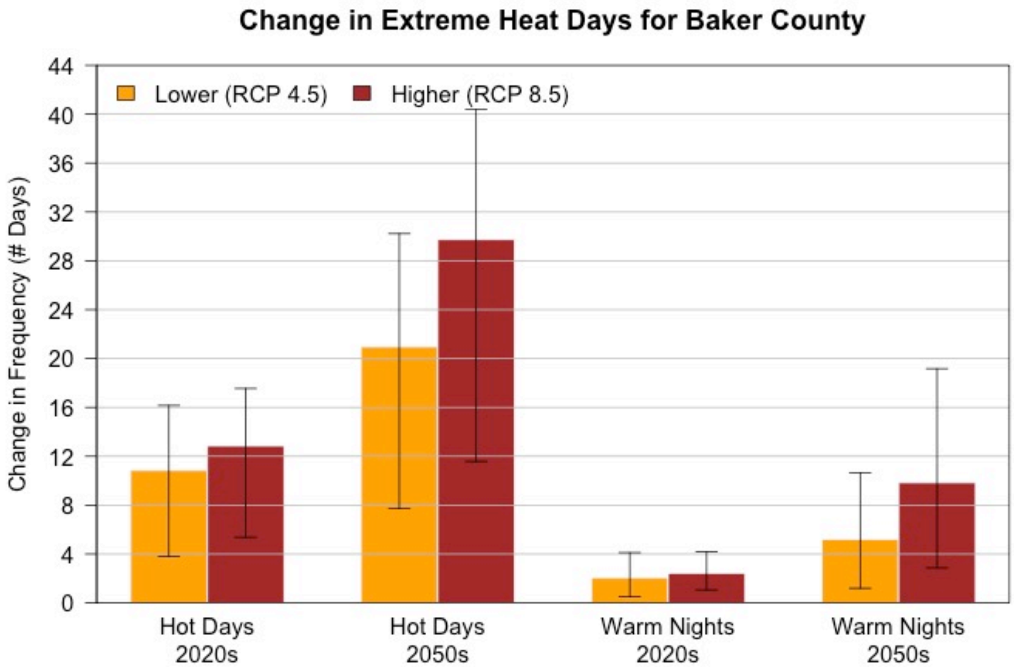

Figure 4 Projected future changes in the number of hot days (left two sets of bars) and number of warm nights (right two sets of bars) for Baker County relative to the historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 global climate models (GCMs). The bars and whiskers display the mean and range, respectively, of changes across the 20 GCMs relative to each GCM's historical baseline. Hot days are defined as days with maximum temperature of at least 90°F; warm nights are defined as days with minimum temperature of at least 65°F.

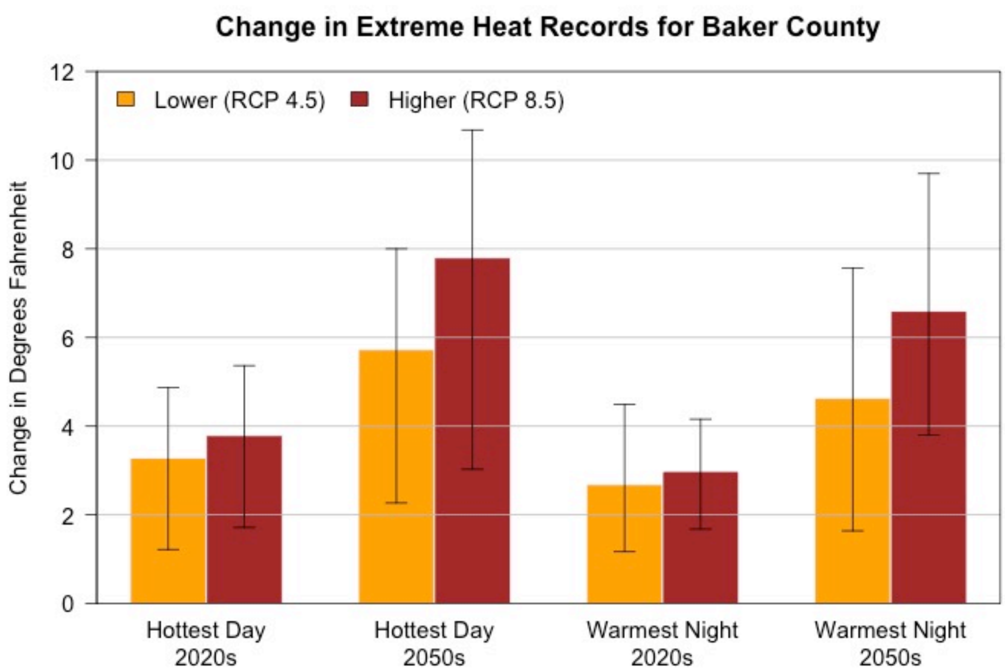

Figure 5 Projected future changes in the hottest day of the year (left two sets of bars) and warmest night of the year (right two sets of bars) for Baker County relative to the historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 global climate models (GCMs). The bars and whiskers display the mean and range, respectively, of changes across the 20 GCMs relative to each GCM's historical baseline.

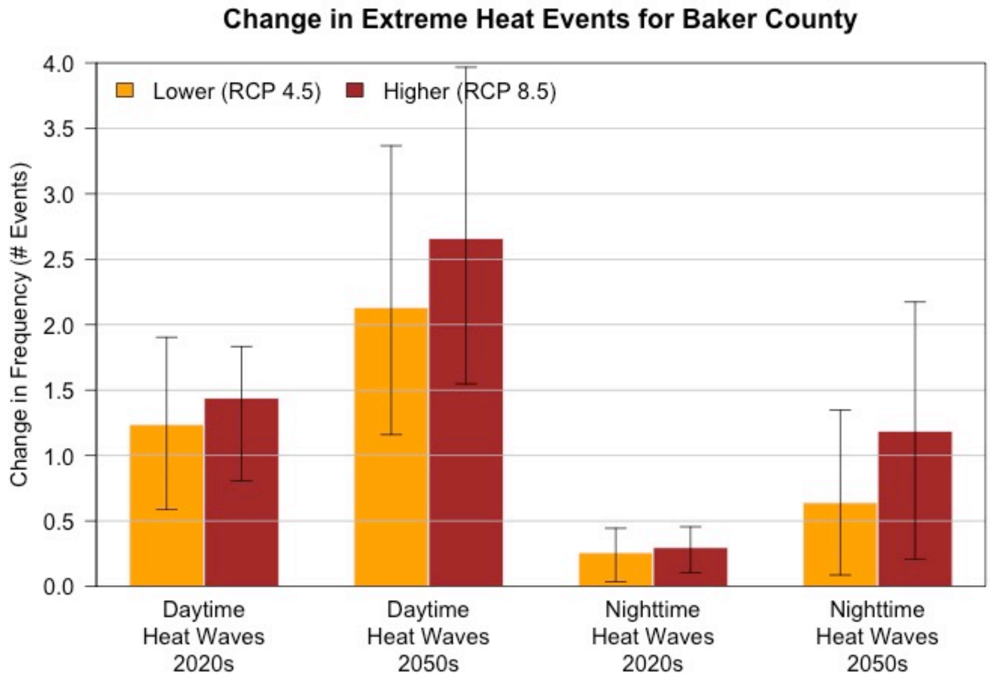

Figure 6 Projected future changes in the number of daytime heat waves (left two sets of bars) and number of nighttime heat waves (right two sets of bars) for Baker County relative to the historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 global climate models (GCMs). The bars and whiskers display the mean and range, respectively, of changes across the 20 GCMs relative to each GCM's historical baseline. Daytime heat waves are defined as events with three or more consecutive days with maximum temperature of at least 90°F; nighttime heat waves are defined as events with three or more consecutive days with minimum temperature of at least 65°F.

Key Messages:

⇒ Extreme heat events are expected to increase in frequency, duration, and intensity due to continued warming temperatures.

⇒ In Baker County, all the extreme heat metrics in Table 5 are projected to increase by the 2020s and 2050s under both the lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios (Table 6).

⇒ In Baker County, the frequency of hot days per year with temperatures at or above 90°F is projected to increase on average by 30 days, with a range of about 12 to 40 days, by the 2050s under the higher emissions scenario relative to the historical baselines. This average increase represents a more than tripling of hot days relative to the average historical baseline.

⇒ In Baker County, the temperature of the hottest day of the year is projected to increase on average by nearly 8°F, with a range of about 3 to 11°F, by the 2050s under the higher emissions scenario relative to the historical baselines.

Cold Waves

Over the past century, cold extremes have become less frequent and severe in the Northwest; this trend is expected to continue under future global warming of the climate system (Vose *et al.*, 2017). This report presents projected changes for three metrics of cold extremes for both daytime (maximum temperature) and nighttime (minimum temperature) (Table 7).

Table 7 Cold extreme metrics and definitions

Metric	Definition
Cold Days	Number of days per year maximum temperature is less than or equal to 32°F
Cold Nights	Number of days per year minimum temperature is less than or equal to 0°F
Coldest Day	Annual minimum of maximum temperature
Coldest Night	Annual minimum of minimum temperature
Daytime Cold Waves	Number of events per year with at least 3 consecutive days with maximum temperature less than or equal to 32°F
Nighttime Cold Waves	Number of events per year with at least 3 consecutive days with minimum temperature less than or equal to 0°F

In Baker County, the extreme cold metrics in Table 7 are projected to become less frequent or less cold by the 2020s (2010–2039) and 2050s (2040–2069) under both the lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios (Table 8). For example, for the 2050s under the higher emissions scenario climate models project that the number of cold days less than or equal to 32°F per year, relative to each model's 1971–2000 historical baseline, would decrease by at least 10 days to as much as 28 days. The average projected decrease in the number of cold days per year is 19 days relative to the average historical baseline of 31 days. This represents a future with less than half as many cold days as before by the 2050s under the higher emissions scenario.

Likewise, the temperature of the coldest night of the year is projected to increase by at least 1.1°F to at most 17.1°F relative to the models' historical baselines. The average projected increase is 9.5°F above the average historical baseline of -3.5°F. The frequency of daytime cold waves is projected to decrease by two events per year on average relative to the average historical baseline of about four events. In other words, cold days are projected to become less frequent and the coldest nights are projected to become warmer.

Projected changes in the frequency of extreme cold days (i.e., Cold Days and Cold Nights) are shown in Figure 7. Projected changes in the magnitude of cold records (i.e., Coldest Day and Coldest Night) are shown in Figure 8. Projected changes in the frequency of extreme cold events (i.e., Daytime Cold Waves and Nighttime Cold Waves) are shown in Figure 9.

Table 8 Mean and range of projected future changes in extreme cold metrics for Baker County relative to each global climate model's (GCM) historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 GCMs. The average historical baseline across the 20 GCMs is also presented and can be combined with the average projected future change to infer the average projected future absolute value of a given variable. However, the average historical baseline cannot be combined with the range of projected future changes to infer the range of projected future absolute values.

		Change by Early 21st Century "2020s"		Change by Mid 21st Century "2050s"	
	Average Historical Baseline	Lower	Higher	Lower	Higher
Cold Days	31.0 days	-9.8 days (-18.6 to -1.6)	-11.5 days (-17.6 to -2.3)	-16.5 days (-21.6 to -7.8)	-19.3 days (-27.8 to -10.4)
Cold Nights	2.7 days	-1.1 days (-2.5 to 0.3)	-1.5 days (-2.7 to -0.4)	-1.9 days (-3.2 to -0.5)	-2.0 days (-3.0 to -0.5)
Coldest Day	16.5°F	+2.1°F (-2.5 to 5.4)	+3.4°F (0.2 to 7.6)	+5.2°F (0.2 to 8.2)	+6.6°F (1.4 to 11.8)
Coldest Night	-3.5°F	+3.3°F (-1.9 to 9.1)	+5.1°F (0.7 to 11.7)	+7.5°F (1.2 to 13.3)	+9.5°F (1.1 to 17.1)
Daytime Cold Waves	3.9 events	-1.2 events (-2.3 to -0.2)	-1.3 events (-2.2 to -0.4)	-2.0 events (-2.8 to -0.9)	-2.4 events (-3.5 to -1.2)
Nighttime Cold Waves	0.3 events	-0.1 events (-0.3 to 0.1)	-0.2 events (-0.4 to 0.1)	-0.2 events (-0.5 to -0.0)	-0.3 events (-0.4 to -0.0)

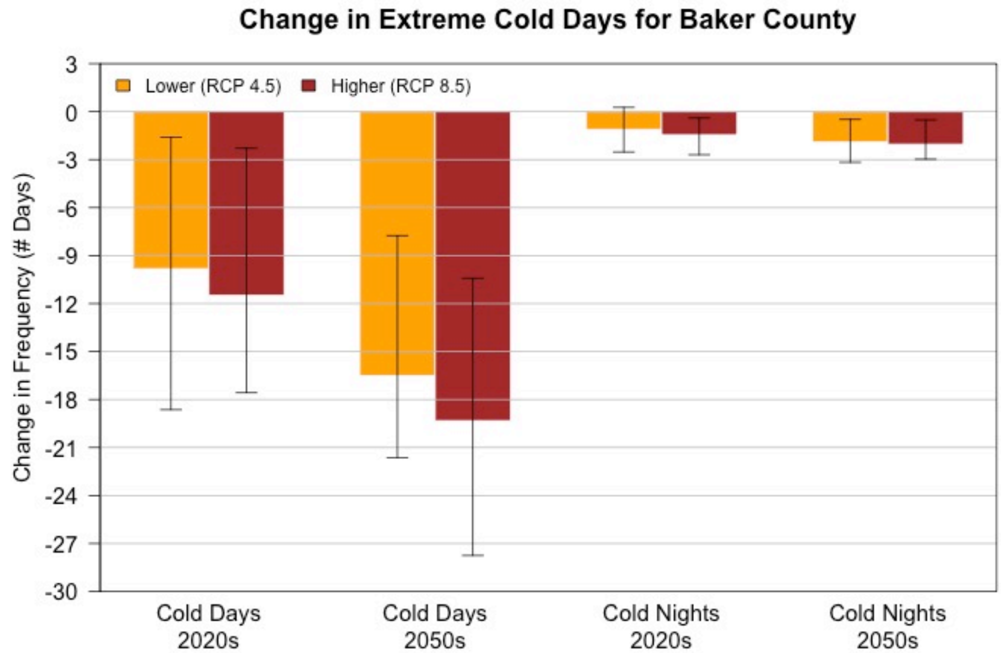

Figure 7 Projected future changes in the number of cold days (left two sets of bars) and number of cold nights (right two sets of bars) for Baker County relative to the historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 global climate models (GCMs). The bars and whiskers display the mean and range, respectively, of changes across the 20 GCMs relative to each GCM's historical baseline. Cold days are defined as days with maximum temperature at or below 32°F; cold nights are defined as days with minimum temperature at or below 0°F.

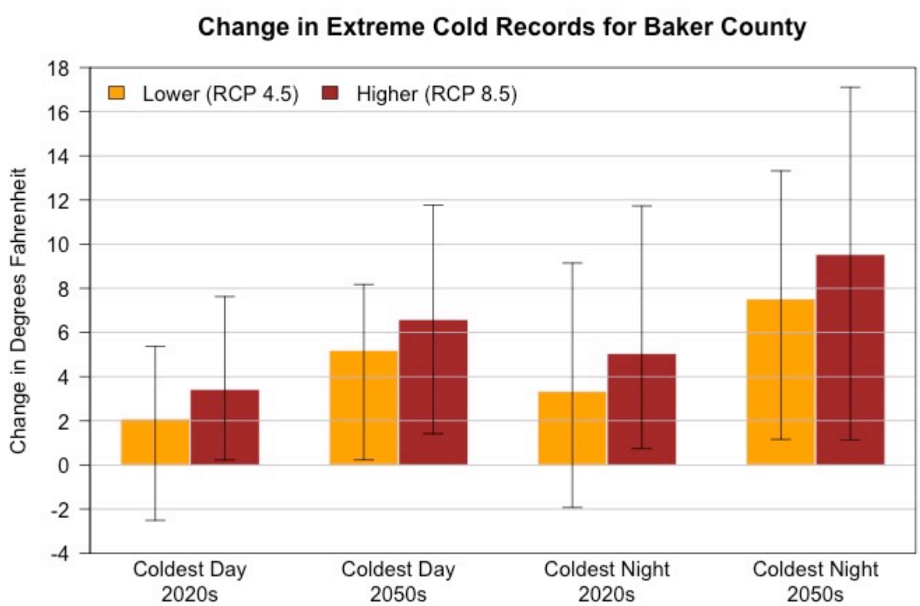

Figure 8 Projected future changes in the coldest day of the year (left two sets of bars) and coldest night of the year (right two sets of bars) for Baker County relative to the historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 global climate models (GCMs). The bars and whiskers display the mean and range, respectively, of changes across the 20 GCMs relative to each GCM's historical baseline.

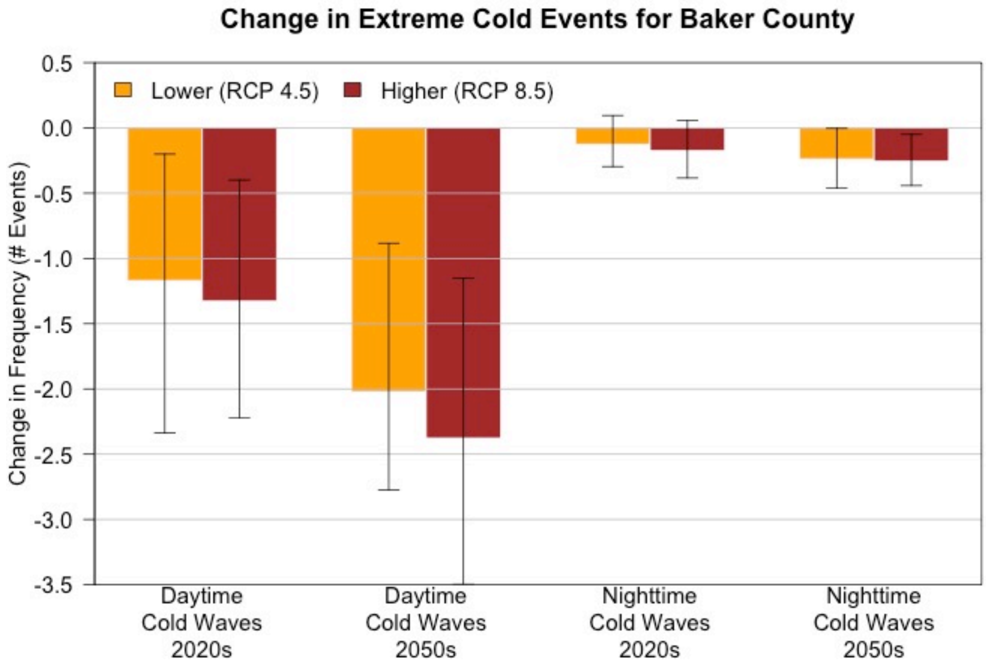

Figure 9 Projected future changes in the number of daytime cold waves (left two sets of bars) and number of nighttime cold waves (right two sets of bars) for Baker County relative to the historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 global climate models (GCMs). The bars and whiskers display the mean and range, respectively, of changes across the 20 GCMs relative to each GCM's historical baseline. Daytime cold waves are defined as events with three or more consecutive days with maximum temperature at or below 32°F; nighttime cold waves are defined as events with three or more consecutive days with minimum temperature at or below 0°F.

Key Messages:

⇒ Cold extremes are still expected to occur from time to time, but with much less frequency and intensity as the climate warms.

⇒ In Baker County, the extreme cold metrics in Table 7 are projected to become less frequent or less cold by the 2020s and 2050s under both the lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios (Table 8).

⇒ In Baker County, the frequency of cold days per year at or below freezing is projected to decrease on average by 19 days, with a range of about 10 to 28 days, by the 2050s under the higher emissions scenario relative to the historical baselines. This average decrease represents a future with less than half as many cold days per year as in the average historical baseline.

⇒ In Baker County, the temperature of the coldest night of the year is projected to increase on average by nearly 10°F, with a range of about 1 to 17°F, by the 2050s under the higher emissions scenario relative to the historical baselines.

Heavy Rains

There is greater uncertainty in future projections of precipitation-related metrics than temperature-related metrics. This is because of the large natural variability in precipitation patterns and the fact that the atmospheric patterns that influence precipitation are manifested differently across GCMs. From a global perspective, mean precipitation is likely to decrease in many dry regions in the sub-tropics and mid-latitudes and increase in many mid-latitude wet regions (IPCC, 2013). That boundary between mid-latitude increases and decreases in precipitation is positioned a little differently for each GCM, which results in some models projecting increases and others decreases in Oregon (Mote *et al.*, 2013).

In Oregon, observed precipitation is characterized by high year-to-year variability and future precipitation trends are expected to continue to be dominated by this large natural variability. On average, summers in Oregon are projected to become drier and other seasons to become wetter resulting in a slight increase in annual precipitation by the 2050s (2040–2069). However, some models project increases and others decreases in each season (Dalton *et al.*, 2017).

Extreme precipitation events in the Pacific Northwest are governed both by atmospheric circulation and by how it interacts with complex topography (Parker and Abatzoglou, 2016). Atmospheric rivers—long, narrow swaths of warm, moist air that carry large amounts of water vapor from the tropics to mid-latitudes—generally result in coherent extreme precipitation events west of the Cascade Range, while closed low pressure systems often lead to isolated precipitation extremes east of the Cascade Range (Parker and Abatzoglou, 2016).[2]

Observed trends in the frequency of extreme precipitation events across Oregon have depended on the location, time frame, and metric considered, but overall the frequency has not changed substantially. As the atmosphere warms, it is able to hold more water vapor that is available for precipitation. As a result, the frequency and intensity of extreme precipitation events are expected to increase in the future (Dalton *et al.*, 2017), including atmospheric river events (Kossin *et al.*, 2017). In addition, regional climate modeling results suggest a weakened rain shadow effect in winter projecting relatively larger increases in precipitation east of the Cascades and smaller increases west of the Cascades in terms of both seasonal precipitation totals and precipitation extremes (Mote *et al.*, 2019).

This report presents projected changes for four metrics of precipitation extremes (Table 9).

[2] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017)

Table 9 Precipitation extreme metrics and definitions

Metric	Definition
Wettest Day	Annual maximum 1-day precipitation per water year
Wettest Five-Days	Annual maximum 5-day precipitation total per water year
Wet Days	Number of days per year with precipitation greater than 0.75 inches
Landslide Risk Days	Number of days per water year exceeding the USGS landslide threshold[3]: https://pubs.er.usgs.gov/publication/ofr20061064 ○ P3/(3.5-.67*P15)>1, where: ▪ P3 = Previous 3-day precipitation accumulation ▪ P15 = 15-day precipitation accumulation prior to P3

In Baker County, the magnitude of precipitation on the wettest day and wettest consecutive five days is projected to increase on average by the 2020s (2010–2039) and 2050s (2040–2069) under both the lower and higher emissions scenarios (Table 10). However, some models project decreases in the wettest consecutive five days in all time periods and scenarios.

For the 2050s under the higher emissions scenario, climate models project that the magnitude, or amount, of precipitation on the wettest day of the year, relative to each model's 1971–2000 historical baseline, would increase by as little as 5.4% to as much as 25.9%. The average projected percent increase in the amount of precipitation on the wettest day of the year is 16.9% above the average historical baseline of nearly 1 inch.

For the magnitude of precipitation on the wettest consecutive five days of the year, some models project decreases by as much as 3.4% while other models project increases by as much as 22.7% for the 2050s under the higher emissions scenario. The average projected percent change in the amount of precipitation on the wettest consecutive five days is an increase of 11.4% above the average historical baseline of 2.3 inches.

The average number of days per year with precipitation greater than ¾" is projected to increase only by one day per year by the 2050s under the higher emissions scenario relative to the average historical baseline of three days per year.

Landslides are often triggered by rainfall when the soil becomes saturated. This report analyzes a cumulative rainfall threshold based on the previous 3-day and 15-day precipitation accumulation as a surrogate for landslide risk. For Baker County, the average number of days per year exceeding the landslide risk threshold is projected to increase on average by one day per year by the 2050s under the higher emissions scenario relative to the average historical baseline of three days per year. Landslide risk depends on a variety of site-specific factors and this metric may not reflect all aspects of the hazard. It is important to note that this particular landslide threshold was developed for Seattle, Washington and may or may not have similar applicability to other locations.

[3] This threshold was developed for Seattle, Washington and may or may not have similar applicability to other locations.

Projected changes in the magnitude of extreme precipitation events (i.e., Wettest Day and Wettest Five-Days) are shown in Figure 10. Projected changes in the frequency of extreme precipitation events (i.e., Wet Days and Landslide Risk Days) are shown in Figure 11.

Table 10 Mean and range of projected future changes in extreme precipitation metrics for Baker County relative to each global climate model's (GCM) historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 GCMs. The average historical baseline across the 20 GCMs is also presented and can be combined with the average projected future change to infer the average projected future absolute value of a given variable. However, the average historical baseline cannot be combined with the range of projected future changes to infer the range of projected future absolute values.

		Change by Early 21st Century "2020s"		Change by Mid 21st Century "2050s"	
	Average Historical Baseline	**Lower**	**Higher**	**Lower**	**Higher**
Wettest Day	0.99"	+12.3% (1.0 to 19.0)	+9.9% (0.2 to 21.8)	+13.1% (3.7 to 26.0)	+16.9% (5.4 to 25.9)
Wettest Five-Days	2.29"	+7.3% (-1.8 to 19.2)	+6.5% (-10.9 to 23.9)	+8.2% (-1.9 to 17.7)	+11.4% (-3.4 to 22.7)
Wet Days	2.9 days	+0.4 days (-0.0 to 0.8)	+0.4 days (-0.2 to 1.0)	+0.6 days (0.2 to 1.0)	+0.8 days (0.1 to 1.4)
Landslide Risk Days	3.5 days	0.5 days (-0.3 to 1.3)	0.4 days (-0.3 to 1.3)	0.6 days (-0.1 to 1.5)	0.9 days (-0.2 to 2.1)

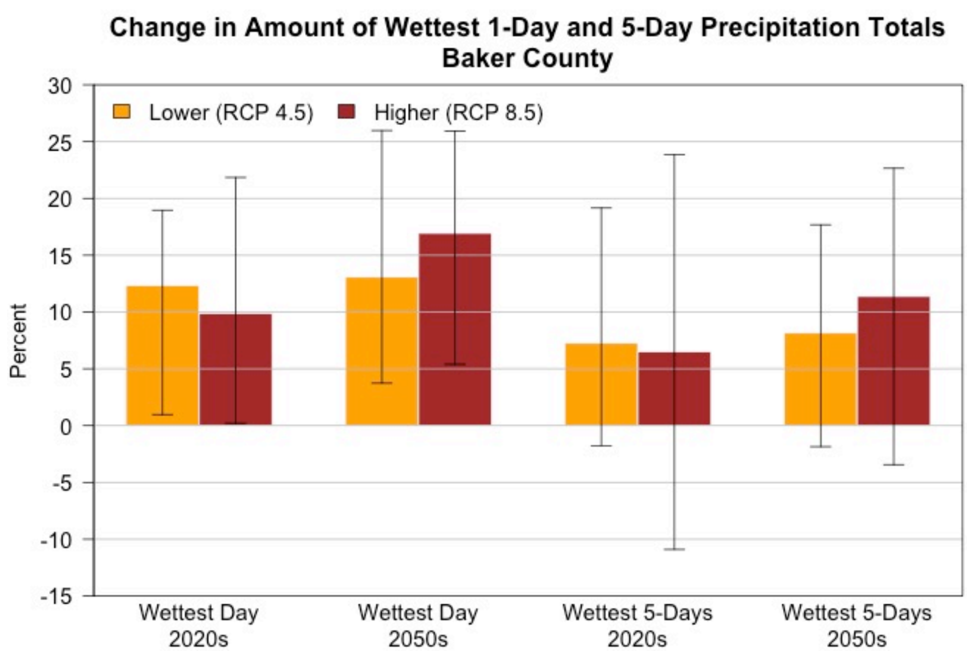

Figure 10 Projected future changes in the wettest day of the year (left two sets of bars) and wettest consecutive five days of the year (right two sets of bars) for Baker County relative to the historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 global climate models (GCMs). The bars and whiskers display the mean and range, respectively, of changes across the 20 GCMs relative to each GCM's historical baseline.

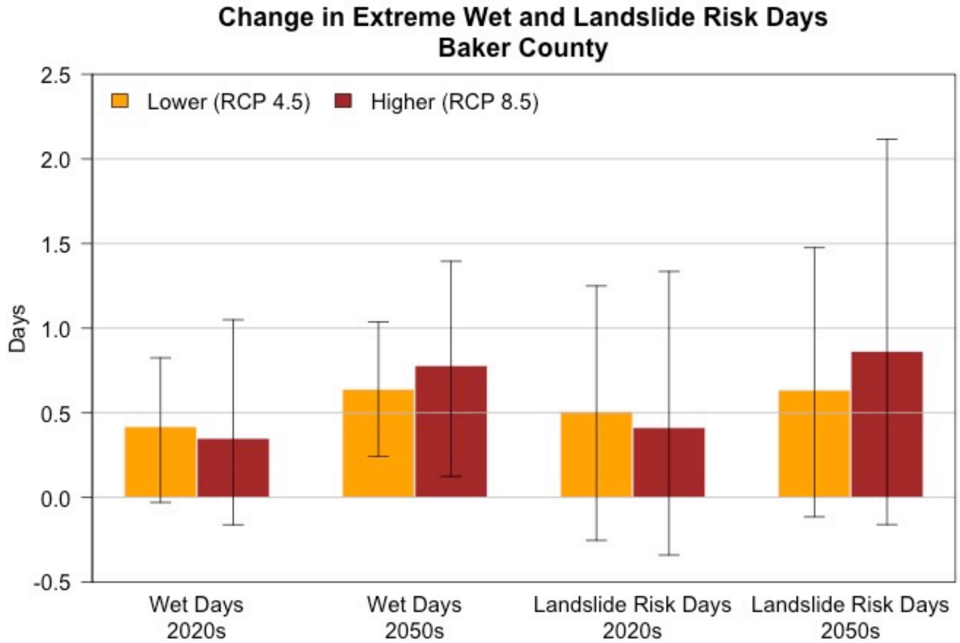

Figure 11 Projected future changes in the frequency of wet days (left two sets of bars) and landslide risk days (right two sets of bars) for Baker County relative to the historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 20 global climate models (GCMs). The bars and whiskers display the mean and range, respectively, of changes across the 20 GCMs relative to each GCM's historical baseline.

Key Messages:

⇒ The intensity of extreme precipitation events is expected to increase in the future as the atmosphere warms and is able to hold more water vapor.

⇒ In Baker County, the frequency of days with at least ¾" of precipitation is not projected to change substantially. However, the magnitude of precipitation on the wettest day and wettest consecutive five days per year is projected to increase on average by about 16% (with a range of 1% to 27%) and 11% (with a range of -4% to 29%), respectively, by the 2050s under the higher emissions scenario relative to the historical baselines.

⇒ In Baker County, the frequency of days exceeding a threshold for landslide risk, based on 3-day and 15-day precipitation accumulation, is not projected to change substantially. However, landslide risk depends on a variety of factors and this metric may not reflect all aspects of the hazard.

River Flooding

Future streamflow magnitude and timing in the Pacific Northwest is projected to shift toward higher winter runoff, lower summer and fall runoff, and an earlier peak runoff, particularly in snow-dominated regions (Raymondi *et al.*, 2013; Naz *et al.*, 2016).[4] These changes are expected to result from warmer temperatures causing precipitation to fall more as rain and less as snow, in turn causing snow to melt earlier in the spring; and in combination with increasing winter precipitation and decreasing summer precipitation (Dalton *et al.*, 2017; Mote *et al.*, 2019).

The projected change in the mean monthly hydrograph of the Snake River at Brownlee Dam is shown in Figure 12. On the Snake River at Brownlee Dam, the monthly hydrograph is characteristic of a snow-dominated basin with peak flows during the late spring snowmelt season (Figure 12). By the 2050s (2040–2069), under both emissions scenarios, the peak streamflow is projected to shift earlier in the spring as warmer temperatures cause the snowpack to melt earlier. In addition, winter streamflow is projected to increase due to increased winter precipitation and that precipitation falling more as rain than snow.

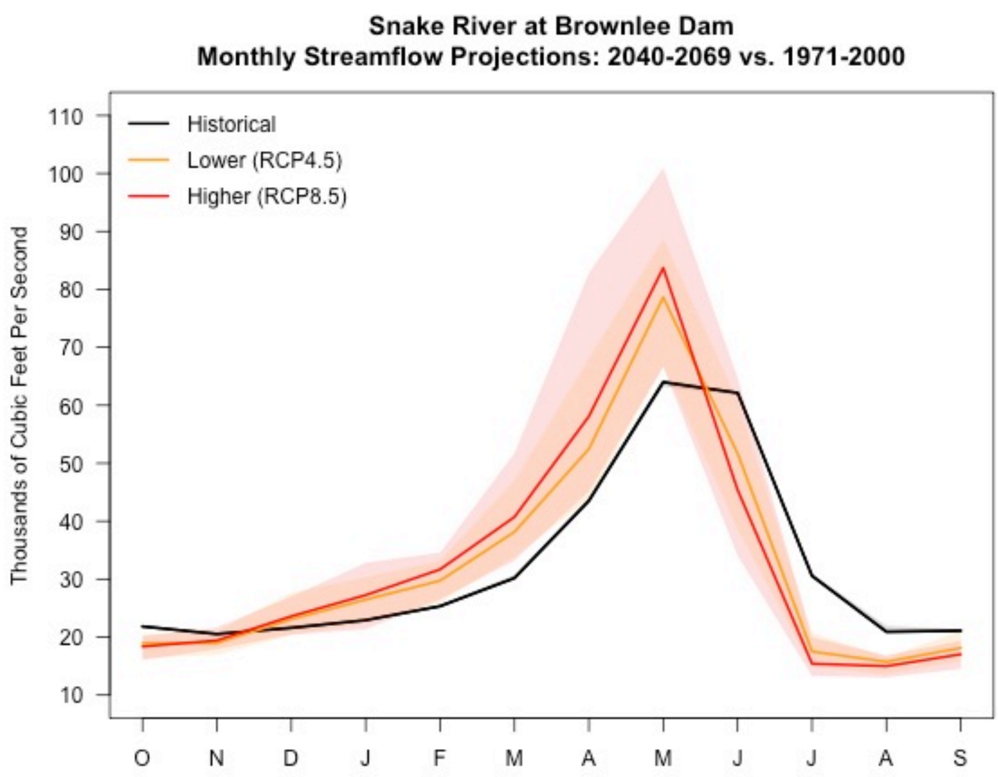

Figure 12 Simulated historical and future bias-corrected mean monthly non-regulated streamflow at the Snake River at Brownlee Dam for 2040–2069 compared to 1971–2000. Solid lines and shading depict the mean and range across ten global climate models. (Data source: Integrated Scenarios of the Future Northwest Environment, https://climatetoolbox.org/tool/future-streamflows)

[4] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017)

Warming temperatures and increased winter precipitation are expected to increase flood risk for many basins in the Pacific Northwest, particularly mid- to low-elevation mixed rain-snow basins with near freezing winter temperatures (Tohver *et al.*, 2014). The greatest changes in peak streamflow magnitudes are projected to occur at intermediate elevations in the Cascade Range and the Blue Mountains (Safeeq *et al.*, 2015). Recent advances in regional hydro-climate modeling support this expectation, projecting increases in extreme high flows for most of the Pacific Northwest, especially west of the Cascade Crest (Salathé *et al.*, 2014; Najafi and Moradkhani, 2015; Naz *et al.*, 2016). One study, using a single climate model, projects flood risk to increase in the fall due to earlier, more extreme storms, including atmospheric river events, and to a shift of precipitation from snow to rain (Salathé *et al.*, 2014).[5]

In parts of the Blue Mountains (the Wallowa Mountains, Hells Canyon Wilderness Area, and northeast Wallowa-Whitman National Forest), flood magnitude for the 1.5-year return period event is expected to increase by the end of the 21st century under a medium emission scenario (SRES-A1B)[6], particularly in mid-elevation areas, as precipitation falls more as rain and less as snow (Clifton *et al.*, 2018) (Figure 13). The 1.5-year return period event has a 67% probability of occurrence in a given year and is indicative of flooding levels that can begin to cause damage to roads. An increase in flood magnitude for a specified flood frequency implies an increase in flood frequency for a given flood magnitude. Figure 12 shows projections of flood magnitude change for the 1.5-year return period event for the 2080s compared to a historical baseline. Unfortunately, quantitative information about flood risk in Baker County is not available for the 2020s and 2050s.

Across the western US, the 100-year and 25-year peak flow magnitudes—major flooding events—are projected to increase at a majority of streamflow sites by the 2070–2099 period compared to the 1971–2000 historical baseline under the higher emissions scenario (RCP 8.5) (Maurer *et al.*, 2018). For the Snake River at Brownlee Dam, the 25-year and 100-year peak flow magnitudes are projected to increase by about 25% and 29%, respectively, by the 2070–2099 period compared to the historical baseline (

Table 11). This corresponds with the magnitude of the 25-year and 100-year peak flow events becoming the 9-year and 22-year events, respectively (Maurer *et al.*, 2018).

[5] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017)

[6] The medium emissions pathway (SRES-A1B) is from an earlier generation of emissions scenarios and it is most similar to RCP 6.0 from Figure 2.

