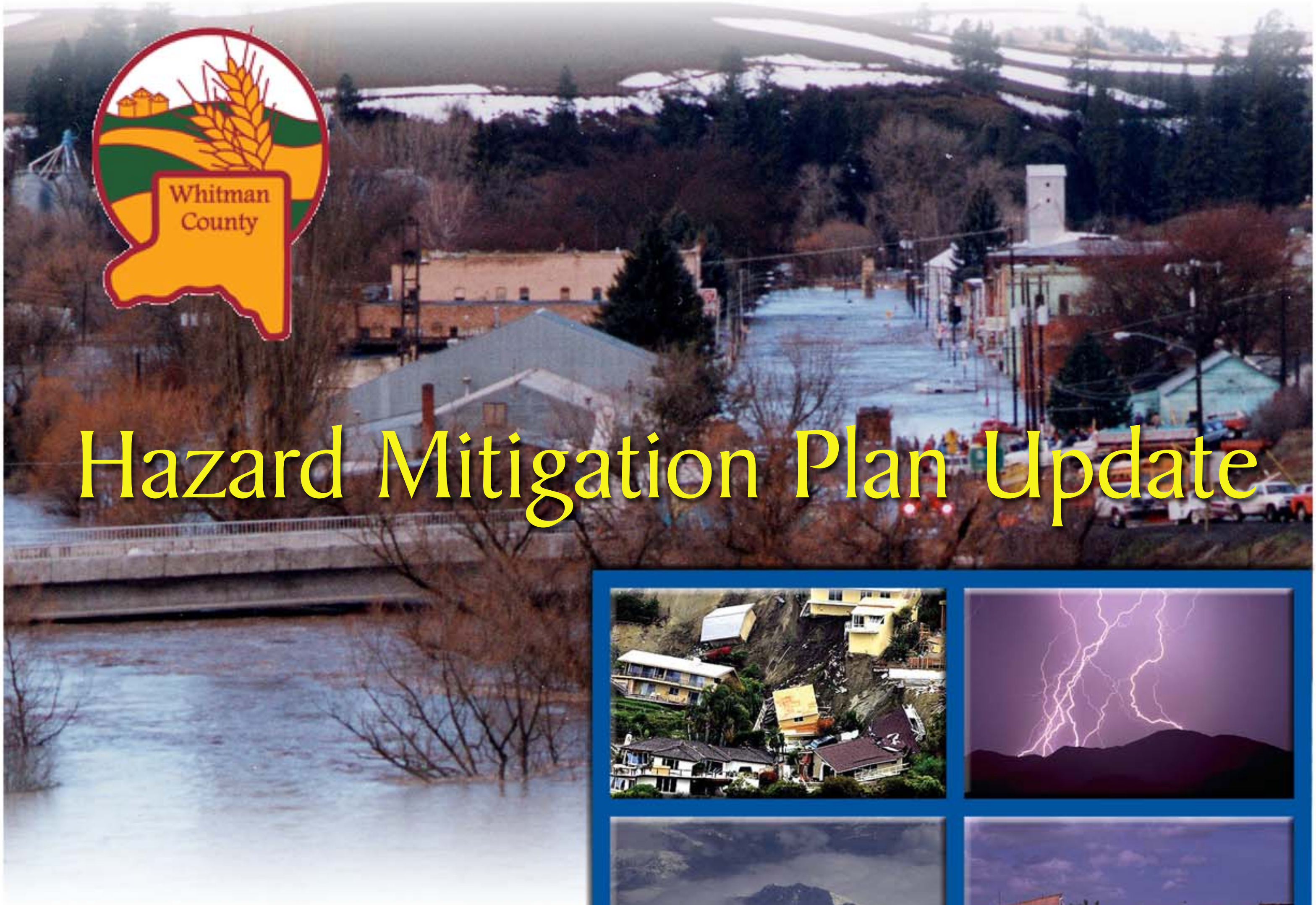
Whitman County



Hazard Mitigation Plan Update

Volume 1: Planning-Area-Wide Elements

Public Review Draft

January 2013

TETRA TECH

Whitman County

HAZARD MITIGATION PLAN UPDATE
VOLUME 1: PLANNING-AREA-WIDE ELEMENTS

DRAFT

January 2013

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Project #135-12436-11001

Whitman County

Hazard Mitigation Plan Update;

Volume 1—Planning-Area-Wide Elements

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Special Acknowledgments

The development of this plan would not have been possible without the dedication and commitment to this process of the Whitman County Hazard Mitigation Plan Steering Committee, the planning partners, and the stakeholders and citizens of Whitman County. The dedication of the steering committee volunteers who graciously allocated their time to this process is greatly appreciated. Whitman County citizens and all who participated in the public process are commended for their participation and contributions to this planning process.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Disaster Mitigation Act (DMA) is federal legislation that requires proactive, pre-disaster planning as a prerequisite for some funding available under the Robert T. Stafford Act. The DMA encourages state and local authorities to work together on pre-disaster planning. The enhanced planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects.

Hazard mitigation is the use of long- and short-term strategies to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. It is impossible to predict exactly when and where disasters will occur or the extent to which they will impact an area, but with careful planning and collaboration among public agencies, stakeholders and citizens, it is possible to minimize losses that disasters can cause. The responsibility for hazard mitigation lies with many, including private property owners; business and industry; and local, state and federal government.

Whitman County and a partnership of local governments within the County have developed and maintained a hazard mitigation plan to reduce risks from natural disasters and to comply with the DMA.

PLAN UPDATE

Federal regulations require monitoring, evaluation and updating of hazard mitigation plans. An update provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. A jurisdiction covered by a plan that has expired is no longer in compliance with the DMA.

The initial Whitman County Natural Hazard Mitigation Plan was approved by the Federal Emergency Management Agency (FEMA) on May 26, 2006. Since then, the partnership has completed or initiated ongoing action on over 44 percent of the 107 initiatives identified in the initial plan. While the initial performance of this plan was a success, the partnership's progress reporting has identified enhancements that would enable the plan to better support local needs:

- Use of best available data to update the risk assessment portion of the plan
- Use of available tools to enhance the risk assessment to better support future grant applications and local emergency management programs
- Re-engaging the public to see if the perception of risk within the planning area has changed since the initial effort
- Re-energizing and educating the participating partners on the funding opportunities the plan can enable.

Updating the plan consisted of the following phases:

- **Phase 1, Organize and Review**—A planning team was assembled to provide technical support for the plan update, consisting of key County staff from the Department of Emergency Management and a technical consultant. The first step in developing the plan update was to re-organize the planning partnership. The initial planning effort covered 21 local governments. For the update, 14 planning partners participated:

- Colton
- Endicott
- Farmington
- Garfield
- LaCrosse
- Oakesdale
- Palouse
- Pullman
- Pullman Regional Medical Center
- St. John
- Whitman County
- Whitman County Fire District #11
- Whitman County Fire District #7
- Whitman Hospital and Medical Center

A 16-member steering committee was assembled to oversee plan update, consisting of planning partner staff, citizens, and other stakeholders in the planning area. Coordination with other county, state and federal agencies involved in hazard mitigation occurred throughout the plan update process. This phase included a comprehensive review of the existing plan, the Washington State Hazard Mitigation Plan, and existing programs that may support or enhance hazard mitigation actions.

- **Phase 2, Update the Risk Assessment**—Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. This process assesses the vulnerability of people, buildings and infrastructure to natural hazards. All facets of the risk assessment of the plan were re-visited by the planning team and updated with the best available data and technology. The work included the following:
  - Hazard identification and profiling
  - Assessment of the impact of hazards on physical, social and economic assets
  - Vulnerability identification
  - Estimates of the cost of potential damage.
- **Phase 3, Engage the Public**—A public involvement strategy developed by the Steering Committee was implemented by the planning team. It included public meetings to present the risk assessment as well as the draft plan, distribution of a hazard mitigation survey, a County-sponsored website for the plan update, and multiple media releases.
- **Phase 4, Assemble the Updated Plan**—The planning team and Steering Committee assembled key information into a document to meet the DMA requirements for all planning partners. The updated plan contains two volumes. Volume 1 contains components that apply to all partners and the broader planning area. Volume 2 contains all components that are jurisdiction-specific. Each planning partner has a dedicated chapter in Volume 2.
- **Phase 5, Plan Adoption/Implementation**—Once pre-adoption approval has been granted by Washington's Emergency Management Division and FEMA Region X, the final adoption phase will begin. Each planning partner will individually adopt the updated plan. The plan maintenance process includes a schedule for monitoring and evaluating the plan's progress annually and producing a plan revision every 5 years. Throughout the life of this plan, a steering committee representative of the original committee will provide a consistent source of guidance and oversight.

MITIGATION GUIDING PRINCIPLE, GOALS AND OBJECTIVES

The following principle guided the Steering Committee and the planning partnership in selecting the initiatives contained in this plan update:

> Through public and private partnerships among local, state and federal partners, reduce the risk to natural hazards in order to ensure the health, safety, welfare and economic sustainability of the community.