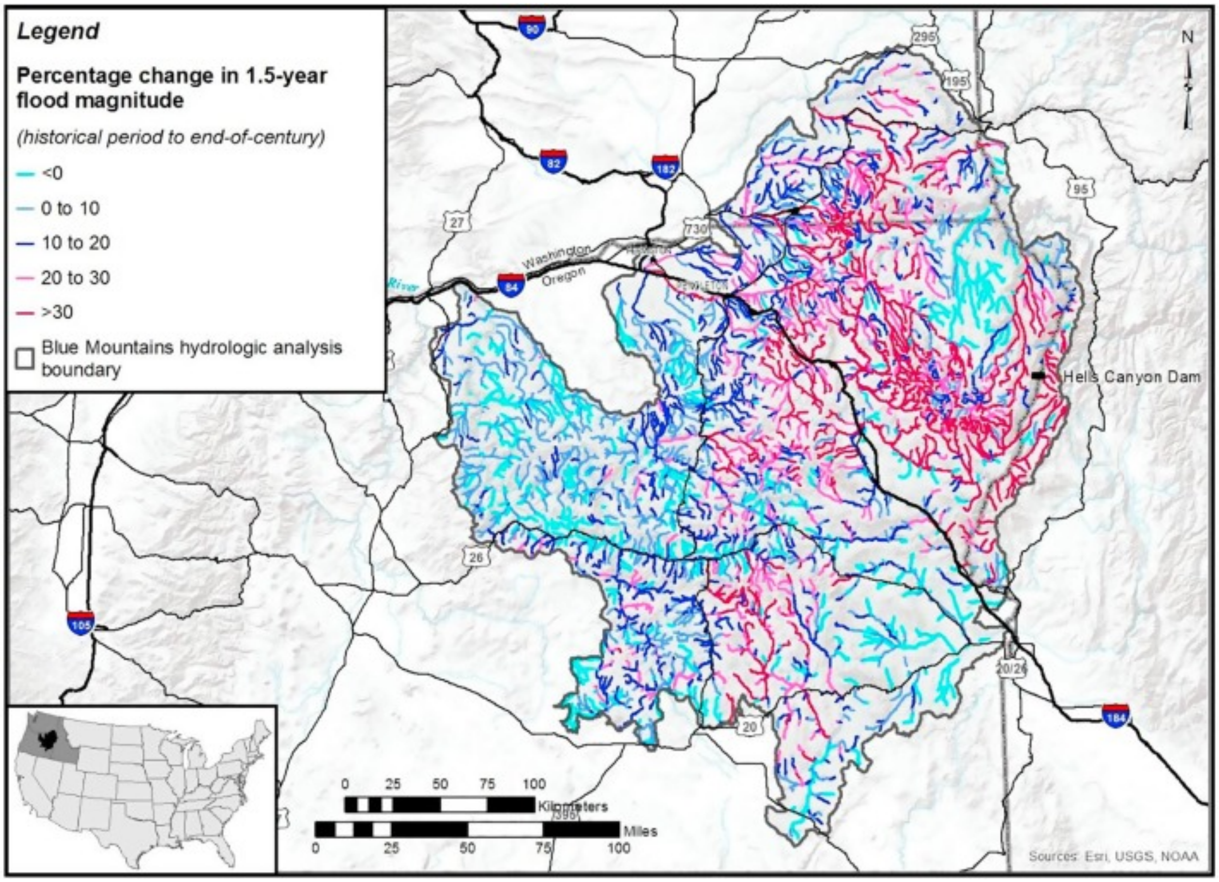

Figure 13 Projected change in the 1.5-year return interval daily flow magnitude between the historical period (1970–1999) and the 2080s (2070–2099) under a medium emissions scenario (SRES-A1B)[7] for the Blue Mountains region. (Source: Clifton et al., 2018)

Table 11 Percent change in the 100-year and 25-year recurrence interval flows for the Snake River at Brownlee Dam between 2070–2099 and 1971–2000 and the return period in 2070–2099 of the flow with a magnitude equal to that of the 100-year and 25-year flow as determined fro 1971–2000. (Source: Maurer et al., 2018, personal communication)

Return Period (N) (Probability in a given year)	Percent Change in N-Year Peak Flow 2070–2099 vs. 1971–2000	Return Period of N-Year Peak Flow (2070–2099)
25-Year (4%)	24.58% (p-val=0.000)	9.01-Year (11.1%)
100-Year (1%)	29.44% (p-val=0.000)	22.29-Year (4.5%)

[7] The medium emissions pathway (SRES-A1B) is from an earlier generation of emissions scenarios and it is most similar to RCP 6.0 from Figure 2.

Some of the Pacific Northwest's largest floods occur when copious warm rainfall from atmospheric rivers combine with a strong snowpack, resulting in rain-on-snow flooding events (Safeeq *et al.*, 2015).[8] The frequency and intensity—amount of transported moisture—of atmospheric river events is projected to increase along the West Coast in response to rising atmospheric temperatures (Kossin *et al.*, 2017). This larger moisture transport of atmospheric rivers would lead to greater likelihoods of flooding along the West Coast (Konrad and Dettinger, 2017).

Future changes in rain-on-snow events as a result of climate warming depend on elevation. At lower elevations, the frequency of rain-on-snow events is projected to decrease due to decreasing snowpack, whereas at high elevations the frequency of rain-on-snow events is projected to increase due to the shift from snowy to rainy days (Surfleet and Tullos, 2013; Safeeq *et al.*, 2015; Musselman *et al.*, 2018). How such changes in rain-on-snow frequency would affect high streamflow events is varied. For example, projections for the Santiam River, OR, show an increase in annual peak daily flows with moderate return intervals (<10 years) but a decrease at higher (> 10-year) return intervals (Surfleet and Tullos, 2013). In the Middle Snake-Powder water basins in northeast Oregon, the total volume and intensity of the top ten rain-on-snow events is projected to increase in the future due to precipitation falling more as rain and less as snow (Musselman *et al.*, 2018).

Key Messages:

⇒ Mid- to low-elevation areas in Baker County's Blue Mountains that are near the freezing level in winter, receiving a mix of rain and snow, are projected to experience an increase in winter flood risk due to warmer winter temperatures causing precipitation to fall more as rain and less as snow.

[8] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017)

Drought

Across the western US, mountain snowpack is projected to decline leading to reduced summer soil moisture in mountainous environments (Gergel *et al.*, 2017). Climate change is expected to result in lower summer streamflows in historically snow-dominated basins across the Pacific Northwest as snowpack melts off earlier due to warmer temperatures and summer precipitation decreases (Dalton *et al.*, 2017; Mote *et al.*, 2019). See, for example, the decrease in summer flows expected for the Snake River at Brownlee Dam (Figure 12) by the 2050s (2040–2069) under both lower and higher emissions scenarios.

This report presents future changes in five variables indicative of drought conditions—low spring snowpack, low summer soil moisture[9], low summer runoff, low summer precipitation, and high summer evaporation—in terms of a change in the frequency of the historical baseline 1-in-5 year event (that is, an event having a 20% chance of occurrence in any given year). The future projections, displayed in the orange and brown bars of Figure 14, are the frequency in the future period of the magnitude of the event that has a 20% frequency in the historical period.

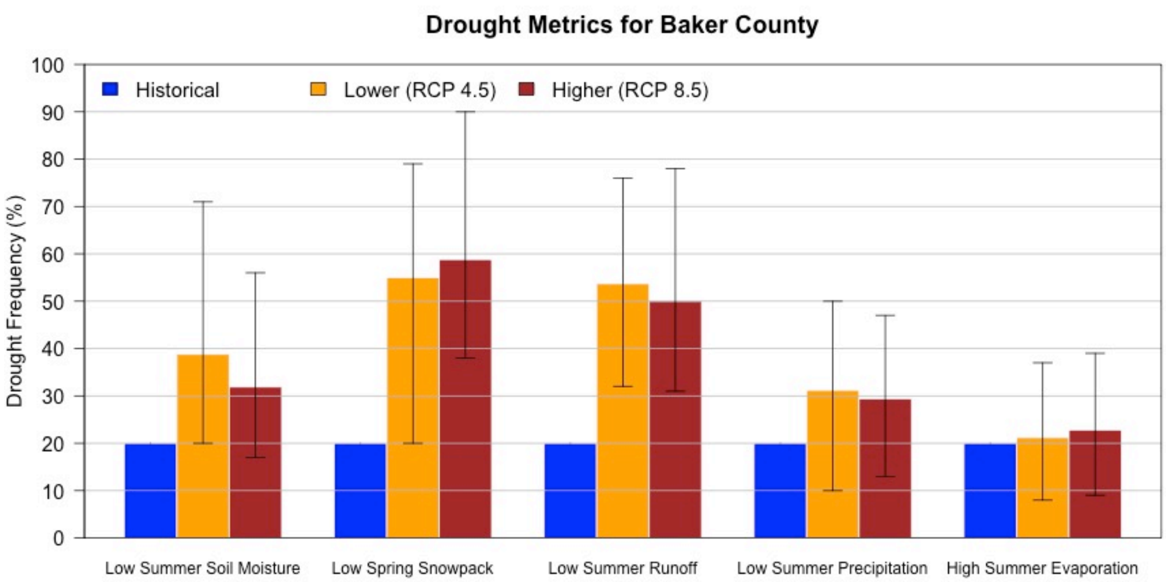

Figure 14 Frequency of the historical baseline (1971–2000) 1-in-5 year event (by definition 20% frequency) of low summer soil moisture (average of June-July-August), low spring snowpack (April 1 snow water equivalent), low summer runoff (total of June-July-August), low summer precipitation (total for June-July-August), high summer evaporation (total for June-July-August) for the future period 2040–2069 for lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios. The bar and whiskers depict the mean and range across ten global climate models. (Data Source: Integrated Scenarios of the Future Northwest Environment, https://climate.northwestknowledge.net/IntegratedScenarios/)

In Baker County, spring snowpack (that is, the snow water equivalent on April 1), summer runoff, summer soil moisture, and summer precipitation are projected to decline under both lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios by the 2050s (2040–2069). This leads to the magnitude of low summer soil moisture, low spring snow pack, low summer runoff, and low summer precipitation expected with a 20% chance in any given

[9] Soil moisture projections are for the total moisture in the soil column from the surface to 140 cm below the surface.

year of the historical period being projected to occur more frequently by the 2050s under both emissions scenarios (Figure 14). Of the five metrics, climate change shows the strongest impact on spring snowpack and summer runoff in Baker County. By the 2050s under the higher emissions scenario the 1-in-5 year events for low spring snowpack and low summer runoff are projected to become roughly a 1-in-1.7 year event and 1-in-2 year event, respectively. The projected changes in the 1-in-5 year events for the other variables are smaller and less certain given that some models project an increase and others a decrease. The 2020s (2010–2039) were not evaluated in this drought analysis due to data limitations, but can be expected to be similar but of smaller magnitude to the changes for the 2050s.

Some areas in northeast Oregon are more sensitive to changes in spring snowpack and summer streamflow than others. A recent climate vulnerability analysis for the Blue Mountains region indicates that declines in spring snowpack are projected to be largest in low to mid-elevation locations, but even some locally higher elevation ranges, such as the Strawberry Mountains and Monument Rock Wilderness, and mid-elevations in the North Fork John Day, and Hells Canyon Wilderness would have relatively high sensitivity to snow losses (Clifton *et al.*, 2018). Summer streamflow in about half of the perennial streams in the Blue Mountains are projected to decrease by less than 10%, while areas more sensitive to changing low flows, such as the Wallowa Mountains and Elkhorn Mountains, are projected to see decreases in summer streamflow of more than 30% by the late 21st century (Clifton *et al.*, 2018) (Figure 15). Sub-basins with high risk for summer water shortage associated with low streamflow include the Burnt, Powder, Upper Grande Ronde, Silver, Silvies, Upper John Day, Wallowa, and Willow sub-basins (Clifton *et al.*, 2018).

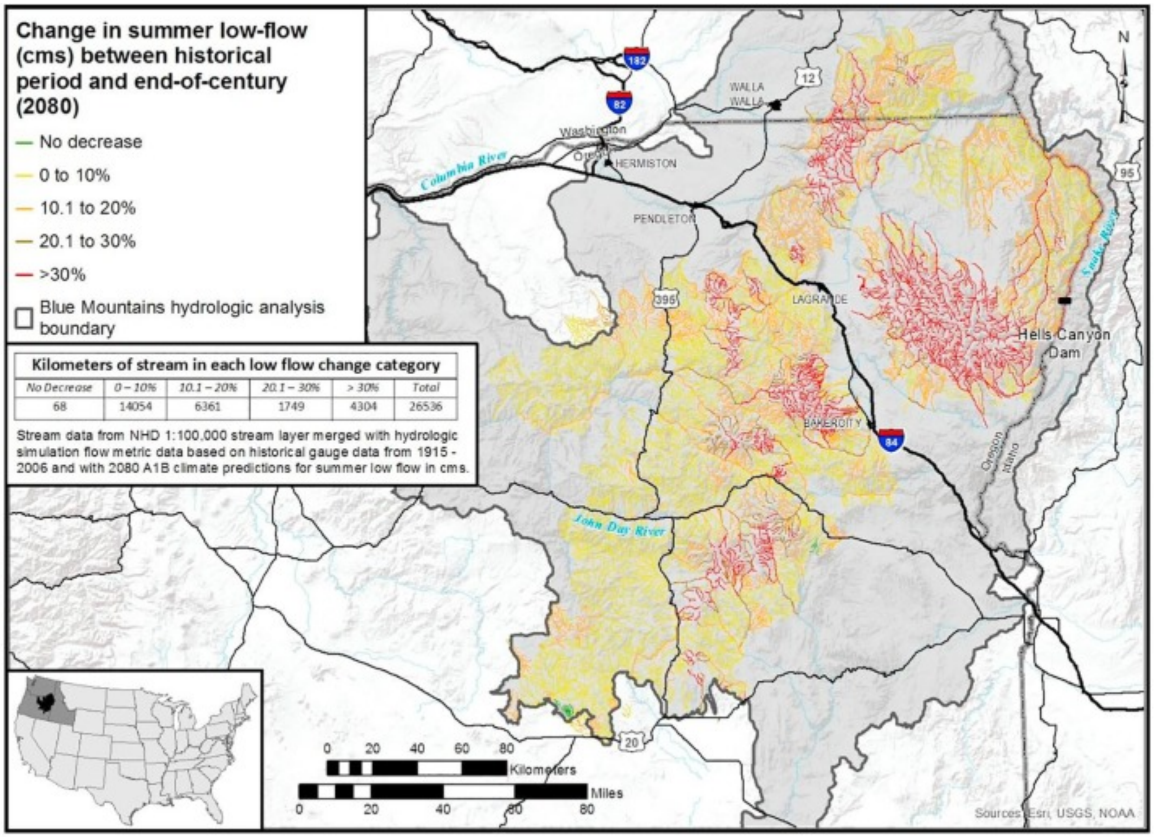

Figure 15 Projected change in mean summer streamflow from the historic time period (1970–1999) to the 2080s (2070–2099) under a medium emissions scenario[10] for streams in the Blue Mountains region. Note, the 0 to 10%, 10.1 to 20%, etc. all indicate decreases in flow. (Source: Clifton et al., 2018)

Key Messages:

⇒ Drought conditions, as represented by low summer soil moisture, low spring snowpack, low summer runoff, and low summer precipitation are projected to become more frequent in Baker County by the 2050s relative to the historical baseline.

⇒ By the end of the 21st century, summer low flows are projected to decrease in the Blue Mountains region putting some sub-basins at high risk for summer water shortage associated with low streamflow.

[10] The medium emissions pathway (SRES-A1B) is from an earlier generation of emissions scenarios and it is most similar to RCP 6.0 from Figure 2.

Wildfire

Over the last several decades, warmer and drier conditions during the summer months have contributed to an increase in fuel aridity and enabled more frequent large fires, an increase in the total area burned, and a longer fire season across the western United States, particularly in forested ecosystems (Dennison *et al.*, 2014; Jolly *et al.*, 2015; Westerling, 2016; Williams and Abatzoglou, 2016). The lengthening of the fire season is largely due to declining mountain snowpack and earlier spring snowmelt (Westerling, 2016). Recent wildfire activity in forested ecosystems is partially attributed to human-caused climate change: during the period 1984–2015, about half of the observed increase in fuel aridity and 4.2 million hectares (or more than 16,000 square miles) of burned area in the western United States were due to human-caused climate change (Abatzoglou and Williams, 2016). Under future climate change, wildfire frequency and area burned are expected to continue increasing in the Pacific Northwest (Barbero *et al.*, 2015; Sheehan *et al.*, 2015).[11]

As a proxy for wildfire risk, this report considers a fire danger index called 100-hour fuel moisture (FM100), which is a measure of the amount of moisture in dead vegetation in the 1–3 inch diameter class available to a fire. It is expressed as a percent of the dry weight of that specific fuel. FM100 is a common index used by the Northwest Interagency Coordination Center to predict fire danger. A majority of climate models project that FM100 would decline across Oregon by the 2050s (2040–2069) under the higher (RCP 8.5) emissions scenario (Gergel *et al.*, 2017). This drying of vegetation would lead to greater wildfire risk, especially when coupled with projected decreases in summer soil moisture. This report defines a "very high" fire danger day to be a day in which FM100 is lower (i.e., drier) than the historical baseline 10th percentile value. By definition, the historical baseline has 36.5 very high fire danger days annually. The future change in wildfire risk is expressed as the average annual number of additional "very high" fire danger days for two future periods under two emissions scenarios compared with the historical baseline (Figure 16). The impacts of wildfire on air quality are discussed in the following section on Air Quality.

[11] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017)

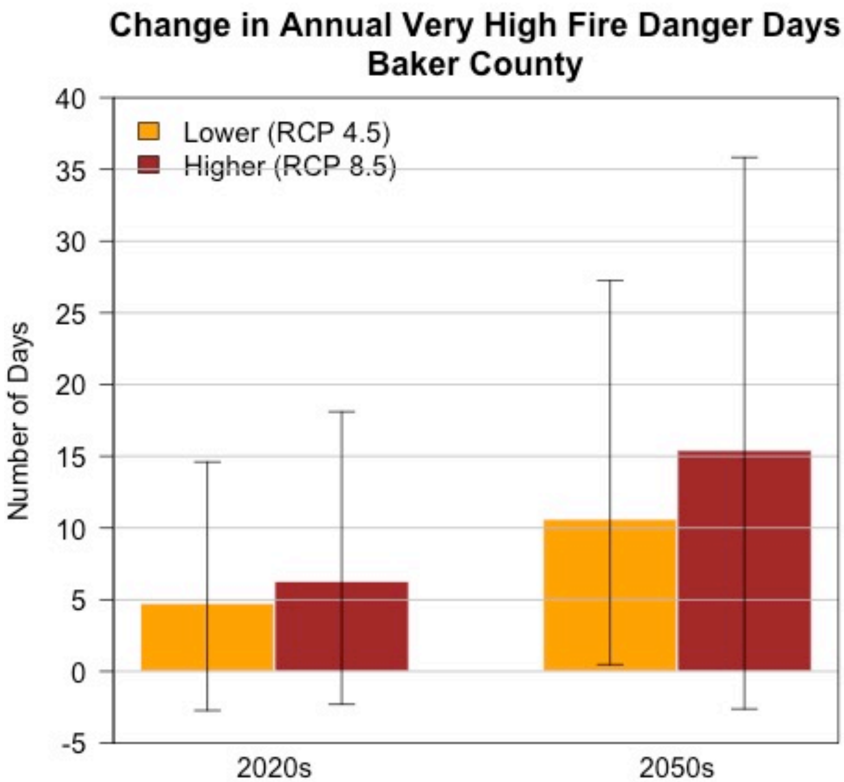

Figure 16 Projected future changes in the frequency of very high fire danger days for Baker County from the historical baseline (1971–2000 average) for the 2020s (2010–2039 average) and 2050s (2040–2069 average) under a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario based on 18 global climate models. The bars and whiskers display the mean and range, respectively, of changes across the 18 GCMs. (Data Source: Northwest Climate Toolbox, climatetoolbox.org/tool/Climate-Mapper)

Key Messages:

⇒ Wildfire risk, as expressed through the frequency of very high fire danger days, is projected to increase under future climate change in Baker County.

⇒ In Baker County, the frequency of very high fire danger days per year is projected to increase on average by about 15 days (with a range of -3 to +36 days) by the 2050s under the higher emissions scenario compared to the historical baseline.

⇒ In Baker County, the frequency of very high fire danger days per year is projected to increase on average by about 42% (with a range of -7 to +98%) by the 2050s under the higher emissions scenario compared to the historical baseline.

Air Quality

Climate change is expected to worsen outdoor air quality. Warmer temperatures may increase ground level ozone pollution, more wildfires may increase smoke and particulate matter, and longer, more potent pollen seasons may increase aeroallergens. Such poor air quality is expected to exacerbate allergy and asthma conditions and increase respiratory and cardiovascular illnesses and death (Fann *et al.*, 2016).[12] In addition to increasing health risks, wildfire smoke impairs visibility and disrupts outdoor recreational activities (Nolte *et al.*, 2018). This report presents quantitative projections of future air quality measures related to fine particulate matter (PM2.5) from wildfire smoke.

Climate change is expected to result in a longer wildfire season with more frequent wildfires and greater area burned (Sheehan *et al.*, 2015). Wildfires are primarily responsible for days when air quality standards for PM2.5 are exceeded in western Oregon and parts of eastern Oregon (Liu *et al.*, 2016), although woodstove smoke and diesel emissions are also main contributors (Oregon DEQ, 2016). Across the western United States, PM2.5 levels from wildfires are projected to increase 160% by mid-century under a medium emissions pathway[11] (SRES A1B) (Liu *et al.*, 2016). This translates to a greater risk of wildfire smoke exposure through increasing frequency, length, and intensity of "smoke waves"—that is, two or more consecutive days with high levels of PM2.5 from wildfires (Liu *et al.*, 2016).[13]

The change in risk of poor air quality due to wildfire-specific PM2.5 is expressed as the number of "smoke wave" days within a six-year period and the average intensity—concentration of particulate matter—of smoke wave days in the present (2004–2009) and mid-century (2046–2051) under a medium emissions pathway[14] (Figure 17). See Appendix for description of methodology and access to the Smoke Wave data.

In Baker County the frequency of "smoke wave" days is expected to double and the intensity—the concentration of particulate matter—of "smoke wave" days is expected to increase.

[12] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017)

[13] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017)

[14] The medium emissions pathway used is from an earlier generation of emissions scenarios. Liu et al. (2016) used SRES-A1B, which is most similar to RCP 6.0 from Figure 2.

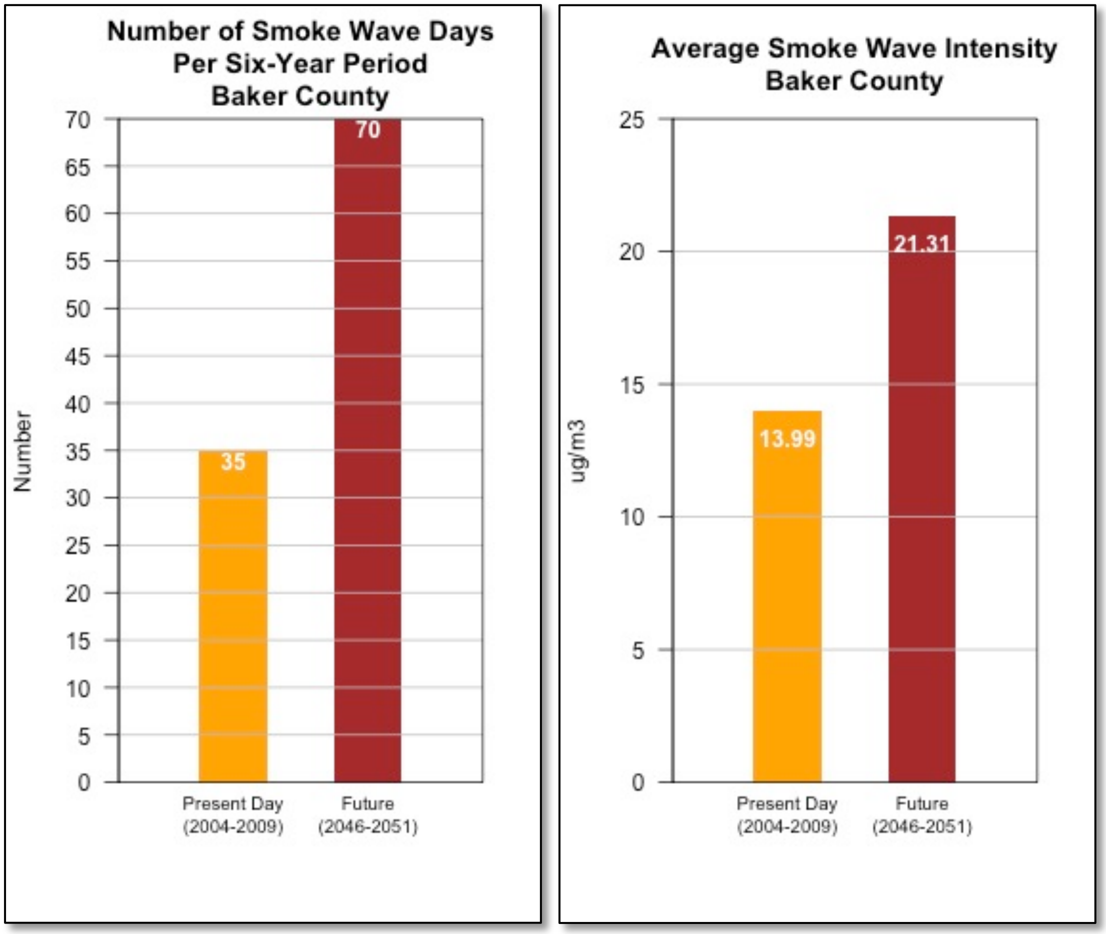

Figure 17 Simulated present day (2004–2009) and future (2046–2051) frequency (left) and intensity (right) of "smoke wave" days for Baker County under a medium emissions scenario[11]. The bars display the mean across 15 GCMs. (Data source: Liu et al. 2016, https://khanotations.github.io/smoke-map/)

Key Messages:

⇒ Under future climate change, the risk of wildfire smoke exposure is projected to increase in Baker County.

⇒ In Baker County, the number of "smoke wave" days is projected to increase by 100% and the intensity of "smoke waves" is projected to increase by 52% by 2046–2051 under a medium emissions scenario compared with 2004–2009.

Windstorms

Climate change has the potential to alter surface winds through changes in the large-scale free atmospheric circulation and storm systems, and through changes in the connection between the free atmosphere and the surface. West of the Cascade Mountains in the Pacific Northwest, changes in surface wind speeds tend to follow changes in upper atmosphere winds associated with extratropical cyclones (Salathé *et al.*, 2015). East of the Cascades, cool air pooling is common which can impede the transport of wind energy from the free atmosphere to the surface. Changes in this factor are likely important for understanding future changes in windstorms (Salathé *et al.*, 2015). However, this is not yet well studied.

Winter extratropical storm frequency in the northeast Pacific exhibited a positive, though statistically not significant, trend since 1950 (Vose *et al.*, 2014). However, there is a high degree of uncertainty in future projections of extratropical cyclone frequency (IPCC, 2013). Future projections indicate a slight northward shift in the jet stream and extratropical cyclone activity, but there is as yet no consensus on whether or not extratropical storms (Vose *et al.*, 2014; Seiler and Zwiers, 2016; Chang, 2018) and associated extreme winds (Kumar *et al.*, 2015) will intensify or become more frequent along the Northwest coast under a warmer climate. Therefore, no descriptions of future changing conditions are included in this report.

Key Messages:

⇒ Limited research suggests very little, if any, change in the frequency and intensity of windstorms in the Pacific Northwest as a result of climate change.

Dust Storms

Climate, through precipitation and winds, and vegetation coverage can influence the frequency and magnitude of dust events, or dust storms, which primarily concern parts of eastern Oregon. Periods of low precipitation can dry out the soils increasing the amount of soil particulate matter available to be entrained in high winds. In addition, the amount of vegetation cover can influence the amount of soil susceptible to high winds.

One study found that in eastern Oregon, precipitation is the dominant factor affecting dust event frequency in the spring whereas vegetation cover is the dominant factor in the summer (Pu and Ginoux, 2017). The same study projected that in the summertime in eastern Oregon, dust event frequency would decrease largely due to a decrease in bareness (or an increase in vegetation cover) (Pu and Ginoux, 2017). There were no clear projected changes in other seasons or locations in Oregon. These projections compare the 2051–2100 average under a higher emissions scenario (RCP 8.5) with the 1861–2005 average.

Another study found that wind erosion in Columbia Plateau agricultural areas is projected to decrease by mid-century under a lower emissions scenario (RCP 4.5) largely due to increases in biomass production, which retain the soil (Sharratt *et al.*, 2015). The increase in vegetation cover in both studies is likely due to the fertilization effect of increased amounts of carbon dioxide in the atmosphere and warmer temperatures. Tillage practices may also influence the amount of soil available to winds. Therefore, no descriptions of future changing conditions are included in this report.

Key Messages:

⇒ Limited research suggests that the risk of dust storms in summer would decrease in eastern Oregon under climate change in areas that experience an increase in vegetation cover from the carbon dioxide fertilization effect.

Increased Invasive Species Risk

Warming temperatures, altered precipitation patterns, and increasing atmospheric carbon dioxide levels increase the risk for invasive species, insect and plant pests for forest and rangeland vegetation, and cropping systems.

Warming and more frequent drought will likely lead to a greater susceptibility among trees to insects and pathogens, a greater risk of exotic species establishment, more frequent and severe forest insect outbreaks (Halofsky and Peterson, 2016), and increased damage by a number of forest pathogens (Vose *et al.*, 2016). In Oregon and Washington, mountain pine beetle (*Dendroctonus ponderosae*) and western spruce budworm (*Choristoneura freemani*) are the most common native forest insect pests, and both have caused substantial tree mortality and defoliation over the past several decades (Meigs *et al.*, 2015).[15]

Climatic warming has facilitated the expansion and survival of mountain pine beetles, particularly in areas that have historically been too cold for the insect (Littell *et al.*, 2013). Across the western United States, the time between generations among different populations of mountain pine beetles is similar; however, the amount of thermal units required to complete a generation cycle was significantly less for beetles at cooler sites (Bentz *et al.*, 2014). Winter survival and faster generation cycles could be favored under future projections of decreases in the number of freeze days (Rawlins *et al.*, 2016).[16]

Western spruce budworm is a destructive defoliator that sporadically breaks out in interior Oregon Douglas-fir (*Pseudotsuga menziesii*) forests (Flower *et al.*, 2014). An analysis of three hundred years of tree ring data reveals that outbreaks tended to occur near the end of a drought, when trees' physiological thresholds had likely been reached. This analysis suggests that such outbreaks would likely intensify under the more frequent drought conditions that are projected for the future (Flower *et al.*, 2014), unless increasing atmospheric carbon dioxide, which may enhance water use efficiency, mitigates drought stress.[17]

More frequent rangeland droughts could facilitate invasion of non-native weeds as native vegetation succumbs to drought or wildfire cycles, leaving bare ground (Vose *et al.*, 2016). Cheatgrass (*Bromus tectorum L.*), a lower nutritional quality forage grass, facilitates more frequent fires, which reduces the capacity of shrub steppe ecosystem to provide livestock forage and critical wildlife habitat (Boyte *et al.*, 2016). Cheatgrass is a highly invasive species in the rangelands in the West that is projected to expand northward (Creighton *et al.*, 2015) and remain stable or increase in cover in most parts of the Great Basin (Boyte *et al.*, 2016) under climate change.[18]

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[15] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017), p. 49

[16] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017), p. 49

[17] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017), p. 49–50

[18] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017), p. 70

Crop pests and pathogens may continue to migrate poleward under global warming as has been observed globally for several types since the 1960s (Bebber *et al.*, 2013). Much remains to be learned about which pests and pathogens are most likely to affect certain crops as the climate changes, and about which management strategies will be most effective.[19]

Key Messages:

⇒ Warming temperatures, altered precipitation patterns, and increasing atmospheric carbon dioxide levels increase the risk for invasive species, insect and plant pests for forest and rangeland vegetation, and cropping systems.

[19] Verbatim from the Third Oregon Climate Assessment Report (Dalton *et al.*, 2017), p. 67

Loss of Wetland Ecosystems

Wetlands play key roles in major ecological processes and provide a number of essential ecosystem services: flood reduction, groundwater recharge, pollution control, recreational opportunities, and fish and wildlife habitat, including for endangered species.[20] Climate change stands to affect freshwater wetlands Oregon through changes in the duration, frequency, and seasonality of precipitation and runoff; decreased groundwater recharge; and higher rates of evapotranspiration (Raymondi *et al.*, 2013).

Reduced snowpack and altered runoff timing may contribute to the drying of many ponds and wetland habitats across the Northwest.[21] The absence of water or declining water levels in permanent or ephemeral wetlands would affect resident and migratory birds, amphibians, and other animals that rely on the wetlands (Dello and Mote, 2010). However, potential future increases in winter precipitation may lead to the expansion of some wetland systems, such as wetland prairies.[22]

In Oregon's western Great Basin, changes in climate would alter the water chemistry of fresh and saline wetlands affecting the migratory water birds that depend on them. Hotter summer temperatures would cause freshwater sites to become more saline making them less useful to raise young birds that haven't yet developed the ability to process salt. At the same time, increased precipitation would cause saline sites to become fresher thereby decreasing the abundance of invertebrate food supply for adult water birds (Dello and Mote, 2010).

Key Messages:

⇒ Freshwater wetland ecosystems are sensitive to warming temperatures and altered hydrological patterns, such as changes in precipitation seasonality and reduction of snowpack.

[20] Verbatim from the Oregon Climate Change Adaptation Framework, p. 62

[21] Verbatim from the Climate Change in the Northwest (Dalton *et al.*, 2013), p. 53

[22] Verbatim from the Climate Change in the Northwest (Dalton *et al.*, 2013), p. 53

Appendix

Future Climate Projections Background

Read more about emissions scenarios, global climate models, and uncertainty in the Climate Science Special Report, Volume 1 of the Fourth National Climate Assessment (https://science2017.globalchange.gov).

Emissions Scenarios: https://science2017.globalchange.gov/chapter/4#section-2

Global Climate Models & Downscaling:
https://science2017.globalchange.gov/chapter/4#section-3

Uncertainty: https://science2017.globalchange.gov/chapter/4#section-4

Climate & Hydrological Data

Statistically downscaled GCM output from the Fifth phase of the Coupled Model Intercomparison Project (CMIP5) served as the basis for future projections of temperature, precipitation, and hydrology variables. The coarse resolution of GCMs output (100–300 km) was downscaled to a resolution of about 6 km using the Multivariate Adaptive Constructed Analogs (MACA) method, which has demonstrated skill in complex topographic terrain (Abatzoglou and Brown, 2012). The MACA approach utilizes a gridded training observation dataset to accomplish the downscaling by applying bias-corrections and spatial pattern matching of observed large-scale to small-scale statistical relationships. (For a detailed description of the MACA method see: https://climate.northwestknowledge.net/MACA/MACAmethod.php.)

This downscaled gridded meteorological data (i.e., MACA data) is used as the climate inputs to an integrated climate-hydrology-vegetation modeling project called Integrated Scenarios of the Future Northwest Environment (https://climate.northwestknowledge.net/IntegratedScenarios/). Snow dynamics were simulated using the Variable Infiltration Capacity hydrological model (VIC version 4.1.2.l; (Liang *et al.*, 1994) and updates) run on a 1/16th x 1/16th (6 km) grid.

Simulations of historical and future climate for the variables maximum temperature (*tasmax*), minimum temperature (*tasmin*), and precipitation (*pr*) are available at the daily time step from 1950 to 2099 for 20 GCMs and 2 RCPs (i.e., RCP4.5 and RCP8.5). Hydrological simulations of snow water equivalent (*SWE*) are only available for the 10 GCMs used as input to VIC. Table 12 lists all 20 CMIP5 GCMs and indicates the subset of 10 used for hydrological simulations. Data for all the models available was obtained for each variable from the Integrated Scenarios data archives in order to get the best uncertainty estimates.

Table 12 The 20 CMIP5 GCMs used in this project. The subset of 10 CMIP5 GCMs used in the Integrated Scenarios: Hydrology dataset are noted with asterisks.

Model Name	Modeling Center
BCC-CSM1-1 BCC-CSM1-1-M*	Beijing Climate Center, China Meteorological Administration
BNU-ESM	College of Global Change and Earth System Science, Beijing Normal University, China
CanESM2*	Canadian Centre for Climate Modeling and Analysis
CCSM4*	National Center for Atmospheric Research, USA
CNRM-CM5*	National Centre of Meteorological Research, France
CSIRO-Mk3-6-0*	Commonwealth Scientific and Industrial Research Organization/Queensland Climate Change Centre of Excellence, Australia
GFDL-ESM2G GFDL-ESM2M	NOAA Geophysical Fluid Dynamics Laboratory, USA
HadGEM2-CC* HadGEM2-ES*	Met Office Hadley Center, UK
INMCM4	Institute for Numerical Mathematics, Russia
IPSL-CM5A-LR IPSL-CM5A-MR* IPSL-CM5B-LR	Institut Pierre Simon Laplace, France
MIROC5* MIROC-ESM MIROC-ESM-CHEM	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies
MRI-CGCM3	Meteorological Research Institute, Japan
NorESM1-M*	Norwegian Climate Center, Norway

All simulated climate data and the streamflow data have been bias-corrected using quantile-mapping techniques. Only SWE is presented without bias correction. Quantile mapping adjusts simulated values by creating a one-to-one mapping between the cumulative probability distribution of simulated values and the cumulative probability distribution of observed values. In practice, both the simulated and observed values of a variable (e.g., daily streamflow) over the some historical time period are separately sorted and ranked and the values are assigned their respective probabilities of exceedence. The bias corrected value of a given simulated value is assigned the observed value that has the same probability of exceedence as the simulated value. The historical bias in the simulations is assumed to stay constant into the future; therefore the same mapping relationship developed from the historical period was applied to the future scenarios. For MACA, a separate quantile mapping relationship was made for each non-overlapping 15-day window in the calendar year. For streamflow, a separate quantile mapping relationship was made for each calendar month.

Hydrology was simulated using the Variable Infiltration Capacity hydrological model (VIC; Liang et al. 1994) run on a $1/16^{th}$ x $1/16^{th}$ (6 km) grid. To generate daily streamflow estimates, runoff from VIC grid cells was then routed to selected locations along the stream network using a daily-time-step routing model. Where records of naturalized flow were available, the daily streamflow estimates were then bias-corrected so that their statistical distributions matched those of the naturalized streamflows.

The wildfire danger day metric was computed using the same MACA climate variables to compute the 100-hour fuel moisture content according to the equations in the National Fire Danger Rating System.

Smoke Wave Data

Abstract from Liu et al. (2016):
Wildfire can impose a direct impact on human health under climate change. While the potential impacts of climate change on wildfires and resulting air pollution have been studied, it is not known who will be most affected by the growing threat of wildfires. Identifying communities that will be most affected will inform development of fire management strategies and disaster preparedness programs. We estimate levels of fine particulate matter ($PM_{2.5}$) directly attributable to wildfires in 561 western US counties during fire seasons for the present-day (2004–2009) and future (2046–2051), using a fire prediction model and GEOS-Chem, a 3-D global chemical transport model. Future estimates are obtained under a scenario of moderately increasing greenhouse gases by mid-century. We create a new term “Smoke Wave,” defined as ≥2 consecutive days with high wildfire-specific $PM_{2.5}$, to describe episodes of high air pollution from wildfires. We develop an interactive map to demonstrate the counties likely to suffer from future high wildfire pollution events. For 2004–2009, on days exceeding regulatory $PM_{2.5}$ standards, wildfires contributed an average of 71.3 % of total $PM_{2.5}$. Under future climate change, we estimate that more than 82 million individuals will experience a 57 % and 31 % increase in the frequency and intensity, respectively, of Smoke Waves. Northern California, Western Oregon and the Great Plains are likely to suffer the highest exposure to wildfire smoke in the future. Results point to the potential health impacts of increasing wildfire activity on large numbers of people in a warming climate and the need to establish or modify US wildfire management and evacuation programs in high-risk regions. The study also adds to the growing literature arguing that extreme events in a changing climate could have significant consequences for human health.

Data can be accessed here: https://khanotations.github.io/smoke-map/
For the DLCD project, we looked at the variables “Total # of SW days in 6 yrs” and “Average SW Intensity”. The first variable tallies all the days within each time period in which the fine particulate matter exceeded the threshold defined as the 98^{th} quantile of the

distribution of daily wildfire-specific $PM_{2.5}$ values in the modeled present-day years, on average across the study area. The second variable computes the average concentration of fine particulate matter across identified “smoke wave” days within each time period. Liu et al. (2016) used 15 GCMs from the Third Phase of the Coupled Model Intercomparison Project (CMIP3) under a medium emissions scenario (SRES-A1B). The data site only offers the multi-model mean value (not the range), which should be understood as the aggregate direction of projected change rather than the actual number expected.

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Appendix E: Economic Analysis of Natural Hazard Mitigation Projects

This appendix was developed by the Oregon Partnership for Disaster Resilience at the University of Oregon's Community Service Center. It has been reviewed and accepted by the Federal Emergency Management Agency as a means of documenting how the prioritization of actions shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

The appendix outlines three approaches for conducting economic analyses of natural hazard mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Information in this section is derived in part from: The Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon Military Department – Office of Emergency Management, 2000), and Federal Emergency Management Agency Publication 331, *Report on Costs and Benefits of Natural Hazard Mitigation*. This section is not intended to provide a comprehensive description of benefit/cost analysis, nor is it intended to evaluate local projects. It is intended to (1) raise benefit/cost analysis as an important issue, and (2) provide some background on how economic analysis can be used to evaluate mitigation projects.

Why Evaluate Mitigation Strategies?

Mitigation activities reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs, which would otherwise be incurred. Evaluating possible natural hazard mitigation activities provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Evaluating mitigation projects is a complex and difficult undertaking, which is influenced by many variables. First, natural disasters affect all segments of the communities they strike, including individuals, businesses, and public services such as fire, police, utilities, and schools. Second, while some of the direct and indirect costs of disaster damages are measurable, some of the costs are non-financial and difficult to quantify in dollars. Third, many of the impacts of such events produce "ripple-effects" throughout the community, greatly increasing the disaster's social and economic consequences.

While not easily accomplished, there is value, from a public policy perspective, in assessing the positive and negative impacts from mitigation activities, and obtaining an instructive benefit/cost comparison. Otherwise, the decision to pursue or not pursue various mitigation options would not be based on an objective understanding of the net benefit or loss associated with these actions.

What are some Economic Analysis Approaches for Evaluating Mitigation Strategies?

The approaches used to identify the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into three general categories: benefit/cost analysis, cost-effectiveness analysis and the STAPLE/E approach. The distinction between the three methods is outlined below:

Benefit/Cost Analysis

Benefit/cost analysis is a key mechanism used by the state Oregon Military Department – Office of Emergency Management (OEM), the Federal Emergency Management Agency, and other state and federal agencies in evaluating hazard mitigation projects, and is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended.

Benefit/cost analysis is used in natural hazards mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Benefit/cost analysis is based on calculating the frequency and severity of a hazard, avoiding future damages, and risk. In benefit/cost analysis, all costs and benefits are evaluated in terms of dollars, and a net benefit/cost ratio is computed to determine whether a project should be implemented. A project must have a benefit/cost ratio greater than 1 (i.e., the net benefits will exceed the net costs) to be eligible for FEMA funding.

Cost-Effectiveness Analysis

Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. This type of analysis, however, does not necessarily measure costs and benefits in terms of dollars. Determining the economic feasibility of mitigating natural hazards can also be organized according to the perspective of those with an economic interest in the outcome. Hence, economic analysis approaches are covered for both public and private sectors as follows.

Investing in Public Sector Mitigation Activities

Evaluating mitigation strategies in the public sector is complicated because it involves estimating all of the economic benefits and costs regardless of who realizes them, and potentially to a large number of people and economic entities. Some benefits cannot be evaluated monetarily, but still affect the public in profound ways. Economists have developed methods to evaluate the economic feasibility of public decisions which involve a diverse set of beneficiaries and non-market benefits.

Investing in Private Sector Mitigation Activities

Private sector mitigation projects may occur on the basis of one or two approaches: it may be mandated by a regulation or standard, or it may be economically justified on its own merits. A building or landowner, whether a private entity or a public agency, required to conform to a mandated standard may consider the following options:

1. Request cost sharing from public agencies;
2. Dispose of the building or land either by sale or demolition;
3. Change the designated use of the building or land and change the hazard mitigation compliance requirement; or
4. Evaluate the most feasible alternatives and initiate the most cost effective hazard mitigation alternative.

The sale of a building or land triggers another set of concerns. For example, real estate disclosure laws can be developed which require sellers of real property to disclose known defects and deficiencies in the property, including earthquake weaknesses and hazards to prospective purchases. Correcting deficiencies can be expensive and time consuming, but their existence can prevent the sale of the building. Conditions of a sale regarding the deficiencies and the price of the building can be negotiated between a buyer and seller.

STAPLE/E Approach

Considering detailed benefit/cost or cost-effectiveness analysis for every possible mitigation activity could be very time consuming and may not be practical. There are some alternate approaches for conducting a quick evaluation of the proposed mitigation activities which could be used to identify those mitigation activities that merit more detailed assessment. One of those methods is the STAPLE/E approach.

Using STAPLE/E criteria, mitigation activities can be evaluated quickly by steering committees in a synthetic fashion. This set of criteria requires the committee to assess the mitigation activities based on the Social, Technical, Administrative, Political, Legal, Economic and Environmental (STAPLE/E) constraints and opportunities of implementing the particular mitigation item in your community. The second chapter in FEMA's How-To Guide "Developing the Mitigation Plan – Identifying Mitigation Actions and Implementation Strategies" as well as the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process" outline some specific considerations in analyzing each aspect. The following are suggestions for how to examine each aspect of the STAPLE/E approach from the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process."

Social: Community development staff, local non-profit organizations, or a local planning board can help answer these questions.

- Is the proposed action socially acceptable to the community?
- Are there equity issues involved that would mean that one segment of the community is treated unfairly?
- Will the action cause social disruption?

Technical: The city or county public works staff, and building department staff can help answer these questions.

- Will the proposed action work?
- Will it create more problems than it solves?
- Does it solve a problem or only a symptom?

- Is it the most useful action in light of other community goals?

Administrative: Elected officials or the city or county administrator, can help answer these questions.

- Can the community implement the action?
- Is there someone to coordinate and lead the effort?
- Is there sufficient funding, staff, and technical support available?
- Are there ongoing administrative requirements that need to be met?

Political: Consult the mayor, city council or city board of commissioners, city or county administrator, and local planning commissions to help answer these questions.

- Is the action politically acceptable?
- Is there public support both to implement and to maintain the project?

Legal: Include legal counsel, land use planners, risk managers, and city council or county planning commission members, among others, in this discussion.

- Is the community authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity?
- Are there legal side effects? Could the activity be construed as a taking?
- Is the proposed action allowed by the comprehensive plan, or must the comprehensive plan be amended to allow the proposed action?
- Will the community be liable for action or lack of action?
- Will the activity be challenged?

Economic: Community economic development staff, civil engineers, building department staff, and the assessor's office can help answer these questions.

- What are the costs and benefits of this action?
- Do the benefits exceed the costs?
- Are initial, maintenance, and administrative costs taken into account?
- Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private?)
- How will this action affect the fiscal capability of the community?
- What burden will this action place on the tax base or local economy?
- What are the budget and revenue effects of this activity?
- Does the action contribute to other community goals, such as capital improvements or economic development?
- What benefits will the action provide? (This can include dollar amount of damages prevented, number of homes protected, credit under the CRS, potential for funding under the HMGP or the FMA program, etc.)

Environmental: Watershed councils, environmental groups, land use planners and natural resource managers can help answer these questions.

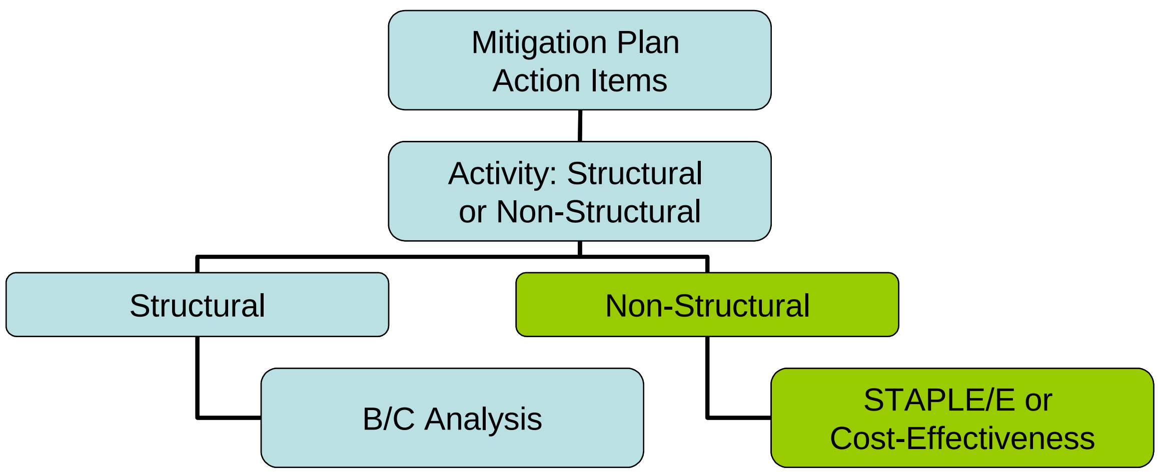
- How will the action impact the environment?
- Will the action need environmental regulatory approvals?
- Will it meet local and state regulatory requirements?
- Are endangered or threatened species likely to be affected?

The STAPLE/E approach is helpful for doing a quick analysis of mitigation projects. Most projects that seek federal funding and others often require more detailed benefit/cost analyses.

When to use the various approaches

It is important to realize that various funding sources require different types of economic analyses. The following figure is to serve as a guideline for when to use the various approaches.

Figure C.1: Economic Analysis Flowchart



Source: Oregon Partnership for Disaster Resilience. 2005.

Implementing the Approaches

Benefit/cost analysis, cost-effectiveness analysis, and the STAPLE/E are important tools in evaluating whether or not to implement a mitigation activity. A framework for evaluating mitigation activities is outlined below. This framework should be used in further analyzing the feasibility of prioritized mitigation activities.

1. Identify the Activities

Activities for reducing risk from natural hazards can include structural projects to enhance disaster resistance, education and outreach, and acquisition or demolition of exposed properties, among others. Different mitigation projects can assist in minimizing risk to natural hazards, but do so at varying economic costs.

2. Calculate the Costs and Benefits

Choosing economic criteria is essential to systematically calculating costs and benefits of mitigation projects and selecting the most appropriate activities. Potential economic criteria to evaluate alternatives include:

- ***Determine the project cost***. This may include initial project development costs, and repair and operating costs of maintaining projects over time.
- ***Estimate the benefits***. Projecting the benefits, or cash flow resulting from a project can be difficult. Expected future returns from the mitigation effort depend on the correct specification of the risk and the effectiveness of the project, which may not be well known. Expected future costs depend on the physical durability and potential economic obsolescence of the investment. This is difficult to project. These considerations will also provide guidance in selecting an appropriate salvage value. Future tax structures and rates must be projected. Financing alternatives must be researched, and they may include retained earnings, bond and stock issues, and commercial loans.
- ***Consider costs and benefits to society and the environment***. These are not easily measured, but can be assessed through a variety of economic tools including existence value or contingent value theories. These theories provide quantitative data on the value people attribute to physical or social environments. Even without hard data, however, impacts of structural projects to the physical environment or to society should be considered when implementing mitigation projects.
- ***Determine the correct discount rate***. Determination of the discount rate can just be the risk-free cost of capital, but it may include the decision maker's time preference and also a risk premium. Including inflation should also be considered.

3. Analyze and Rank the Activities

Once costs and benefits have been quantified, economic analysis tools can rank the possible mitigation activities. Two methods for determining the best activities given varying costs and benefits include net present value and internal rate of return.

- ***Net present value***. Net present value is the value of the expected future returns of an investment minus the value of the expected future cost expressed in today's dollars. If the net present value is greater than the projected costs, the project may be determined feasible for implementation. Selecting the discount rate, and identifying the present and future costs and benefits of the project calculates the net present value of projects.

- ***Internal rate of return***. Using the internal rate of return method to evaluate mitigation projects provides the interest rate equivalent to the dollar returns expected from the project. Once the rate has been calculated, it can be compared to rates earned by investing in alternative projects. Projects may be feasible to implement when the internal rate of return is greater than the total costs of the project. Once the mitigation projects are ranked on the basis of economic criteria, decision-makers can consider other factors, such as risk, project effectiveness, and economic, environmental, and social returns in choosing the appropriate project for implementation.

Economic Returns of Natural Hazard Mitigation

The estimation of economic returns, which accrue to building or land owners as a result of natural hazard mitigation, is difficult. Owners evaluating the economic feasibility of mitigation should consider reductions in physical damages and financial losses. A partial list follows:

- Building damages avoided
- Content damages avoided
- Inventory damages avoided
- Rental income losses avoided
- Relocation and disruption expenses avoided
- Proprietor's income losses avoided

These parameters can be estimated using observed prices, costs, and engineering data. The difficult part is to correctly determine the effectiveness of the hazard mitigation project and the resulting reduction in damages and losses. Equally as difficult is assessing the probability that an event will occur. The damages and losses should only include those that will be borne by the owner. The salvage value of the investment can be important in determining economic feasibility. Salvage value becomes more important as the time horizon of the owner declines. This is important because most businesses depreciate assets over a period of time.

Additional Costs from Natural Hazards

Property owners should also assess changes in a broader set of factors that can change as a result of a large natural disaster. These are usually termed "indirect" effects, but they can have a very direct effect on the economic value of the owner's building or land. They can be positive or negative, and include changes in the following:

- Commodity and resource prices
- Availability of resource supplies
- Commodity and resource demand changes
- Building and land values
- Capital availability and interest rates
- Availability of labor
- Economic structure
- Infrastructure
- Regional exports and imports
- Local, state, and national regulations and policies
- Insurance availability and rates

Changes in the resources and industries listed above are more difficult to estimate and require models that are structured to estimate total economic impacts. Total economic impacts are the sum of direct and indirect economic impacts. Total economic impact models are usually not combined with economic feasibility models. Many models exist to estimate total economic impacts of changes in an economy. Decision makers should understand the total economic impacts of natural disasters in order to calculate the benefits of a mitigation activity. This suggests that understanding the local economy is an important first step in being able to understand the potential impacts of a disaster, and the benefits of mitigation activities.

Additional Considerations

Conducting an economic analysis for potential mitigation activities can assist decision-makers in choosing the most appropriate strategy for their community to reduce risk and prevent loss from natural hazards. Economic analysis can also save time and resources from being spent on inappropriate or unfeasible projects. Several resources and models are listed on the following page that can assist in conducting an economic analysis for natural hazard mitigation activities.

Benefit/cost analysis is complicated, and the numbers may divert attention from other important issues. It is important to consider the qualitative factors of a project associated with mitigation that cannot be evaluated economically. There are alternative approaches to implementing mitigation projects. With this in mind, opportunity rises to develop strategies that integrate natural hazard mitigation with projects related to watersheds, environmental planning, community economic development, and small business development, among others. Incorporating natural hazard mitigation with other community projects can increase the viability of project implementation.

Resources

CUREe Kajima Project, *Methodologies for Evaluating the Socio-Economic Consequences of Large Earthquakes*, Task 7.2 Economic Impact Analysis, Prepared by University of California, Berkeley Team, Robert A. Olson, VSP Associates, Team Leader; John M. Eidinger, G&E Engineering Systems; Kenneth A. Goettel, Goettel and Associates, Inc.; and Gerald L. Horner, Hazard Mitigation Economics Inc., 1997

Federal Emergency Management Agency, *Benefit/Cost Analysis of Hazard Mitigation* Projects, Riverine Flood, Version 1.05, Hazard Mitigation Economics, Inc., 1996

Federal Emergency Management Agency, *Report on the Costs and Benefits of Natural Hazard Mitigation*. Publication 331, 1996.

Goettel & Horner Inc., *Earthquake Risk Analysis Volume III: The Economic Feasibility of Seismic Rehabilitation of Buildings in the City of Portland*, Submitted to the Bureau of Buildings, City of Portland, August 30, 1995.

Goettel & Horner Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects* Volume V, Earthquakes, Prepared for FEMA's Hazard Mitigation Branch, Ocbober 25, 1995.

Horner, Gerald, *Benefit/Cost Methodologies for Use in Evaluating the Cost Effectiveness of Proposed Hazard Mitigation Measures*, Robert Olsen Associates, Prepared for Oregon Military Department – Office of Emergency Management, July 1999.

Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, 2000.)

Risk Management Solutions, Inc., *Development of a Standardized Earthquake Loss Estimation Methodology*, National Institute of Building Sciences, Volume I and II, 1994.

VSP Associates, Inc., *A Benefit/Cost Model for the Seismic Rehabilitation of Buildings*, Volumes 1 & 2, Federal Emergency management Agency, FEMA Publication Numbers 227 and 228, 1991.

VSP Associates, Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects: Section 404 Hazard Mitigation Program and Section 406 Public Assistance Program, Volume 3: Seismic Hazard Mitigation Projects*, 1993.

VSP Associates, Inc., *Seismic Rehabilitation of Federal Buildings: A Benefit/Cost Model*, Volume 1, Federal Emergency Management Agency, FEMA Publication Number 255, 1994.

Appendix F: Grant Programs and Resources

Post-Disaster Federal Programs

Hazard Mitigation Grant Program

- The Hazard Mitigation Grant Program (HMGP) provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.
  http://www.fema.gov/hazard-mitigation-grant-program

Physical Disaster Loan Program

- When physical disaster loans are made to homeowners and businesses following disaster declarations by the U.S. Small Business Administration (SBA), up to 20% of the loan amount can go towards specific measures taken to protect against recurring damage in similar future disasters.
  http://www.sba.gov/category/navigation-structure/loans-grants/small-business-loans/disaster-loans

Pre-Disaster Federal Programs

Pre-Disaster Mitigation Grant Program

- The Pre-Disaster Mitigation (PDM) program provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds.
  http://www.fema.gov/pre-disaster-mitigation-grant-program

Flood Mitigation Assistance Program

- The overall goal of the Flood Mitigation Assistance (FMA) Program is to fund cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other National Flood Insurance Program (NFIP) insurable structures. This specifically includes:
  - Reducing the number of repetitively or substantially damaged structures and the associated flood insurance claims;
  - Encouraging long-term, comprehensive hazard mitigation planning;
  - Responding to the needs of communities participating in the NFIP to expand their mitigation activities beyond floodplain development activities; and

- Complementing other federal and state mitigation programs with similar, long-term mitigation goals. http://www.fema.gov/flood-mitigation-assistance-program

Detailed program and application information for federal post-disaster and pre-disaster programs available at : https://www.fema.gov/library/viewRecord.do?id=4225

For Oregon Military Department – Office of Emergency Management grant guidance on Federal Hazard Mitigation Assistance, visit:
http://www.oregon.gov/OMD/OEM/pages/all_grants.aspx - Hazard_Mitigation_Grants

OEM contact: Amie Bashant, amie.bashant@state.or.us

State Programs

Community Development Block Grant Program

- Promotes viable communities by providing: 1) decent housing; 2) quality living environments; and 3) economic opportunities, especially for low and moderate income persons. Eligible Activities Most Relevant to Hazard Mitigation include: acquisition of property for public purposes; construction/reconstruction of public infrastructure; community planning activities. Under special circumstances, CDBG funds also can be used to meet urgent community development needs arising in the last 18 months which pose immediate threats to health and welfare. https://www.hudexchange.info/programs/cdbg/

Oregon Watershed Enhancement Board

- While OWEB's primary responsibilities are implementing projects addressing coastal salmon restoration and improving water quality statewide, these projects can sometimes also benefit efforts to reduce flood and landslide hazards. In addition, OWEB conducts watershed workshops for landowners, watershed councils, educators, and others, and conducts a biennial conference highlighting watershed efforts statewide. Funding for OWEB programs comes from the general fund, state lottery, timber tax revenues, license plate revenues, angling license fees, and other sources. OWEB awards approximately $20 million in funding annually. http://www.oregon.gov/OWEB/Pages/index.aspx

Federal Mitigation Programs, Activities & Initiatives

Basic & Applied Research/Development

- National Earthquake Hazard Reduction Program (NEHRP), National Science Foundation. Through broad based participation, the NEHRP attempts to mitigate the effects of earthquakes. Member agencies in NEHRP are the US Geological Survey (USGS), the National Science Foundation (NSF), the Federal Emergency Management Agency (FEMA), and the National Institute for Standards and Technology (NIST). The agencies focus on research and development in areas such as the science of earthquakes, earthquake performance of buildings and other structures, societal impacts, and emergency response and recovery. http://www.nehrp.gov/

- Decision, Risk, and Management Science Program, National Science Foundation. Supports scientific research directed at increasing the understanding and effectiveness of decision making by individuals, groups, organizations, and society. Disciplinary and interdisciplinary research, doctoral dissertation research, and workshops are funded in the areas of judgment and decision making; decision analysis and decision aids; risk analysis, perception, and communication; societal and public policy decision making; management science and organizational design. The program also supports small grants for exploratory research of a time-critical or high-risk, potentially transformative nature. http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5423

Hazard ID and Mapping

- National Flood Insurance Program: Flood Mapping; FEMA. Flood insurance rate maps and flood plain management maps for all NFIP communities. http://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping
- National Digital Orthophoto Program, DOI – USGS. Develops topographic quadrangles for use in mapping of flood and other hazards. http://www.ndop.gov/
- Mapping Standards Support, DOI-USGS. Expertise in mapping and digital data standards to support the National Flood Insurance Program. http://ncgmp.usgs.gov/standards.html
- Soil Survey, USDA-NRCS. Maintains soil surveys of counties or other areas to assist with farming, conservation, mitigation or related purposes. http://soils.usda.gov/survey/printed_surveys/

Project Support

- Coastal Zone Management Program, NOAA. Provides grants for planning and implementation of non-structural coastal flood and hurricane hazard mitigation projects and coastal wetlands restoration https://coast.noaa.gov/czm/
- Community Development Block Grant Entitlement Communities Program, HUD. Provides grants to entitled cities and urban counties to develop viable communities (e.g., decent housing, a suitable living environment, expanded economic opportunities), principally for low- and moderate- income persons. https://www.hudexchange.info/programs/cdbg-entitlement/
- National Fire Plan (DOI – USDA) Provides technical, financial, and resource guidance and support for wildland fire management across the United States. Addresses five key points: firefighting, rehabilitation, hazardous fuels reduction, community assistance, and accountability. http://www.forestsandrangelands.gov/
- Assistance to Firefighters Grant Program, FEMA. Grants are awarded to fire departments to enhance their ability to protect the public and fire service personnel from fire and related hazards. Three types of grants are available: Assistance to Firefighters Grant (AFG), Fire Prevention and Safety (FP&S), and Staffing for Adequate Fire and Emergency Response (SAFER). http://www.fema.gov/welcome-assistance-firefighters-grant-program
- Emergency Watershed Protection Program, USDA-NRCS. Provides technical and financial assistance for relief from imminent hazards in small watersheds, and to reduce vulnerability of life and property in small watershed areas damaged by severe natural hazard events. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp

- Rural Development Assistance – Utilities, USDA. Direct and guaranteed rural economic loans and business enterprise grants to address utility issues and development needs. https://www.rd.usda.gov/about-rd/agencies/rural-utilities-service
- Rural Development Assistance – Housing, USDA. Grants, loans, and technical assistance in addressing rehabilitation, health and safety needs in primarily low-income rural areas. Declaration of major disaster necessary. https://www.usda.gov/topics/rural/housing-assistance
- Public Assistance Grant Program, FEMA. The objective of the Federal Emergency Management Agency's (FEMA) Public Assistance (PA) Grant Program is to provide assistance to State, Tribal and local governments, and certain types of Private Nonprofit organizations so that communities can quickly respond to and recover from major disasters or emergencies declared by the President. http://www.fema.gov/public-assistance-local-state-tribal-and-non-profit
- National Flood Insurance Program, FEMA. Makes available flood insurance to residents of communities that adopt and enforce minimum floodplain management requirements. http://www.fema.gov/national-flood-insurance-program
- HOME Investments Partnerships Program, HUD. Grants to states, local government and consortia for permanent and transitional housing (including support for property acquisition and rehabilitation) for low-income persons. https://www.hud.gov/hudprograms/home-program
- Disaster Recovery Initiative, HUD. Grants to fund gaps in available recovery assistance after disasters (including mitigation). https://www.hud.gov/program_offices/comm_planning/communitydevelopment/programs/dri
- Emergency Management Performance Grants, FEMA. Helps state and local governments to sustain and enhance their all-hazards emergency management programs and to fund some hazard mitigation work. https://www.fema.gov/emergency-management-performance-grant-program
- Partners for Fish and Wildlife, DOI – FWS. Financial and technical assistance to private landowners interested in pursuing restoration projects affecting wetlands and riparian habitats. http://www.fws.gov/partners/
- North American Wetland Conservation Fund, DOI-FWS. Cost-share grants to stimulate public/private partnerships for the protection, restoration, and management of wetland habitats. https://www.fws.gov/birds/grants/north-american-wetland-conservation-act.php
- Federal Land Transfer / Federal Land to Parks Program, DOI-NPS. Identifies, assesses, and transfers available Federal real property for acquisition for State and local parks and recreation, such as open space. http://www.nps.gov/ncrc/programs/flp/index.htm
- Wetlands Reserve program, USDA-NCRS. Financial and technical assistance to protect and restore wetlands through easements and restoration agreements. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/home/?cid=STELPRDB1049327
- Secure Rural Schools and Community Self-Determination Act of 2000, US Forest Service. Reauthorized for FY2012, it was originally enacted in 2000 to provide five years of

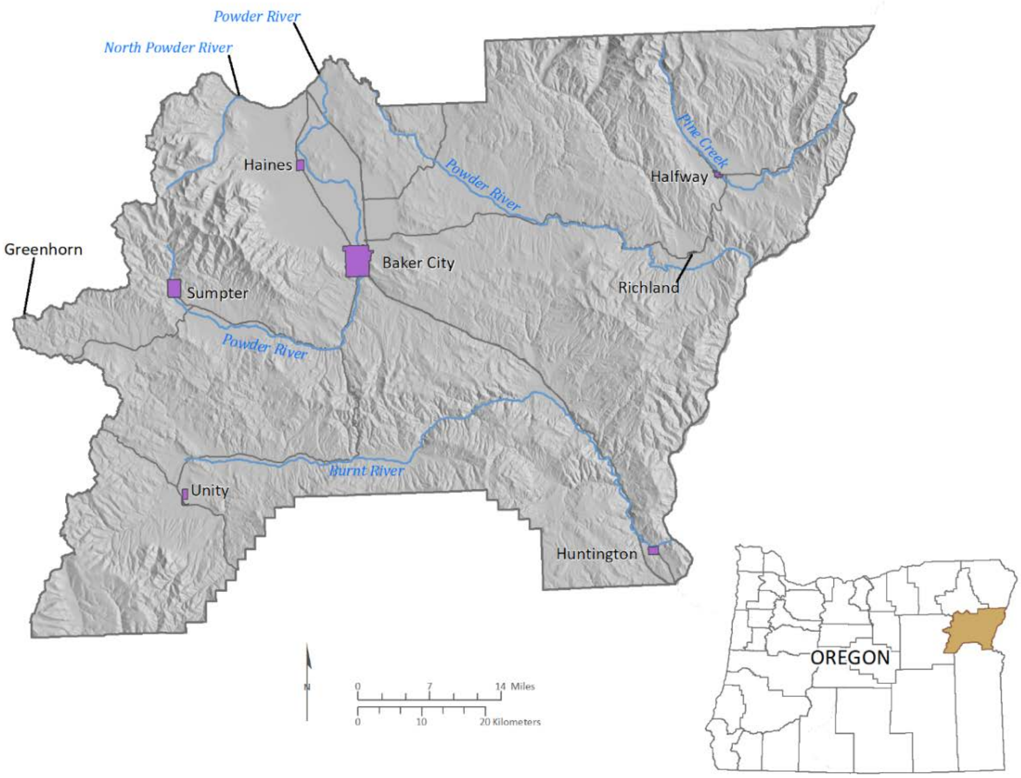
transitional assistance to rural counties affected by the decline in revenue from timber harvests on federal lands. Funds have been used for improvements to public schools, roads, and stewardship projects. Money is also available for maintaining infrastructure, improving the health of watersheds and ecosystems, protecting communities, and strengthening local economies. http://www.fs.usda.gov/pts/

Appendix G:
Natural Hazard Risk Report for
Baker County, Oregon

State of Oregon
Oregon Department of Geology and Mineral Industries
Brad Avy, State Geologist

NATURAL HAZARD RISK REPORT FOR BAKER COUNTY, OREGON: FINAL REPORT TO THE OREGON DEPARTMENT OF LAND CONSERVATION AND DEVELOPMENT

INCLUDING THE CITIES OF BAKER CITY, GREENHORN, HAINES, HALFWAY, HUNTINGTON, RICHLAND, SUMPTER, AND UNITY



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Cover image: Study area of the Baker County Risk Report. Map depicts Baker County, Oregon and incorporated communities included in this report.

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EXECUTIVE SUMMARY

This report describes the methods and results of the natural hazard risk assessments performed in 2019 by the Oregon Department of Geology and Mineral Industries (DOGAMI) for the communities of Baker County. The purpose of this project is to provide communities within Baker County a detailed risk assessment of the natural hazards that affect them to enable them to compare hazards and act to reduce their risk. The risk assessments contained in this project quantify the impacts of natural hazards to these communities and enhance the decision-making process in planning for disaster.

The primary findings and conclusions of this project are:

1. **Hazus-MH earthquake analysis show a moderate amount of damage and losses for the study area**—The results indicate that Baker County would incur a moderate amount of damage (6.6%) from an earthquake similar to the one simulated in this report. Areas of liquefaction have some influence on the damage results. Building vulnerability was a strong factor due to the general age of the building inventory being built before seismic building code enforcement in Oregon. In addition, several high value buildings in downtown Baker City are constructed with materials that are highly vulnerable to earthquake shaking. The high vulnerability of the building inventory (primarily because of the age of construction), building construction materials, and the areas of high liquefaction all contribute to the estimated levels of losses expected in the study area.
2. **Retrofitting buildings to modern seismic building codes can reduce damages and loses from earthquake**—Seismic building codes have a major influence on earthquake shaking damage estimated by Hazus-MH, a software tool developed by the Federal Emergency Management Agency (FEMA) for calculating loss from natural hazards. We examined potential loss reduction from seismic retrofits (modifications that improve building's seismic resilience) in simulations by using Hazus-MH building code "design level" attributes of pre, low, moderate, and high codes (FEMA, 2012b) in earthquake scenarios where permanent ground deformation (PGD) has been removed. The simulations were accomplished by upgrading every pre (non-existent) and low seismic code building to moderate seismic code levels in one scenario, and then further by upgrading all buildings to high (current) code in another scenario. We found that retrofitting to at least moderate code was the most cost-effective mitigation strategy because the additional benefit from retrofitting to high code was minimal. In our simulation of upgrading buildings to at least moderate code, the estimated loss for the entire study area went from 4.8% to 1.2%. We found further reduction in estimated loss in our simulation to 0.8% only by upgrading all buildings to high code. Some communities would see greater loss reduction than the study area as a whole due to older building stock constructed at pre or low code seismic building code standards. An example is the Baker City, which would see a significant loss reduction (from 4.2% to 0.9%) by retrofitting all buildings to at least moderate code. While seismic retrofits are an effective strategy for reducing earthquake shaking damage, it should be noted that earthquake-induced landslide and liquefaction hazards will also be present in some areas, and these hazards require different geotechnical mitigation strategies.
3. **Flooding is a threat for some areas in the study area**—Most of the development in Baker County is located in the flatter agricultural lands where flooding can occur. Many buildings in the study area, primarily within the Powder River floodplain in and north of Baker City, are vulnerable to flooding. We estimate a moderate amount of damage from flooding in this area and many buildings exposed to flooding. Several streams in Baker County that may be prone to

flooding have never been studied for flood hazard, so the level of risk from flooding may be higher. The effective stream studies that are currently in use may be out-of-date due to their age and new studies may be beneficial. During a 100-year flood event, the current stream models show that Baker City is expected to sustain losses near 0.1% of total building value.

4. **Elevating structures in the flood zone reduces vulnerability**—Flood exposure analysis was used in addition to Hazus-MH loss estimation to identify buildings that were not damaged but were within the area expected to experience a 100-year flood. By using both analyses in this way, the number of elevated structures within the flood zone could be quantified. This showed possible mitigation needs in flood loss prevention and the effectiveness of past activities. Baker City was identified as a community with a large number of buildings (98) in the floodplain elevated above the estimated flood height.
5. **New landslide mapping would increase the accuracy of future risk assessments**—Exposure analysis was used to assess the threat from landslide hazard. Landslide is a widespread hazard for much of the undeveloped portions of the county. The landslide data suggests that a cluster of residential buildings in the northeastern portion of Sumpter are exposed to very high landslide hazard as they are currently mapped, but interpretations from the lidar indicate that this may be incorrect. The landslide hazard data used in this risk assessment was created before modern mapping technology and future risk assessments using lidar derived landslide hazard data would provide more accurate results. Earthquake analysis would also benefit from better landslide mapping since Hazus-MH analysis uses landslide probability as an input dataset.
6. **Wildfire is a natural hazard threat for many areas in Baker County**—Exposure analysis shows that buildings throughout the study area are at high risk to wildfire hazard. Several communities within the county have a minimum of 30% of exposure to at least moderate wildfire hazard and some communities are at much greater risk. The communities of Sumpter, Greenhorn, Halfway, and Huntington are particularly at risk to high wildfire hazard. Additionally, wildfire risk is high throughout the unincorporated county.
7. **Several of Baker County's critical facilities are at risk to earthquake hazard**—Critical facilities were identified and were specifically examined within this report. DOGAMI has estimated that 14 of Baker County's 33 critical facilities are at risk to be non-functioning due to an earthquake similar to the one simulated in this report. DOGAMI has also found that 1 critical facility is exposed to landslide hazard. No critical facilities were found to be exposed to flood or wildfire.
8. **Biggest displacement to population was wildfire**—Displacement of permanent residents from natural hazards was quantified within this report. We estimate that of the 16,134 total residents in Baker County 5.1% of the population or 830 residents could be potentially displaced due to wildfire. Flood hazard is a potential threat to 2% (359) of permanent residents, and landslide hazard makes 1.6% (254) vulnerable to displacement.
9. **Community needs can be prioritized**—Each community within Baker County was assessed for natural hazard exposure and loss. This allowed for comparison of risk between communities and impacts from each natural hazard. In using Hazus-MH and exposure analysis, these results can assist in developing plans that address the concerns for those individual communities.

We arrived at these findings and conclusions by completing three main tasks: compiling an asset database, identifying and using best available hazard data, and performing natural hazard risk assessment.

In the first task, we created a comprehensive asset database for the entire study area by synthesizing assessor data, U.S. Census information, Hazus-MH general building stock information, and building footprint data. This work resulted in a single dataset of building points and their associated building characteristics. With these data we were able to conduct highly accurate hazard analysis on a building-by-building basis.

The second task was to identify and use the most current and appropriate hazard datasets for Baker County. Most of the hazard datasets used in this report were created by DOGAMI and some were produced by using high-resolution lidar topographic data. Each hazard dataset for Baker County were the best available at the time of writing.

In the third task, we performed risk assessments using Esri® ArcGIS Desktop® software. We used two risk assessment approaches: (1) estimated loss (in dollars) to buildings from flood and earthquake scenarios using FEMA Hazus®-MH methodology, and (2) calculated number of buildings, their value, and associated populations that are exposed to earthquake and flood inundation scenarios, or susceptible to varying levels of hazard from landslides and wildfire.

Results were broken out for the following geographic areas:

- Unincorporated Baker County
- City of Greenhorn
- City of Halfway
- City of Richland
- City of Unity
- City of Baker City
- City of Haines
- City of Huntington
- City of Sumpter

Selected Countywide Results

Total buildings: 16,108

Total estimated building value: $3.1 billion

2500-year Probabilistic Magnitude 6.7 Earthquake
Red-tagged buildings[a]: 154
Yellow-tagged buildings[b]: 1,356
Loss estimate: $209 million

Landslide Exposure (High and Very High-Susceptibility)
Number of buildings exposed: 463
Exposed building value: $53 million

100-year Flood Scenario
Number of buildings damaged: 125
Loss estimate: $986,000

Wildfire Exposure (High Hazard)
Number of buildings exposed: 1,798
Exposed building value: $240 million

[a]Red-tagged buildings are considered uninhabitable due to complete damage
[b]Yellow-tagged buildings are considered limited habitability due to extensive

1.0 INTRODUCTION

A natural hazard risk assessment analyzes how a hazard could affect the built environment, population, and local economy and identifies potential risk. In natural hazard mitigation planning, risk assessments are the basis for developing mitigation strategies and actions. A risk assessment enhances the decision-making process, so that steps can be taken to prepare for a potential hazard event.

This is the first multi-hazard risk assessment analyzing individual buildings and residents in Baker County and therefore is the most detailed and comprehensive analysis to date of natural hazard risk and provides a comparative perspective never before available. In this report, we describe our assessment results, which quantify the various levels of risk that each hazard presents to Baker County's communities.

Baker County is subject to several significant natural hazards, including: riverine flooding, earthquake, landslides, and wildfire. This region of the state is lightly developed, with most of the development occurring in the county's largest city, Baker City. Natural hazards that pose a potential threat to development results in risk. The primary goal of the risk assessment is to inform communities of their vulnerability to and risk from natural hazards and to be a resource for risk reduction actions.

1.1 Purpose

The purpose of this project is to help communities in Baker County better understand their risk and increase resilience to natural hazards that may threaten their community. This is accomplished by providing accurate, detailed, and up-to-date information about these hazards and by measuring the number of people and buildings at risk.

The main objectives of this study are to:

- compile and/or create a database of critical facilities, tax lot data, buildings, and population distribution data,
- incorporate and use existing data from previous geologic, hydrologic, and wildfire hazard studies,
- perform exposure and Hazus–based risk analysis, and
- share this report widely so that all interested parties have access to its information and data.

The body of this report describes the methods and results for these objectives. Two primary methods (Hazus-MH or exposure), depending on the type of hazard, were used to assess risk. We describe the methods for creating the building and population information used in this project. Results for each hazard type are reported on a study area basis within each hazard section, and community based results are reported in detail in **Appendix A: Community Risk Profiles**.