The Steering Committee and the planning partnership established the following goals for the plan update:

1. Protect lives.
2. Protect property
3. Enhance the public's awareness of and preparedness for the impacts of natural hazards.
4. Develop and implement natural hazard mitigation strategies that use public and private funds in a cost-effective manner.
5. Maintain, enhance, or restore the natural environment's capacity to deal with the impacts of natural hazard events.

The following objectives were identified that meet multiple goals, acting as a bridge between the mitigation goals and actions and helping to establish priorities:

1. Consider the impacts of natural hazards on future land uses in Whitman County.
2. Educate the public on natural hazards and the risk they pose, with emphasis on preparation, mitigation, response and recovery activities.
3. Seek mitigation projects that will provide protection to property, including critical facilities, and/or mitigate impacts on the environment.
4. Enhance all facets of partnership emergency response capabilities, including mitigation of vulnerable critical facilities and infrastructure.
5. Seek mitigation projects that provide the highest degree of natural hazard protection at the least cost.
6. Create and maintain partnerships among all levels of government and the business community to coordinate mutually beneficial mitigation strategies.
7. Continually improve understanding of the location and potential impacts of natural hazards, the vulnerability of building types, community development patterns, and the measures needed to protect life safety.
8. Provide incentives to mitigate private property through programs such as the Community Rating System, Firewise and Storm Ready programs.
9. Seek appropriate land uses such as open space or agricultural uses of known high hazard areas within the planning area.
10. Strengthen codes so that new construction can withstand the impacts of identified natural hazards and lessen the impact of that development on the environment's ability to absorb the impact of natural hazards.

MITIGATION INITIATIVES

Mitigation initiatives presented in this update are activities designed to reduce or eliminate losses resulting from natural hazards. The update process resulted in the identification 108 mitigation initiatives for implementation by individual planning partners, as presented in Volume 2 of this plan. In addition, the steering committee and planning partnership identified countywide initiatives benefiting the whole partnership, as listed in Table ES-1.

TABLE ES-1.
ACTION PLAN—COUNTYWIDE MITIGATION INITIATIVES

Hazards Addressed	Lead Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-1— Enhance the Whitman County Emergency Response Plan so that it can be implemented uniformly in a coordinated effort throughout the planning area. This should include a post-disaster action plan that defines responsibilities and actions, leveraging all resources in the planning area.				
All Hazards	Whitman County Emergency Management	Department funding, DHS grants	Short-term	3, 4, 6
CW-2— Integrate the Hazard Mitigation Plan Steering Committee with the Local Emergency Planning Committee to ensure implementation of the plan maintenance strategy.				
All Hazards	Whitman County Emergency Management	Department funding	Short-term, Ongoing	2, 3, 4, 6
CW-3— Enhance the County Assessor data to a full digital format to better support a parcel-based risk assessment for future updates to this plan.				
All Hazards	Whitman County Assessor	General Fund	Long-term	1, 2, 6, 7
CW-4— Continue to maintain a countywide hazard mitigation plan website to present the plan and plan updates, in order to provide the public an opportunity to monitor plan implementation and progress. Each planning partner may support the initiative by including an initiative in its action plan and creating a web link to the website.				
All Hazards	Whitman County Emergency Management	Department funding	Short-term, Ongoing	2, 6, 7
CW-5— Leverage public outreach partnering capabilities to inform and educate the public about hazard mitigation and preparedness.				
All Hazards	Whitman County Emergency Management, All Planning Partners	General Fund, Planning Partner contributions, FEMA Grant funding	Short-term-Ongoing	2, 6, 7
CW-6—Coordinate all mitigation planning and project efforts, including grant application support, to maximize all resources available to the planning partnership.				
All Hazards	Whitman County Emergency Management	FEMA Grant Funding	Long-term	3, 5, 6, 7
CW-7— Consider the development of a Community Wildfire Protection Plan for Whitman County				
Wildfire	Whitman County Emergency Management	FEMA Grant Funding, general Fund	Long term	1, 2, 4, 6, 7
CW-8— Support the collection of improved data (hydrologic, geologic, topographic, volcanic, historical, etc.) to better assess risks and vulnerabilities.				
All Hazards	Whitman County Department of Public Works	General Fund, FEMA mitigation grants	Short term/ ongoing	1, 2, 4, 6, 7
CW-9—Where appropriate, support retrofitting, purchase, or relocation of structures or infrastructure located in hazard-prone areas to protect structures and infrastructure from future damage, with repetitive loss and severe repetitive loss properties as priorities when applicable.				
All Hazards	Al Planning Partners	FEMA mitigation grants	Long term	2, 3, 5, 6

IMPLEMENTATION

Full implementation of the recommendations of this plan will require time and resources. The measure of the plan's success will be its ability to adapt to the changing climate of hazard mitigation. Funding resources are always evolving, as are state and federal mandates. Whitman County and its planning partners will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan commits all planning partners to pursue initiatives when the benefits of a project exceed its costs. The planning partnership developed this plan with extensive public input, and public support of the actions identified in this plan will help ensure the plan's success.

PART 1 —
THE PLANNING PROCESS

CHAPTER 1.
INTRODUCTION TO THE PLANNING PROCESS

1.1 WHY PREPARE THIS PLAN?

1.1.1 The Big Picture

Hazard mitigation is defined as a way to reduce or alleviate the loss of life, personal injury and property damage that can result from a disaster through long- and short-term strategies. It involves strategies such as planning, policy changes, programs, projects and other activities that can mitigate the impacts of hazards. The responsibility for hazard mitigation lies with many, including private property owners; business and industry; and local, state and federal government.

The federal Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390) required state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Prior to 2000, federal disaster funding focused on disaster relief and recovery, with limited funding for hazard mitigation planning. The DMA increased the emphasis on planning for disasters before they occur.

The DMA encourages state and local authorities to work together on pre-disaster planning, and it promotes sustainability for disaster resistance. “Sustainable hazard mitigation” includes the sound management of natural resources and the recognition that hazards and mitigation must be understood in the largest possible social and economic context. The enhanced planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects.

1.1.2 Whitman County’s Response to the DMA

Whitman County has a tradition of proactive planning and preparedness for all phases of emergency management. In 2004, Whitman County Emergency Management led a multi-jurisdictional planning effort to fulfill the requirements of the DMA and Chapter 44 of the Code of Federal Regulations (44 CFR). The *Whitman County Natural Hazards Mitigation Plan* was adopted by the County and 20 planning partners in April 2006. The Plan was approved by FEMA Region X on May 23, 2006, establishing compliance with the DMA for the County and its planning partners. The plan addressed six hazards of concern: drought, earthquake, flood, severe weather, volcano and wildfire. The partnership has achieved numerous objectives identified in the plan, as reviewed in Chapter 2. Local hazard mitigation plans must be regularly updated to comply with the DMA, and the partnership is responding to this requirement with this plan update.

1.1.3 Purposes for Planning

This hazard mitigation plan update identifies resources, information and strategies for reducing risk from natural hazards. Elements and strategies in the plan were selected because they meet a program requirement and because they best meet the needs of the planning partners and their citizens. One of the benefits of multi-jurisdictional planning is the ability to pool resources and eliminate redundant activities within a planning area that has uniform risk exposure and vulnerabilities. The Federal Emergency Management Agency (FEMA) encourages multi-jurisdictional planning under its guidance for the DMA. The plan will help guide and coordinate mitigation activities throughout Whitman County. The plan was developed to meet the following objectives:

- Meet or exceed requirements of the DMA.
- Enable all planning partners to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner as well as state and federal requirements.
- Create a risk assessment that focuses on Whitman County hazards of concern.
- Create a single planning document that integrates all planning partners into a framework that supports partnerships within the County, and puts all partners on the same planning cycle for future updates.
- Meet the planning requirements of FEMA's Community Rating System (CRS), allowing planning partners that participate in the CRS program to maintain or enhance their CRS classifications.
- Coordinate existing plans and programs so that high-priority initiatives and projects to mitigate possible disaster impacts are funded and implemented.

1.2 WHO WILL BENEFIT FROM THIS PLAN?

All citizens and businesses of Whitman County are the ultimate beneficiaries of this hazard mitigation plan update. The plan reduces risk for those who live in, work in, and visit the County. It provides a viable planning framework for all foreseeable natural hazards that may impact the County. Participation in development of the plan by key stakeholders in the County helped ensure that outcomes will be mutually beneficial. The resources and background information in the plan are applicable countywide, and the plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.3 HOW TO USE THIS PLAN

This plan has been set up in two volumes so that elements that are jurisdiction-specific can easily be distinguished from those that apply to the whole planning area:

- **Volume 1**—Volume 1 includes all federally required elements of a disaster mitigation plan that apply to the entire planning area. This includes the description of the planning process, public involvement strategy, goals and objectives, countywide hazard risk assessment, countywide mitigation initiatives, and a plan maintenance strategy.
- **Volume 2**—Volume 2 includes all federally required jurisdiction-specific elements, in annexes for each participating jurisdiction. It includes a description of the participation requirements established by the Steering Committee, as well as instructions and templates that the partners used to complete their annexes. Volume 2 also includes "linkage" procedures for eligible jurisdictions that did not participate in development of this plan but wish to adopt it in the future.

All planning partners will adopt Volume 1 in its entirety and at least the following parts of Volume 2: Part 1; each partner's jurisdiction-specific annex; and the appendices.

The following appendices provided at the end of Volume 1 include information or explanations to support the main content of the plan:

- Appendix A—A glossary of acronyms and definitions
- Appendix B—Public outreach information, including the hazard mitigation questionnaire and summary and documentation of public meetings.

- Appendix C—Five-year progress report on the initial Whitman County Hazard Mitigation Plan
- Appendix D—A template for progress reports to be completed as this plan is implemented
- Appendix E—Plan Adoption Resolutions from Planning Partners

CHAPTER 2.
PLAN UPDATE—WHAT HAS CHANGED

2.1 THE INITIAL PLAN

Whitman County was awarded a grant from the federal Pre-Disaster Mitigation Grant Program to prepare the initial *Whitman County Natural Hazards Mitigation Plan*. The County hired a consultant to prepare the plan with oversight from a 13-member steering committee. The committee acted as the principle vehicle for public involvement in the plan development. The plan development process covered five principal phases: organization, risk assessment, public involvement, plan development and adoption. Preparation of the plan began in 2004, and the plan was adopted by 20 planning partners in the spring of 2006. The partnership received formal approval by FEMA on May 23, 2006. The plan consisted of two volumes divided into seven parts:

- Volume 1—Planning-Area-Wide Elements
  - Part 1—Background Information
  - Part 2—The Planning Process
  - Part 3—Risk Assessment
    - Drought
    - Earthquake
    - Flood
    - Severe Weather
    - Volcano (Ash fall)
    - Wildfire
  - Part 4—Mitigation Strategies
- Volume 2—Planning Partner Annexes
  - Part 1—Planning Partner Participation Requirements
  - Part 2—Municipal Partner Jurisdictional Annexes
  - Part 3—Special Purpose District Jurisdictional Annexes

The plan identified a guiding principal, five goals and 10 objectives, as well as 105 mitigation initiatives. Each initiative was prioritized based on the benefits of the project versus the cost, whether the project met multiple objectives, and whether the project could be implemented within the capabilities of the jurisdiction. The action plan was reviewed annually via a prescribed plan maintenance process that involved progress reports reviewed and prepared by the same steering committee that oversaw the plan's development.

2.2 HAZARD MITIGATION PROGRESS REPORT

The initial plan identified a plan maintenance strategy that included annual progress reports, but progress reporting was not completed during the initial performance period for the plan. This plan update process reviewed the feasibility of the initial plan's maintenance strategy and confirmed the value of annual progress reporting. To facilitate the process, this update includes a template for an annual progress report.

As the principle component of the initial plan review step for this update process, the template was completed by all participating planning partners as a five-year progress report,. This gave the planning partners an opportunity to familiarize themselves with the report format and content. The completed five-year progress report is included in Appendix C of this volume of the updated plan. Appendix D includes the template for future annual progress reports. Procedures for completion of the annual progress report are identified in Section 17.5 of this volume of the updated plan.

2.3 WHY UPDATE?

Title 44 of the Code of Federal Regulations (44 CFR) stipulates that hazard mitigation plans must present a schedule for monitoring, evaluating and updating the plan. This provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. A jurisdiction covered by a plan that has expired is not able to pursue elements of federal funding under the Robert T. Stafford Act for which a current hazard mitigation plan is a prerequisite.

2.4 THE UPDATED PLAN—WHAT IS DIFFERENT?

Due to the success of the initial plan, no major changes were made to the plan's format and function for this update. The plan has been significantly enhanced using recently updated best available data and technology, especially in the risk assessment portion. This plan update followed the same basic planning process as was used for the initial effort. A Steering Committee was once again the critical planning component in the process. Table 2-1 indicates the major changes between the two plans as they relate to 44 CFR planning requirements.

TABLE 2-1.
PLAN CHANGES CROSSWALK

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval; (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and (3) Review and incorporation, if appropriate, of existing plans, studies, reports and technical information.	Volume 1, Chapters 1, 2, 3, 4 and 5 describe the planning process the initial plan went through, including the planning process, organization of resources, agency coordination and public involvement.	Volume 1, Chapters 1, 2 and 3 describe the planning process the initial plan went through, including the planning process, organization of resources, agency coordination and public involvement. The narrative in these sections has been refined to reflect the process required for a plan update.
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	Part 3 of Volume 1 presents a comprehensive risk assessment for the planning area that looks at six hazards of concern: drought, earthquake, flood, severe weather, volcano (ash fall) and wildfire.	Part 2 of Volume 1 presents a comprehensive risk assessment for the planning area that looks at eight hazards of concern: dam failure, drought, earthquake, flood, landslide, severe weather, volcano (ash fall) and wildfire. This represents an enhancement from the initial plan by adding the dam failure and landslide hazards to the risk assessment.

**TABLE 2-1.
PLAN CHANGES CROSSWALK**

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(2)(i): [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	Volume 1, Part 3 included countywide extent location mapping for all hazards of concern. Each municipal annex in Volume 2 has jurisdiction-specific hazard maps.	Volume 1, Chapters 7 – 14 present a comprehensive risk assessment of each hazard of concern. Each chapter consists of the following components: • Hazard profile, including maps of extent and location, historical occurrences, frequency, severity and warning time. • Secondary hazards • Climate change impacts • Exposure of people, property, critical facilities and environment. • Vulnerability of people, property, critical facilities and environment. • Future trends in development • Scenarios • Issues
§201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community	Vulnerability was estimated using GIS applications with an emphasis on exposure and land use. Level 1 HAZUS analysis was used for exposure analyses only. HAZUS outputs were modeled for all hazards of concern.	Vulnerability was assessed for all hazards of concern. The HAZUS-MH computer model was used for the earthquake and flood hazards. These were abbreviated Level 2 analyses using planning partner and County data. Site-specific data on County-identified critical facilities was entered into the HAZUS model. HAZUS-MH outputs were generated for other hazards by applying an estimated damage function to affected assets. The asset inventory was extracted from the HAZUS-MH model. Best available data was used for all analyses.
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods	This was not a Section 201.6 planning requirement when the initial plan was done. However, Chapter 13.6.2 did include discussion on FEMA repetitive losses per CRS planning criteria.	The repetitive loss section was significantly enhanced to meet new DMA and CRS planning requirements. The update includes a comprehensive analysis of repetitive loss areas that includes an inventory of the number and types of structures in the repetitive loss area. Repetitive loss areas were delineated, causes of repetitive flooding was cited, and these areas were reflected on maps.

**TABLE 2-1.
PLAN CHANGES CROSSWALK**

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure and critical facilities located in the identified hazard area.	A complete inventory of the numbers and types of structures (assets) was developed using the census block level data on general building stock and critical facilities contained in HAZUS. The FEMA standard definition for critical facilities was used.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The Steering Committee defined “critical facilities” as they pertained to the planning area, and these facilities were inventoried by exposure. Each hazard chapter provides a discussion on future development trends as they pertain to each hazard
§201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	HAZUS-MH (MR-2) was used to estimate damage for the earthquake and flood hazards. These were Level 1 analyses using HAZUS default data. For the non-HAZUS hazards, vulnerability was discussed in anecdotal terms with an emphasis on exposure and land use. No loss-estimation models were used in the risk assessment.	Loss estimations in terms of dollar loss were generated for all hazards of concern. These were generated by HAZUS-MH for the earthquake and flood hazards. For the other hazards, loss estimates were generated by applying a regionally relevant damage function to the exposed inventory. In all cases, a damage function was applied to an asset inventory. The asset inventory was the same for all hazards and was generated in the HAZUS-MH model.
§201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.	An anecdotal analysis of future trends in development was applied to all hazards of concern.	Due to the lack of active growth management planning in the planning area, the same anecdotal approach to looking at future trends in development was applied for the plan update.
§201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment must assess each jurisdiction’s risks where they vary from the risks facing the entire planning area.	Each participating jurisdiction used data from the risk assessment to rank the hazards of concern based on the potential impact on the jurisdiction. A risk ranking methodology was developed to support this step.	Using the same risk ranking methodology developed for the initial plan, each jurisdiction ranked its risk using new data from the updated risk assessment.

**TABLE 2-1.
PLAN CHANGES CROSSWALK**

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.	The plan identifies 105 mitigation initiatives classified as countywide initiatives and jurisdiction-specific initiatives. The countywide initiatives are in Volume 1; the jurisdiction-specific initiatives are in Volume 2.	The update includes countywide initiatives and jurisdiction-specific initiatives. A crosswalk identifies the status of actions recommended in the initial plan.
§201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	The Steering Committee identified a guiding principal, 5 goals and 10 objectives, as described in Chapter 5.	The Steering Committee determined that the original guiding principal, goals and objectives are still relevant for the updated plan, with minor revisions.
§201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	A catalog of mitigation alternatives was developed via a facilitated planning process that looked at strengths, weaknesses, obstacles, and opportunities within the planning area. This catalog supported each planning partner in identification of actions for the plan.	An enhanced mitigation catalog was used by the partners during the update process. The catalog supported each planning partner as it did during the initial plan development process. The mitigation catalog was included in the body of the plan of the update, and not as an appendix, as it was in the initial plan. A matrix analyzing mitigation initiatives was added to each jurisdictional annex to identify which of six mitigation categories each initiative meets. This helps to illustrate the comprehensive range of actions identified.
§201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	This was not a section 201.6 planning requirement when the initial plan was done.	All municipal planning partners that participate in the National Flood Insurance Program have identified an action stating their commitment to maintain compliance and good standing under the program.