1.2 Study Area

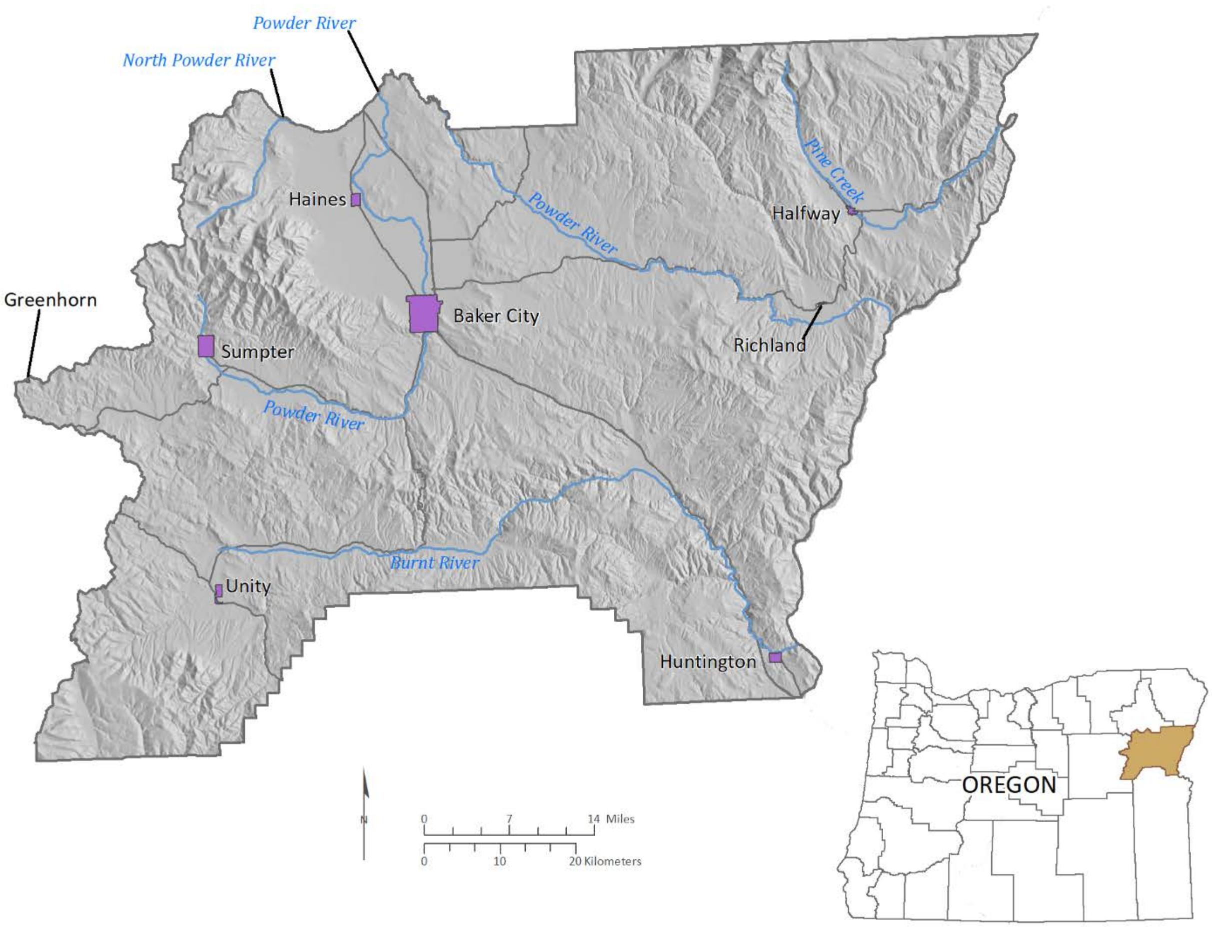
The study area for this project is the entirety of Baker County, Oregon. Baker County is located in the northeastern portion of the state and is bordered by Wallowa and Union Counties on the north, the State of Idaho on the east. Malheur County on the south and Grant County on the east. The total area of Baker County is 3,075 square miles (7,964 square km). A large portion of the county (50%) is federally or state owned with about 30% being part of the Malheur or Whitman National Forests.

The geography of Baker County consists of the rugged Blue Mountain range, which is a part of the Columbia River Plateau. Baker County features river canyons and high plateaus, which are interspersed with wide grasslands. The Snake River defines the eastern border of the county and the headwaters of the Burnt, North Powder, and Powder Rivers all originate within Baker County

The population of Baker County is 16,134 according to the 2010 U.S. Census (2010a). The county's largest community and county seat is the City of Baker City. Most of the residents in the county reside in the central part of county in or near Baker City (**Figure 1-1**).

No unincorporated communities within Baker County were selected as separate communities from the unincorporated county. DOGAMI considers a community's population size and density to determine if it should be distinct from the overall unincorporated county. We use census block and building count information to make these determinations.

Figure 1-1. Study area: Baker County with communities identified.



1.3 Project Scope

For this risk assessment, we took a quantitative approach and applied it to buildings and population. The decision to limit the project scope to buildings and population was driven by data availability, strengths and limitations of the risk assessment methodology, and funding availability. We did not analyze impacts to the local economy. Depending on the natural hazard, we used one of two methodologies: loss estimation or exposure. Loss estimation was modeled using methodology from Hazus®-MH (Hazards U.S., Multi-Hazard), a tool developed by FEMA for calculating damage to buildings from flood and earthquake.

Exposure is a simpler methodology, where buildings are categorized based on their location relative to various hazard zones. To account for impacts on population (permanent residents only), 2010 U.S. census data (U.S. Census Bureau, 2010a) were associated with residential buildings.

A critical component of this risk assessment is a countywide building inventory developed from building footprint data and the Baker County tax assessor database. The other key component is a suite of datasets that represent the currently best available science for a variety of natural hazards. The geologic hazard scenarios were selected by DOGAMI staff based on their expert knowledge of the datasets; most datasets are DOGAMI publications. In addition to geologic hazards, we included wildfire hazard in this risk assessment. The following is a list of the natural hazards and the risk assessment methodologies that were applied. See **Table 1-1** for data sources.

Earthquake Risk Assessment

- Hazus-MH loss estimation from a 2500-year probabilistic magnitude 6.7 scenario

Flood Risk Assessment

- Hazus-MH loss estimation to four recurrence intervals (10%, 2%, 1%, 0.2% annual chance)
- Exposure to 1% annual chance recurrence interval

Landslide Risk Assessment

- Exposure based on landslide susceptibility (low to very high)

Wildfire Risk Assessment

- Exposure based on fire risk index (low to high)

Table 1-1. Hazard data sources in Baker County.

Hazard	Scenario or Classes	Scale/Level of Detail	Data Source
Earthquake	2500-year probabilistic M6.7	National	USGS (Peterson and others, 2014)
Flood	Depth Grids: 10% (10-yr) 2% (50-yr) 1% (100-yr) 0.2% (500-yr)	Countywide	DOGAMI – derived from FEMA (1988)
Landslide*	Susceptibility (Low, Moderate, High, Very High)	Statewide	DOGAMI (Burns and others, 2016)
Wildfire	Risk (Low, Moderate, High)	Regional (Pacific Northwest, US)	ODF (Pyrologix, LCC, 2018)

*Landslide data comprise a composite dataset where the level of detail varies greatly from place to place within the state. Please refer to Section 3.4.1 or the report by Burns and others (2016) for further information.

1.4 Previous Studies

One previous risk assessment has been conducted that included Baker County by DOGAMI. Wang and Clark (1999: DOGAMI Special Paper 29) ran two general level Hazus-MH earthquake analyses, a magnitude 8.5 CSZ earthquake and a 500-year probabilistic earthquake scenario, for the entire state of Oregon. In those analyses Baker County had a very low loss ratio relative to most counties in the state.

We did not compare the results of this project with the results of the previous study since very different methodologies were used.

2.0 METHODS

2.1 HAZUS-MH Loss Estimation

Key Terms:

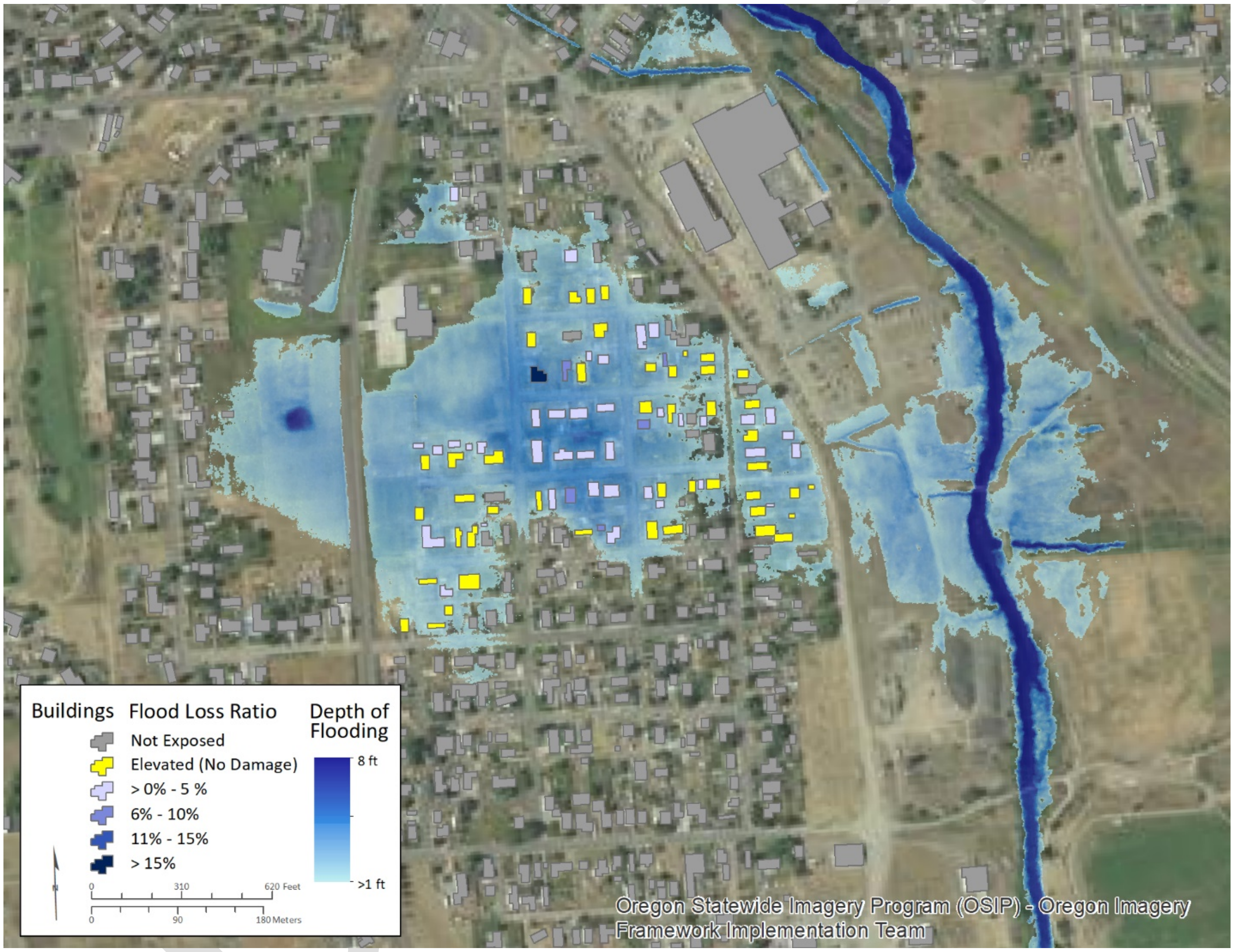
- *Loss estimation:* Damage that occurs to a building in an earthquake or flood scenario, as modeled with Hazus-MH methodology.
- *Loss ratio:* Percentage of estimated loss relative to the total value.

"Hazus provides nationally applicable, standardized methodologies for estimating potential wind, flood, and earthquake losses on a regional basis. Hazus can be used to conduct loss estimation for floods and earthquakes […]. The multi-hazard Hazus is intended for use by local, state, regional officials, and consultants to assist mitigation planning and emergency response and recovery preparedness" (FEMA, 2012a, p. 1-1).

DOGAMI used Hazus-MH version 3.0 for the flood and earthquake analyses (FEMA, 2015). Hazus-MH can be used in different modes depending on the level of detail required. Given the high spatial precision of the building inventory data and quality of the natural hazard data, DOGAMI chose the user-defined facility (UDF) mode. This mode makes loss estimations for individual buildings relative to their "cost," which DOGAMI then aggregates to the community level to report loss ratios. DOGAMI derives cost from the estimated building replacement cost. Replacement cost is based on a method called RSMeans valuation (The Gordian Group, 2017) and is calculated by multiplying the building square footage by a standard cost per square foot. These standard rates per square foot are in tables within the default Hazus-MH database.

Damage functions are at the core of Hazus-MH. The damage functions stored within the Hazus-MH data model were developed and calibrated from the observed results of past disasters. Estimates of loss are made by intersecting building locations with natural hazard layers and applying damage functions based on the hazard severity and building characteristics. **Figure 2-1** illustrates the range of building loss estimates from Hazus-MH flood analysis.

Figure 2-1. 100-year flood zone and building loss estimates example in the City of Baker City.



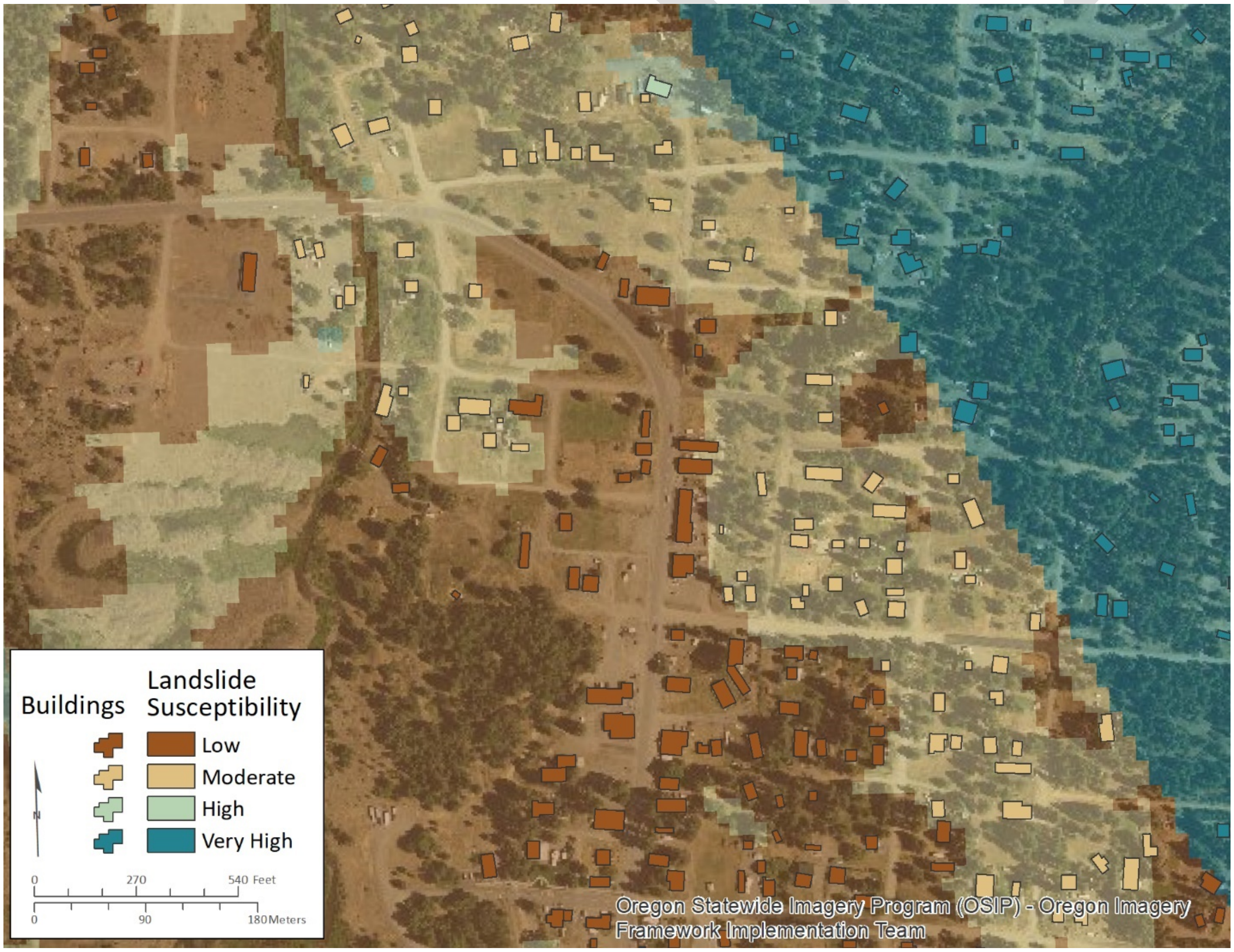
2.2 Exposure

> ***Key Terms:***
> - *Exposure:* Determination of whether a building is within or outside of a hazard zone. No loss estimation is modeled.
> - *Building value:* Total monetary value of a building. This term is used in the context of exposure.

Exposure methodology is calculating the buildings and population that are within a natural hazard zone. This is an alternative for natural hazards that do not have readily available damage functions and, therefore, loss estimation is not possible. It provides a way to easily quantify what is and what is not threatened. Exposure results are communicated in terms of total building value exposed, rather than loss estimate because the loss ratio is unknown. For example, **Figure 2-2** shows buildings that are exposed to different landslide susceptibility areas.

Exposure is used for landslide and wildfire. For comparison with loss estimates, exposure is also used for the 1% annual chance flood.

Figure 2-2. Landslide susceptibility areas and building exposure example in the City of Sumpter.



2.3 Building Inventory

A key piece of the risk assessment is the building inventory for the entire study area. This inventory consists of all buildings larger than 400 square feet (37 square meters), as determined from existing building footprints or tax lot data. **Figure 2-3** shows an example of building inventory occupancy types used in the Hazus-MH and exposure analyses in Baker County. See also Appendix F, **Plate 1** and **Plate 2**.

To use the building inventory within the Hazus-MH methodology, building footprints were converted to points and migrated them into a UDF database with standardized field names and attribute domains. The UDF database formatting allows for the correct damage function to be applied to each building. Hazus-MH version 2.1 technical manuals (FEMA, 2012b, c) provide references for acceptable field names, field types, and attributes. The fields and attributes used in the UDF database (including building seismic codes) are discussed in more detail in Appendix **C.2.2**.

Figure 2-3. Building occupancy types in the City of Baker City.

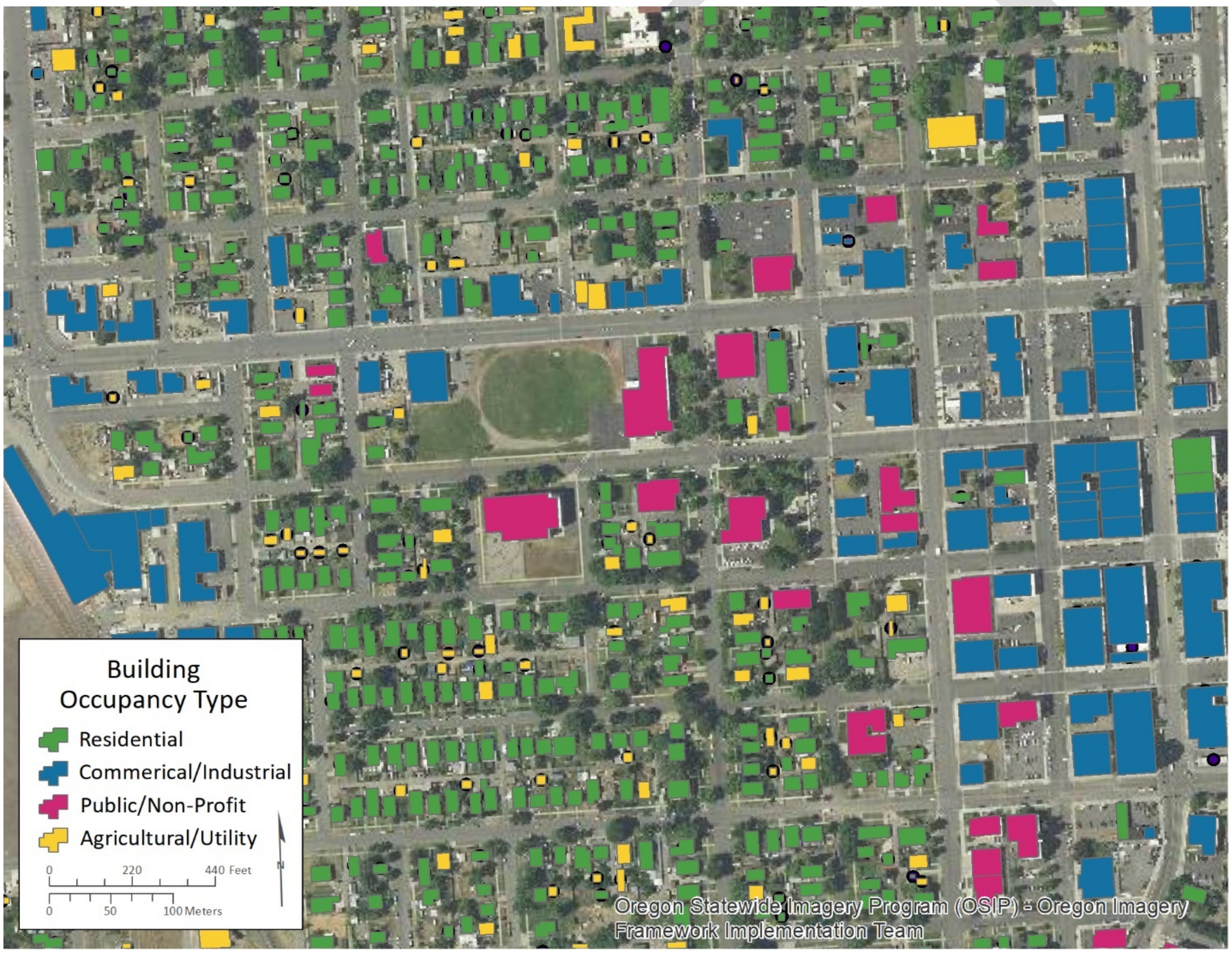


Table 2-1 shows the distribution of building count and value within the UDF database for Baker County. A table detailing the occupancy class distribution by community is included in **Appendix B: Detailed Risk Assessment Tables**.

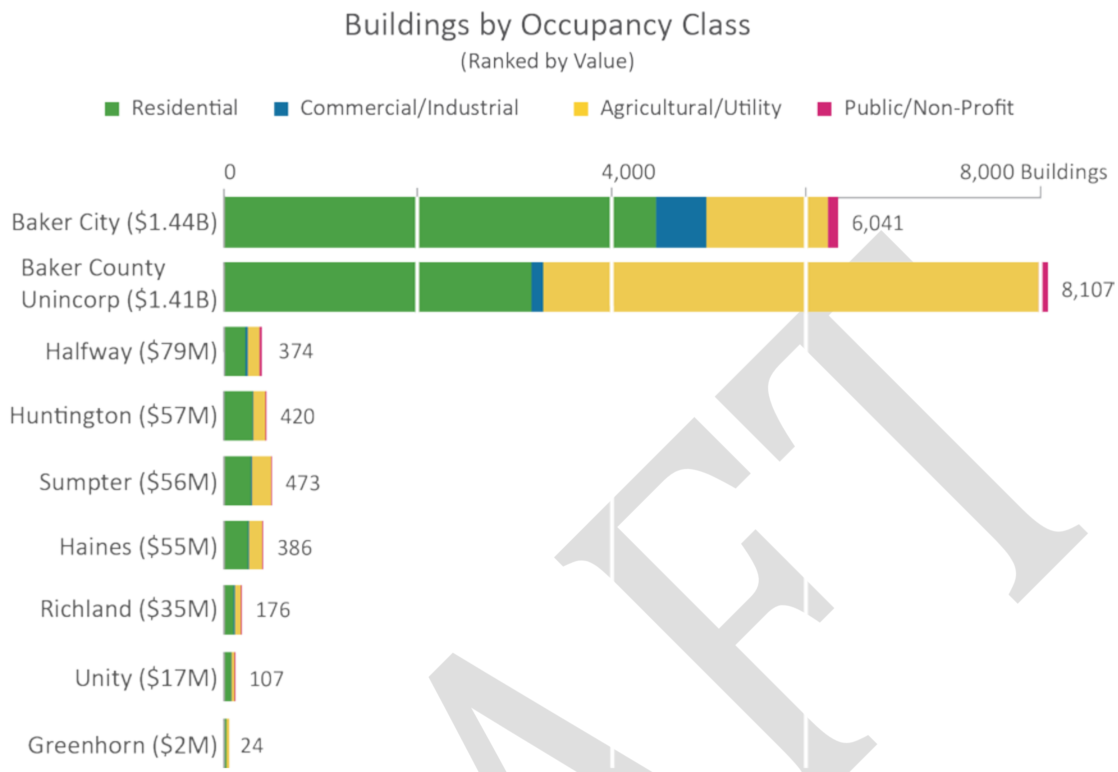
Table 2-1. Study area building inventory.

Community	Total Number of Buildings	Percentage of Total Buildings	Estimated Total Building Value ($)	Percentage of Total Building Value
Unincorporated Baker County	8,107	50%	1,408,882,000	45%
Baker City	6,041	38%	1,437,408,000	46%
Greenhorn	24	0.1%	1,876,000	0.1%
Haines	386	2.4%	55,066,000	1.7%
Halfway	374	2.3%	78,700,000	2.5%
Huntington	420	2.6%	57,259,000	1.8%
Richland	176	1.1%	34,987,000	1.1%
Sumpter	473	2.9%	55,531,000	1.8%
Unity	107	0.7%	16,938,000	0.5%
Total Baker County	16,108	100%	3,146,647,000	100%

The building inventory was developed from several data sources and was refined for use in loss estimation and exposure analyses. A database of building footprints for the entirety of Baker County was already available from an open source database created by Microsoft (Bing Maps, 2018). Building footprints in the database were developed using artificial intelligence and collected from the best available aerial imagery; see (https://github.com/Microsoft/USBuildingFootprints). The building footprints provide a spatial location and 2D representation of a structure.

Baker County supplied assessor data that we formatted for use in the risk assessment. The assessor data contains an array of information about each improvement (i.e., building). Tax lot data, which contains property boundaries and other information regarding the property, was obtained from the county assessor and was used to link the buildings with assessor data. The linkage between the two datasets resulted in a database of UDF points that contain attributes for each building. These points are used in the risk assessments for both loss estimation and exposure analysis. **Figure 2-4** illustrates the variation of building value and occupancy across the communities of the Baker County.

Figure 2-4. Community building value in Baker County by occupancy class.



We attributed critical facilities in the UDF database so that they could be highlighted in the results. Critical facilities data came from the DOGAMI Statewide Seismic Needs Assessment (SSNA; Lewis, 2007). We updated the SSNA data by reviewing Google Maps™ data. The critical facilities we attributed include hospitals, schools, fire stations, police stations, emergency operations, and military facilities. In addition to these standard building types, we considered other building types based on local input or special considerations that are specific to Baker County that would be essential during a natural hazard event, such as public works and water treatment facilities. Critical facilities are important to note because these facilities play a crucial role in emergency response efforts. Communities that have critical facilities that can function during and immediately after a natural disaster are more resilient than those with critical facilities that are inoperable after a disaster. **Table 2-2** shows the critical facilities on a community basis. Critical facilities are listed for each community (see **Community Risk Profiles**).

Table 2-2. Study area critical facilities inventory.

Community	Hospital & Clinic		School		Police/Fire		Emergency Services		Military		Other*		Total	
	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)
	(all dollar amounts in thousands)													
Unincorp. Baker County	0	0	0	0	5	4,458	0	0	0	0	1	6,403	6	10,861
Baker City	3	27,907	5	61,230	2	4,656	1	410	1	4,530	3	7,243	15	105,975
Greenhorn	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haines	0	0	1	2,279	0	0	0	0	0	0	0	0	1	2,279
Halfway	1	1,579	2	16,839	1	803	0	0	0	0	0	0	4	19,221
Huntington	0	0	0	0	1	411	0	0	0	0	1	225	2	635
Richland	0	0	0	0	1	1,098	0	0	0	0	0	0	1	1,098
Sumpter	0	0	0	0	1	884	0	0	0	0	0	0	1	884
Unity	0	0	1	1,567	1	995	0	0	0	0	1	787	3	3,350
Total Baker County	4	29,486	9	81,914	12	13,304	1	410	1	4,530	6	14,658	33	144,303

Note: Facilities with multiple buildings were consolidated into one individual building.

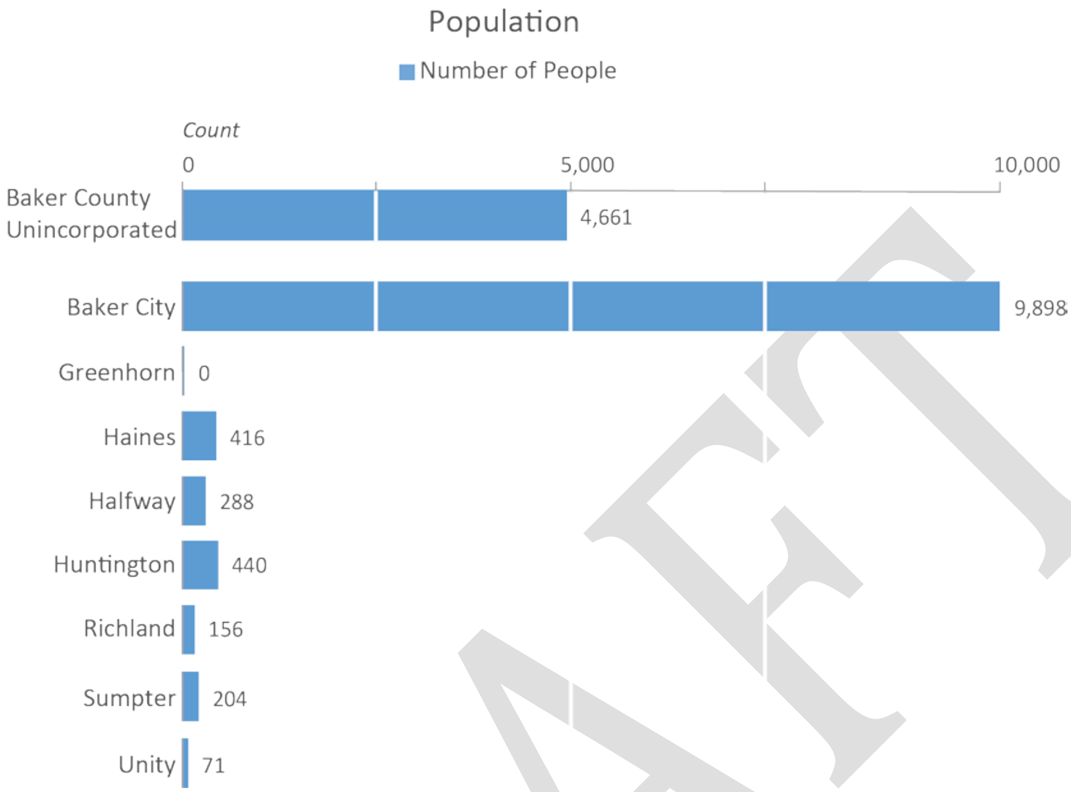
*Category includes buildings that are not traditional (emergency response) critical facilities but considered critical during an emergency based on input from local stakeholders (e.g. water treatment facilities or airports).

2.4 Population

Within the UDF database, the population of permanent residents reported per census block was distributed among residential buildings and pro-rated based on square footage (**Figure 2-5**). We did not examine for this report the impacts from natural hazards to non-permanent populations (e.g., tourists), whose total numbers fluctuate seasonally. Due to lack of information within the assessor and census databases, the distribution includes vacation homes. From information reported in the 2010 U.S. Census, American FactFinder regarding vacation rentals within the county and Baker County's communities, it is estimated that 12% of residential buildings are vacation rentals (United States Census Bureau, 2010b).

Using this population distribution, DOGAMI estimated the number of permanent residents who could be affected by a natural hazard scenario. For each natural hazard, with the exception of the 2500-year probabilistic 6.7 earthquake scenario, a simple exposure analysis was used to find the number of potentially displaced residents within a hazard zone. For the earthquake scenario the potentially displaced residents were based on residents in buildings estimated to be significantly damaged by the earthquake.

Figure 2-5. Total population by community.



3.0 ASSESSMENT OVERVIEW AND RESULTS

This risk assessment considers four natural hazards (earthquake, flood, landslide, and wildfire) that pose a risk to Baker County. The assessment describes both localized vulnerabilities and the widespread challenges that impact all communities. The loss estimation and exposure results, as well as the rich dataset included with this report, can lead to greater understanding of the potential impact of disasters. Communities can use the results to update plans as part of the work toward becoming more resilient to future disasters.

3.1 Hazards and Study Area Results

In this section, results are presented for Baker County. Baker County includes all unincorporated areas, unincorporated communities, and cities within Baker County. Individual community results are in **Appendix A: Community Risk Profiles**.

3.2 Earthquake

An earthquake is a sudden movement of material on each side of a fault in the earth's crust that abruptly releases strain accumulated over a long period of time. The movement along the fault produces waves of strong shaking that spread in all directions. Oregon is underlain by a large and complex system of faults that can produce damaging earthquakes. Although smaller faults produce smaller earthquakes, they are often close to populated areas, and damage can be extensive to nearby buildings (Madin and Burns, 2013).

Two potential earthquake-induced hazards are liquefaction and landslides. Liquefaction occurs when loose, saturated soils substantially lose bearing capacity due to ground shaking, causing the soil to behave like a liquid; this action can be a source of tremendous damage. If an earthquake causes strong shaking in populated areas, it may result in causalities, economic disruption, and extensive property damage.

3.2.1 Data sources

The earthquake scenario used in this analysis was the 2500-year (2% in 50 years) probabilistic, which is based on a national map of seismic hazard created by the USGS and is used within the Hazus-MH earthquake model (Petersen et al, 2014). Based on results from a few initial Hazus-MH earthquake analyses and available seismic data (historical events, fault locations, etc.) from DOGAMI and USGS, the earthquake scenario used in this report was deemed the most appropriate for communicating earthquake risk for Baker County. It is important to note that there is a large amount of uncertainty in the probabilistic ground shaking maps for Baker County. The historical seismicity and active fault data on which the probabilistic maps are based are known to be very incomplete for Baker County. For example, using lidar topographic data, DOGAMI has identified a significant active fault in the county which is not considered in the probabilistic model and would likely increase the expected shaking.

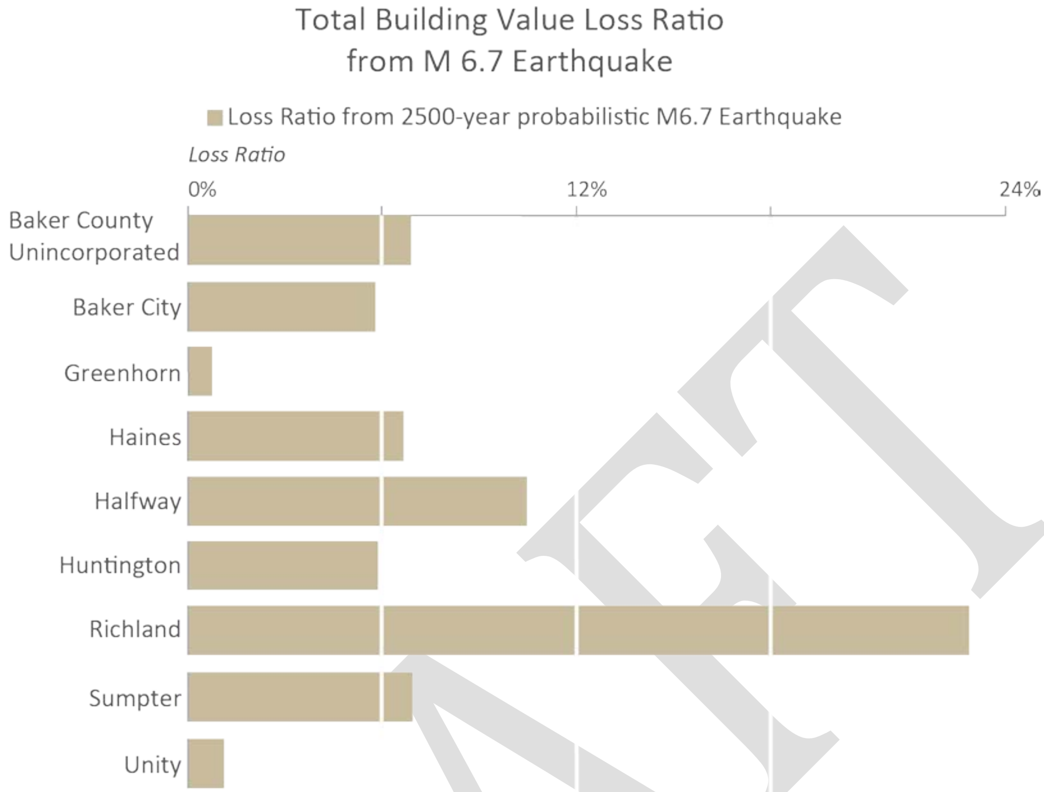
Hazus-MH offers two scenario methods for estimating loss from earthquake, probabilistic and deterministic (FEMA Hazus-MH, 2012b). A probabilistic scenario uses U.S. Geological Survey (USGS) National Seismic Hazard Maps which are derived from seismic hazard curves calculated on a grid of sites across the United States that describe the annual frequency of exceeding a set of ground motions as a result of all possible earthquake sources (USGS, 2017). A deterministic scenario is based on a specific seismic event, such as a Cascadia Subduction Zone magnitude 9.0 event. We selected the probabilistic scenario method because there is no clearly defined dominant seismic source for the area and it best suited estimating the level of seismic risk. This method was used along with the UDF database so that loss estimates could be calculated on a building-by-building basis.

The USGS 2500-year probabilistic map (Petersen et al, 2014) provides the Hazus-MH earthquake model with ground shaking parameters (peak ground acceleration [PGA], peak ground velocity [PGV], spectral acceleration at 1.0 second period and 0.3 second period [SA10 and SA03]) that have been integrated together. We set the magnitude to 6.7 within Hazus-MH for the scenario used in this report. Additional seismic inputs utilized in the earthquake scenario were liquefaction susceptibility and NEHRP site classification derived from the Oregon Resilience Plan (ORP) (Madin and Burns, 2013) and landslide susceptibility from Burns and others (2016).

3.2.2 Countywide results

Because an earthquake can affect a wide area, it is unlike other hazards in this report—every building in Baker County, to some degree, would be affected by it. Hazus-MH loss estimates (see **Table B-2**) for each building are based on a formula where coefficients are multiplied by each of the five damage state percentages (none, low, moderate, extensive, and complete). These damage states are correlated to loss ratios that are then multiplied by the building dollar value to obtain a loss estimate (FEMA, 2012b). **Figure 3-1** shows the loss estimates by community for Baker County from a 2500-year probabilistic magnitude 6.7 event.

Figure 3-1. Earthquake loss ratio by community.



In keeping with earthquake damage reporting conventions, we used the ATC-20 post-earthquake building safety evaluation color-tagging system to represent damage states (Applied Technology Council, 2015). Red-tagged buildings correspond to a Hazus-MH damage state of "complete," which means the building is uninhabitable. Yellow-tagged buildings are in the "extensive" damage state, indicating limited habitability. The number of buildings in each damage state is based on an aggregation of probabilities per community and does not represent individual buildings (FEMA, 2012b).

Critical facilities were considered non-functioning if the Hazus-MH earthquake analysis showed that a building or complex of buildings had a greater than 50-percent chance of being at least moderately damaged (FEMA, 2012b).

The number of potentially displaced residents from the scenario earthquake is based on the number of red-tagged and a percentage of yellow-tagged residences that were determined in the Hazus-MH earthquake analysis results.