**TABLE 2-1.
PLAN CHANGES CROSSWALK**

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in section (c)(3)(ii) will be prioritized, implemented and administered by the local jurisdiction. Prioritization 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.	Each recommended initiative is prioritized using an qualitative methodology that looked at the objectives the project will meet, the timeline for completion, how the project will be funded, the impact of the project, the benefits of the project and the costs of the project. This prioritization scheme is detailed in Chapter 1 of Volume 2 of the plan.	The same prioritization scheme was carried over to the updated plan. This scheme is described in Chapter 1 of Volume 2 of the updated plan.
§201.6(c)(3)(iv): For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.	This was not a Section 201.6 planning requirement when the initial plan was done.	Chapter 17 of Volume 1 includes a countywide initiative for all participating jurisdictions to provide documentation of adoption to FEMA with a formal request for approval. This will be coordinated by Whitman County Department of Emergency Management
§201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.	Chapter 7 of Volume 1 details a plan maintenance strategy that includes maintaining a steering committee, annual progress reporting, a 5-year update protocol, a strategy for continuing public involvement, and methods for incorporation into other planning mechanisms.	The initial plan maintenance strategy has been carried over to the plan update.
§201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	Chapter 7 details recommendations for incorporating the plan into other planning components such as: • Critical areas regulation • Growth management • Capital improvements • Stormwater master planning.	The initial plan maintenance strategy has been carried over to the plan update.

**TABLE 2-1.
PLAN CHANGES CROSSWALK**

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	Chapter 7 details a strategy for continuing public involvement such as: • Website • Libraries • Publication of annual progress report	The initial plan maintenance strategy has been carried over to the plan update.
§201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commission, Tribal Council).	Volume 1, Chapter 6.	Volume 1, Section 17.4.

CHAPTER 3.
PLAN METHODOLOGY

To develop the Whitman County Hazard Mitigation Plan Update, the County followed a process that had the following primary objectives:

- Secure grant funding
- Form a planning team
- Establish a planning partnership
- Define the planning area
- Establish a steering committee
- Coordinate with other agencies
- Review existing programs
- Engage the public.

These objectives are discussed in the following sections.

3.1 GRANT FUNDING

This planning effort was supplemented by a grant from Washington Emergency Management Division. Whitman County Emergency Management was the applicant for the grant. The grant was applied for in 2009, and funding was appropriated in 2011. It covered 75 percent of the cost for development of this plan; the County and its planning partners covered the balance through in-kind contributions.

3.2 FORMATION OF THE PLANNING TEAM

Whitman County hired Tetra Tech, Inc. to assist with development and implementation of the plan update. The Tetra Tech project manager assumed the role of the lead planner, reporting directly to a County-designated project manager. A planning team was formed to lead the planning effort, made up of the following members:

- Fran Martin, Whitman County Emergency Management—County project manager
- Robin Cocking, Whitman County Emergency Management
- Rob Flaner, Tetra Tech—Lead project planner
- Ed Whitford, Tetra Tech—Risk assessment lead
- Beverly O’Dea, Tetra Tech—Planning support
- Dan Portman, Tetra Tech—Technical editor.

3.3 ESTABLISHMENT OF THE PLANNING PARTNERSHIP

Whitman County opened this planning effort to all eligible local governments within the County. The planning team made a presentation at a stakeholder meeting on May 11, 2011 to introduce the mitigation planning process and solicit planning partners. Key meeting objectives were as follows:

- Provide an overview of the Disaster Mitigation Act.
- Describe the reasons for a plan.
- Outline the County work plan.
- Outline planning partner expectations.
- Seek commitment to the planning partnership.
- Seek volunteers for the Steering Committee.

Each jurisdiction wishing to join the planning partnership was asked to provide a "letter of intent to participate" that designated a point of contact for the jurisdiction and confirmed the jurisdiction's commitment to the process and understanding of expectations. Linkage procedures have been established (see Volume 2 of this plan) for any jurisdiction wishing to link to the Whitman County plan in the future. The municipal planning partners covered under this Plan are shown in Table 3-1. The special purpose district planning partners are shown in Table 3-2.

TABLE 3-1.
COUNTY AND CITY PLANNING PARTNERS

Jurisdiction	Point of Contact	Title
Whitman County	Fran Martin	Director of Emergency Management
City of Palouse	Rick Wekenman	--
City of Pullman	Mark Workman	Director of Public Works
Town of Colton	Brian Keller	--
Town of Endicott	Sue Bafus	Town Clerk/Treasurer
Town of Farmington	Barbara Dial-Flomer	Town Clerk/Treasurer
Town of Garfield	Annie Pillers	Town Clerk
Town of LaCrosse	Angela Broeckel	Town Clerk/Treasurer
Town of Oakesdale	Mary Degon	Town Clerk/Treasurer
Town of St. John	Linda Hayes	Town Clerk/Treasurer

TABLE 3-2.
SPECIAL PURPOSE DISTRICT PLANNING PARTNERS

District	Point of Contact	Title
Whitman County FD #7	Bill Tensfeld	Fire Chief
Whitman County FD #11	Bill Tensfeld	—
Pullman Regional Hospital	Bill Whitman	Emergency Preparedness Coordinator
Whitman Hospital and Medical Center	Gary R. Burns	Facilities Manager/Safety Officer

3.4 DEFINING THE PLANNING AREA

The defined planning area for this effort is contiguous with the Whitman County boundary. All partners to this plan have jurisdictional authority within this planning area. The area is shown on Map 3-1.

3.5 THE STEERING COMMITTEE

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. A steering committee was formed to oversee all phases of the plan. The members of this committee included key planning partner staff, citizens and other stakeholders from within the planning area. The planning team assembled a list of candidates representing interests within the planning area that could have recommendations for the plan or be impacted by its recommendations. The partnership confirmed a committee of 16 members at the kickoff meeting. Table 3-3 lists the committee members.

**TABLE 3-3.
STEERING COMMITTEE MEMBERS**

Name	Title	Jurisdiction/Agency	Representing
Bill Tensfeld (Chair)	Fire Chief	Whitman Co. Fire Protection District #7	Planning Partner
Fran Martin (Vice-Chair)	Emergency Manager	Whitman Co. Emergency Management	Stakeholder
Mark Workman	Director of Public Works	City of Pullman	Planning Partner
Rick Wekenman	—	City of Palouse	Stakeholder/Citizen
Annie Pillars	Town Clerk	Town of Garfield	Planning Partner
Bill Whitman	—	Pullman Regional Hospital	Planning Partner
Sue Bafus	Town Clerk	Town of Endicott	Planning Partner
Barbara Dial Flomer	Town Clerk	Town of Farmington	Planning Partner
Linda Hayes	Town Clerk	Town of St. John	Planning Partner
Daryl Ruby	Regional Coordinator	Region IX	Stakeholder
Ted Olsen	Floodplain Management Specialist	Washington Department of Ecology	Agency/Stakeholder
Mary Degon	—	Town of Oakesdale	Planning Partner
Larry Burgess	—	Town of LaCrosse	Planning Partner
Brian Keller	—	Town of Colton	Planning Partner
Gary Burns	—	Whitman County Hospital	Planning Partner
Aaron Lee	Citizen	Citizen/Academia	Stakeholder/Citizen

Leadership roles and ground rules were established during the Steering Committee's initial meeting on November 30, 2011. The Steering Committee agreed to meet monthly as needed throughout the course of the plan's development. The planning team facilitated each Steering Committee meeting, which addressed a set of objectives based on the work plan established for the plan. The Steering Committee met six times from November 2011 through December 2012. Meeting agendas, notes and attendance logs are available for review upon request. All Steering Committee meetings were open to the public and agendas and meeting notes were posted to the hazard mitigation plan website (see Section 3.9).

3.6 COORDINATION WITH OTHER AGENCIES

Opportunities for involvement in the planning process must be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (44 CFR, Section 201.6(b)(2)). This task was accomplished by the planning team as follows:

- **Steering Committee Involvement**—Agency representatives were invited to participate on the Steering Committee.
- **Agency Notification**—The following agencies were invited to participate in the plan development process from the beginning and were kept apprised of plan development milestones:
  - Federal Emergency Management Agency (FEMA) Region X
  - Washington Department of Emergency Management
  - Washington Department of Ecology
  - Washington State Homeland Security Region IX

  These agencies received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan development process. These agencies supported the effort by attending meetings or providing feedback on issues.
- **Pre-Adoption Review**—All the agencies listed above were provided an opportunity to review and comment on this plan, primarily through the hazard mitigation plan website (see 3.9). Each agency was sent an e-mail message informing them that draft portions of the plan were available for review. In addition, the complete draft plan was sent to the Washington Department of Emergency Management for a pre-adoption review to ensure program compliance.

3.7 REVIEW OF EXISTING PROGRAMS

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (44 CFR, Section 201.6(b)(3)). Chapter 6 of this plan provides a review of laws and ordinances in effect within the planning area that can affect hazard mitigation initiatives. In addition, the following programs can affect mitigation within the planning area:

- Whitman County Emergency Response Plan—This is an emergency support function-based plan that directs emergency response actions in the planning area.
- Whitman County Comprehensive Plan—Amended in October 4, 2010, this plan directs land use policy in Whitman County.
- Washington Department of Transportation 6-Year Transportation Improvement Program (2013-2018) for Whitman County
- City of Pullman Comprehensive Flood Hazard Management Plan—Adopted in 2003, this plan was developed to provide the City of Pullman with direction and strategies for mitigating flooding problems in the community.

- City of Palouse Flood Mitigation Plan—Adopted in 1996, this plan identifies flood hazard mitigation strategies for the City of Palouse that affirms the city's goals for flood planning.

An assessment of all planning partners' regulatory, technical and financial capabilities to implement hazard mitigation initiatives is presented in Chapter 17 and in the individual jurisdiction-specific annexes in Volume 2. Many of these relevant plans, studies and regulations are cited in the capability assessment.

3.8 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 3-4 summarizes important milestones in the development of the plan.

**TABLE 3-4.
PLAN DEVELOPMENT MILESTONES**

Date	Event	Description	Attendance
2009			
11/1	Grant application submittal	County submits planning grant application under the Hazard Mitigation Grant Program for DR 1817/1825	N/A
2010			
6/30	County receives notice of grant award	Funding secured.	N/A
12/5	County initiates contractor procurement	Seek a planning expert to facilitate the process	N/A
2011			
1/6	County selects Tetra Tech to facilitate plan development	Facilitation contractor secured	N/A
5/11	Planning partner kickoff meeting	Initial meeting with potential planning partners. Attendees were advised of planning partner expectations and asked to formally commit to the process. Steering Committee volunteers were solicited.	17
6/17	Planning partnership finalized	Deadline for submittal of letters of intent to participate in the planning effort.	N/A
8/31	Steering Committee formed	Planning partners nominated potential committee members. The planning team received commitments from 15 members, finalizing the formation of the Steering Committee.	N/A
11/30	Steering Committee Meeting #1	• Review purposes for update • Organize steering committee • Plan review • Public involvement strategy	14
2012			
2/2	Steering Committee Meeting #2	• Risk assessment update • Plan review observations • Guiding principal, goals and objectives • Critical facilities • Public outreach update	11

**TABLE 3-4.
PLAN DEVELOPMENT MILESTONES**

Date	Event	Description	Attendance
3/15	Steering Committee Meeting #3	• Risk assessment update • Critical facilities definition • Progress report • Public outreach Phase 1	9
4/19	Steering Committee Meeting #4	• Risk assessment update • Critical facilities inventory • Progress report-update • Public outreach Phase 1 update	12
6/21	Steering Committee Meeting #5	• Presentation of the risk assessment • Progress report status • Public outreach	9
7/19	Jurisdictional Annex workshop	Mandatory session for planning partners. Workshop focused on how to complete the jurisdictional annex template.	15
10/17	Steering Committee Meeting #6	• Jurisdictional annex status • Schedule public meeting • Questionnaire status • What's next	8
12/13	Public Outreach	Public meeting to present both the final risk assessment as well as the draft plan. Meeting was held in conjunction with the Local Emergency Planning Committee meeting	31
2013			
X/X	Draft Plan	Internal review draft provided by planning team to Steering Committee	N/A
X/X	Public Comment Period	Initial public comment period of draft plan opens. Draft plan posted on plan website with press release notifying public of plan availability	N/A
X/X	Public Outreach	Final public meeting on Draft Plan	XX
X/X	Adoption	Adoption window of final plan b opens	N/A
X/X	Plan approval	Final draft plan submitted to [STATE REVIEW AGENCY] for review and approval	N/A
X/X	Plan Approval	Final plan approved by FEMA	N/A

3.9 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)). The Community Rating System expands on these requirements by making CRS credits available for optional public involvement activities.

3.9.1 Strategy

The strategy for involving the public in this plan emphasized the following elements:

- Include members of the public on the Steering Committee.

- Use a questionnaire to determine if the public's perception of risk and support of hazard mitigation has changed since the initial planning process.
- Attempt to reach as many planning area citizens as possible using multiple media.
- Identify and involve planning area stakeholders.

Stakeholders and the Steering Committee

Stakeholders are the individuals, agencies and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan, including planning partners. All planning partners are stakeholders in the process. The diversity brought to the table by special purpose districts and private non-profit entities creates an opportunity to forge partnerships between entities that typically do not work together in the field of hazard mitigation.

The effort to include stakeholders in this plan update included stakeholder participation on the Steering Committee. All members of the Steering Committee live or work within the planning area. Two members of the committee represent Whitman County citizen and property owner interests, and two members represent state agencies. The Steering Committee met throughout the course of the plan's development, and all meetings were open to the public. Protocols for handling public comments were established in the ground rules developed by the Steering Committee.

Questionnaire

A hazard mitigation plan questionnaire (see Figure 3-1) was developed by the planning team with guidance from the Steering Committee. The questionnaire was used to gauge household preparedness for natural hazards and the level of knowledge of tools and techniques that assist in reducing risk and loss from natural hazards. This questionnaire was designed to help identify areas vulnerable to one or more natural hazards. The answers to its 35 questions helped guide the Steering Committee in selecting goals, objectives and mitigation strategies. Over 100 hard copies of the questionnaires were disseminated throughout the planning area by multiple means. Additionally, a web-based version of the questionnaire was made available on the hazard mitigation plan website. Over 300 questionnaires were completed during the course of this planning process. The complete questionnaire and a summary of its findings can be found in Appendix B of this volume.

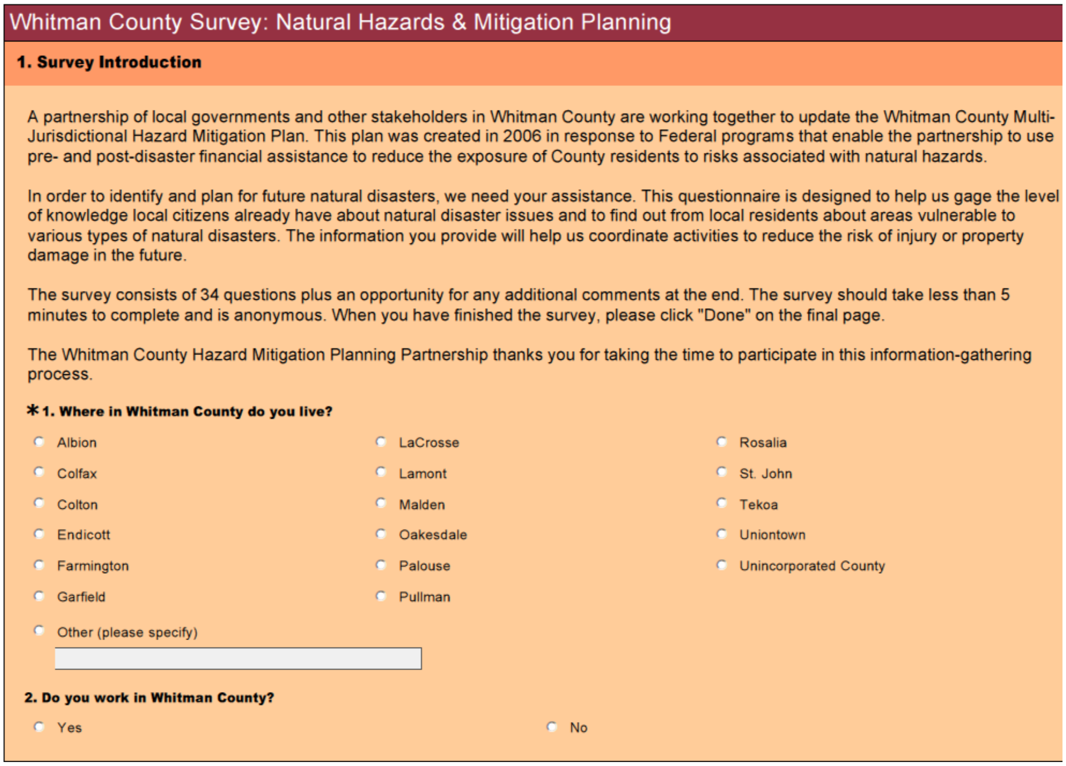
Opportunity for Public Comment

Public Meetings

A public meeting was held in conjunction with a Local Emergency Planning Committee meeting in Colfax on December 13, 2012 from 10 a.m. until noon (see Figure 3-2, Figure 3-3, Figure 3-4 and Figure 3-5). The purpose of the meeting was to present the final risk assessment as well as to initiate the final public comment period on the draft plan. The meeting format allowed attendees to examine maps and handouts and have direct conversations with project staff. Reasons for planning and information generated for the risk assessment were shared with attendees via a digital slide presentation. Planning partners and the planning team were present to answer questions. Each attendee was given an opportunity to provide written comments to the Steering Committee. Local media outlets were informed of the open houses by a press release from the County.