Baker County 2500-year probabilistic M6.7 earthquake results:

- Number of red-tagged buildings: 254
- Number of yellow-tagged buildings: 1,356
- Loss estimate: $209,210,000
- Loss ratio: 6.6%
- Non-functioning critical facilities: 14
- Potentially displaced population: 257

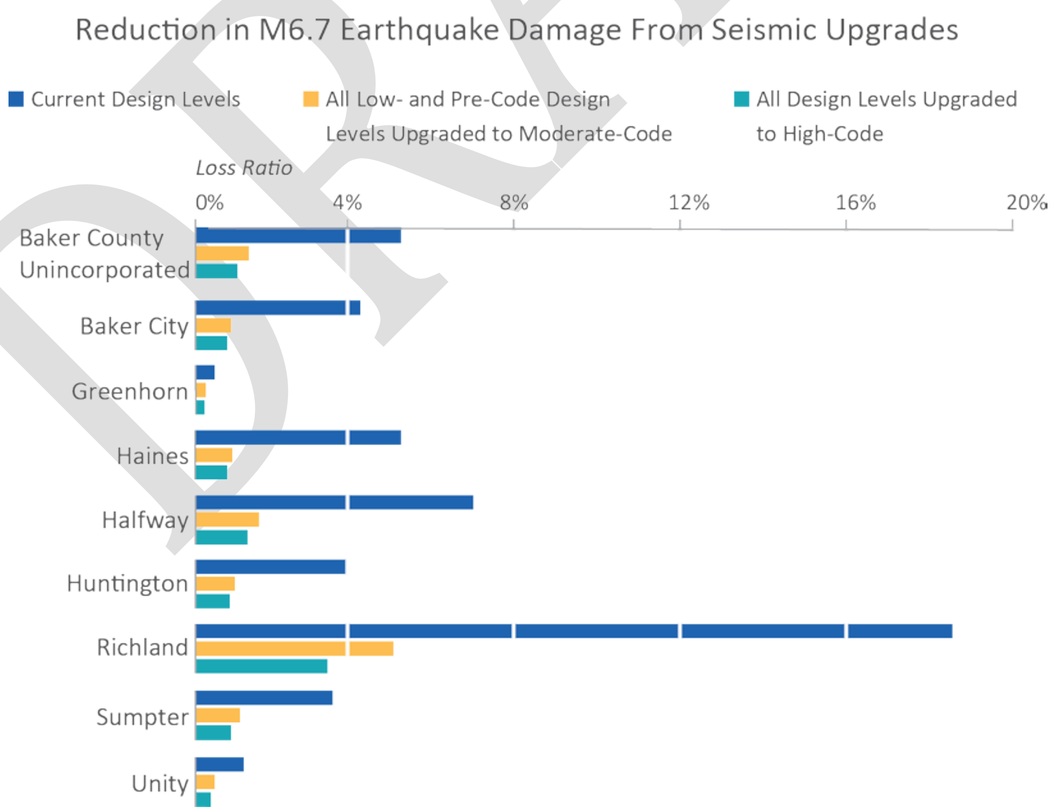
The results indicate that Baker County would incur a moderate amount of damage (6.6%) from an earthquake similar to the one simulated in this report. These results were moderately influenced by earthquake-induced liquefaction; however, the overall age of the building stock was the primary factor. This shows us that the age of the building stock is one metric of earthquake vulnerability for a community. Seismic building codes were implemented in Oregon in the 1970s, as such, 75% of buildings were built before "moderate" code enforcement. Communities within Baker County that are composed of an older building stock are expected to experience more damage from earthquake than newer ones.

> ***Key Terms:***
> - *Seismic retrofit:* Structural modification to a building that improves its resilience to earthquake.
> - *Design level: Hazus-MH terminology referring to the quality of a building's seismic building code (i. e. pre, low, moderate, and high).*

Moderate to high liquefaction zones exist throughout the county and in the densest populated areas, which increases the risk from earthquake. Another consideration of these areas is that liquefaction could present difficulties for first responders and people in need of medical attention after an earthquake event. This factor, as well as the overall age of the building stock results in moderate levels of damage.

If buildings could be seismically retrofitted to moderate or high code standards, the impact of this event would be greatly reduced. In a simulation by DOGAMI using a dataset that has removed landslide and liquefaction factors (PGD), Hazus-MH earthquake analysis shows that loss estimates drop from 4.8% to 1.2%, when all buildings are upgraded to at least moderate code level. **Figure 3-2** illustrates the reduction in loss estimates from a CSZ magnitude 9.0 earthquake through two simulations where all buildings are upgraded to at least moderate code standards and then all buildings to high code standards.

Figure 3-2. 2500-year probabilistic M6.7 earthquake (PGD removed) loss ratio in Baker County, with simulated seismic building code upgrades.



3.2.3 Areas of vulnerability or risk

> ***Key Terms:***
> - *Vulnerability:* Characteristics that make people or assets more susceptible to a natural hazard.
> - *Risk:* Probability multiplied by consequence; the degree of probability that a loss or injury may occur as a result of a natural hazard.

We identified locations within Baker County that are comparatively more vulnerable or at greater risk to the 2500-year probabilistic M6.7 earthquake hazard:

- Very high liquefaction soils are found throughout most of the populated portions of Baker County, which include the communities of Baker City, Haines, Halfway, and Huntington.
- Building inventory for the many communities in the county are comprised of older buildings, which implies lower seismic building design codes. Buildings built with older building code standards are more vulnerable to damage from earthquakes.
- Many (42%) of the critical facilities in the incorporated communities of Baker County could be non-functioning due to an earthquake similar to the scenario used in this report.

3.3 Flooding

In its most basic form, a flood is an accumulation of water over normally dry areas. Floods become hazardous to people and property when they inundate an area where development has occurred, causing losses. Floods are a frequently occurring natural hazard in Baker County and have the potential to create public health hazards, public safety concerns, close and damage major highways, destroy railways, damage structures, and cause major economic disruption. A typical method for determining flood risk is to identify the probability of flooding and the impacts of flooding. The probabilities calculated for flood hazard used in this report are 10%, 2%, 1%, and 0.2%, henceforth referred to by their equivalent return periods as 10-year, 50-year, 100-year, and 500-year, respectively.

The primary river for Baker County is the Powder River and the Snake River defines it eastern border. The additional major streams within Baker County are Burnt River, North Powder River, and Pine Creek. All the listed streams are subject to flooding and causing damage to buildings within the floodplain.

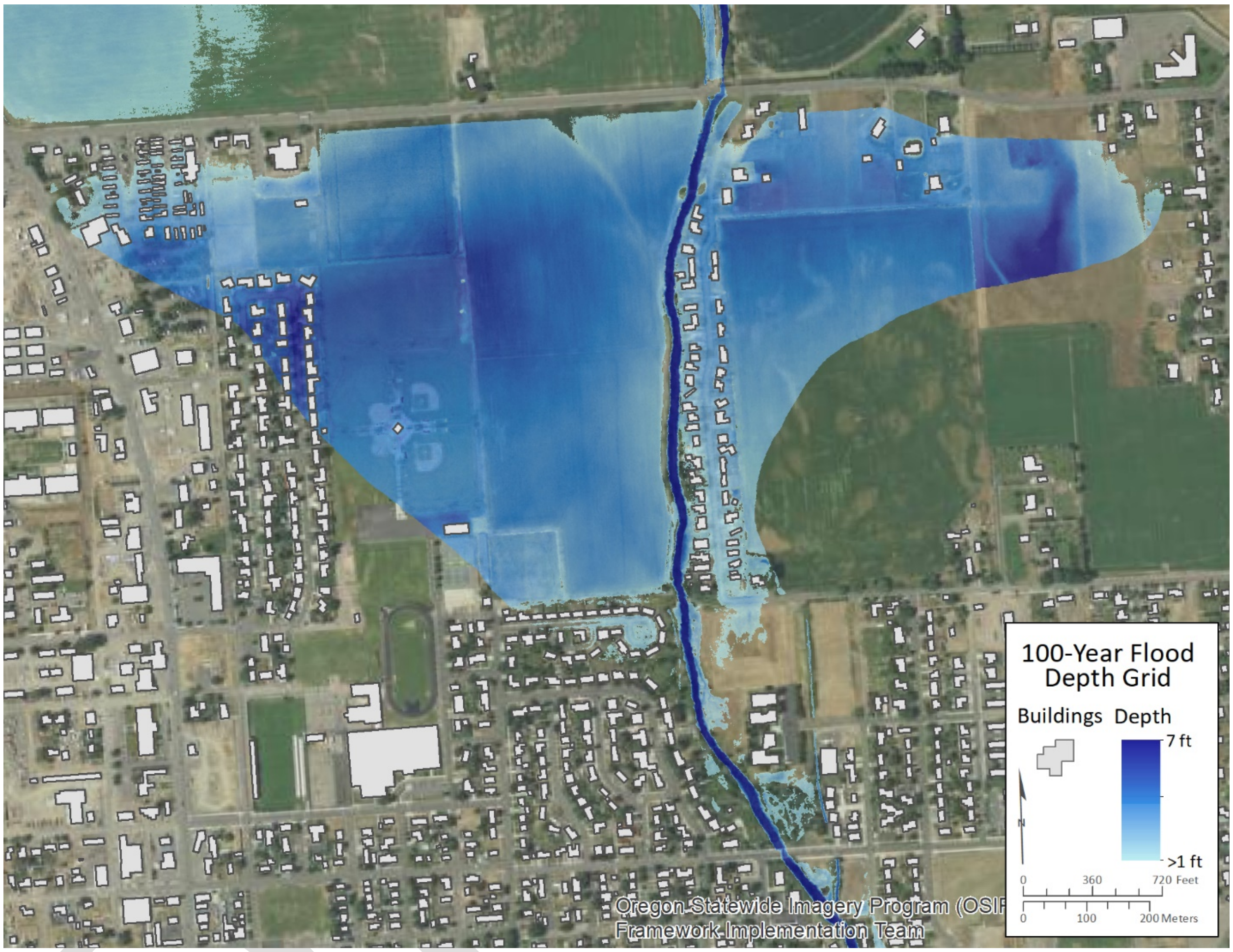
The ability to assess the probability of a flood, and the level of accuracy of that assessment, is influenced by modeling methodology advancements, better knowledge, and longer periods of record for the stream or water body in question. The impacts of flooding are determined by adverse effects to human activities within the area and the natural and built environment. A common mitigating activity is by elevating structures above the expected level of flooding or by removing the structure through FEMA's property acquisition ("buyout") program.

3.3.1 Data sources

The Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for the study area were made effective in 1988 (FEMA, 1988); these were the primary data sources for the flood risk assessment. Further information regarding NFIP related statistics can be found at FEMA's website: https://www.fema.gov/policy-claim-statistics-flood-insurance. This was the only flood data source that DOGAMI used in the analysis, but flooding does occur in areas outside of the detail mapped areas. Flood issues like flash flooding, ice jams, post-wildfire floods, and dam safety were not looked at in this report.

Depth grids, developed by DOGAMI in 2019 and based on the effective map data, were used in this risk assessment to determine the level to which buildings are impacted by flooding. Depth grids are raster GIS datasets where each digital pixel value represents the depth of flooding at that location within the flood zone **(Figure 3-3)**. Though considered draft at the time of this analysis, the depth grid data are the best available flood hazard data. Depth grids for four flooding scenarios (10-, 50-, 100-, and 500-year) were used for loss estimations and, for comparative purposes, exposure analysis.

Figure 3-3. Flood depth grid example, portion of the City of Baker City.



Building loss estimates are determined by Hazus-MH by overlaying building data over a depth grid. Hazus-MH uses individual building information, specifically the first-floor height above ground and the presence of a basement, to calculate the loss ratio from a particular depth of flood.

For the Baker County, occupancy type and basement presence attributes were derived from the assessor database for most buildings. Where individual building information was not available from assessor data, we used oblique imagery and street level imagery to estimate these important building attributes. Only buildings in a flood zone or within 500 feet (152 meters) of a flood zone were examined closely to attribute buildings with more accurate information for first-floor height and basement presence. Because our analysis accounted for building first-floor height, buildings that have been properly elevated above the flood level were not given a loss estimate—but we counted residents in those structures as displaced. We did not look at the duration that residents would be displaced from their homes due to flooding. For information about structures exposed to flooding but not damaged, please see the **Exposure analysis** section below.

3.3.2 Countywide results

Since there are few areas where flood hazard has been mapped from detailed studies within Baker County, there are only a few areas where we can see vulnerability to flooding. For this risk assessment, we imported Baker County UDF data and depth grids into Hazus-MH and a ran a flood analysis for the four flood scenarios (10-, 50-, 100-, and 500-year). We used the 100-year flood as the primary scenario for reporting the flood results (also see Appendix F. **Plate 4)**. The 100-year flood has traditionally been used as a reference level for flooding and is the standard probability that FEMA uses for regulatory purposes (FEMA, 2013). See **Table B-3** for multi-scenario cumulative results.

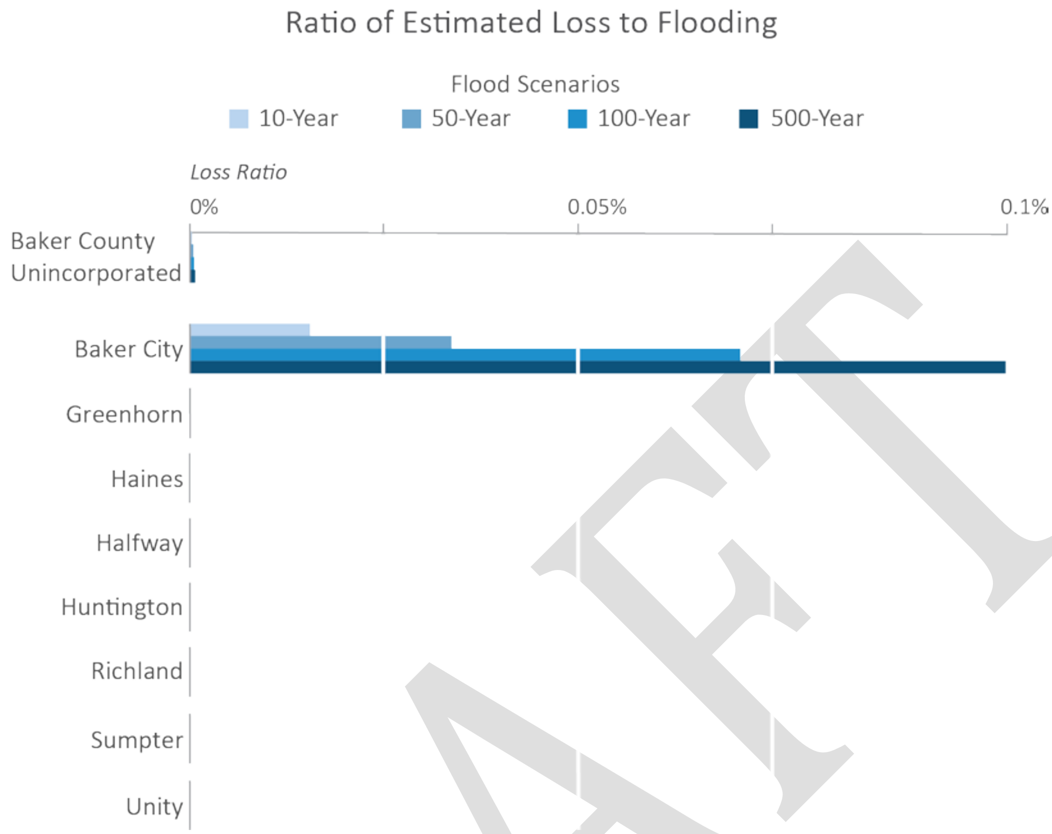
Baker Countywide 100-year flood loss:

- Number of buildings damaged: 125
- Loss Estimate: $986,000
- Loss Ratio: 0.03%
- Damaged critical facilities: 0
- Potentially Displaced Population: 359

3.3.3 Hazus-MH analysis

The Hazus-MH loss estimate of the 100-year flood scenario for Baker County is approximately $1 million. While the overall loss ratio for flood damage in Baker County is only 0.03%, 100-year flooding has a significant impact to Baker County where development exists near streams that are prone to flooding. (**Figure 3-4**). In situations with communities where most residents are not within flood designated zones, the loss ratio may not be as helpful as the actual replacement cost and number of residents displaced to assess the level of risk from flooding. The Hazus-MH analysis also provides useful flood data on individual communities so that planners can identify problems and consider which mitigating activities will provide the greatest resilience to flooding.

Figure 3-4. Flood loss estimates by community.



3.3.4 Exposure analysis

Separate from the Hazus-MH flood analysis, we did an exposure analysis by overlaying building locations on the 100-year flood extent. A large number (223 buildings) of Baker County's buildings were found to be within designated flood zones. By comparing the number of non-damaged buildings from Hazus-MH with exposed buildings in the flood zone, we estimated the number of buildings that could be elevated above the level of flooding. Of the 223 buildings that are exposed to flooding, we estimate that 98 are above the height of the 100-year flood. This evaluation can also shed some light on the number of residents that might have mobility or access issues due to surrounding water. See appendix **Table B-4** for community-based results of flood exposure.

3.3.5 Areas of vulnerability or risk

We identified locations within Baker County that are comparatively more vulnerable or at greater risk to flood hazard:

- Flood maps indicate backwater flooding from the Powder River in Baker City, south of Route 7 and railroad crossing.
- A wide but shallow flooding area forms in an area north of Baker City during large flooding events.
- The stream studies and mapping currently in use in Baker County are older and would be more accurate if an updated study occurred.

3.4 Landslide susceptibility

Landslides are downhill movements of rock, debris, or soil. There are many different types of landslides in Oregon. In Baker County, the most common are debris flow, shallow-, and deep-seated landslides. Landslides can occur in many sizes, at different depths, and with varying rates of movement. Generally, they are large, deep, and slow moving or small, shallow, and rapid. Some factors that influence landslide type are hillside slope, water content, and geology. Many triggers can cause a landslide: intense rainfall, earthquakes, or human-induced factors like excavation along a landslide toe or loading at the top. Landslides can cause severe damage to buildings and infrastructure. Fast-moving landslides may pose life safety risks and can occur throughout Oregon (Burns and others, 2016).

3.4.1 Data sources

The Statewide Landslide Information Layer for Oregon [SLIDO], release 3.2 [Burns and Watzig, 2014]) is an inventory of mapped landslides in the state of Oregon. SLIDO is a compilation of past studies; some studies were completed very recently using new technologies, like lidar-derived topography, and some studies were performed more than 50 years ago. Consequently, SLIDO data vary greatly in scale, scope, and focus and thus in accuracy and resolution across the state. Landslide inventory mapping for Baker County was done before lidar was available for high-accuracy mapping.

Burns and others (2016) used SLIDO inventory data along with maps of generalized geology and slope to create a landslide susceptibility overview map of Oregon that shows zones of relative susceptibility: Very High, High, Moderate, and Low. SLIDO data directly define the Very High landslide susceptibility zone, while SLIDO data coupled with statistical results from generalized geology and slope maps define the other relative susceptibility zones (Burns and others, 2016). Statewide landslide susceptibility map data have the inherent limitations of SLIDO and of the generalized geology and slope maps used to create the map. Therefore, the statewide landslide susceptibility map varies significantly in quality across the state, depending on the quality of the input datasets. Another limitation is that susceptibility mapping does not include some aspects of landslide hazard, such as runout, where the momentum of the landslide can carry debris beyond the zone deemed to be a high hazard area.

We used the data from the statewide landslide susceptibility map (Burns and others, 2016) in this report to identify the general level of susceptibility of given area to landslide hazards, primarily shallow and deep landslides. We overlaid building and critical facilities data on landslide susceptibility zones to assess the exposure for each community (see **Table B-5**). The total dollar value of exposed buildings was summed for Baker County and is reported below. We also estimated the number of people threatened by landslides. Land value losses due to landslides were not examined for this report, in addition to potentially hazardous unmapped areas that may pose real risk to communities.

3.4.2 Countywide results

Baker County's communities have very little exposure to landslide risk. High and very high landslide susceptibility is most prominent in the forested areas in the Blue Mountains and in the northeastern portion of the county. While these areas are highly prone to landslides, a large percentage of the populated areas are not within these zones as they are currently mapped. The percentage of building value exposed to very high and high landslide susceptibility is approximately 2% for the entire study area, but the threat is elevated for buildings in these hazard zones.

We combined high and very high susceptibility zones as the primary scenarios to provide a general sense of community risk for planning purposes (see Appendix F, **Plate 5**). It was useful to combine exposure for both susceptibility zones to accurately depict the level of landslide risk to communities.

These susceptibility zones represent areas most prone to landslides with the highest impact to the community.

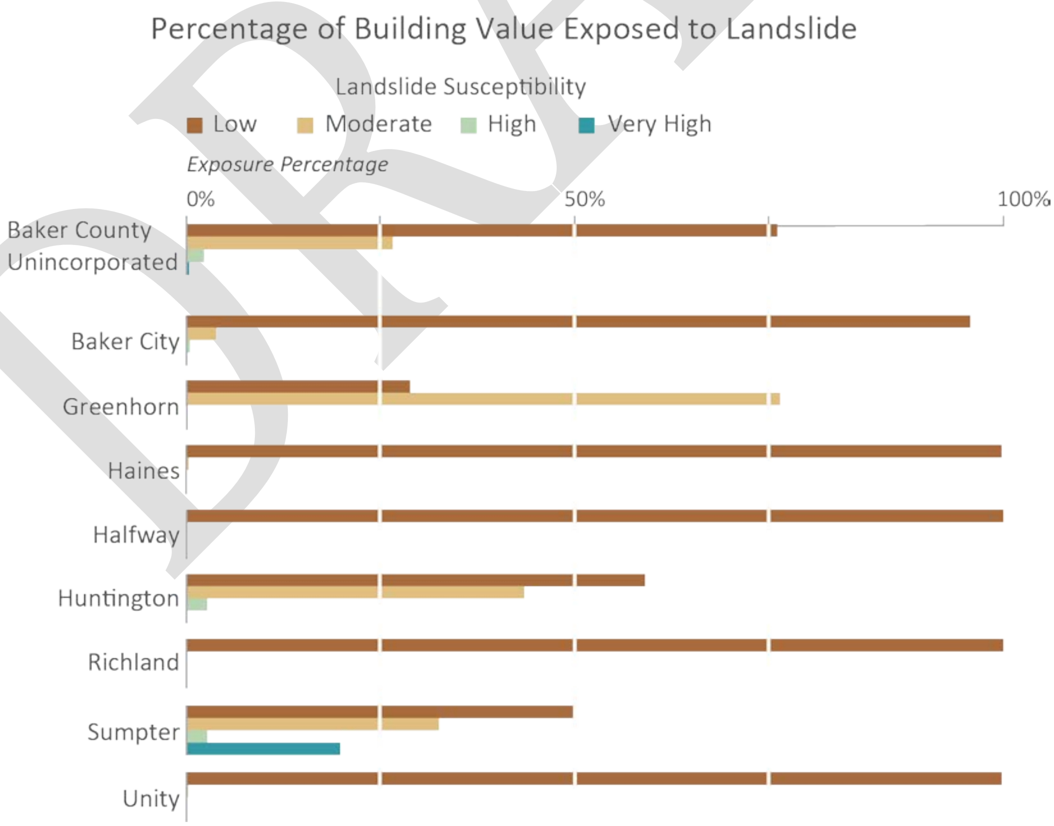
For this risk assessment we compared building locations to geographic extents of the landslide susceptibility zones (**Figure 3-5**). The exposure results shown below are for the high and very high susceptibility zones. See **Appendix B: Detailed Risk Assessment Tables** for multi-scenario analysis results.

Baker Countywide landslide exposure (High and Very High susceptibility):

- Number of buildings: 463
- Exposure Value: $53,399,000
- Ratio of Exposure Value: 1.7%
- Critical facilities exposed: 1
- Potentially Displaced Population: 254

The majority of developed land in Baker County corresponds to low and moderate susceptibility landslide zones. The City of Sumpter was the only community with significant exposure to the currently mapped landslide hazard at 20%, but this exposure could be indicative of inaccurate mapping Landslide hazard is ubiquitous in a large percentage of undeveloped land and may present challenges for planning and mitigation efforts. Awareness of nearby areas of landslide hazard is beneficial to reducing risk for every community and rural area of Baker County. Lidar based landslide mapping would provide a more accurate picture of the landslide hazard within Baker County.

Figure 3-5. Landslide susceptibility exposure by study area community.



3.4.3 Areas of vulnerability or risk

We identified locations within Baker County that are comparatively more vulnerable or at greater risk to landslide hazard:

- The landslide data suggests that a cluster of residential buildings in the northeastern portion of Sumpter are exposed to very high landslide hazard. However, there is some indication that hazard mapping for this specific area is incorrect.
- Some communities in Baker County may be at higher or lower risk than what the data show, lidar-based landslide mapping would provide a better understanding of the risk.

3.5 Wildfire

Wildfires are a natural part of the ecosystem in Oregon. However, wildfires can present a substantial hazard to life and property in growing communities, because often development occurs in the wildland-urban interface (WUI). The most common wildfire hazard factors include: hot, dry, and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation). Once a fire has started, its behavior is influenced by numerous conditions, including fuel, topography, weather, drought, and development (Pyrologix, LCC., 2018). Post-wildfire geologic hazards can also present risk. These usually include flood, debris flows, and landslides. Post-wildfire geologic hazards were not evaluated in this project.

There is potential for losses due to WUI fires in Baker County. Fire prone areas cover a large portion of the county and are present in developed areas in the county. The Baker County Community Wildfire Protection Plan (2015), recommends several steps that homeowners can take to reduce their risk to wildfire. Some risk reduction examples are maintaining defensible space around structures, reducing fuels, and using non-flammable materials in construction (BCCWPP, 2015).

3.5.1 Data sources

The Pacific Northwest Quantitative Wildfire Risk Assessment: Methods and Results (PNRA; Pyrologix LCC, 2018) is a comprehensive report that includes a database developed by the United States Forest Service (USFS) for the states of Oregon and Washington. The steward of this database in Oregon is the Oregon Department of Forestry (ODF). The database was created to assess the level of risk residents and structures have to wildfire. For this project, the burn probability dataset, a dataset included in the PNRA database, was used to measure the risk to communities in Baker County.

Using guidance from ODF, we categorized the Burn Probability dataset into low, moderate, and high-hazard zones for the wildfire exposure analysis. Probability ranges of the Burn Probability dataset from the PNRA were grouped into 3 categories of wildfire hazard. Burn probability is derived from simulations using many elements, such as, weather, ignition frequency, ignition density, and fire modeling landscape (Pyrologix LCC, 2018).

Burn probabilities were grouped into 3 hazard categories:

- Low wildfire hazard (0.0001 – 0.0002 or 1/10,000 – 1/5,000)
- Moderate wildfire hazard (0.0002 – 0.002 or 1/5,000 – 1/500)
- High wildfire hazard (0.002 – 0.04 or 1/500 – 1/25)

We overlaid the buildings layer and critical facilities on each of the wildfire hazard zones to determine exposure. In certain areas no wildfire data is present which indicates areas that have minimal risk to wildfire hazard (see **Table B-6**). The total dollar value of exposed buildings Baker County is reported below. We also estimated the number of people threatened by wildfire. Land value losses due to wildfire were not examined for this project.

3.5.2 Countywide results

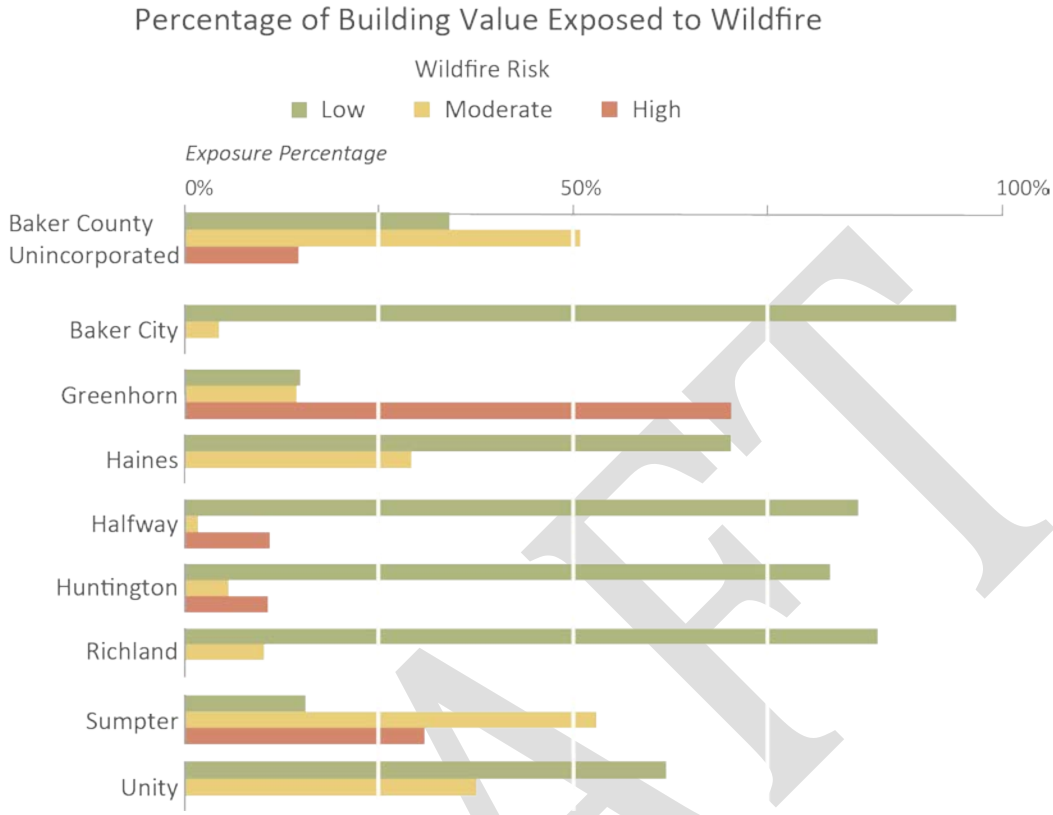
We chose the high hazard category as the primary scenario for this report because it represents the areas that have the highest potential for losses. However, a large amount of loss would occur if the moderate hazard areas were to burn, as some communities have ~30–50% of exposure to moderate wildfire hazard. Still, the focus of this section is on high hazard areas within Baker County to emphasize the areas where lives and property are most threatened.

Baker Countywide wildfire exposure (High risk):

- Number of buildings: 1,798
- Exposure Value: $240,321,000
- Ratio of Exposure Value: 7.6%
- Critical facilities exposed: 0
- Potentially Displaced Population: 830

For this risk assessment, the building locations were compared to the geographic extent of the wildfire hazard categories. Several communities in Baker County have a high percentage of buildings and residents exposed to high wildfire hazard. The primary areas of exposure to this hazard are in the forested unincorporated areas of the county that have not already experienced recent burns (see Appendix F, **Plate 6)**. The communities of Sumpter, Halfway, Huntington, and the unincorporated county have the highest percentage of exposure to high wildfire hazard within Baker County. **Figure 3-6** illustrates the distribution of exposure to wildfire with the different communities of Baker County. See **Appendix B: Detailed Risk Assessment Tables** for multi-scenario analysis results.

Figure 3-6. Wildfire hazard exposure by community.



3.5.3 Areas of vulnerability or risk

We identified locations within Baker County that are comparatively more vulnerable or at greater risk to wildfire hazard:

- Wildfire risk is high for many of homes in the forested area north of Halfway.
- The communities of Sumpter, Halfway, Huntington, and the unincorporated county are most at risk to high wildfire hazard compared to other Baker County communities.
- The buildings in and around Greenhorn are exposed to high wildfire. Evacuation may be difficult due to the remoteness of this community.

4.0 CONCLUSIONS

The purpose of this study is to provide a better understanding of potential impacts from multiple natural hazards at the community scale. We accomplish this by using the latest natural hazard mapping and loss estimation tools to quantify expected damage to buildings and potential displacement of permanent residents. The comprehensive and fine-grained approach to the analysis provides new context for the county's risk reduction efforts. Based on the results of this study we note several important findings:

1. **Hazus-MH earthquake analysis show a moderate amount of damage and losses for the study area**—The results indicate that Baker County would incur a moderate amount of damage (6.6%) from an earthquake similar to the one simulated in this report. Areas of liquefaction have a strong influence on the damage results. Building vulnerability was a strong factor due to the general age of the building inventory being built before seismic building code enforcement in Oregon. In addition, several high value buildings in downtown Baker City are constructed with

materials that are highly vulnerable to earthquake shaking. The high vulnerability of the building inventory (primarily because of the age of construction), building construction materials, and the areas of high liquefaction all contribute to the estimated levels of losses expected in the study area.

2. **Retrofitting buildings to modern seismic building codes can reduce damages and loses from earthquake**—Seismic building codes have a major influence on earthquake shaking damage estimated by Hazus-MH, a software tool developed by the Federal Emergency Management Agency (FEMA) for calculating loss from natural hazards. We examined potential loss reduction from seismic retrofits (modifications that improve building's seismic resilience) in simulations by using Hazus-MH building code "design level" attributes of pre, low, moderate, and high codes (FEMA, 2012b) in earthquake scenarios where permanent ground deformation (PGD) has been removed. The simulations were accomplished by upgrading every pre (non-existent) and low seismic code building to moderate seismic code levels in one scenario, and then further by upgrading all buildings to high (current) code in another scenario. We found that retrofitting to at least moderate code was the most cost-effective mitigation strategy because the additional benefit from retrofitting to high code was minimal. In our simulation of upgrading buildings to at least moderate code, the estimated loss for the entire study area went from 4.8% to 1.2%. We found further reduction in estimated loss in our simulation to 0.8% only by upgrading all buildings to high code. Some communities would see greater loss reduction than the study area as a whole due to older building stock constructed at pre or low code seismic building code standards. An example is the Baker City, which would see a significant loss reduction (from 4.2% to 0.9%) by retrofitting all buildings to at least moderate code. While seismic retrofits are an effective strategy for reducing earthquake shaking damage, it should be noted that earthquake-induced landslide and liquefaction hazards will also be present in some areas, and these hazards require different geotechnical mitigation strategies.
3. **Flooding is a threat for some areas in the study area**—Most of the development in Baker County is located in the flatter agricultural lands where flooding can occur. Many buildings in the study area, primarily within the Powder River floodplain in and north of Baker City, are vulnerable to flooding. We estimate a moderate amount of damage from flooding in this area and many buildings exposed to flooding. Several streams in Baker County that may be prone to flooding have never been studied for flood hazard, so the level of risk from flooding may be higher. The effective stream studies that are currently in use may be out-of-date due to their age and new studies may be beneficial. During a 100-year flood event, the current stream models show that Baker City is expected to sustain losses near 0.1% of total building value.
4. **Elevating structures in the flood zone reduces vulnerability**—Flood exposure analysis was used in addition to Hazus-MH loss estimation to identify buildings that were not damaged but were within the area expected to experience a 100-year flood. By using both analyses in this way, the number of elevated structures within the flood zone could be quantified. This showed possible mitigation needs in flood loss prevention and the effectiveness of past activities. Baker City was identified as a community with a large number of buildings (98) in the floodplain elevated above the estimated flood height.
5. **New landslide mapping would increase the accuracy of future risk assessments**—Exposure analysis was used to assess the threat from landslide hazard. Landslide is a widespread hazard for much of the undeveloped portions of the county. The landslide data suggests that a cluster of residential buildings in the northeastern portion of Sumpter are exposed to very high landslide

hazard as they are currently mapped, but interpretations from the lidar indicate that this may be incorrect. The landslide hazard data used in this risk assessment was created before modern mapping technology and future risk assessments using lidar derived landslide hazard data would provide more accurate results. Earthquake analysis would also benefit from better landslide mapping since Hazus-MH analysis uses landslide probability as an input dataset.

6. **Wildfire is a natural hazard threat for many areas in Baker County**—Exposure analysis shows that buildings throughout the study area are at high risk to wildfire hazard. Several communities within the county have a minimum of 30% of exposure to at least moderate wildfire hazard and some communities are at much greater risk. The communities of Sumpter, Greenhorn, Halfway, and Huntington are particularly at risk to high wildfire hazard. Additionally, wildfire risk is high throughout the unincorporated county.
7. **Several of Baker County's critical facilities are at risk to earthquake hazard**—Critical facilities were identified and were specifically examined within this report. DOGAMI has estimated that 14 of Baker County's 33 critical facilities are at risk to be non-functioning due to an earthquake similar to the one simulated in this report. DOGAMI has also found that 1 critical facility is exposed to landslide hazard. No critical facilities were found to be exposed to flood or wildfire.
8. **Biggest displacement to population was wildfire**—Displacement of permanent residents from natural hazards was quantified within this report. We estimate that of the 16,134 total residents in Baker County 5.1% of the population or 830 residents could be potentially displaced due to wildfire. Flood hazard is a potential threat to 2% (359) of permanent residents, and landslide hazard makes 1.6% (254) vulnerable to displacement.
9. **Community needs can be prioritized**—Each community within Baker County was assessed for natural hazard exposure and loss. This allowed for comparison of risk between communities and impacts from each natural hazard. In using Hazus-MH and exposure analysis, these results can assist in developing plans that address the concerns for those individual communities.

5.0 LIMITATIONS

There are several limitations to keep in mind when interpreting the results of this risk assessment.

- **Spatial and temporal variability of natural hazard occurrence** – Flood, landslide, and wildfire are extremely unlikely to occur across the fully mapped extent of the hazard zones. For example, areas mapped in the 1% annual chance flood zone will be prone to flooding on occasion in certain portions of Baker County during specific events, but not all at once throughout the entire study area or even the entire community. While we report the overall impacts of a given hazard scenario, the losses from a single hazard event probably will not be as severe and widespread. An exception to this is earthquake ground-shaking, which is expected to impact the entire study area, and loss estimates for this hazard are based on a single event.
- **Loss estimation for individual buildings** – Hazus-MH is a model, not reality, which is an important factor when considering the loss ratio of an individual building. Hazus-MH does not provide a site-specific analysis. On-the-ground mitigation, such as elevation of buildings to avoid flood loss, has been only minimally captured. Also, due to a lack of building material information, assumptions were made about the distribution of wood, steel, and un-reinforced masonry buildings. Loss estimation is most insightful when individual building results are aggregated to the community level, smoothing out the noise.

- **Loss estimation versus exposure** – We recommend careful interpretation of exposure results. This is due to the spatial and temporal variability of natural hazards (described above) and the inability to perform loss estimations due to the lack of Hazus-MH damage functions. Exposure is reported in terms of total building value, which could imply a total loss of the buildings in a particular hazard zone, but this is not the case. Exposure is simply a calculation of the number of buildings and their value and does not make estimates about the level to which an individual building could be damaged.
- **Population variability** – Some of the communities in Baker County are considered vacation destinations, particularly during the summer. Our estimates of potentially displaced people rely on permanent populations published in the 2010 U.S. Census (United States Census Bureau, 2010b). As a result, we are slightly underestimating the number of people that may be in harm's way on a summer weekend.
- **Data accuracy and completeness** – Some datasets in our risk assessments had incomplete coverage or no high-resolution data within Baker County. We used lower resolution data to fill gaps where there was incomplete coverage or where high resolution was not available. Assumptions to amend areas of incomplete data coverage were made based on reasonable methods described within this report. However, we are aware that some uncertainty has been introduced from these data amendments at an individual building scale. At community-wide scales the effects of the uncertainties are slight. Data layers in which assumptions were made to fill gaps are: building footprints, population, some attributes derived from the assessor database, and landslide susceptibility. Many of the datasets included known or suspected artifacts, omissions and errors, identifying or repairing these problems was beyond the scope of the project.