Press Releases

Press releases were distributed over the course of the plan's development as key milestones were achieved and prior to each public meeting. The planning effort received press coverage on March 6, 2012 and November 30, 2012.


Whitman County Survey: Natural Hazards & Mitigation Planning

1. Survey Introduction

A partnership of local governments and other stakeholders in Whitman County are working together to update the Whitman County Multi-Jurisdictional Hazard Mitigation Plan. This plan was created in 2006 in response to Federal programs that enable the partnership to use pre- and post-disaster financial assistance to reduce the exposure of County residents to risks associated with natural hazards.

In order to identify and plan for future natural disasters, we need your assistance. This questionnaire is designed to help us gage the level of knowledge local citizens already have about natural disaster issues and to find out from local residents about areas vulnerable to various types of natural disasters. The information you provide will help us coordinate activities to reduce the risk of injury or property damage in the future.

The survey consists of 34 questions plus an opportunity for any additional comments at the end. The survey should take less than 5 minutes to complete and is anonymous. When you have finished the survey, please click "Done" on the final page.

The Whitman County Hazard Mitigation Planning Partnership thanks you for taking the time to participate in this information-gathering process.

***1. Where in Whitman County do you live?**

Albion	LaCrosse	Rosalia
Colfax	Lamont	St. John
Colton	Malden	Tekoa
Endicott	Oakesdale	Uniontown
Farmington	Palouse	Unincorporated County
Garfield	Pullman	

Other (please specify)

2. Do you work in Whitman County?

Yes   No

Figure 3-1. Sample Page from Questionnaire Distributed to the Public


Figure 3-2. Maps Displayed at Public Meeting

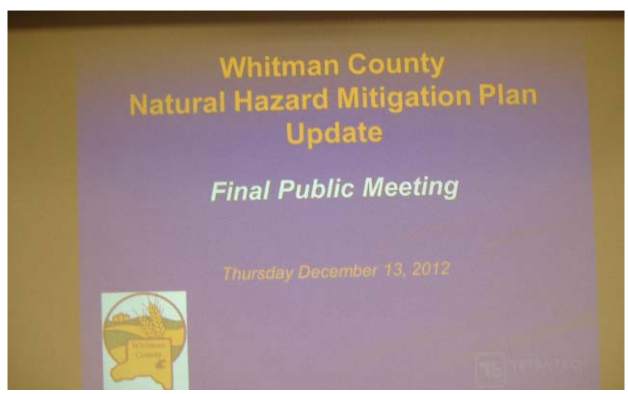


Figure 3-3. Digital Slide Presentation


Figure 3-4. Public Meeting Introductions


Figure 3-5. Citizens Look at Maps at Public Meeting

Internet

At the beginning of the plan development process, a website was created to keep the public informed on plan development milestones and to solicit relevant input (see Figure 3-6):

http://www.whitmancounty.org/Page.aspx?pn=Emergency+Management

The site’s address was publicized in all press releases, mailings, questionnaires and public meetings. Information on the plan development process, the Steering Committee, the questionnaire and phased drafts of the plan was made available to the public on the site throughout the process. The County intends to keep a website active after the plan’s completion to keep the public informed about successful mitigation projects and future plan updates.

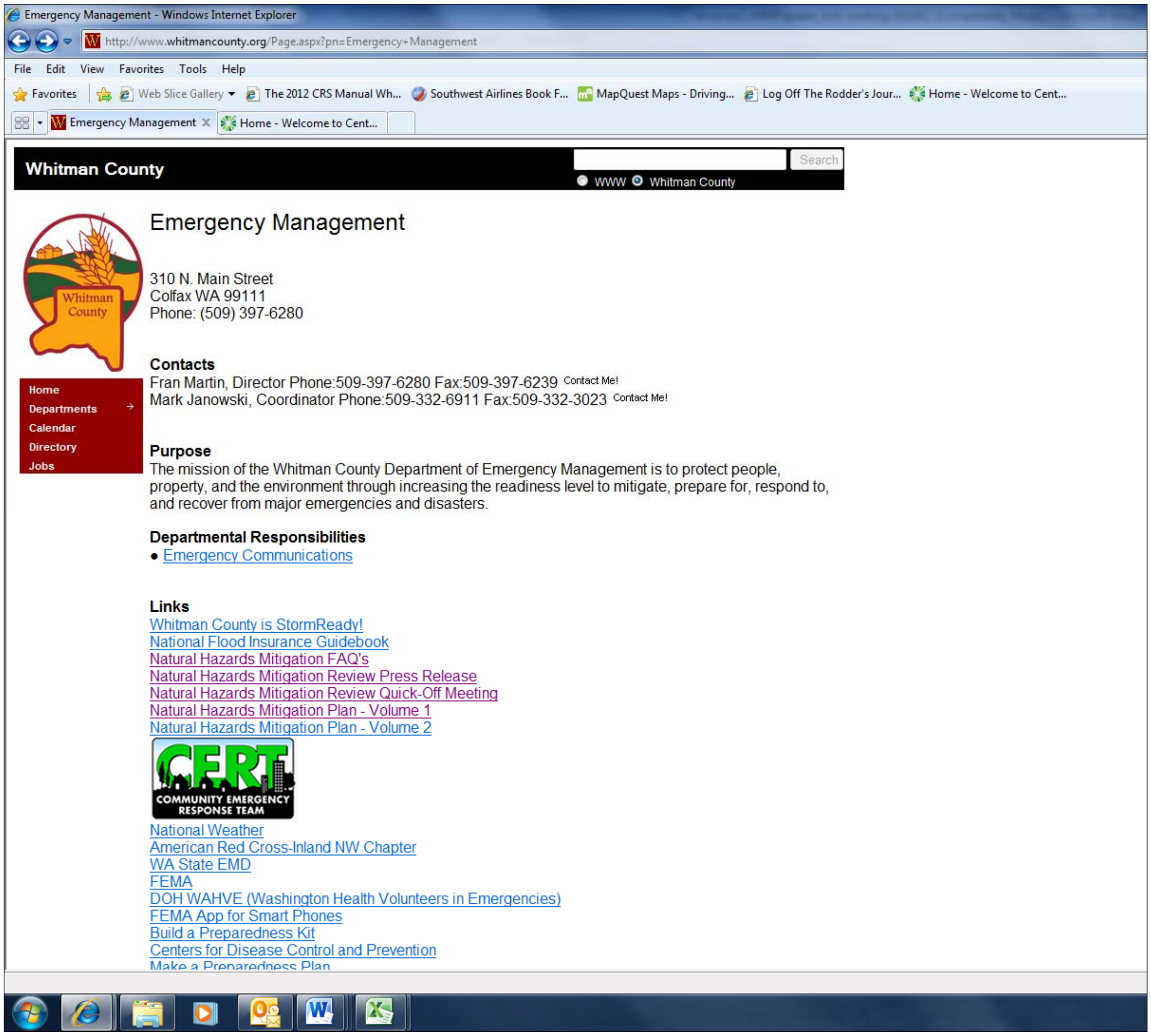
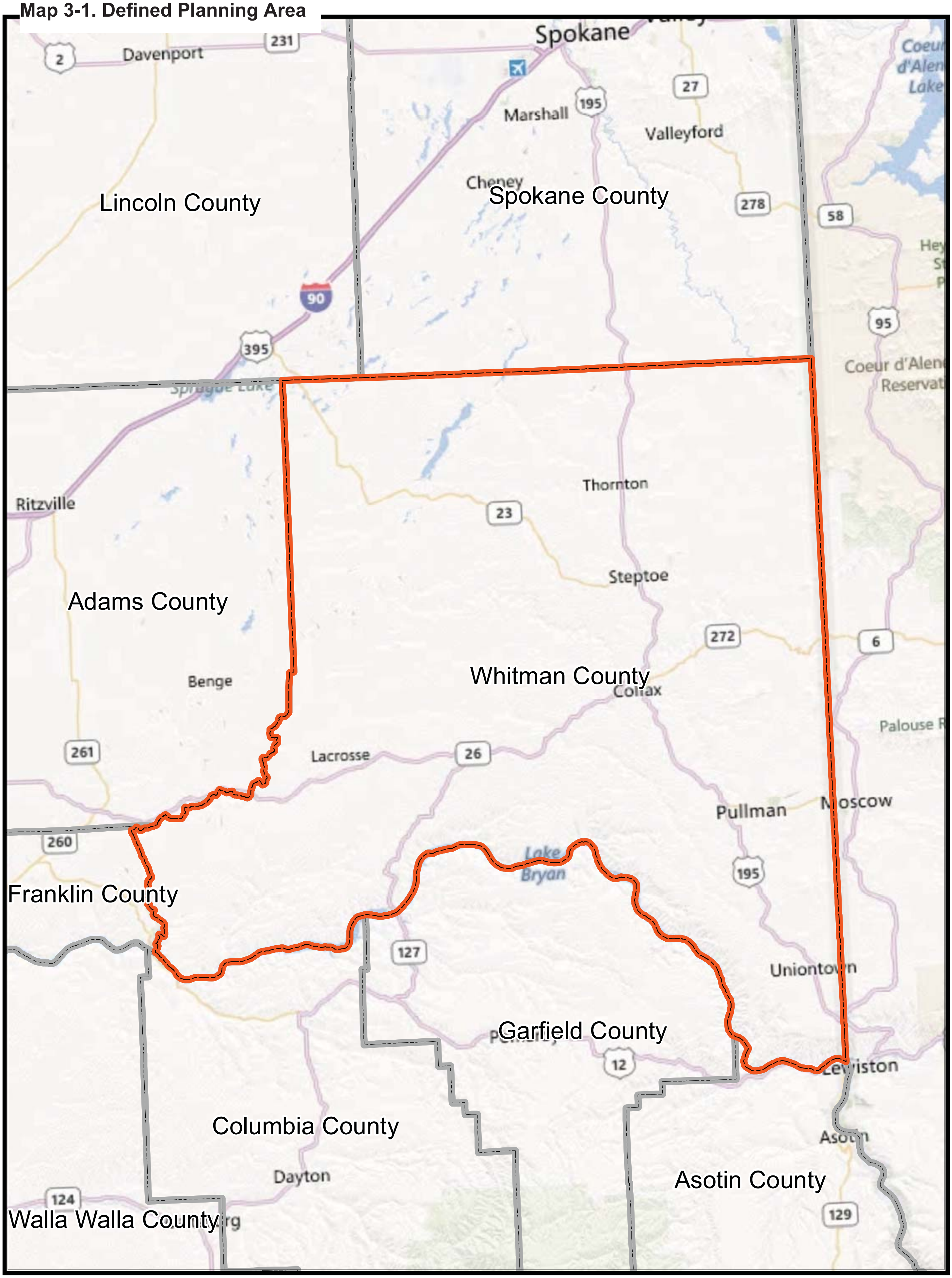