6.0 RECOMMENDATIONS

We recommend the following items for future work to reduce risk to natural hazards. These recommendations, while not comprehensive, touch on all phases of risk management. The recommendations focus on awareness, planning, regulation, emergency response, mitigation funding opportunities, and hazard-specific risk reduction activities.

6.1 Awareness and Preparation

Awareness is crucial to lowering risk and lessening the impacts of natural hazards. When community members understand their risk and know the role that they play in preparedness, the community in general is a much safer place to live. Awareness and preparation not only reduce the initial impact from natural hazards, they also reduce the amount of recovery time for a community to bounce back from a disaster—this ability is commonly referred to as "resilience."

This report is intended to provide local officials a comprehensive and authoritative profile of natural hazard risk to underpin their public outreach efforts. We encourage local officials to design outreach campaigns that target elected officials, businesses, utility managers, civic groups, developers, students, and homeowners.

Messaging can be tailored to stakeholder groups. For example, outreach to homeowners could focus on actions they can take to reduce risk to their property. The DOGAMI Homeowners Guide to Landslides (http://www.oregongeology.org/sub/Landslide/ger_homeowners_guide_landslides.pdf) provides a variety of risk reduction options for homeowners who live in high landslide susceptibility areas. This guide is one of many existing resources; we recommend local officials coordinate with DOGAMI and Oregon Department of Land Conservation and Development (DLCD) to discover other resources.

6.2 Planning

Incorporating the information presented here into local plans can help guide community development away from risky areas. The primary framework for accomplishing this is through the comprehensive planning process. The comprehensive plan sets the long-term trajectory of capital improvements, zoning, and urban growth boundary expansion, all of which are planning tools that can be used to reduce natural hazard risk.

Another framework is the natural hazard mitigation plan (NHMP) process. NHMP plans focus on characterizing natural hazard risk and identifying actions to reduce risk. The recommendations in this report can be considered when reviewing and updating mitigation actions. Additionally, the information presented here serves as the basis for the vulnerability assessment section of the NHMP plan. In fact, the study results have been organized for easy incorporation into the plan.

While there are many similarities between this report and an NHMP, the hazards or critical facilities in the two reports can vary. Differences between the reports may be due to data availability or limited methodologies for specific hazards. The critical facilities considered in this report may not be identical to those listed in a typical NHMP due to the lack of damage functions in Hazus-MH for non-building structures and to different considerations about emergency response during and after a disaster.

6.3 Regulation

One effective way to encourage risk reduction is the adoption and enforcement of regulations and ordinances. Having these in place will ensure new development complies with hazard-reducing construction methods and development standards.

Local officials working with DOGAMI can determine which natural hazard maps provide sufficient detail to support their regulatory goals. DLCD can also be engaged for technical assistance in developing ordinance language.

Existing regulatory programs can incentivize safer development or discourage building in known hazardous areas. Some jurisdictions in Baker County are already engaged in these regulatory programs, but wider implementation is recommended. The NFIP is one federal program that provides a framework for flood risk reduction through regulation. Communities can improve their standing in the NFIP by exceeding minimum requirements and earning points in the Community Rating System (CRS). Another regulatory program is the State of Oregon Structural Specialty Code (OSSC) and Fire and Life Safety Code, which define building codes for seismic safety that reduce the risk to earthquake. Local officials working with DLCD, DOGAMI, and the Oregon Building Codes Division can ensure they comply with existing programs or explore enhanced regulations.

6.4 Emergency response

Critical facilities will play a major role during and immediately after a natural disaster. This study can help emergency managers identify vulnerable critical facilities and develop contingencies in their response plans. Additionally, detailed mapping of potentially displaced residents can be used to re-evaluate evacuation routes and identify vulnerable populations to target for early warning.

The building database that accompanies this report presents many opportunities for future pre-disaster mitigation, emergency response, and community resilience improvements. Vulnerable areas can be identified and targeted for awareness campaigns. These campaigns can be aimed at pre-disaster mitigation through, for example, improvements of the structural connection of the frame to the foundation. Emergency response entities can benefit from the use of the building dataset through identification of potential hazards and populated buildings before and during a disaster. Both reduction of the magnitude of the disaster and increase in the response time contribute to a community's overall resilience.

6.5 Mitigation funding opportunities

Several funding options are available to communities that are susceptible to natural hazards and have specific mitigation projects they wish to accomplish. State and federal funds are available for projects that demonstrate cost effective natural hazard risk reduction. The Oregon Office of Emergency Management (OEM) State Hazard Mitigation Officer (SHMO) can provide communities assistance in determining eligibility, finding mitigation grants, and navigating the mitigation grant application process.

FEMA has two programs that assist with mitigation funding for natural hazards: the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) Grant Program. FEMA also has a grant program specifically for flooding called Flood Mitigation Assistance (FMA). The SHMO can help with finding further opportunities for earthquake assistance and funding.

- OEM Grants webpage (includes links to HMGP, PDM, and FMA information): http://www.oregon.gov/oem/emresources/Grants/Pages/HMA.aspx

Before applying for a mitigation grant the county must have an approved NHMP that includes the specific mitigation project need. The project also must meet eligibility requirements. Some grants require in-kind local funding for as high as 25% of the project cost. We advise working closely with the SHMO on exploring the various options available.

Other funding sources include:

- State of Oregon Seismic Rehabilitation Grant Program, including hospitals: www.orinfrastructure.org/Infrastructure-Programs/Seismic-Rehab/
- Oregon Health Authority Public Health: https://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/SRF/Pages/sipp.aspx
- Oregon Business Development Department (OBDD) Infrastructure Authority (IFA) Special Public Works Fund: http://www.orinfrastructure.org/Infrastructure-Programs/SPWF/
-

6.6 Hazard-specific risk reduction actions

6.6.1 Earthquake

- Evaluate critical facilities for seismic preparedness by identifying structural deficiencies and vulnerabilities to dependent systems (e.g. water, fuel, power).
- Address vulnerabilities of critical facilities.
- Conduct awareness campaigns to encourage home and business owners to perform seismic retrofits. Our findings indicate that seismic upgrades can significantly reduce losses to buildings.

- Ensure seismic building codes are strictly adhered to, especially for manufactured homes.
- Consider implementing regulations in highly liquefiable soil zone areas or using planning to reduce risk.

6.6.2 Flood

- For communities that participate in the NFIP, enforce minimum requirements and explore enhanced measures to achieve standing in CRS.
- Find opportunities to increase flood water storage areas. One possibility is to incentivize farm landowners to convert portions of their land to wetlands.
- Relocate or elevate vulnerable structures above the estimated base flood elevation. In some cases, communities can use FEMA's property acquisition or "buyout" program to remove structures that have repeatedly flooded in the past. https://www.fema.gov/media-library-data/20130726-1507-20490-4551/fema_317.pdf
- Create more permeable surfaces within urban areas, especially large parking lots.

6.6.3 Landslide

- Create modern landslide inventory and susceptibility maps and use in planning and regulations for future development.
- Control storm water in landslide-prone areas.
- Monitor ground movement in highly susceptible areas.
- Implement grading codes, especially in areas of high landslide susceptibility.

6.6.4 Wildfire

- Maintain building buffer areas from forestland, especially in the fire-prone wildland-urban interface.
- Reduce fuel loads in buffer areas that can act as firebreaks.
- Evaluate post-wildfire geologic hazards include flood, debris flows, and landslides.

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9.0 APPENDICES

APPENDIX A. COMMUNITY RISK PROFILES

A hazard analysis summary for each community is provided in this section to encourage ideas for natural hazard risk reduction. Increasing disaster preparedness, public hazards communication and education, ensuring functionality of emergency services, and access to evacuation routes are actions that every community can take to reduce their risk. This appendix contains community specific data to provide an overview of the community and the level of risk from each natural hazard analyzed. In addition, for each community a list of critical facilities and assumed impact from individual hazards is provided.

A.1 Unincorporated Baker County

Table A-1. Unincorporated Baker County hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Unincorporated Baker County	4,661	8,107	6	1,408,882,000

Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0.0%	4	0	48,000	0.0%
Earthquake	2500-year Probabilistic	106	2.3%	866	4	97,490,000	6.9%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	135	2.9%	302	1	34,558,000	2.5%
Wildfire	High Hazard	690	15%	1,502	0	206,898,000	15%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-2. Unincorporated Baker County critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**
Baker City Municipal Airport		X		
Baker RFPD		X		
Greater Bowen Valley RFPD		X	X	
Keating RFPD		X		
Mosquito Flat North RFPD				
Oregon State Police				

A.2 City of Baker City

Table A-3. City of Baker City hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Baker City	9,898	6,041	15	1,437,408,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	359	3.6%	121	0	938,000	0.1%
Earthquake	2500-year Probabilistic	109	1.1%	486	5	84,942,000	5.9%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	43	0.4%	36	0	5,554,000	0.4%
Wildfire	High Hazard	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-4. City of Baker City critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed
Baker City Armory				
Baker City Fire Department		X		
Baker City Hall				
Baker City Police Department				
Baker City Warehouse and Shop		X		
Baker County Road Department		X		
Baker County Sheriff's Office				
Baker High School*				
Baker Middle School				
Brooklyn Elementary School*				
North Baker Elementary School				
South Baker Elementary School		X		
St. Alphonsus Baker Clinic				
St. Elizabeth Hospital		X		
St. Luke's Clinic				

*Seismic retrofits completed for building(s).

A.3 City of Greenhorn

Table A-5. City of Greenhorn hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]		Total Building Value ($)
Greenhorn		0	24		0		1,876,000
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	2500-year Probabilistic	0	0%	0	0	22,000	1.1%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High Hazard	0	75%	19	0	1,327,000	71%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

A.4 City of Haines

Table A-6. City of Haines hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]		Total Building Value ($)
Haines		416	386		1		55,066,000
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	2500-year Probabilistic	5	1.2%	44	0	3,753,000	6.8%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High Hazard	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-7. City of Haines critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Wildfire High Hazard**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**
Haines Elementary School				

A.5 City of Halfway

Table A-8. City of Halfway hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Halfway	288	374	4	78,700,000

Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	2500-year Probabilistic	5	1.7%	52	2	7,717,000	9.8%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High Hazard	21	7.3%	58	0	8,681,000	11%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-9. City of Halfway critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Wildfire High Hazard**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**
Halfway Elementary School				
Pine Eagle Clinic				
Pine Eagle High School		X		
Pine Valley VFD		X		

A.6 City of Huntington

Table A-10. City of Huntington hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
Huntington	440	420	2	57,259,000	

Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	2500-year Probabilistic	5	1.1%	43	0	3,378,000	5.9%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	6	1.3%	9	0	1,441,000	2.5%
Wildfire	High Hazard	37	8.4%	53	0	6,174,000	11%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-11. City of Huntington critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Wildfire High Hazard**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**
Huntington City Hall				
Huntington Fire Station				

A.7 City of Richland

Table A-12. City of Richland hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Richland	156	176	1	34,987,000

Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	2500-year Probabilistic	19	12%	59	1	7,794,000	22%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High Hazard	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-13. City of Richland critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Wildfire High Hazard**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**
Eagle Valley Fire Department		X		

A.8 City of Sumpter

Table A-14. City of Sumpter hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]		Total Building Value ($)
Sumpter		204	473		1		55,531,000
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	2500-year Probabilistic	8	3.9%	59	0	3,872,000	7.0%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	71	35%	116	0	11,846,000	21%
Wildfire	High Hazard	82	40%	166	0	17,243,000	31%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-15. City of Sumpter critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Wildfire High Hazard**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**
Sumpter Fire Department				

A.9 City of Unity

Table A-16. City of Unity hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Unity		71	107		3	16,938,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	2500-year Probabilistic	0	0%	1	0	241,000	1.4%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High Hazard	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-17. City of Unity critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**
Burnt River School				
Unity Community Hall				
Unity Fire Department				

APPENDIX B. DETAILED RISK ASSESSMENT TABLES

Table B-1. Study area building inventory.

(all dollar amounts in thousands)

	Residential			Commercial and Industrial			Agricultural			Public and Non-Profit			All Buildings			
Community	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Number of Buildings per County Total	Building Value ($)	Value of Buildings per County Total
Unincorp. Baker County	3,026	492,963	35%	115	62,001	4.4%	4,871	816,590	58%	95	37,329	2.6%	8,107	50%	1,408,882	45%
Baker City	4,252	747,100	52%	494	404,622	28%	1,197	131,241	9.1%	98	154,445	11%	6,041	38%	1,437,408	46%
Greenhorn	12	1,260	67%	0	0	0.0%	12	616	33%	0	0	0%	24	0.1%	1,876	0.1%
Haines	237	25,925	47%	10	5,483	10%	130	18,225	33%	9	5,434	9.9%	386	2.4%	55,066	1.7%
Halfway	213	25,907	33%	23	12,283	16%	116	14,912	19%	22	25,598	33%	374	2%	78,700	3%
Huntington	281	33,023	58%	7	3,451	6.0%	122	12,466	22%	10	8,319	15%	420	2.6%	57,259	1.8%
Richland	98	15,528	44%	11	5,541	16%	60	8,978	26%	7	4,941	14%	176	1.1%	34,987	1.1%
Sumpter	264	29,213	53%	12	4,686	8%	190	19,107	34%	7	2,525	5%	473	2.9%	55,531	1.8%
Unity	64	7,233	43%	5	1,938	11%	30	3,830	23%	8	3,937	23%	107	0.7%	16,938	0.5%
Total Baker County	8,447	1,378,152	44%	677	500,004	16%	6,728	1,025,964	33%	256	242,527	7.7%	16,108	100%	3,146,647	100%

Table B-2. Earthquake loss estimates.

	Total Number of Buildings	Total Estimated Building Value ($)	Buildings Damaged from Earthquake (all dollar amounts in thousands) Yellow-Tagged Buildings	Red-Tagged Buildings	Sum of Economic Loss	Loss Ratio
Unincorp. Baker County	8,107	1,408,882	711	154	97,490	6.9%
Baker City	6,041	1,437,408	429	57	84,942	5.9%
Greenhorn	24	1,876	0	0	22	1.1%
Haines	386	55,066	40	4	3,753	6.8%
Halfway	374	78,700	46	6	7,717	9.8%
Huntington	420	57,259	38	4	3,378	5.9%
Richland	176	34,987	43	16	7,794	22%
Sumpter	473	55,531	47	13	3,872	6.9%
Unity	107	16,938	1	0	241	1.4%
Total Baker County	16,108	3,146,647	1,356	154	209,210	6.6%

Table B-3. Flood loss estimates.

			(all dollar amounts in thousands)											
			10% (10-yr)			**2% (50-yr)**			**1% (100-yr)**			**0.2% (500-yr)**		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**
Unincorp. Baker County	8,107	1,408,882	4	25	0.0%	4	46	0.0%	4	48	0.0%	6	63	0.0%
Baker City	6,041	1,437,408	35	201	0.01%	78	390	0.03%	121	938	0.07%	176	1,803	0.13%
Greenhorn	24	1,876	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Haines	386	55,066	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Halfway	374	78,700	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Huntington	420	57,259	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Richland	176	34,987	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Sumpter	473	55,531	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Unity	107	16,938	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Total Baker County	16,108	3,146,647	39	225	0.0%	82	436	0.0%	125	986	0.03%	182	1,866	0.1%

Table B-4. Flood exposure.

Community	Total Number of Buildings	Total Population	1% (100-yr) Potentially Displaced Residents from Flood Exposure	% Potentially Displaced Residents from flood Exposure	Number of Flood Exposed Buildings	% of Flood Exposed Buildings	Number of Flood Exposed Buildings Without Damage
Unincorp. Baker County	8,107	4,661	0	0.0%	4	0.0%	0
Baker City	6,041	9,898	359	3.6%	219	3.6%	98
Greenhorn	24	0	0	0%	0	0%	0
Haines	386	416	0	0%	0	0%	0
Halfway	374	288	0	0%	0	0%	0
Huntington	420	440	0	0%	0	0%	0
Richland	176	156	0	0%	0	0%	0
Sumpter	473	204	0	0%	0	0%	0
Unity	107	71	0	0%	0	0%	0
Total Baker County	16,108	16,134	359	2%	223	1%	98

Table B-5. Landslide exposure.

(all dollar amounts in thousands)

Community	Total Number of Buildings	Total Estimated Building Value ($)	Very High Susceptibility: Number of Buildings	Very High Susceptibility: Building Value ($)	Very High Susceptibility: Percent of Building Value Exposed	High Susceptibility: Number of Buildings	High Susceptibility: Building Value ($)	High Susceptibility: Percent of Building Value Exposed	Moderate Susceptibility: Number of Buildings	Moderate Susceptibility: Building Value ($)	Moderate Susceptibility: Percent of Building Value Exposed
Unincorp. Baker County	8,107	1,408,882	39	4,400	0.3%	263	30,158	2.1%	2,224	355,554	25%
Baker City	6,041	1,437,408	0	0	0%	36	5,554	0.4%	180	52,697	4%
Greenhorn	24	1,876	0	0	0%	0	0	0%	15	1,363	73%
Haines	386	55,066	0	0	0%	0	0	0%	1	135	0.2%
Halfway	374	78,700	0	0	0%	0	0	0%	0	0	0%
Huntington	420	57,259	0	0	0%	9	1,441	2.5%	166	23,674	41%
Richland	176	34,987	0	0	0%	0	0	0%	0	0	0%
Sumpter	473	55,531	99	10,441	19%	17	1,405	2.5%	170	17,159	31%
Unity	107	16,938	0	0	0%	0	0	0%	1	35	0.2%
Total Baker County	16,108	3,146,647	138	14,841	0.5%	325	38,559	1.2%	2,757	450,616	14%

Table B-6. Wildfire exposure.

			(all dollar amounts in thousands)					
			High Hazard			Moderate Hazard		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**
Unincorp. Baker County	8,107	1,408,882	1,502	206,898	15%	4,329	720,354	51%
Baker City	6,041	1,437,408	0	0	0%	301	60,540	4.2%
Greenhorn	24	1,876	19	1,327	71%	2	270	14%
Haines	386	55,066	0	0	0%	118	16,145	29%
Halfway	374	78,700	58	8,681	11%	13	1,382	1.8%
Huntington	420	57,259	53	6,174	11%	31	3,246	5.7%
Richland	176	34,987	0	0	0%	28	3,606	10%
Sumpter	473	55,531	166	17,243	31%	256	29,596	53%
Unity	107	16,938	0	0	0%	46	6,387	38%
Total Baker County	16,108	3,146,647	1,798	240,321	7.6%	5,124	841,526	27%

APPENDIX C. HAZUS-MH METHODOLOGY

C.1 Software

We performed all loss estimations using Hazus®-MH 3.0 and ArcGIS® Desktop® 10.2.2.

C.2 User-Defined Facilities (UDF) Database

We compiled a UDF database for all buildings in the study area for use in both flood and earthquake modules of Hazus-MH. We used the Baker County assessor database (acquired in 2019) to determine which tax lots had improvements (i.e., buildings) and how many building points should be included in the UDF database.

C.2.1 Locating buildings points

DOGAMI used a dataset of building footprints produced from the work of Microsoft to digitize every building in the United States of America. The buildings used in this report were extracted and revised from this open source dataset (Bing Maps, 2018). Extra effort was spent to make edits and corrections, especially along the 1% and 0.2% annual chance inundation fringe. For buildings partially within the inundation zone, we moved the building point to the centroid of the portion of the building within the inundation zone. We used an iterative approach to further refine locations of building points for the flood module by generating results, reviewing the highest value buildings, and moving the building point over a representative elevation on the lidar digital elevation model to ensure an accurate first-floor height.

C.2.2 Attributing building points

Populating the required attributes for Hazus-MH was achieved through a variety of approaches. We used the Baker County tax lot dataset or Google Street View™ whenever possible, but in many cases this data or application did not provide the necessary information. The following is list of attributes and their sources:

- **Longitude and Latitude** – Location information that provides Hazus-MH the x and y-position of the UDF point. This allows for an overlay to occur between the UDF point and the flood or earthquake input data layers. The hazard model uses this spatial overlay to determine the correct hazard risk level that will be applied to the UDF point. The format of the attribute must be in decimal degrees. A simple geometric calculation using GIS software is done on the point to derive this value.
- **Occupancy class** – An alphanumeric attribute that indicates the use of the UDF (e.g. 'RES1' is a single family dwelling). The alphanumeric code is composed of seven broad occupancy types (RES = residential, COM = commercial, IND = industrial, AGR = agricultural, GOV = public, REL = non-profit/religious, EDU = education) and various suffixes that indicate more specific types. This code determines the damage function to be used for flood analysis. It is also used to attribute the Building Type field, discussed below, for the earthquake analysis. The code was interpreted from the Baker County tax lot dataset. When data was not available, the default value of RES1 was applied throughout.

- **Cost** – The replacement cost of an individual UDF. Loss ratio is derived from this value. Replacement cost is based on a method called RSMeans valuation (The Gordian Group, 2017) and is calculated by multiplying the building square footage by a standard cost per square foot. These standard rates per square foot are in tables within the default Hazus database.
- **Year built** – The year of construction that is used to attribute the Building Design Level field for the earthquake analysis. The year of "1900" was applied as a default value.
- **Square feet** – The size of the UDF is used to pro-rate the total improvement value for tax lots with multiple UDFs. The value distribution method will ensure that UDFs with the highest square footage will be the most expensive on a given tax lot. This value is also used to pro-rate the Number of People field for Residential UDFs within a census block. The value was obtained from Bing Map's building footprints.
- **Number of stories** – The number of stories for an individual UDF, along with Occupancy Class, determines the applied damage function for flood analysis. Due to lack of information the default values of 1 story was used throughout. For UDFs without assessor information for number of stories that are within the flood zone, closer inspection using Google Street View™ or available oblique imagery was used for attribution.
- **Foundation type** – The UDF foundation type correlates with First Floor Height values in feet (see Table 3.11 in the Hazus-MH Technical Manual for the Flood Model [FEMA Hazus-MH, 2012a]). It also functions within the flood model by indicating if a basement exists or not. UDFs with a basement have a different damage function from UDFs that do not have one. For UDFs without adequate information for basements that are within the flood zone, closer inspection using Google Street View™ or available oblique imagery was used to ascertain if one exists or not.
- **First floor height** – The height in feet above grade for the lowest habitable floor. The height is factored during the depth of flooding analysis. The value is used directly by Hazus-MH, where Hazus-MH overlays a UDF location on a depth grid and using the first floor height determines the level of flooding occurring to a building. It is derived from the Foundation Type attribute or observation via oblique imagery or Google Street View™.
- **Building type** – This attribute determines the construction material and structural integrity of an individual UDF. It is used by Hazus-MH for estimating earthquake losses by determining which damage function will be applied. This information was derived from a statistical distribution based on Occupancy Class.
- **Building design level** – This attribute determines the seismic building code for an individual UDF. It is used by Hazus-MH for estimating earthquake losses by determining which damage function will be applied. This information is derived from the Year Built attribute state/regional Seismic Building Code benchmark years.
- **Number of people** – The estimated number of permanent residents living within an individual residential structure. It is used in the post-analysis phase to determine the amount of people affected by a given hazard. This attribute is derived from default Hazus database (United States Census Bureau, 2010a) of population per census block and distributed across residential UDFs.
- **Community** – The community that a UDF is within. These areas are used in the post-analysis for reporting results. The communities were based on incorporated boundaries and for unincorporated areas, based on building density.

C.2.3 Seismic building codes

The years that seismic building codes are enforced within a community, called "benchmark" years, have a great effect on the results produced from the Hazus-MH earthquake model. Oregon initially adopted seismic building codes in the mid-1970s (Judson, 2012). The established benchmark years of code enforcement are used in determining a "design level" for individual buildings. The design level attributes (pre code, low code, moderate code, and high code) are used in the Hazus-MH earthquake model to determine what damage functions are applied to a given building (FEMA, 2012b). The year built or the year of the most recent seismic retrofit are the main considerations for an individual design level attribute. Seismic retrofitting information for structures would be ideal for this analysis but was not available for Baker County. **Table C-1** outlines the benchmark years that apply to buildings within Baker County.

Table C-1. Baker County seismic design level benchmark years.

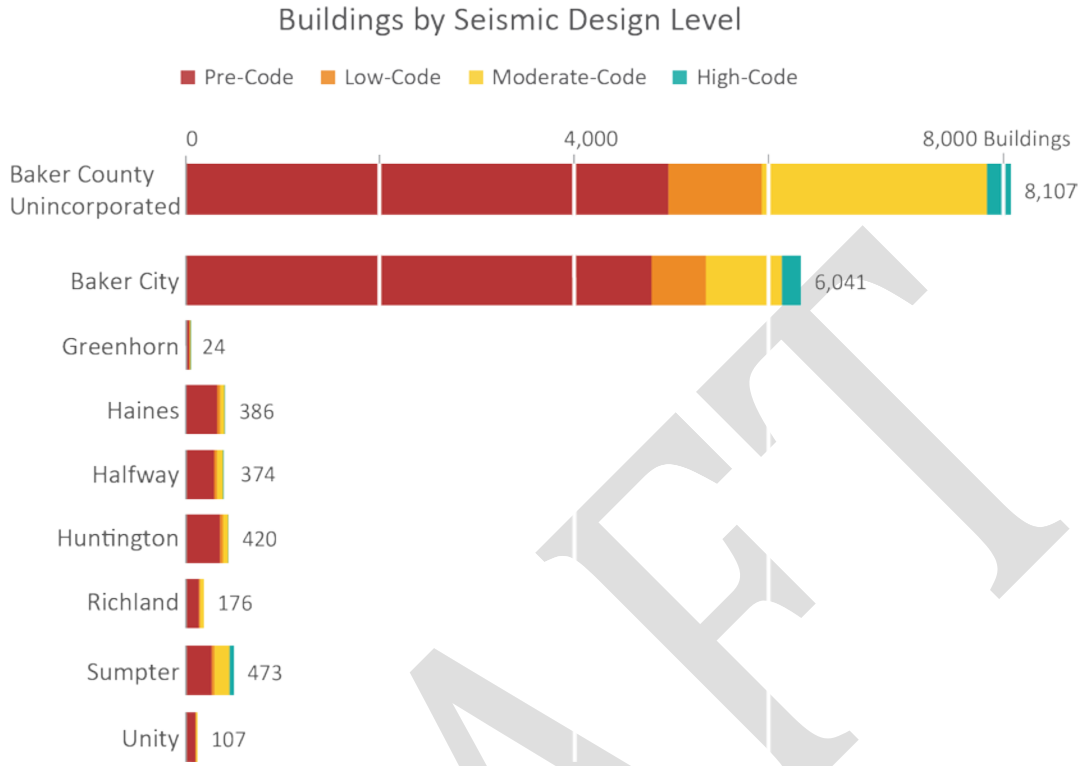
Building Type	Year Built	Design Level	Basis
Single Family Dwelling (includes Duplexes)	prior to 1976 1976–1991 1992–2003 2004–2016	Pre Code Low Code Moderate Code High Code	Interpretation of Judson (Judson, 2012)
Manufactured Housing	prior to 2003 2003–2010	Pre Code Low Code	Interpretation of OR BCD 2002 Manufactured Dwelling Special Codes (Oregon Building Codes Division, 2002)
	2011–2016	Moderate Code	Interpretation of OR BCD 2010 Manufactured Dwelling Special Codes Update (Oregon Building Codes Division, 2010)
All other buildings	prior to 1976 1976–1990 1991–2016	Pre Code Low Code Moderate Code	Business Oregon 2014-0311 Oregon Benefit-Cost Analysis Tool, p. 24 (Business Oregon, 2015)

Table C-2 and corresponding **Figure C-1** illustrate the current state of seismic building codes for the county.

Table C-2. Seismic design level in Baker County.

		Pre Code		Low Code		Moderate Code		High Code	
Community	**Total Number of Buildings**	**Number of Buildings**	**Percentage of Buildings**	**Number of Buildings**	**Percentage of Buildings**	**Number of Buildings**	**Percentage of Buildings**	**Number of Buildings**	**Percentage of Buildings**
Unincorp. Baker County	8,107	4,742	58%	917	11%	2,213	27%	235	2.9%
Baker City	6,041	4,576	76%	533	8.8%	748	12%	184	3.0%
Greenhorn	24	16	67%	1	4.2%	6	25%	1	4.2%
Haines	386	307	80%	31	8.0%	42	11%	6	1.6%
Halfway	374	277	74%	29	7.8%	61	16%	7	1.9%
Huntington	420	335	80%	28	6.7%	56	13%	1	0.2%
Richland	176	128	73%	13	7.4%	35	20%	0	0.0%
Sumpter	473	253	53%	28	5.9%	149	32%	43	9.1%
Unity	107	88	82%	6	5.6%	13	12%	0	0%
Total Baker County	16,108	10,722	67%	1,586	9.8%	3,323	20.6%	477	3.0%

Figure C-1. Seismic design level by Baker County community.



C.3 Flood Hazard Data

DOGAMI developed flood hazard data in 2019 from the Baker County FEMA Flood Insurance Study. The hazard data was based on some previous flood studies and new riverine hydrologic and hydraulic analyses. For riverine areas, the flood elevations for the 100-year event for each stream cross-section were used to develop depth of flooding raster dataset or a "depth grid."

A countywide, 2-meter, lidar-based depth grid was developed for each of the 10-, 50-, 100-, and 500-year annual chance flood events. The depth grids were imported into Hazus-MH for determining the depth of flooding for areas within the FEMA flood zones.

Once the UDF database was developed into a Hazus-compliant format, the Hazus-MH methodology was applied using a Python (programming language) script developed by DOGAMI. The analysis was then run for a given flood event, and the script cross-referenced a UDF location with the depth grid to find the depth of flooding. The script then applied a specific damage function, based on a UDF's Occupancy Class [OccCls], which was used to determine the loss ratio for a given amount of flood depth, relative to the UDF's first-floor height.

C.4 Earthquake Hazard Data

The primary data layer used for the probabilistic analysis conducted for this report was the USGS 2500-year (2% in 50 years) seismic hazard map for the conterminous United States for 2014. This data layer does not represent a single event, rather it is a probability for intensities of PGA, PGV, SA03, and SA10 for a given location (Petersen et al, 2014). Hazus has integrated this data layer into its standard probabilistic source, so there is no need to import from a USGS source.

Liquefaction susceptibility and NEHRP site classification data came directly from the ORP (Madin and Burns, 2013). The landslide susceptibility data from the ORP was replaced with newer and more accurate data from DOGAMI’s 2016 Landslide Susceptibility Dataset (Burns and others, 2016). We used a magnitude of 6.7 in Hazus along with the previously mentioned data layers to derive our loss estimates.

During the Hazus earthquake analysis, each UDF is analyzed given its site-specific parameters (ground motion and ground deformation) and are evaluated for its loss, expressed as a probability of a damage state. Specific damage functions based on Building Type and Design Level are used to calculate the damage states given the site-specific parameters for each UDF. The output provides probabilities of the five damage states (None, Slight, Moderate, Extensive, Complete) from which losses in dollar amount is derived.

C.5 Post-Analysis Quality Control

Ensuring the quality of the results from Hazus-MH flood and earthquake modules is an essential part of the process. A primary characteristic of the process is that it is iterative. A UDF database without errors is highly unlikely, so this part of the process is intended to limit and reduce the influence these errors have on the final outcome. Before applying the Hazus-MH methodology, closely examining the top 10 largest area UDFs and the top 10 most expensive UDFs is advisable. Special consideration can also be given to critical facilities due to their importance to communities.

Identifying, verifying, and correcting (if needed) the outliers in the results is the most efficient way to improve the UDF database. This can be done by sorting the results based on the loss estimates and closely scrutinizing the top 10 to 15 records. If corrections are made, then subsequent iterations are necessary. We continued checking the “loss leaders” until no more corrections were needed.

Finding anomalies and investigating possible sources of error are crucial in making corrections to the data. A wide range of corrections might be required to produce a better outcome. For example, floating homes may need to have a first-floor height adjustment or a UDF point position might need to be moved due to issues with the depth grid. Incorrect basement or occupancy type attribution could be the cause of a problem. Commonly, inconsistencies between assessor data and tax lot geometry can be the source of an error. These are just a few of the many types of problems addressed in the quality control process.

APPENDIX D. ACRONYMS AND DEFINITIONS

D.1 Acronyms

CRS	Community Rating System
CSZ	Cascadia subduction zone
DLCD	Oregon Department of Land Conservation and Development
DOGAMI	Department of Geology and Mineral Industries (State of Oregon)
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FRI	Fire risk index
GIS	Geographic Information System
NFIP	National Flood Insurance Program
NHMP	Natural hazard mitigation plan
NOAA	National Oceanic and Atmospheric Administration
ODF	Oregon Department of Forestry
OEM	Oregon Emergency Management
OFR	Open-File Report
OPDR	Oregon Partnership for Disaster Resilience
PGA	Peak ground acceleration
PGD	Permanent ground deformation
PGV	Peak ground velocity
Risk MAP	Risk Mapping, Assessment, and Planning
SHMO	State Hazard Mitigation Officer
SLIDO	State Landslide Information Layer for Oregon
UDF	User Defined Facilities
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WUI	Wildland-urban interface

D.2 Definitions

1-% annual chance flood – The flood elevation that has a 1-percent chance of being equaled or exceeded each year. Sometimes referred to as the 100-year flood.

0.2% annual chance flood – The flood elevation that has a 0.2-percent chance of being equaled or exceeded each year. Sometimes referred to as the 500-year flood.

Base flood elevation (BFE) – Elevation of the 1-percent-annual-chance flood. This elevation is the basis of the insurance and floodplain management requirements of the NFIP.

Critical facilities – Facilities that, if damaged, would present an immediate threat to life, public health, and safety. As categorized in HAZUS-MH, critical facilities include hospitals, emergency operations centers, police stations, fire stations and schools.

Exposure – Determination of whether a building is within or outside of a hazard zone. No loss estimation is modeled.

Flood Insurance Rate Map (FIRM) – An official map of a community, on which FEMA has delineated both the SFHAs and the risk premium zones applicable to the community.

Flood Insurance Study (FIS) – Contains an examination, evaluation, and determination of the flood hazards of a community and, if appropriate, the corresponding water-surface elevations.

Hazus-MH – A GIS-based risk assessment methodology and software application created by FEMA and the National Institute of Building Sciences for analyzing potential losses from floods, hurricane winds, and earthquakes.

Lidar – A remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light. Lidar is popularly used as a technology to make high-resolution maps.

Liquefaction – Describes a phenomenon whereby a saturated soil substantially loses strength and stiffness in response to an applied stress, usually an earthquake, causing it to behave like liquid.

Loss Ratio – The expression of loss as a fraction of the value of the local inventory (total value/loss).

Magnitude – A scale used by seismologists to measure the size of earthquakes in terms of energy released.

Risk – Probability multiplied by consequence; the degree of probability that a loss or injury may occur as a result of a natural hazard. Sometimes referred to as vulnerability.

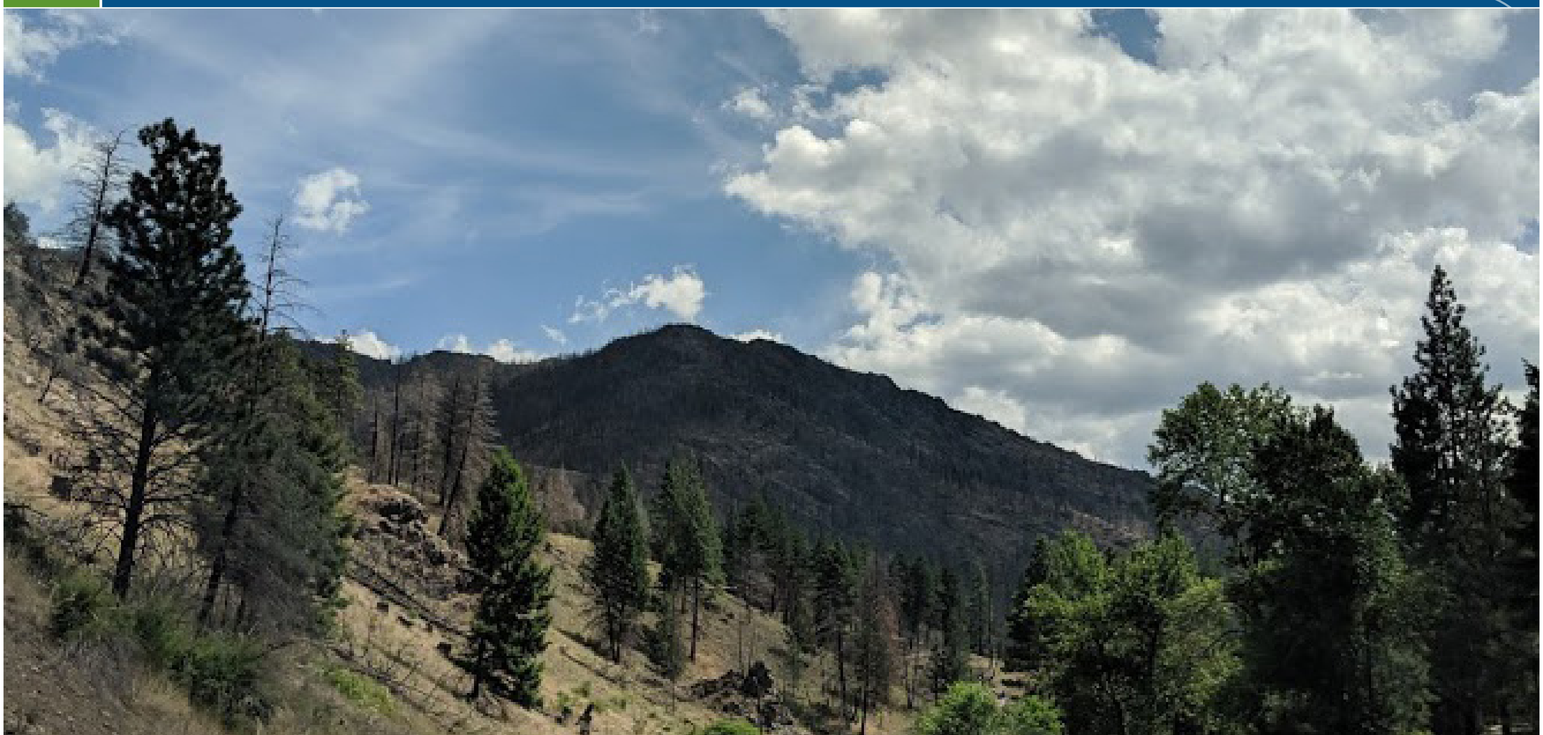
Risk MAP – The vision of this FEMA strategy is to work collaboratively with State, local, and tribal entities to deliver quality flood data that increases public awareness and leads to action that reduces risk to life and property.

Riverine – Of or produced by a river. Riverine floodplains have readily identifiable channels.