Figure 3-6. Sample Page from Hazard Mitigation Plan Web Site

3.9.2 Public Involvement Results

By engaging the public through the public involvement strategy, the concept of mitigation was introduced to the public, and the Steering Committee received feedback that was used in developing the components of the plan. The December 2012 public meeting drew 31 citizen attendees who completed five questionnaires and submitted five comments on the plan update.

Map 3-1. Defined Planning Area



CHAPTER 4.
GUIDING PRINCIPLE, GOALS AND OBJECTIVES

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). The Steering Committee established a guiding principle, a set of goals and measurable objectives for this plan, based on data from the preliminary risk assessment and the results of the public involvement strategy. The guiding principle, goals, objectives and actions in this plan all support each other. Goals were selected to support the guiding principle. Objectives were selected that met multiple goals. Actions were prioritized based on the action meeting multiple objectives.

4.1 GUIDING PRINCIPLE

A guiding principle focuses the range of objectives and actions to be considered. This is not a goal because it does not describe a hazard mitigation outcome, and it is broader than a hazard-specific objective. A guiding principal was chosen for the initial planning effort, and after review, the Steering Committee amended the guiding principle for this plan update as follows:

> Through public and private partnerships among local, state and federal partners, reduce the risk to natural hazards in order to ensure the health, safety, welfare and economic sustainability of the community.

4.2 GOALS

As was with the initial plan, the guiding principle, goals and objectives are linear. This means that all of these planning components directly support one another. Goals were selected that support the guiding principle. Objectives were selected that met multiple goals, and mitigation initiatives were prioritized based on meeting multiple objectives. This gives the plan more versatility in meeting multiple program requirements. After reviewing the initial plan goals, the Steering Committee revised them as follows for the plan update:

1. Protect lives.
2. Protect property
3. Enhance the public’s awareness of and preparedness for the impacts of natural hazards.
4. Develop and implement natural hazard mitigation strategies that use public and private funds in a cost-effective manner.
5. Maintain, enhance, or restore the natural environment’s capacity to deal with the impacts of natural hazard events.

The effectiveness of a mitigation strategy is assessed by determining how well these goals are achieved.

4.3 OBJECTIVES

Each selected objective meets multiple goals, serving as a stand-alone measurement of the effectiveness of a mitigation action, rather than as a subset of a goal. The objectives also are used to help establish priorities. As with the guiding principle and goals, the Steering Committee reviewed the objectives from the initial plan and revised them as follows for this update:

1. Consider the impacts of natural hazards on future land uses in Whitman County.

2. Educate the public on natural hazards and the risk they pose, with emphasis on preparation, mitigation, response and recovery activities.
3. Seek mitigation projects that will provide protection to property, including critical facilities, and/or mitigate impacts on the environment.
4. Enhance all facets of partnership emergency response capabilities, including mitigation of vulnerable critical facilities and infrastructure.
5. Seek mitigation projects that provide the highest degree of natural hazard protection at the least cost.
6. Create and maintain partnerships among all levels of government and the business community to coordinate mutually beneficial mitigation strategies.
7. Continually improve understanding of the location and potential impacts of natural hazards, the vulnerability of building types, community development patterns, and the measures needed to protect life safety.
8. Provide incentives to mitigate private property through programs such as the Community Rating System, Firewise and Storm Ready programs.
9. Seek appropriate land uses such as open space or agricultural uses of known high hazard areas within the planning area.
10. Strengthen codes so that new construction can withstand the impacts of identified natural hazards and lessen the impact of that development on the environment’s ability to absorb the impact of natural hazards.

PART 2 —
RISK ASSESSMENT

CHAPTER 5. IDENTIFIED HAZARDS OF CONCERN AND RISK ASSESSMENT METHODOLOGY

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury and property damage resulting from natural hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- Hazard identification—Use all available information to determine what types of disasters may affect a jurisdiction, how often they can occur, and their potential severity.
- Vulnerability identification—Determine the impact of natural hazard events on the people, property, environment, economy and lands of the region.
- Cost evaluation—Estimate the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan update evaluates the risk of natural hazards prevalent in Whitman County and meets requirements of the DMA (44 CFR, Section 201.6(c)(2)).

5.1 IDENTIFIED HAZARDS OF CONCERN

For this plan, the Steering Committee considered the full range of natural hazards that could impact the planning area and then listed hazards that present the greatest concern. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on the review, this plan addresses the following hazards of concern:

- Dam Failure
- Drought
- Earthquake
- Flood
- Landslide
- Severe weather
- Volcano
- Wildfire.

Technological hazards (e.g., hazardous material incidents) and human-caused hazards (e.g., terrorist acts) are not addressed in this plan.

5.2 CLIMATE CHANGE

Climate includes patterns of temperature, precipitation, humidity, wind and seasons. Climate plays a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them. "Climate change" refers to changes over a long period of time. It is generally perceived that climate change will have a measurable impact on the occurrence and severity of natural hazards around the world. Impacts include the following:

- Snow cover losses will continue, and declining snowpack will affect snow-dependent water supplies and stream flow levels around the world.
- The risk of drought and the frequency, intensity, and duration of heat waves are expected to increase.
- More extreme precipitation is likely, increasing the risk of flooding.
- The world's average temperature is expected to increase.

Climate change will affect communities in a variety of ways. Impacts could include an increased risk for extreme events such as drought, storms, flooding and forest fires; more heat-related stress; and the spread of existing or new vector-born disease into a community. In many cases, communities are already facing these problems to some degree. Climate change changes the frequency, intensity, extent and/or magnitude of the problems.

This hazard mitigation plan update addresses climate change as a secondary impact for each identified hazard of concern. Each chapter addressing one of the hazards of concern includes a section with a qualitative discussion on the probable impacts of climate change for that hazard. While many models are currently being developed to assess the potential impacts of climate change, there are currently none available to support hazard mitigation planning. As these models are developed in the future, this risk assessment may be enhanced to better measure these impacts.

5.3 METHODOLOGY

The risk assessments in Chapter 8 through Chapter 14 describe the risks associated with each identified hazard of concern. Each chapter describes the hazard, the planning area's vulnerabilities, and probable event scenarios. The following steps were used to define the risk of each hazard:

- Identify and profile each hazard—The following information is given for each hazard:
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity estimates
  - Warning time likely to be available for response.
- Determine exposure to each hazard—Exposure was determined by overlaying hazard maps with an inventory of structures, facilities, and systems to determine which of them would be exposed to each hazard.
- Assess the vulnerability of exposed facilities—Vulnerability of exposed structures and infrastructure was determined by interpreting the probability of occurrence of each event and assessing structures, facilities and systems that are exposed to each hazard. Tools such as GIS and FEMA's hazard-modeling program called HAZUS-MH were used to perform this assessment for the flood, dam failure and earthquake hazards. Outputs similar to those from HAZUS were generated for other hazards, using maps generated by the HAZUS program.