Appendix H: FEMA Risk MAP Discovery Report Baker County, Oregon

FEMA

REGION X DISCOVERY REPORT



BAKER COUNTY | OREGON

WEBINARS: 7/31/2019 - 8/22/2019

MEETING: 9/12/2019

REPORT: 1/15/2020

RiskMAP
Increasing Resilience Together

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EXECUTIVE SUMMARY

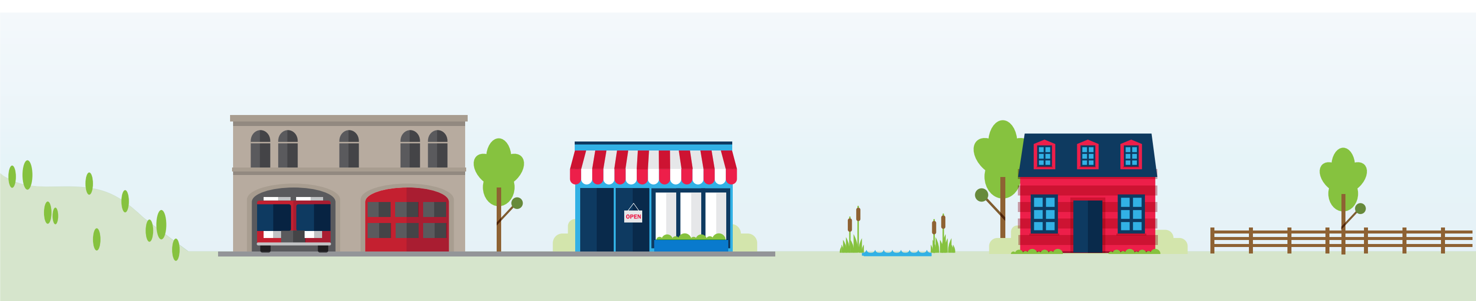
The Federal Emergency Management Agency's (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) process begins with Discovery. The Discovery phase is twofold: (1) Pre-Discovery Information Exchange webinars held with each participating community, and (2) an in-person Discovery Meeting to build upon the discussions held via the webinars. The Baker County Discovery Report provides users with an understanding of historical and current natural hazard risks, and identified, current, and completed mitigation activities within the county.

The goals of Discovery are to (1) determine what natural hazard information already exists, (2) learn what natural hazard information is still needed to make mitigation decisions, and (3) identify what critical infrastructure and resources could potentially be affected during a natural hazard event. This report discusses the risks and needs identified during the Discovery process. The information gathered during Discovery can be used to inform discussions regarding community resilience and to identify or support mitigation projects.

Discussions with Baker County led to the request for a variety of Risk MAP products and services that can improve community resilience. These are listed on the right.

COMMUNITY-REQUESTED RISK MAP PRODUCTS AND SERVICES:

- Multi-hazard outreach materials
- Expanded LiDAR (Light Detection and Ranging) reaches
- Updated flood maps with new topography developed from LiDAR
- Detailed flow data for the Powder River
- Flood studies and redelineation for areas of concern
- Training on the Letter of Map Amendment (LOMA) process for surveyors and property owners
- Hazard Risk Assessments for landslide, earthquake, and wildfire – all to be strengthened by LiDAR
- Seismic analysis of critical infrastructure for Baker City
- Scenario-based mapping related to post-wildfire flooding
- Non-regulatory mapping for ice jams, post-storm flooding events, and channel migration
- Information on the Cooperating Technical Partners (CTP) Program and additional funding opportunities



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PROJECT OVERVIEW

Discovery Meeting maps were developed for Baker County and incorporated jurisdictions to visually display areas of concern identified during Pre-Discovery with the communities. Additional information included in these maps came from the best available data from local, State, and Federal data sources. Below, you will find the Baker County Project Area Map. Additional maps for the project area can be found at: http://www.starr-team.com/starr/RegionalWorkspaces/RegionX/OR_Baker_Discovery/Forms/AllItems.aspx.

RiskMAP DISCOVERY

Map Contains:

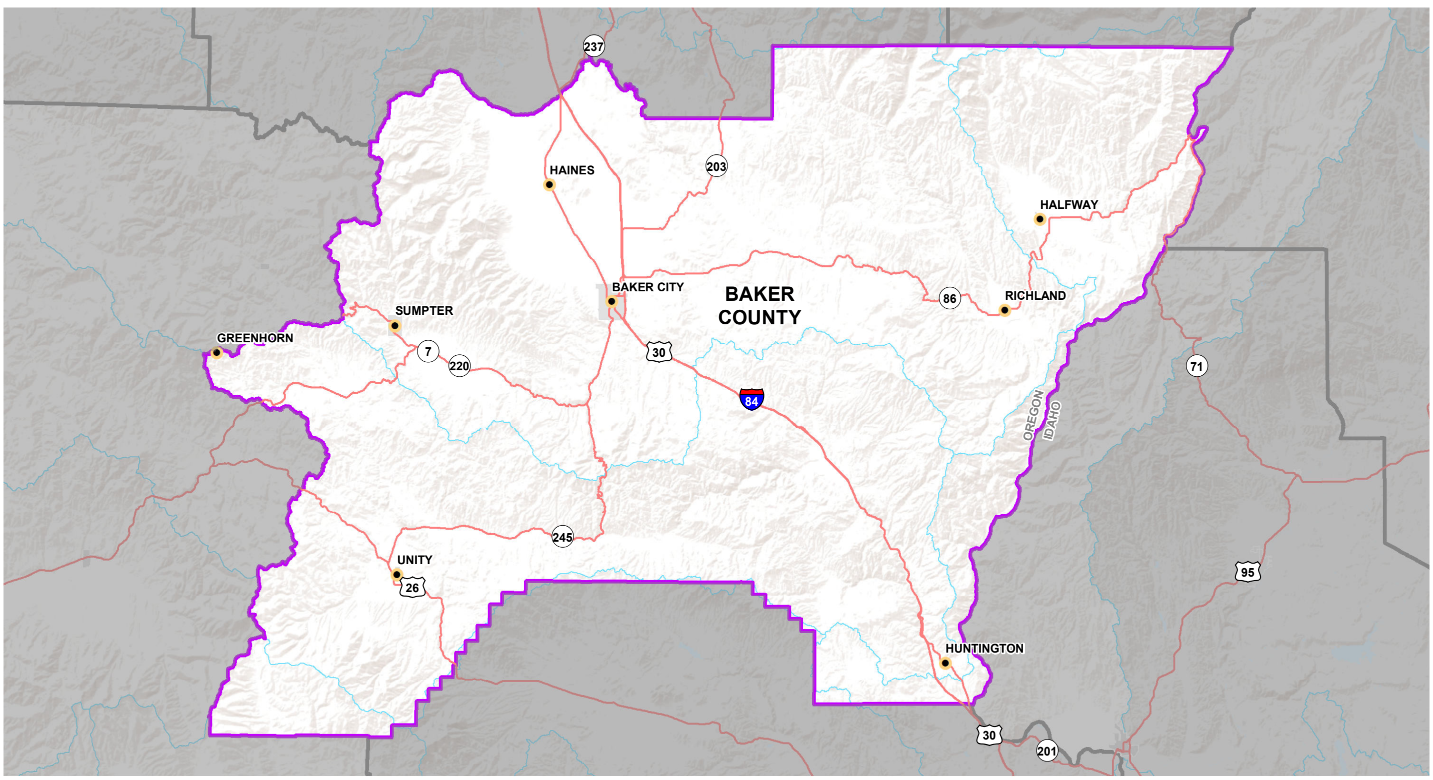
PROJECT AREA MAP

BAKER COUNTY, OREGON

DATE November 2019

This is a non-regulatory product and is provided for information gathering and sharing purposes only.

FEMA



BASEMAP LAYERS

JURISDICTION

STATE

COUNTY

MAJOR ROAD

COMMUNITIES & POPULATION

BAKER, COUNTY OF	15,980
BAKER CITY, CITY OF	9,783
HAINES, CITY OF	415
HALFWAY, CITY OF	288
HUNTINGTON, CITY OF	436
RICHLAND, CITY OF	176
SUMPTER, CITY OF	203
UNITY, CITY OF	69

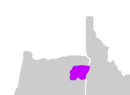
REFERENCE

1 inch = 11.8 miles 1:750,000

N

Service Layer Credits: Sources: Esri, USGS, NOAA

STUDY AREA



BAKER COUNTY | OREGON

DISCOVERY MEETING OUTCOMES

At the Discovery Meeting, local community attendees were asked to participate in two main workshop activities: (1) to identify areas on a map where participants might want more information, either on the structure or location itself, or for data relating to hazards in that location; and (2) to discuss each identified area in more detail during breakout groups. During this second activity, mitigation actions were addressed along with ways Risk MAP data could support each risk reduction effort. Attendees also discussed how this information could be used to inform the hazard mitigation plan update process. Each community ranked its mitigation actions for each timeframe (short term: 1 to 3 years, mid-term: 3 to 7 years, and long term: 7+ years) after all mitigation projects were identified and discussed. To organize the information further, each risk reduction effort was grouped within a category: planning, project, hazard mapping, risk assessment, outreach, training, and technical assistance, which are described below. The outcomes of the discussion from this workshop activity are described on the next pages for each jurisdiction that attended the Discovery Meeting.

COMMUNITY NEED	RISK MAP SUPPORT EXAMPLES	COMMUNITY NEED	RISK MAP SUPPORT EXAMPLES
PLANNING	· Hazard Mitigation Plan development · Developing mitigation strategies · Assistance with recovery and emergency response planning · Land use planning · Plan integration · Plan maintenance	OUTREACH	· Development of handouts, flyers, brochures, posters, etc. focused on hazard information, preparedness, response, and recovery · Assistance with developing effective community outreach through messaging and public events
PROJECT	· Mapping and hazard assessments to support planning efforts · Hazard data and assistance to strengthen grant applications	TRAINING	· Training provided to local staff; such as NFIP training and technical support, risk assessment training and technical support, and hazard mitigation planning support
HAZARD MAPPING	· Flood Studies, both approximate and detailed · LiDAR collection	TECHNICAL ASSISTANCE	· Support for ideas in public engagement · Best practices for mitigation strategies · Presenting or advocating hazard and response-related plans to elected officials · Linking hazard mitigation to other local planning efforts
RISK ASSESSMENT	· Multi-hazard risk assessments analyzing hazard extent and structural loss estimates using hazard scenarios and local parcel data · Hazards can include earthquake, wildfire, drought, flood, severe storm, landslide, dam failure, avalanche, ice jam, and volcano		

BAKER COUNTY | OREGON

COMMUNITY NEED	RISK REDUCTION INTEREST	2014 NATURAL HAZARD MITIGATION PLAN LINKAGE	RISK MAP SUPPORT	TIMELINE	PRIORITY
HAZARD MAPPING	Collect LIDAR data for the following locations: • Main horizontal county and highway routes • Headwaters of the Powder River • North of Sumpter (location of mineral extraction) • Powder River Tributaries that contribute to the high water • Hole in the Wall - near Halfway • LIDAR gaps near Sumpter • State highway I-84 post fire and flood areas	The 2014 NHMP does not mention leveraging or expanding LIDAR data to inform mitigation priorities.	LiDAR data provided through Risk MAP will improve flood and multi-hazard mapping in populated areas, areas with projected population growth, and other areas of identified concern.	Short term (green)	#1
RISK ASSESSMENTS	Post-Wildfire Flooding: Information is needed on impacts to drainage following a wildfire event. A post-burn map would inform post-fire rehabilitation plans as well as assess the impact on culverts and other hydraulics.	The 2014 NHMP does not mention post-wildfire mitigation projects or post-wildfire flooding.	Hazard risk and exposure assessments, provided through Risk MAP, can identify areas prone to post-wildfire flooding and debris flows, which can improve communication, and support and prioritize mitigation efforts. Leveraging the CTP grants, State, Federal, and Regional partnerships, and other funding/ resource opportunities, post-wildfire burn information can be coordinated.	Short term (green)	#2
PROJECT	Drought Data: Data collection for drought mitigation and wet meadow degradation would support addressing vertical erosion and increase floodplain access.	Goal 2: Increase the resilience of local and regional economies.	Drought exposure assessments, provided through Risk MAP, can identify areas of historic droughts and identify gaps in hazard data. Leveraging the CTP grants, State, Federal, and Regional partnerships, and other funding/resource opportunities, drought information can be coordinated.	Short term (green)	#3
RISK ASSESSMENTS	Flood: Map along Highway 86 for flooding and washout risk. Highway 86 and the Burnt River Corridor on Pine Creek below Halfway needs maps and assessment of the area.	Action Item: FL # 4 – Update the county and city FEMA Flood Insurance Rate Maps (FIRMs) and digitize the updated maps.	FIRM and FIS report and hazard risk and exposure assessments, provided through Risk MAP, can identify areas prone to flooding, which can improve communication, and support and prioritize mitigation efforts.	Short term (green)	#4

● SHORT TERM (1-3 YEARS) ● MID-TERM (3-7 YEARS) ● LONG TERM (7+ YEARS)

FEMA

BAKER COUNTY | OREGON

COMMUNITY NEED	RISK REDUCTION INTEREST	2014 NATURAL HAZARD MITIGATION PLAN LINKAGE	RISK MAP SUPPORT	TIMELINE	PRIORITY
RISK ASSESSMENTS	Landslide: Conduct an assessment of landslide risk along railroads, highways and roads, and utilities.	Action Item: LS #1 - Identify obtain and, evaluate detailed risk assessments in landslide prone areas and develop mitigation strategies to reduce the likelihood of a potential hazardous event.	Hazard risk and exposure assessments, provided through Risk MAP, can identify areas prone to landslides, which can improve communication, and support and prioritize mitigation efforts.	● (Mid-term)	#1
PROJECT	Floodplain restoration on the headwaters of Pine Creek is needed to reduce flooding downstream near Halfway.	Goal 1: Protect human welfare, property, and natural resources.	Hazard risk and exposure assessments, provided through Risk MAP, can identify areas prone to flooding, which can improve communication tools, and support and prioritize mitigation efforts.	● (Mid-term)	#2
PROJECT	Data Need: Request for data to inform natural hazard impacts in Burnt River Canyon, including flooding, wildfire, earthquake, and landslide. Focus data collection around transportation corridors.	Goal 2: Increase the resilience of local and regional economies.	Hazard risk and exposure assessments, provided through Risk MAP, can identify areas prone to the risks of natural hazards within the Burnt River Canyon, which can improve communication, and support and prioritize mitigation efforts.	● (Mid-term)	#3

SHORT TERM (1-3 YEARS)　MID-TERM (3-7 YEARS)　LONG TERM (7+ YEARS)

BAKER CITY| OREGON

COMMUNITY NEED	RISK REDUCTION INTEREST	2014 NATURAL HAZARD MITIGATION PLAN LINKAGE	RISK MAP SUPPORT	TIMELINE	PRIORITY
HAZARD MAPPING	New flood analysis is requested with the following details: · The current FIRM has areas in the floodplain that the city does not agree with. Not a lot of flooding has occurred within the current SFHA. LOMAs are an indicator of inaccuracy (many found in South Baker City). · The irrigation ditch near the industrial part in the west region of the city floods. · Sheet flow is a problem throughout the city. · Seasonal snow causes flash flooding - if a rain or snow event occurs the city does not have a way to control high water. · Ice jams are common on the north side of the city along the Powder River. · Undeveloped residential land has growth limitations due to flood zones. · The school district purchased land for future development at Hughes Lane and Sports Complex. This area is currently mapped in the floodplain.	Action Item: FL # 4 – Update the county and city FEMA Flood Insurance Rate Maps and digitize the updated maps.	FIRM and FIS report and hazard risk and exposure assessments, provided through Risk MAP, can identify areas prone to flooding, which can improve communication, and support and prioritize mitigation efforts.	● (Short term)	#1
RISK ASSESSMENTS	Earthquake: Seismic analysis of critical infrastructure is requested. The old buildings downtown are vulnerable to earthquakes and there are concerns about city hall and emergency operation centers. The city would like to retrofit their city hall and fire station.	Action Item: FL # 4 –Update the county and city FEMA Flood Insurance Rate Maps and digitize the updated maps.	FIRM and FIS report and hazard risk and exposure assessments, provided through Risk MAP, can identify areas prone to flooding, which can improve communication, and support and prioritize mitigation efforts.	● (Short term)	#2

● SHORT TERM (1-3 YEARS) ● MID-TERM (3-7 YEARS) ● LONG TERM (7+ YEARS)

BAKER CITY| OREGON

COMMUNITY NEED	RISK REDUCTION INTEREST	2014 NATURAL HAZARD MITIGATION PLAN LINKAGE	RISK MAP SUPPORT	TIMELINE	PRIORITY
PLANNING AND PROJECT	Develop/implement a watershed resilience plan that identifies wildfire and fire-prone areas, discusses what happens after a large fire, and identifies the impacts to water filtration and wells. The city and the U.S. Forest Service are currently removing vegetation along all the watershed border excluding the inaccessible north end.	Goal 2: Increase the resilience of local and regional economies.	Through Risk MAP, mitigation technical assistance can be provided to support resilience planning. Leveraging existing data and inter-agency partnerships, discussions can be supported to identify data gaps and identify mitigation opportunities.	● Mid-term	#1
PROJECT	Complete ongoing seismic retrofits.	Action Item: EQ #1 - Perform an earthquake risk evaluation in critical buildings not listed in the DOGAMI RVS report.	Through the Risk MAP program, FEMA and their State partners can support grants management (CTP or other funding opportunities) and technical support for identified mitigation projects.	● Mid-term	#2
PROJECT	Complete remaining seismic retrofits.			● Long term	#1

● SHORT TERM (1-3 YEARS) ● MID-TERM (3-7 YEARS) ● LONG TERM (7+ YEARS)

HAINES | OREGON

COMMUNITY NEED	RISK REDUCTION INTEREST	2014 NATURAL HAZARD MITIGATION PLAN LINKAGE	RISK MAP SUPPORT	TIMELINE	PRIORITY
PROJECT	Gauge local preparedness following a recent water project: • During the water project, the city sent out notifications about outages. • Now, the city would like to follow up on those efforts and collect data on who was informed and if they took action to prepare. • Feedback from residents will help identify who was not informed and/or prepared and why.	Action Item: DR #3 - Develop community drought emergency plans and policies.	Through Risk MAP, technical support can be provided to support data collection and assessment.	●	#1
OUTREACH	Improve outreach for the local reverse 911 program. The city would like to increase the number of registered participants in the program as many households are transitioning from landlines to cell phones.	Action Item: MH #4 - Develop and implement education and outreach programs to increase public awareness of the risk associated with natural hazards. Specifically target vulnerable populations.	Through Risk MAP, hazard assessments can spatially map hazard extents. This data can identify hazard areas that overlap with vulnerable population clusters; supporting targeted outreach efforts.	●	#2
RISK ASSESSMENT	Flood: Requesting flood modeling for 12 and 24 hours after storm and flooding events. The city has a high water table and extra water can quickly begin to cause flood damage.	Action Item: FL # 4 –Update the county and city FEMA Flood Insurance Rate Maps and digitize the updated maps.	Hazard risk and exposure assessments, provided through Risk MAP, can identify areas prone to flooding and high-flow diversions and drainage basins, which can improve communication, and support and prioritize mitigation efforts.	●	#1
HAZARD MAPPING	Requesting improved mapping for Rock Creek, Clear Creek, and Willow Creek.	Action Item: FL # 4 – Update the county and city FEMA Flood Insurance Rate Maps and digitize the updated maps.	FIRM and FIS report and hazard risk and exposure assessments, provided through Risk MAP, can identify areas prone to flooding, which can improve communication, and support and prioritize mitigation efforts.	●	#2

● SHORT TERM (1-3 YEARS) ● MID-TERM (3-7 YEARS) ● LONG TERM (7+ YEARS)

HAINES | OREGON

COMMUNITY NEED	RISK REDUCTION INTEREST	2014 NATURAL HAZARD MITIGATION PLAN LINKAGE	RISK MAP SUPPORT	TIMELINE	PRIORITY
PLANNING AND PROJECT	The city plans to divert traffic off of local roads in instances when the interstate is closed due to winter storms. The city does not have the necessary traffic and infrastructure to support truck traffic.	Goal 1: Protect human welfare, property, and natural resources.	Through Risk MAP, technical support and inter-agency coordination can identify opportunities for mitigating adverse effects of winter storms.	Mid-term	#3
PROJECT	Divert the flow from creeks around the city: Identify how water can be diverted away from the city with an east to west flow. Standing water accumulates on 4th Street during seasonal irrigation or rain events.	Action Item: FL #1 - Explore flood mitigation opportunities for homes and critical facilities subject to flooding.	Hazard risk and exposure assessments, provided through Risk MAP, can identify areas prone to flooding, which can identify mitigation project priorities and support funding applications.	Long term	#1

SHORT TERM (1-3 YEARS) | MID-TERM (3-7 YEARS) | LONG TERM (7+ YEARS)

HALFWAY | OREGON

COMMUNITY NEED	RISK REDUCTION INTEREST	2014 NATURAL HAZARD MITIGATION PLAN LINKAGE	RISK MAP SUPPORT	TIMELINE	PRIORITY
OUTREACH	Requesting multi-hazard outreach materials and messaging strategies: • Earthquake: At this time all questions about earthquake risk are re-directed to county officials.	Action Item: MH #4 - Develop and implement education and outreach programs to increase public awareness of the risk associated with natural hazards. Specifically target vulnerable populations.	Through Risk MAP, tailored communication and outreach materials can be developed, leveraging available earthquake data and localized risk assessments. Existing earthquake outreach materials can be shared.	● (Short term)	#1
PROJECT	Address a city-wide evacuation plan that would gain consensus on how best to communicate evacuation routes to residents. The plan would internally clarify evacuation plans and account for contingencies.	Action Item: MH #9 - Develop a warning and emergency evacuation protocol for vulnerable populations.	Leverage risk assessment data to support city-wide evacuation planning and route identification.	● (Short term)	#2
HAZARD MAPPING	Requesting updated flood studies. While the maps tend to reflect flooding patterns, the west side of Halfway floods, which is not reflected in the current SFHA. • The current FIRM only maps flooding on the east side of Halfway - in proximity to creeks. Flooding, however, is more observed on the west side of the city, near ditches. • McMullen Slough is identified in the SFHA; however, not a lot of flooding occurs in this area. • Flooding occurs at Pine Creek and Highway 414. • Flooding occurs near West Bell Street.	Action Item: FL # 4 –Update the county and city FEMA Flood Insurance Rate Maps and digitize the updated maps.	FIRM and FIS Report; Hazard risk and exposure assessments, provided thorough Risk MAP, can identify areas prone to wildfire risk, which can improve communication, and support and prioritize wildfire mitigation planning efforts.	● (Short term)	#3

● SHORT TERM (1-3 YEARS) ● MID-TERM (3-7 YEARS) ● LONG TERM (7+ YEARS)

HALFWAY | OREGON

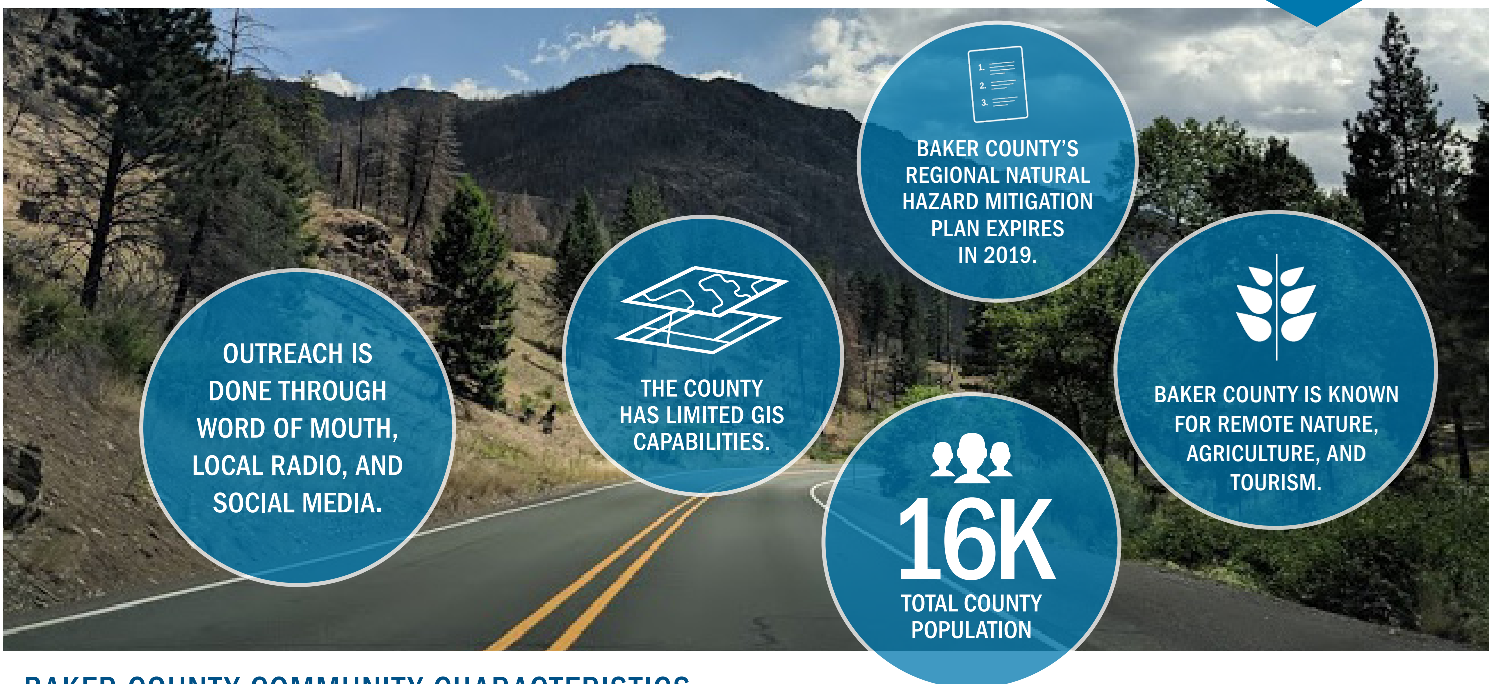
COMMUNITY NEED	RISK REDUCTION INTEREST	2014 NATURAL HAZARD MITIGATION PLAN LINKAGE	RISK MAP SUPPORT	TIMELINE	PRIORITY
PROJECT	Revisit the Silver Jacket project to work on the West Wall and follow up, as needed.	Action Item: FL #6 (Halfway) - Seek Silver Jackets' assistance to investigate opportunities to prevent large infiltration of flood waters into the wastewater treatment facility.	Through Risk MAP, local, State, and Federal partnerships are encouraged and strengthened. FEMA can participate in conversations, as needed, to ensure that cross-agency coordination is achieved.	Mid-term (blue)	#1
PROJECT	Mitigation strategy is needed to reduce flooding hazards for the two local schools on Bell Street. Funding for projects is needed.	Action Item: FL #1 - Explore flood mitigation opportunities for homes and critical facilities subject to flooding.	Through the Risk MAP program, FEMA and their State partners can support grants management (CTP or other funding opportunities) and technical support for identified mitigation projects.	Mid-term (blue)	#2
PROJECT	Identify funding sources to drain ditches.	Action Item: FL #1 - Explore flood mitigation opportunities for homes and critical facilities subject to flooding.	Leverage flood mapping and risk assessment data to identify areas of concern and prioritize project sites to allocate funding to.	Long term (red)	#1

SHORT TERM (1-3 YEARS) MID-TERM (3-7 YEARS) LONG TERM (7+ YEARS)

BAKER COUNTY: COMMUNITY PROFILE

COMMUNITY CHARACTERISTICS

The Baker County community characteristics information was developed to inform the Discovery Meeting and will continue to be used to inform what technical assistance and tools, through Risk MAP, can support the community.



BAKER COUNTY COMMUNITY CHARACTERISTICS

Bordered by the Snake River to the east and the Umatilla and Malheur National Forests to the west, Baker County is situated along the Idaho border in northeastern Oregon. Gold mining was the original impetus for settlement in the area, and at one time the county was the largest gold producer in the northwest. Today, healthcare/social assistance, retail trade, and agriculture, forestry, fishing, and hunting are the largest employment sectors in Baker County. Tourism also plays a role in local economy; surrounding wilderness areas, ski resorts, and the National Historic Oregon Trail Interpretive Center draw visitors to the areas.

Baker County, the Cities of Baker, Haines, Huntington, and Sumpter, and the Town of Halfway all participate in the National Flood Insurance Program (NFIP); the Cities of Greenhorn, Richland, and Unity do not participate in the NFIP.

The county has minimal GIS capabilities, which limits the amount of hazard risk analyses they can carry out in house. Several County departments have individuals with GIS capabilities, but the county does not have a specific department to carry out related tasks.

DATE OF LAST EFFECTIVE FIRM:

1988, ORIGINAL

FEMA & COUNTY TOUCH POINTS

COUNTY CAV: 10/12/2001
COUNTY CAV: 10/19/2001

CRS PARTICIPATION AND RATING:

NOT PARTICIPATING

POLICIES IN FORCE (# OF PAID LOSSES):

107 (3)
$29,769 PAID LOSSES

Information gathered from 2017 American Community Survey, April 2019 Community Information System, the 2014 Northeast Oregon Regional Natural Hazards Mitigation Plan, and information exchange webinars.

NE OREGON PAST DISASTERS
(1964 - CURRENT)

- 2017 WINTER STORM
- 2016 DROUGHT
- 2015 WILDFIRE
  CORNET WINDY, DRY GULCH, ELDORADO, EAGLE; 10% OF COUNTY; 4 STRUCTURES LOST
- 2011 FLOOD
- 2007 WILDFIRE & DROUGHT
- 2006 WILDFIRE
- **2006** FM-2657
  FOSTER GULCH FIRE COMPLEX
  60 HOMES THREATENED; 1,500 ACRES BURNED
  $703K IN DAMAGES; $479K IN FEDERAL FUNDING
- 2005 DROUGHT
- **2004** DR-1510
  SEVERE WINTER STORM(S)
- 2003 TWO SEVERE WIND STORMS AND ONE DROUGHT
- 2002 WILDFIRE
- 2001 DROUGHT
- 1999 DROUGHT
- **1997** DR-1160
  SEVERE WINTER STORM(S), LAND AND MUDSLIDES, FLOODING
- 1996 WILDFIRE
- 1994 TWO WILDFIRES
- 1991 FLOOD
- 1989 WILDFIRE
- 1986 THREE WILDFIRES
- 1978 WILDFIRE
- **1977** EM-3039
  DROUGHT
- 1966 M4.2 EARTHQUAKE
- 1966 M4.3 EARTHQUAKE
- **1964** DR-184
  HEAVY RAINS AND FLOODING

Landslides have accompanied storms in 1964, 1966, 1982, 1996, and 2005. The fatalities and losses resulting from the 1996 landslide events brought about the passage of the Oregon Senate Bill 12, which set site development standards, authorized the mapping of areas subject to rapidly moving landslides, and the development of model landslide ordinances (2014 Northeast Oregon Regional HMP).

Although there have been no recent volcanic events in the Northeast Oregon region, the area is active and susceptible to eruptive events, since it is near the volcanic Cascades Range. Volcanoes were considered as a Hazard in the 2014 Northeast Oregon Regional HMP.

(large circle) = Federally Declared Disaster

(small circle) = Local emergency declarations, specific to Baker County and Jurisdictions, from the *2014 Northeast Oregon Regional Hazards Mitigation Plan Update*.*

*For a complete list of regional hazard events, please reference this document.

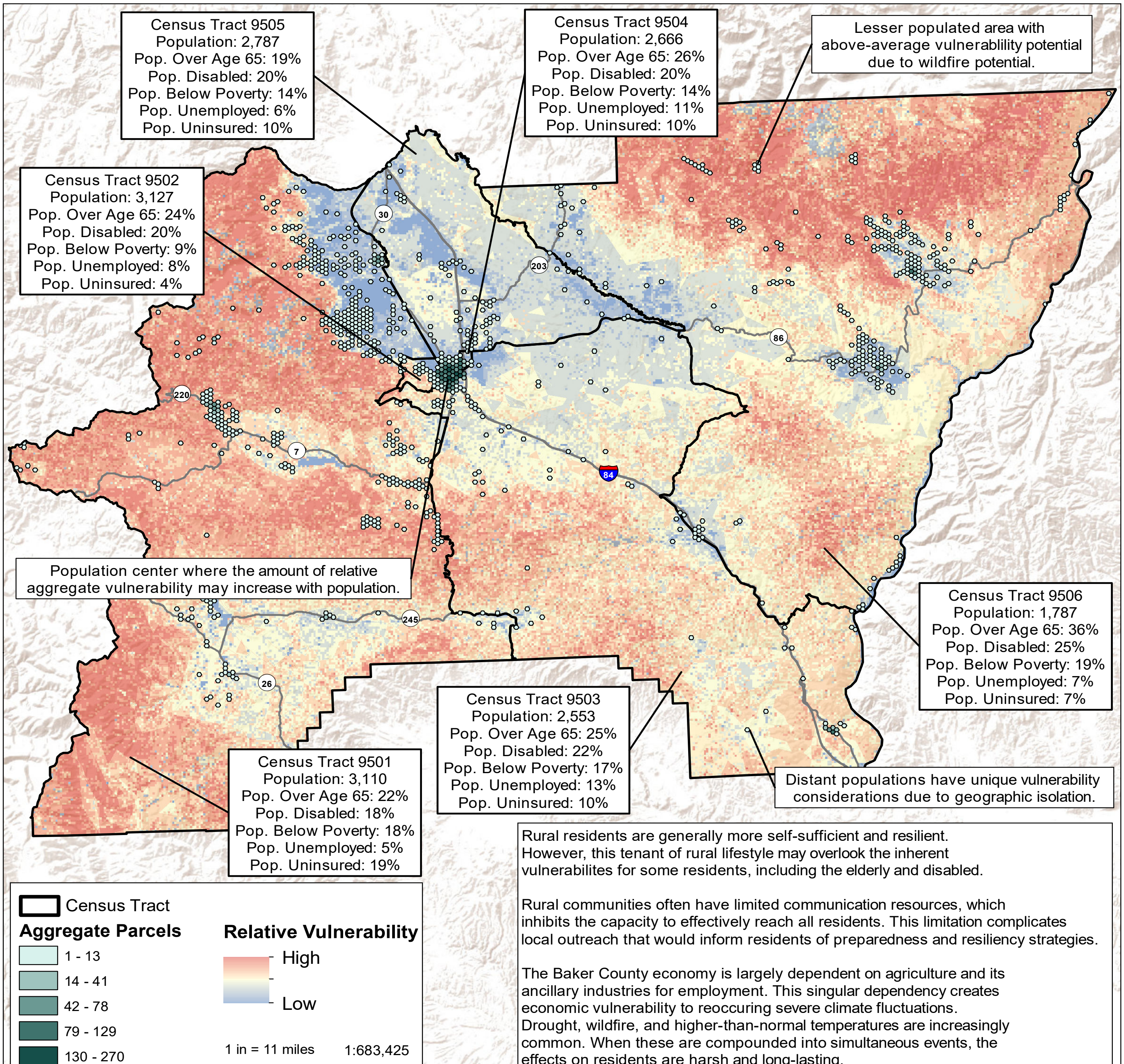
BAKER COUNTY | COMMUNITY DATA

COMMUNITY	POPULATION	FIRM DATES AND STATUS	NFIP	NFIP POLICIES	CRS	FEMA & COMMUNITY FLOOD MAP TOUCH POINTS
BAKER CITY	9,741	**1988** REVISED	YES	80	NO	**CAV:** 10/12/2001 **CAC:** 12/19/1990
GREENHORN	10	NEVER MAPPED	NO	N/A	NO	N/A
HAINES	404	**1988** ALL ZONE C AND X	YES	NONE	NO	**CAV:** 7/1/1991 **CAC:** 9/10/1990
HALFWAY	313	**1988** REVISED	YES	4	NO	**CAV:** N/A **CAC:** 2/25/1993
HUNTINGTON	324	**1988** REVISED	YES	NONE	NO	**CAV:** N/A **CAC:** 10/2/1992
RICHLAND	175	NEVER MAPPED	NO	N/A	NO	N/A
SUMPTER	218	**1988** REVISED	YES	NONE	NO	**CAV:** N/A **CAC:** 8/24/1992
UNITY	63	NEVER MAPPED	NO	N/A	NO	N/A
BAKER COUNTY (UNINCORPORATED)	4,970	**1988** ORIGINAL	YES	23	NO	**CAV:** 10/12/2001 **CAC:** 10/19/2011

NOTE: Information gathered from 2017 American Community Survey and April 2019 Community Information System. CRS= Community Rating System, CAV=Community Assistance Visits, CAC=Community Assistance Contacts. FEMA uses the CAV and CAC process to stay connected with communities about their flood maps.

BAKER COUNTY SOCIOECONOMIC

Socioeconomic factors can significantly affect the community's susceptibility to loss. Understanding these influences can help communities allocate resources effectively and equitably to their more vulnerable populations.



Rural residents are generally more self-sufficient and resilient. However, this tenant of rural lifestyle may overlook the inherent vulnerabilites for some residents, including the elderly and disabled.

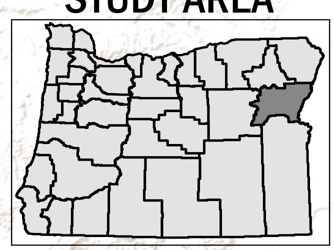
Rural communities often have limited communication resources, which inhibits the capacity to effectively reach all residents. This limitation complicates local outreach that would inform residents of preparedness and resiliency strategies.

The Baker County economy is largely dependent on agriculture and its ancillary industries for employment. This singular dependency creates economic vulnerability to reoccuring severe climate fluctuations. Drought, wildfire, and higher-than-normal temperatures are increasingly common. When these are compounded into simultaneous events, the effects on residents are harsh and long-lasting.

This map depicts human vulnerability to natural hazards including: wildfire, flood, and earthquake. The socioeconomic variables used here consist of 15 unique US Census-derived metrics. Hazard and socioeconomic numeric risk variables are combined to return location-specific sensitivity to natural hazards. Human sensitivity to hazards is based on pre-hazard socioeconomic conditions that are exacerbated during and after an event.

Sources: CDC, BLM, USGS, NOAA, USACE, USFS

STUDY AREA



FEMA

BAKER COUNTY | COMMUNITY CONCERNS

INFORMATION EXCHANGE OUTCOMES

In July and August 2019, Baker County and the Cities of Baker City, Greenhorn, Haines, Huntington, and Unity, and the Town of Halfway participated in Pre-Discovery Information Exchange Webinars. During the sessions, each community was asked to discuss its hazard concerns and identify top-priority hazards. Below is a summary of that discussion. Hazards that were referenced overlap with those identified in the community's Natural Hazard Mitigation Plan (NHMP). These hazards will remain the focus of future Risk MAP projects.

BAKER COUNTY'S TOP HAZARDS AND DISCUSSION NOTES

WILDFIRE

- Communities are acutely aware of the risk; many maintain defensible space and monitor Wildland Urban Interfaces (WUI).
- Air quality is a major concern for some aging communities.
- The entire county is at risk of wildfire, but specifically the City of Sumpter and the Baker County Watershed. The Town of Halfway and City of Richland, where there are many vulnerable structures, were recently cut off due to a wildfire.
- Unity has been affected by wildfires a number of times in the recent past with impacts to cattle and ranching.

FLOOD

- The county disagrees with the current Special Flood Hazard Area (SFHA); most areas currently identified as in a flood zone do not see flooding. Many discrepancies are related to the Phillips Reservoir and its carrying capacity.
- Snow-melt causes isolated flooding events throughout the county.
- Post-wildfire flooding is also a concern. Burn scars from previous fires have had a small debris flow and are monitored closely.
- The cities of Baker City and Haines, and the Town of Halfway have seen recent impacts from floods.
- Ice jamming on the Powder River has caused flooding in Baker City.

SEVERE WEATHER

- Cold weather and winter storms are a regular occurrence; residents are generally prepared for extreme weather, however, extended power outages would be detrimental to communities.
- Cities can become isolated during winter storm events.
- Heavy snow and severe winds have caused structural damage in Greenhorn, Huntington, Halfway, Baker City, Richland, and Haines.
- Snow removal is frequent and well-coordinated.

LANDSLIDES AND EARTHQUAKES

- Landslides are a concern in certain areas, but they are monitored by the county's Roads and Bridges Department.
- The main earthquake concern among the cities and the Oregon Department of Transportation are how to best shelter and feed potential refugees from a Cascadia event.

ADDITIONAL HAZARDS DISCUSSED: DROUGHT | DAM FAILURE | POST-WILDFIRE FLOOD

BAKER COUNTY | LOCAL OUTREACH

INFORMATION EXCHANGE OUTCOMES

During the discussion of the community's top-priority hazards, ongoing and completed outreach efforts were highlighted. Each outreach effort below supports the continued focus on increasing the public's awareness of hazard risk. Additionally, through conversations, the community expressed interest in Risk MAP products and services.

COMMUNITY OUTREACH EFFORTS

Communication about hazard mitigation and personal preparedness is largely driven by word of mouth, throughout Baker County and its cities. Phone trees and localized phone lists are used often throughout the region; this is especially true during wildfire events. In the area, there is a high expectation for self-preparedness and self-sufficiency due to the rural nature of the communities.

Locals receive information most often from local radio and social media. However, access to the internet and certain radio stations can be limited in rural areas of the county. Newspapers, while still a source of information, are only delivered three times weekly, and in certain more remote areas, the newspapers are delivered on a two- to three-day delay. Utility mailers, community flyers, newsletters, and local bulletin boards are also used by local staff. Baker County operates a mass notification system and manages a website with relevant resources. The county also prepares and hosts Preparedness Fairs for the cities, which promotes the Oregon Office of Emergency Management's "2 Weeks Ready" campaign.

Most communities expressed interest in improving outreach to residents, especially to address long-term residents who are hesitant to adapt to changing risk. Most communities shared that locals tend to be more reactive than proactive when it comes to mitigating risk.

BAKER COUNTY | MITIGATION PLANNING

BENEFITS OF RISK MAP THAT SUPPORT HAZARD MITIGATION PLANNING

Mitigation is most effective when it is based on a comprehensive, long-term plan that is developed before a disaster occurs. A FEMA-approved NHMP is a requirement for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects such as infrastructure retrofits, purchasing generators, property buy-outs, and the development of NHMPs and other planning mechanisms that integrate hazard mitigation information.

Trainings and technical assistance are available through Risk MAP and can support your planning efforts. These resources are intended to help build risk awareness and increase a community's ability to communicate risk.

HAZARD MITIGATION PLAN DETAILS

PLAN STATUS:
The current Northeast Oregon Regional Natural Hazards Mitigation Plan expired June 5, 2019.

PARTICIPATING JURISDICTIONS:
The 2014 plan included Baker County, the City of Baker City, the Town of Halfway, along with Grant County, Union County, and Wallowa County.

LOCAL PLANNING TEAM:
The planning committee included Baker County Emergency Management, Baker County Commissioners, the Baker County Planning Department, the Baker County Water Master, representatives from Baker City and the Town of Halfway, and State and Federal partners.

IDENTIFIED HAZARDS OF CONCERN*:
Drought, flood, landslide, wildfire, windstorm, and winter storm

**Hazards discussed at Discovery, to be considered for future NHMP Updates: dam failure and post-wildfire flooding*

MITIGATION OBJECTIVES | FOUND IN THE HAZARD MITIGATION PLAN, UNLESS OTHERWISE NOTED

- Update the county and city FEMA Flood Insurance Rate Maps and digitize the updated maps (Baker County).
- Complete and implement the Pine Creek Flood-plain Management Plan (Town of Halfway).
- Explore the costs and benefits for participation in the NFIP's Community Rating System (Baker County).
- Advocate for the implementation of the actions identified in each county's Community Wildfire Protection Plan (Baker City).
- Conduct an aquifer (groundwater) study for the Pine and Baker Valleys (Baker County).
- Participate in the National Oceanic and Atmospheric Administration (NOAA) Storm Ready Program (Baker County).

COMPLETED AND ONGOING MITIGATION ACTIONS

- Following fires in 2015, Baker County received funding to look at WUIs and run assessments for all communities using Intterra.
- Greenhorn is in the process of building a helipad for airlifts and evacuations.
- Baker County coordinated with the National Weather Service to install systems to monitor burn scars following wildfire to better prepare for debris flows.
- Haines and Baker City recently completed a seismic assessment of their school through a State-wide program.
- Baker County is working with the Forest Service to thin wildfire fuels around roads and structures to create a WUI buffer.
- The City of Haines is implementing a water project that will add wells and a water tower to strengthen existing systems and reduce the risk of water shortages.

BAKER COUNTY | RISK MAP PROCESS

Discovery Meeting: September 12, 2019

Discovery provides an opportunity for communities to share their local risk knowledge with FEMA and identify opportunities for future work. This could include public outreach support, trainings, technical assistance, grant assistance, and hazard mapping.

If the data and research collected during the Discovery phase supports the need for a flood map update and regulatory products, a recommended scope of work is developed for stream reaches requiring studies. The following timeline shows the steps of that process.

RISK MAP PHASE	WHAT TO EXPECT
Data Development	If a flood mapping update project is initiated, FEMA and its partners move forward with preparing the data, maps, and Flood Risk Products. Tasks included in the data development process include gathering information required for hydraulic and hydrologic modeling, ground truthing, and conducting engineering studies.
Data Communication: Flood Risk Review	FEMA, State, and local officials meet to validate mapping data and supporting research, which helps identify areas prone to flooding and provides spatial orientation to project planners.
Issue Preliminary Map	FEMA issues preliminary maps and Flood Insurance Study (FIS) reports for community officials to review.
Data Communication: Consultation Coordination Officer Meeting (CCO)	Preliminary maps are reviewed with community officials at the CCO Meeting. The comment and appeal process is also explained.
Facilitate Public Comment and Appeal Period	Preliminary maps and the comments and appeals process are shared with community residents and business owners during a FEMA-supported Public Meeting or Open House. Communities have 90 days to submit comments and/or appeals. Comments and/or appeals are reviewed, and flood maps may be updated appropriately.
Issue Letter of Final Determination	Once a flood map is finalized, it is adopted by the community. A 6-month adoption period begins to allow communities time to adopt adequate floodplain management ordinances based on the new flood map.
Issue Flood Map	Community leaders monitor and track local developments. Letters of Map Revision (LOMRs) are required within 6 months of project completion for projects that change the flood hazards in a specific area.

Separate from regulatory flood products, FEMA can also support and provide multi-hazard risk products, detailed on the next page. The data and resources provided can support the identification of areas most vulnerable to hazards and inform safer and more resilient development. Throughout the Risk MAP process, communities can be connected to funding opportunities and partnerships that can support mitigation and risk reduction projects. This information often is shared during in-person Resilience Workshops that bring together local, State, and Federal partners.

BAKER COUNTY | RISK MAP PRODUCTS

FEMA and their partners can also develop a suite of multi-hazard products to help your community identify and assess risk from other types of natural hazards to support your local mitigation efforts and future land-use planning decisions.

RISK MAP PRODUCT	WHAT IS IT?	HOW IS IT USED?
MULTI-HAZARD RISK DATABASE AND MAP PACKAGE	The ArcGIS multi-hazard risk database and map package contain spatial data, including outputs from the risk assessment and the various hazard datasets used for the assessment.	By compiling available natural hazard data and quantifying the risk to those natural hazards using community assessor data, this dataset can identify local risk to hazards for each structure in a community. This information can be used for grant applications, local planning and emergency management efforts, identifying vulnerable populations, and communicating risk to various audiences.
MULTI-HAZARD RISK REPORT	Provides a written summary and analysis of the multi-hazard risk database and map package. The report includes recommended mitigation planning strategies and highlights potential areas for mitigation projects and/or risk reduction actions.	The information provided in the risk report can identify vulnerable areas, enhance planning efforts, and improve risk communication and outreach to the public.
MULTI-HAZARD STORY MAP	Leveraging the multi-hazard risk analysis, this product shows where communities are vulnerable to hazards using online interactive maps and shares helpful mitigation planning strategies or other risk reduction recommendations. Links to the risk database, risk report, and other helpful resources are also included.	This product is intended for an audience that is less familiar with GIS analysis and can be easily shared with a wide range of audiences. Officials can use the story map to identify vulnerable areas, enhance planning efforts, and improve risk communication and outreach to the public.
FLOOD DEPTH AND ANALYSIS GRID	Communicates detailed information about the depth and velocity of floodwaters, as well as the probability of an area being flooded over time.	Officials can use depth grids to show individuals the depth of flooding structures might experience at different flood frequencies.
CHANGES SINCE LAST FIRM	Highlights how the new or updated FIRMs differ from the previous maps to help communities understand the changes and prepare for adoption of new maps.	Communities can use this to engage residents and businesses about their changing risk and the implications for flood insurance.
FLOOD & EARTHQUAKE — HAZUS RISK ASSESSMENT	Focuses on damage that results from various flood and earthquake scenarios. Communicates the densities of social and structural vulnerabilities as well as economic risks.	Communities can use this information to identify and support mitigation strategies and understand how to position resources and messaging to vulnerable populations in advance of a disaster.
EXPOSURE RISK ASSESSMENT	Identifies areas and structures that would be affected by natural hazards. Applicable to all natural hazards.	Provides an opportunity for officials to prioritize mitigation actions in areas exposed to natural hazards.

BAKER COUNTY | OREGON

COMMUNITY REQUESTS AND NEXT STEPS

Summarized below are the requests that were captured during both the Information Exchanges and Discovery Meeting that can be supported through Risk MAP.

COMMUNITY REQUESTS

- **MULTI-HAZARD OUTREACH MATERIALS:** Multi-hazard outreach materials can be provided through Risk MAP and tailored to specific communities and needs.
- **LIDAR COLLECTION:** LiDAR is planned to be flown throughout the Baker County project area. LiDAR data can support and enhance flood mapping, multi-hazard risk assessments, grant applications, project prioritization, and multiple local planning efforts.
  For more information, visit: https://www.oregongeology.org/lidar/
- **TECHNICAL ASSISTANCE AND PLANNING:** The Risk MAP program can provide support for hazard mitigation efforts. This can include, but is not limited to, support for public engagement, sharing best practices, advocating hazard and response-related plans to elected officials, and linking hazard mitigation to other local planning efforts.
- **TRAININGS:** Through Risk MAP, inter-agency relationships are strengthened. As a participating community, trainings can be provided through Federal and State agencies for local staff and elected officials.

CONCLUSION

We are all passionate about helping communities understand their risks and develop plans to mitigate those risks. Whether flood, earthquake, wildfire, or other natural hazards, these risks can have a significant impact on the people, property, and resources in our communities. So far, the Information Exchanges and Discovery Meeting have captured your effective, completed, and ongoing efforts to reduce risk to natural hazards. By participating in the Risk MAP process, you are accessing additional tools and resources to support these existing efforts and prioritized mitigation actions.

NEXT STEPS

- LiDAR collection is planned to be completed in 2020 and 2021.
- FEMA will reach out to you to discuss next steps and scoping efforts as this project moves forward.
- Keep an eye out for quarterly reports that will be emailed as updates become available.

QUESTIONS

If you have any questions, please contact the FEMA Region X Oregon State Engineer, David Ratte.
David.Ratte@fema.dhs.gov | (425) 487-4657

BAKER COUNTY | OREGON

LOCAL PARTICIPATION

The Baker County Information Exchange webinars were held in July and August 2019 with Baker County and the cities of Baker City, Greenhorn, Haines, Huntington, and Unity, and the Town of Halfway.

Staff from Baker County and the cities of Baker City, and Haines and the Town of Halfway attended the in-person Baker County Discovery Meeting on September 12, 2019.

DISCOVERY MEETING LOCATION: Oregon Trail Electric Cooperative Office in Baker City, OR

COMMUNITY	NAME	TITLE	INFORMATION EXCHANGE WEBINAR	IN-PERSON DISCOVERY MEETING
BAKER COUNTY	HOLLY KERNS	Planning Department Director	X	X
	EVA HENES	Planner	X	
	CHRISTO MORRIS	Executive Director - Powder Basin Watershed Council		X
	NOODLE PERKINS	Roadmaster	X	
	LYLE UMPLEBY	District Manager - Power Valley Irrigation District		X
	JASON YENCOPAL	Emergency Manager	X	X
BAKER CITY	CHRISTY SETTLES	School District Maintenance Supervisor	X	X
	MICHELLE OWEN	Public Works Director	X	
	FRED WARNER, JR.	City Manager	X	
GREENHORN	DALE MCLOUTH	Mayor	X	
HAINES	JIM BROWN	Mayor	X	
	RICHARD HOWE	Planning Director	X	
	ANDI WALSH	Planner		X
HALFWAY	SALLI HYSELL	City Recorder	X	X
HUNTINGTON	JENNIFER PETERSON	City Recorder	X	
UNITY	MARK BENNETT	General Manager	X	

BAKER COUNTY | OREGON

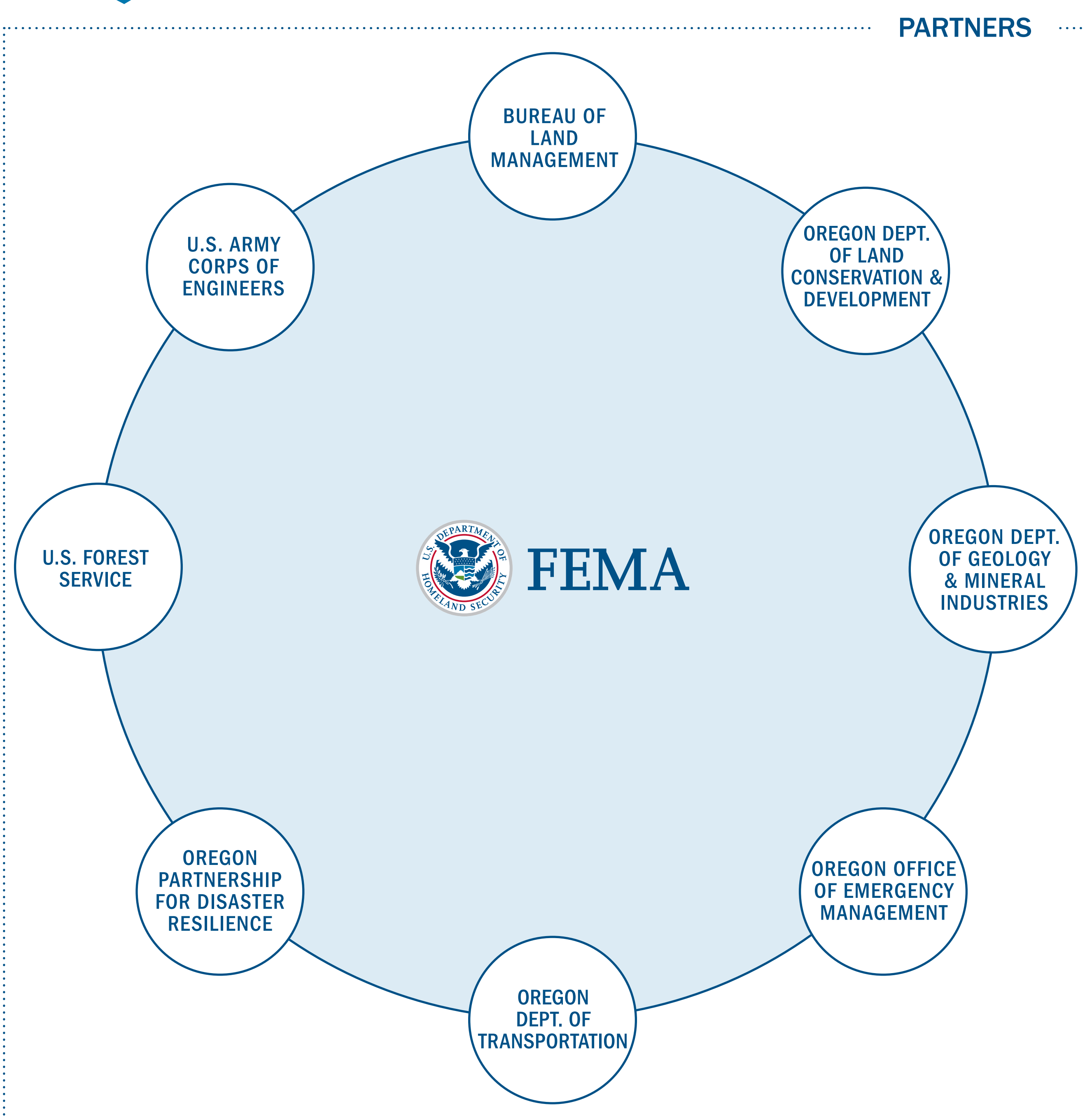
LOCAL PARTICIPATION

COMMUNITY	NAME	TITLE	INFORMATION EXCHANGE WEBINAR	IN-PERSON DISCOVERY MEETING
OREGON DEPARTMENT OF TRANSPORTATION	DAVE DETHLOFF	Region 5 - Assistant District Manager		X
	KENNETH PATTERSON	Region 5 - District Manager		X
WALLOWA-WHITMAN NATIONAL FOREST	STEVE HAWKINS	Deputy Fire Staff, Fuels Program Manager		X

FEDERAL AND STATE PARTNERS

FEDERAL AND STATE CONTACTS

FEMA's Risk MAP effort is supported by multiple State and Federal agencies that are available as data and assistance resources throughout this process. These partnerships exist to better develop hazard planning and technical assistance support and to strengthen the quality and accuracy of any FEMA developed product. The current Baker County project partners are listed below.



FEDERAL AND STATE PARTNERS

FEDERAL AND STATE CONTACT INFORMATION

YOUR PRIMARY RISK MAP CONTACT	DAVID RATTE FEMA Region X	Engineer Lead	David.Ratte@fema.dhs.gov

AGENCY	NAME	TITLE	EMAIL
FEMA	JAKE GRABOWSKY	Hazard Mitigation Community Planner	James.Grabowsky@fema.dhs.gov
	RYNN LAMB	Risk Analyst	Rynn,Lamb@fema.dhs.gov
	ROXANNE PILKENTON	Floodplain Management Specialist	Roxanne.Reale-Pilkenton@fema.dhs.gov
	WENDY SHAW	Regional Engineer	Wendy.Shaw@fema.dhs.gov
DOGAMI	CHRISTINA APPLEBY	GIS & Remote Sensing	Christina.Appleby@oregon.gov
	MATT WILLIAMS	Geohazards Analyst	Matt.Williams@oregon.gov
DLCD	CELINDA ADAIR	State NFIP Coordinator	Cadair@dlcd.state.or.us
OEM	AMIE BASHANT	State Hazard Mitigation Officer	Amie.E.Bashant@mil.state.or.us
STRATEGIC ALLIANCE FOR RISK REDUCTION II	KATIE DOPIERALA	Project Manager	Katie.Dopierala@atkinsglobal.com
RESILIENCE ACTION PARTNERS	CHELSEA KAHN	Community Engagement and Risk Communication	Chelsea.Kahn@mbakerintl.com

Appendix I: FEMA Review Tool and Resolutions of Approval

LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: Baker County, Oregon	**Title of Plan:** 2020 Baker County Multi-Jurisdictional Natural Hazard Mitigation Plan	**Date of Plan:** October 2020
Local Point of Contact: Katherine Daniel	**Address:** 635 Capitol Street NE, Suite 150 Salem, OR 97301-2540	
Title: Hazard Mitigation Planner		
Agency: Oregon Department of Land Conservation and Development		
Phone Number: 971-375-3767	**E-Mail:** katherine.daniel@state.or.us	

State Reviewer: Joseph Murray	**Title:** Planner	10/22/2020

FEMA Reviewer: Claire Fetters Josh Vidmar Edgar Gomez edgar.gomez@fema.dhs.gov	**Title:** CERC Planner CERC Planner Hazard Mitigation Community Planner	**Date:** 10/27/2020 10/27/2020 12/2/2020
Date Received in FEMA Region 10	10/22/2020	
Plan Not Approved		

Plan Approvable Pending Adoption	12/9/2020
Plan Approved	2/9/2021

SECTION 1:
MULTI-JURISDICTION SUMMARY SHEET (OPTIONAL)

INSTRUCTIONS: For multi-jurisdictional plans, a Multi-jurisdiction Summary Spreadsheet may be completed by listing each participating jurisdiction, which required Elements for each jurisdiction were 'Met' or 'Not Met,' and when the adoption resolutions were received. This Summary Sheet does not imply that a mini-plan be developed for each jurisdiction; it should be used as an optional worksheet to ensure that each jurisdiction participating in the Plan has been documented and has met the requirements for those Elements (A through E).

MULTI-JURISDICTION SUMMARY SHEET													
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
1	Baker County	County	Jason Yencopal				Y	Y	Y	Y	Y	
2	Baker City	City	Michelle Owen				Y	Y	Y	Y	Y	
3	Halfway	City	Salli Hysell				Y	Y	Y	Y	Y	
4												
5												
6												
7												
8												

SECTION 2:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan (section and/or page number)**	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Ack., p. iii; Vol. I, Sec. 1, p. 4; App. B, pp. 4-16	X	
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Vol. I, Section 1, p. 4; App. B, p. 4	X	
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Vol. I, Sec. 1, p. 4; Vol. I, Sec. 3, p. 2; App. B, pp. 2-3, 17-22	X	
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Vol. I, Sec. 1, pp. 4-5; References included throughout the plan	X	
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Vol. I, Sec. 4, p. 6	X	
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Vol. I, Sec. 1, p. 5; Vol. I, Sec. 4, pp. 3-8	X	
<u>ELEMENT A: REQUIRED REVISIONS</u>			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Vol. I, Sec. 2, pp. 1-46; **Individual Annexes** Vol. II, Drought, pp. 1-8; Vol. II, Wildfire, pp. 1-11; Vol. II, Flood, pp. 1- 10; Vol. II, Landslide, pp. 1-10; Vol. II, Severe Weather, pp. 1-10; Vol. II, Earthquake, pp. 1-11; Vol. II, Volcanic Event, pp. 1-9; App. A, pp. 32-33	X	
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Vol. I, Sec. 2, pp. 1-46; **Individual Annexes** Vol. II, Drought, pp. 1-8; Vol. II, Wildfire, pp. 1-11; Vol. II, Flood, pp. 1- 10; Vol. II, Landslide, pp. 1-10; Vol. II, Severe Weather, pp. 1-10; Vol. II, Earthquake, pp. 1-11; Vol. II, Volcanic Event, pp. 1-9; App. A, p. 32	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Vol. I, Sec. 2, pp. 1-46; **Individual Annexes** Vol. II, Drought, pp. 1-8; Vol. II, Wildfire, pp. 1-11; Vol. II, Flood, pp. 1- 10; Vol. II, Landslide, pp. 1-10; Vol. II, Severe Weather, pp. 1-10; Vol. II, Earthquake, pp. 1-11; Vol. II, Volcanic Event, pp. 1-9; App. A, pp. 26-27	X	
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Vol. I, Sec. 2, p. 29; Vol. II, Flood, p. 8	X	
ELEMENT B: REQUIRED REVISIONS			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Vol. I, Sec. 3, pp. 10-15; Vol. I, Sec. 4, pp. 1-2 App. A, pp. 36-37	X	
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Vol. I, Sec. 2, pp. 28-29; Vol. I, Sec. 3, pp. 6-8 Vol. II, Flood, pp. 8-9	X	
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Vol. I, Sec. 3, p. 1	X	
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Vol. I, Sec. 3, pp. 4-9	X	
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Vol. I, Sec. 3, pp. 3-9, 15; App. C, p. 11-57; App. E, pp. 1-8; App. F, pp. 1-5	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Vol. I, Sec. 3, pp. 4, 10; Vol. I, Sec. 4, pp. 4-5; App. C, p. 28; App. H, pp. 2-28	X	
ELEMENT C: REQUIRED REVISIONS **C5-c.** The timeframe descriptors – short term, medium term, long term, and routine – need to be defined. Mitigation actions must also identify potential funding sources. Provide definitions for each of the four timeframe terms and provide potential funding sources for each mitigation action in the plan.			
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Vol. I, Sec. 1, pp. 7-9; App. A, pp. 4-5, 13-20, 24-25	X	
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Vol. I, Sec. 3, pp. 4-9; App. C, pp. 1-12	X	
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Vol. I, Sec. 3, pp. 1-2; Vol. II, Introduction, p. iv; App. B, pp. 23-25	X	
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))	Vol. I, Sec. 4, p. 3; App. I, p. 1	x	
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	Vol. I, Sec. 4, p. 3; App. I, p. 1	x	
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

Plan Strengths

- The plan identifies a convener and the possible responsibilities that come with the title.
- A toolkit is provided for the next update of the mitigation plan, streamlining the update process for the planning area.

Opportunities for Improvement

- Include a narrative regarding why the majority of the jurisdictions within Baker County chose to not participate in the planning process.
- In the narratives regarding plan maintenance and continued public participation, use more actionable language to discuss responsibilities, meeting agendas, and efforts to involve the public.

Element B: Hazard Identification and Risk Assessment

Plan Strengths

- HAZUS-MH and other data sets were used to create flooding, wildfire, earthquake, and landslide scenarios to present the impacts each event would have on the planning area.
- A RiskMAP Discovery Report was completed for the planning area as well as included in the Appendix of the mitigation plan.

Opportunities for Improvement

- Be sure that all maps and figures are visible in order to support the risk assessment section.
- Although each hazard profile has a uniform timeframe to measure frequency of events, historical occurrences of hazard events could also be added to support the hazard profiles as significant events may not have occurred since the previous plan was adopted.
- The vulnerability assessment could be improved by conducting a vulnerability assessment for each hazard in the plan. Each hazard identified as a risk to the planning area exposes unique vulnerabilities that should be identified.
- Rather than splitting up the risk assessment and hazard annexes, condense the two sections so that all information regarding each hazard can be found in one complete profile.
- The potential impacts for drought is best described using as much quantitative data as possible.
- It would be useful to provide more detail around the dust storm and extreme temperature hazards.
- Appendix A identifies four dam failure events in the planning area, one of which caused seven deaths. As part of an update if any of the dams are be considered high hazard potential dams there would be an opportunity to apply to the HHPD grand program.

Element C: Mitigation Strategy

Plan Strengths

- The mitigation actions are thorough and include worksheets that provide a surplus of information for each action.
- The capability assessment for the jurisdictions goes beyond the requirements and includes technical, administrative, and fiscal capabilities.

Opportunities for Improvement

- While actions are identified for "multi-hazards" or "all hazards," each jurisdiction's identified hazards should have specified mitigation actions to match. A way to strengthen the plan is to develop actions that address the jurisdiction's vulnerabilities to each hazard.
- Include cost estimates for each mitigation action. While the estimates may not be exact, they will help the jurisdictions gauge how much of local funds may be needed to complete the mitigation actions.
- There is no narrative regarding how the previous plan was incorporated into other planning mechanisms other than the RiskMAP Discovery Report.
- The timeframe descriptors – short term, medium term, long term, and routine – can further be defined. Mitigation actions can also identify potential funding sources. In the future providing definitions for each of the four timeframe terms and providing potential funding sources for each mitigation action in the plan are helpful to consider.
- The plan states how many are living in poverty in the planning area and how these people are more vulnerable to hazards. Consider directly linking or creating mitigation actions that address this specific vulnerability.
- There are mitigation actions in the plan for Haines. Because they did not participate in the plan and are not lined up to formally adopt it, they will not be eligible for FEMA funds.

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

Plan Strengths

- Table 1 in Appendix C provides clear reasoning behind the removal of mitigation actions.
- The mitigation plan is posted on the county's website. To go one step further would be to permit comments to be made by the public via online submission at any time.

Opportunities for Improvement

- Another set of data that could be added to the county profile would be the comparison between occupied versus vacant building structures as the planning area overall has experienced a decline in population. Vacant homes, businesses, and other buildings increase a community's vulnerability to hazards.
- The discussion regarding developments since the previous plan could be expanded upon. While there has not been any new development, identifying areas, structures, and other entities that have become more vulnerable would strengthen the section.

B. Resources for Implementing Your Approved Plan

FEMA **Mitigation Planning and the Community Rating System** Key Topics Bulletin supports communities who participate in the National Flood Insurance Program's CRS Program, or who would like to, and updating a Natural Hazard Mitigation Plan. You can reach this information at https://www.fema.gov/media-library/assets/documents/171290.

The **Region 10 Integrating Natural Hazard Mitigation into Comprehensive Planning** is a resource specific to Region 10 states and provides examples of how communities are integrating natural hazard mitigation strategies into comprehensive planning. You can find it in the FEMA Library at http://www.fema.gov/media-library/assets/documents/89725.

The **Integrating Hazard Mitigation Into Local Planning: Case Studies and Tools for Community Officials** resource provides practical guidance on how to incorporate risk reduction strategies into existing local plans, policies, codes, and programs that guide community development or redevelopment patterns. It includes recommended steps and tools to assist with local integration efforts, along with ideas for overcoming possible impediments, and presents a series of case studies to demonstrate successful integration in practice. You can find it in the FEMA Library at http://www.fema.gov/library/viewRecord.do?id=7130.

The **Mitigation Ideas: A Resource for Reducing Risk from Natural Hazards** resource presents ideas for how to mitigate the impacts of different natural hazards, from drought and sea level rise, to severe winter weather and wildfire. The document also includes ideas for actions that communities can take to reduce risk to multiple hazards, such as incorporating a hazard risk assessment into the local development review process. You can find it in the FEMA Library at http://www.fema.gov/library/viewRecord.do?id=6938.

The **Local Mitigation Planning Handbook** provides guidance to local governments on developing or updating hazard mitigation plans to meet and go above the requirements. You can find it in the FEMA Library at http://www.fema.gov/library/viewRecord.do?id=7209.

The **Integration Hazard Mitigation and Climate Adaptation Planning: Case Studies and Lessons Learned** resource is a 2014 ICLEI publication for San Diego with a clear methodology that could assist in next steps for integration impacts of climate change throughout mitigation actions. http://icleiusa.org/wp-content/uploads/2015/08/Integrating-Hazard-Mitigation-and-Climate-Adaptation-Planning.pdf

The **Local Mitigation Plan Review Guide and Tool** resource is available through FEMA's Library and should be referred to for the next plan update. http://www.fema.gov/library/viewRecord.do?id=4859

The **Tribal Multi-Hazard Mitigation Planning Guidance:** This resource is specific to tribal governments developing or updating tribal mitigation plans. It covers all aspects of tribal planning requirements and the steps to developing tribal mitigation plans. You can find the document in the FEMA Library at http://www.fema.gov/media-library/assets/documents/18355

Volcanic Eruption Mitigation Measures: For information on Mitigation Actions for Volcanic Eruptions that would satisfy the C4 requirement, please visit: http://earthzine.org/2011/03/21/volcanic-crisis-management-and-mitigation-strategies-a-multi-risk-framework-case-study/ and http://www.gvess.org/publ.html.

The FEMA Region 10 **Risk Mapping, Analysis, and Planning program (Risk MAP)** releases a monthly newsletter that includes information about upcoming events and training opportunities, as well as hazard and risk related news from around the Region. Past newsletters can be viewed at http://www.starr-team.com/starr/RegionalWorkspaces/RegionX/Pages/default.aspx. If you would like to receive future newsletters, email rxnewsletter@starr-team.com and ask to be included.

The mitigation strategy may include eligible projects to be funded through FEMA's hazard mitigation grant programs (Building Resilient Infrastructure and Communities, Hazard Mitigation Grant Program, and Flood Mitigation Assistance). Contact your State Hazard Mitigation Officer, Amie Bashant at amie.bashant@mil.state.or.us, for more information.

THE BOARD OF COUNTY COMMISSIONERS OF THE STATE OF OREGON
FOR THE COUNTY OF BAKER

IN THE MATTER OF	) RESOLUTION NO. 2021-1001
ADOPTING THE 2020 BAKER COUNTY	)
MULTI-JURISDICTIONAL NATURAL	)
HAZARD MITIGATION PLAN	)

WHEREAS, Baker County recognizes the threat that natural hazards pose to people, property and infrastructure within our community; and

WHEREAS, undertaking hazard mitigation actions will reduce the potential for harm to people, property and infrastructure from future hazard occurrences; and

WHEREAS, an adopted Natural Hazards Mitigation Plan is required as a condition of future funding for mitigation projects under multiple FEMA pre- and post-disaster mitigation grant programs; and

WHEREAS, Baker County has identified natural hazard risks and prioritized a number of proposed actions and programs needed to mitigate the vulnerabilities of the Baker County to the impacts of future disasters within the 2020 Baker County Multi-Jurisdictional Natural Hazard Mitigation Plan; and

WHEREAS, these proposed projects and programs have been incorporated into the 2020 Baker County Multi-Jurisdictional Natural Hazard Mitigation Plan that has been prepared and promulgated for consideration and implementation by Baker County and the participating cities; and

WHEREAS, the Oregon Office of Emergency Management and Federal Emergency Management Agency, Region X officials have reviewed the 2020 Baker County Multi-Jurisdictional Natural Hazard Mitigation Plan and pre-approved it (dated, December 9, 2020) contingent upon this official adoption of the participating governments and entities;

NOW, THEREFORE, be it resolved, that Baker County adopts the 2020 Baker County Multi-Jurisdictional Natural Hazard Mitigation Plan as an official plan; and

BE IT FURTHER RESOLVED, that Baker County will submit this Adoption Resolution to the Oregon Military Department's Office of Emergency Management and Federal Emergency Management Agency, Region X officials to enable final approval of the 2020 Baker County Multi-Jurisdictional Natural Hazard Mitigation Plan.

Done and Dated this 20th day of January, 2021

Baker County Board of Commissioners

Bill Harvey, Commission Chair

Bruce Nichols, Commissioner

Mark E. Bennett, Commissioner

RESOLUTION NO. 01-14-2021

A RESOLUTION ADOPTING THE CITY OF HALFWAY'S REPRESENTATION IN THE 2020 BAKER COUNTY MULTI-JURISDICTIONAL NATURAL HAZARD MITIGATION PLAN

WHEREAS, natural hazards threaten life, businesses, property, and environmental systems in the City of Halfway and throughout Baker County.

WHERAS, an understanding of the nature, extent, and potential impacts of natural hazards is the foundation for developing strategies to reduce or eliminate those impacts.

WHEREAS, natural hazards mitigation planning is the process through which such understanding and strategies are developed and a process for implementation is established in the City of Halfway and throughout Baker County.

WHEREAS, it is in the interest of Baker County and the cities and special districts located therein to undertake natural hazards mitigation planning and implementation together as coordinated planning strengthens communities and better serves all.

WHEREAS, Baker County and City of Halfway previously prepared implemented, and updated multi-jurisdictional natural hazards mitigation plans in accordance with the Disaster Mitigation Act of 2000. These plans were each approved by the Federal Emergency Management Agency (FEMA) for a period of five years.

WHEREAS, having a natural hazards mitigation plan developed in accordance with the Disaster Mitigation Act of 2000 and approved by FEMA is a prerequisite for local government eligibility for certain federal pre- and post-disaster mitigation funds.

WHEREAS, Baker County, and the City of Halfway participated in updating the 2008 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan in accordance with the Disaster Mitigation Act of 2000.

WHEREAS, the City of Halfway participated in updating the 2008 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan in accordance with the Disaster Mitigation Act of 2000, thereby developing their first natural hazards mitigation plans.

WHEREAS, as a result of coordinated planning, the 2020 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan is an integral plan, without an individual addendum for each participating jurisdiction but with the necessary information for each.

WHEREAS, Adoption of the updated 2020 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan is required for FEMA approval of the 2020 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan and restored eligibility for certain federal pre- and post-disaster mitigation funds.

WHEREAS, adoption of the updated 2020 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan demonstrated the City of Halfway's commitment to reducing or eliminating the potential impacts of natural hazards and to achieving the Plan's goals.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY OF HALFWAY

Section 1. The City of Halfway City Council hereby adopts the recitals above in support of this resolution.

Section 2. The City of Halfway City Council hereby adopts the Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan.

Nik Melchior, Honorable Mayor, City of Halfway

ATTEST:

Salli Hysell

Salli Hysell, City Recorder, City of Halfway

APPROVED AS TO FORM:

Rose Darting

Rose Darting, Council President,
City of Halfway

RESOLUTION NO. 3880

A RESOLUTION ADOPTING THE 2020 BAKER COUNTY MULTI-JURISDICTIONAL NATURAL HAZARDS MITIGATION PLAN

WHEREAS, natural hazards threaten life, businesses, property, and environmental systems in the City of Baker City and throughout Baker County.

WHEREAS, an understanding of the nature, extent, and potential impacts of natural hazards is the foundation for developing strategies to reduce or eliminate those impacts.

WHEREAS, natural hazards mitigation planning is the process through which such understanding and strategies are developed and a process for implementation is established in the City of Baker City and throughout Baker County.

WHEREAS, it is in the interest of Baker County and the cities and special districts located therein to undertake natural hazards mitigation planning and implementation together as coordinated planning strengthens communities and better serves all.

WHEREAS, Baker County and the Cities of Baker City and Halfway previously prepared, implemented, and updated multi-jurisdictional natural hazards mitigation plans in accordance with the Disaster Mitigation Act of 2000. These plans were each approved by the Federal Emergency Management Agency (FEMA) for a period of five years.

WHEREAS, the 2014 Northeast Oregon Multi-Jurisdictional Natural Hazards Mitigation Plan is the most recent and expired in July of 2019,

WHEREAS, having a natural hazards mitigation plan developed in accordance with the Disaster Mitigation Act of 2000 and approved by FEMA is a prerequisite for local government eligibility for certain federal pre- and post-disaster mitigation funds.

WHEREAS, Baker County, the Cities of Baker City and Halfway each participated in updating the 2020 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan in accordance with the Disaster Mitigation Act of 2000.

WHEREAS, as a result of coordinated planning, the 2020 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan is an integrated plan, without an individual addendum for each participating jurisdiction but with the necessary information for each.

WHEREAS, adoption of the updated 2020 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan is required for FEMA approval of the 2020 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan and restored eligibility for certain federal pre- and post-disaster mitigation funds.

WHEREAS, adoption of the updated 2020 Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan demonstrates the City of Baker City's commitment to reducing or eliminating the potential impacts of natural hazards and to achieving the Plan's goals.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF BAKER CITY:

Section 1. The City Council hereby adopts the recitals above in support of this resolution.

Section 2. The City Council hereby adopts the Baker County Multi-Jurisdictional Natural Hazards Mitigation Plan.

DATED this 23rd day of February, 2021.

Kerry McQuisten

Mayor, City of Baker City

ATTEST:

K. LaFavor

City Recorder