5.4 RISK ASSESSMENT TOOLS

5.4.1 Earthquake and Flood—HAZUS-MH

In 1997, FEMA developed the standardized Hazards U.S., or HAZUS, model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. HAZUS was later expanded into a multi-hazard methodology, HAZUS-MH, with new models for estimating potential losses from hurricanes and floods.

HAZUS-MH is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

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

The version used for this plan was HAZUS-MH 2.0, released by FEMA in June 2011.

Levels of Detail for Evaluation

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

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

Application for This Plan

The following methods were used to assess specific hazards for this plan:

- **Flood**—An updated inventory was used in place of the HAZUS-MH defaults for essential facilities. HAZUS-MH was used to create Whitman County 100-year flood depth grids integrating a 10-meter digital elevation model. A Level 1 HAZUS analysis estimated potential losses from the 100-year flood event.

- **Earthquake**—A Level 2 analysis was performed to assess earthquake risk and exposure. Earthquake scenario and probabilistic data prepared by the U.S. Geological Survey (USGS) were used for the analysis of this hazard. An updated inventory of essential facilities was used in place of the HAZUS-MH defaults. A modified version of the Washington State National Earthquake Hazard Reduction Program (NEHRP) soils and liquefaction inventory was used. One scenario event and two probabilistic events were modeled:
  - The selected scenario event for the planning area was a Magnitude-6.0 earthquake event on the Latah Creek Fault.
  - The standard HAZUS analysis was run for the 100- and 500-year probabilistic events.

5.4.2 Landslide, Severe Weather, Volcano and Wildfire

For most of the hazards evaluated in this risk assessment, historical data was not adequate to model future losses. However, HAZUS-MH is able to map hazard areas and calculate exposures if geographic information is available on the locations of the hazards and inventory data. Areas and inventory susceptible to some of the hazards of concern were mapped and exposure was evaluated. For other hazards, a qualitative analysis was conducted using the best available data and professional judgment. County-relevant information was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists and others. The primary data source was the Whitman County GIS database, augmented with state and federal data sets. Additional data sources for specific hazards were as follows:

- **Landslide**—Slopes greater than 15 percent were identified that intersect NEHRP soil classes D and E.
- **Severe Weather**—Severe weather data was downloaded from the Natural Resources Conservation Service and the National Climatic Data Center.
- **Volcano—**The entire planning area was assumed to exposed and the loss was assumed to equal 0.1 percent of total value
- **Wildfire**—Information on wildfire hazards areas was provided by U.S. Forest Service and LANDFIRE (a shared program between the wildland fire management programs of the U.S. Forest Service and the U.S. Department of the Interior, under the direction of the Wildland Fire Leadership Council).

5.4.3 Dam Failure and Drought

The risk assessments for dam failure and drought were more limited and qualitative than the assessments for the other hazards for the following reasons:

- No quantitative risk assessment could be performed for dam failure due to the lack of available inundation mapping. Currently, maps exist for only two of the 11 dams within the planning area, and the owners of these dams declined to release this information for security purposes. The remaining dams do not have sufficient risk to warrant inundation mapping.
- The risk assessment methodologies used for this plan focus on damage to structures. Drought does not impact structures.

5.4.4 Limitations

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

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

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. The results do not predict precise results and should be used only to understand relative risk. Over the long term, Whitman County and its planning partners will collect additional data to assist in estimating potential losses associated with other hazards.

CHAPTER 6.
WHITMAN COUNTY PROFILE

Whitman County is an agricultural region in southeast Washington State (see **Error! Reference source not found.**.). It is the 23rd most populous county in the state and the 10th largest in area. The City of Colfax is the county seat.

6.1 JURISDICTIONS AND FEATURES

Whitman County covers 2,159 square miles along the Washington-Idaho border. On the Washington side, Whitman County is bordered to the north by Spokane County, to the west by Adams County and a small part of Franklin County, and to the south by Columbia, Garfield and Asotin Counties. The County has 16 incorporated cities and towns. It is also home to Washington State University, located in Pullman, the second largest university in the state.

The southern border is defined by the Snake River. The Snake River Canyon cuts a 2,000-foot-deep swath through the Palouse Hills. The County's largest body of water is Rock Lake, in the northwest corner, which is a remnant of the Missoula floods that formed the scablands of this region. The major river is the Palouse River, which drains to the Snake River, and its two branches. Among the Palouse River's major tributaries are Rock Creek, Pine Creek, Pleasant Valley Creek, Rebel Flat Creek and Union Flat Creek. In the summer, about 75 percent of the smaller creeks run dry. The rivers of the County originate in the east, in the Moscow Mountains in Idaho, and generally flow east to west. Hangman Creek, flowing through the northeast corner of the County near Tekoa, drains to the Spokane River.

Whitman County's topography slopes to the west and southwest with rolling hills (Palouse Hills) and channeled scablands (primarily in the northwest portion of the County), with very little timber. Elevations in the region range from 1,100 to 3,400 feet above sea level. At the higher elevations are Tekoa Mountain and a number of prominent rock formations such as Bald Butte, Steptoe Butte and Kamiak Butte. Various forms of bunchgrass constitute the native vegetation, though most of the dryland has since been converted into a productive wheat farming region. Whitman County is one of the most productive farming areas in the United States, exporting wheat, barley, peas and lentils to worldwide markets.

6.2 HISTORICAL OVERVIEW

Since the middle of the last century, the area that is now Whitman County has been settled and developed by immigrants from eastern United States and Europe who were attracted to the region by its agricultural opportunities. The economic history of the County is characterized by a change from an early emphasis on livestock production to the present dominance of commercial wheat farming.

The area has had human settlement for over 10,000 years. In modern times, the area was inhabited by the Palouse Indians, who were related to the Nez Perce or Noon Nee-Mee-Poo Indians. The Appaloosa horse was bred by the tribe.

The first recorded European/Americans in the region were Lewis and Clark, who passed down the Snake River in October 1805. American settlement did not begin until the 1860s, when the flatlands along the Palouse River and Union Creek began to be claimed and settled. At first the tall bunchgrass-filled land was used mainly for grazing, but by the 1870s and 1880s, Eastern European immigrants, who were used to similarly dry conditions, began to cultivate winter wheat and other field crops.

Whitman County was organized by the territorial legislature on November 29, 1871 by partitioning what was then Stevens County—a huge area covering what are now 13 eastern Washington counties, all of Northern Idaho, and much of western Montana. Whitman County at the time of that partitioning covered what are now the counties of Whitman, Franklin and Adams. The County was named in honor of Dr. Marcus Whitman and his wife Narcissa, missionaries living near Walla Walla.

In the 1870s, sawmills became an early local industry, supplying building materials for new settlers and producing flour. Many young towns had water-powered sawmills on its small rivers and creeks, although few, if any, exist today. The 1880s saw the arrival of railroads, which helped further the economic development of the County. In 1890, the State Agricultural College of Washington was founded as a land grant college at Pullman. This college evolved into what is now Washington State University.

Today, Whitman County is still focused on agriculture and the university.

6.3 MAJOR PAST HAZARD EVENTS

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses and public entities. Some of the programs are matched by state programs. Whitman County has experienced 13 events since 1963 for which presidential disaster declarations were issued. These events are listed in Table 6-1.

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

**TABLE 6-1.
PRESIDENTIAL DISASTER DECLARATIONS
FOR HAZARD EVENTS AFFECTING WHITMAN COUNTY**

Disaster Declaration Number	Type of Event	Date
DR-146	Flooding	March 1963
DR-185	Heavy Rains/ Flood	December 1964
DR-300	Flooding	January 1971
DR-322	Severe Storms/Flooding	January 1972
DR-414	Severe Storms/Snowmelt/Flooding	January 1974
Emerg-3037	Drought	March 1977
DR-545	Severe Storms/Flooding	December 1977
DR-623	Volcano/Mount St. Helens Eruption	May 1980
DR-822	Heavy Rains/Sheet Flooding	March 1989
DR-922	"Firestorm 91"/Wind	October 1991
DR-1100	Flooding	February 1996
DR-1159	Ice, Wind, Snow, Landslide, Flood	Dec 1996 – Feb 1997
DR-1825	Severe Winter Storm, near record snowfall	March 2009

6.4 PHYSICAL SETTING

6.4.1 Geology

Whitman County lies on the eastern end of the Columbia Plateau, one of the seven major physiographic regions of Washington State (See Figure 6-1). The Columbia Plateau is generally composed of basalt from volcanic lava floods that erupted during the Miocene Epoch from 17 million to 6 million years ago and have since cooled. Eruptions from fissures in the earth's crust eventually led to the lava being hundreds of feet thick in some locations. The only remnants of the pre-Miocene geology are the buttes, such as Steptoe Butte, which are the severely eroded exposed peaks of high mountains covered in basalt. In between basalt eruptions, sand and gravel deposits left by rivers from the erosion of nearby mountains contributed to the geology of the Palouse region. The fractured basalt and its interbeds are where most of Whitman County's potable water is found.

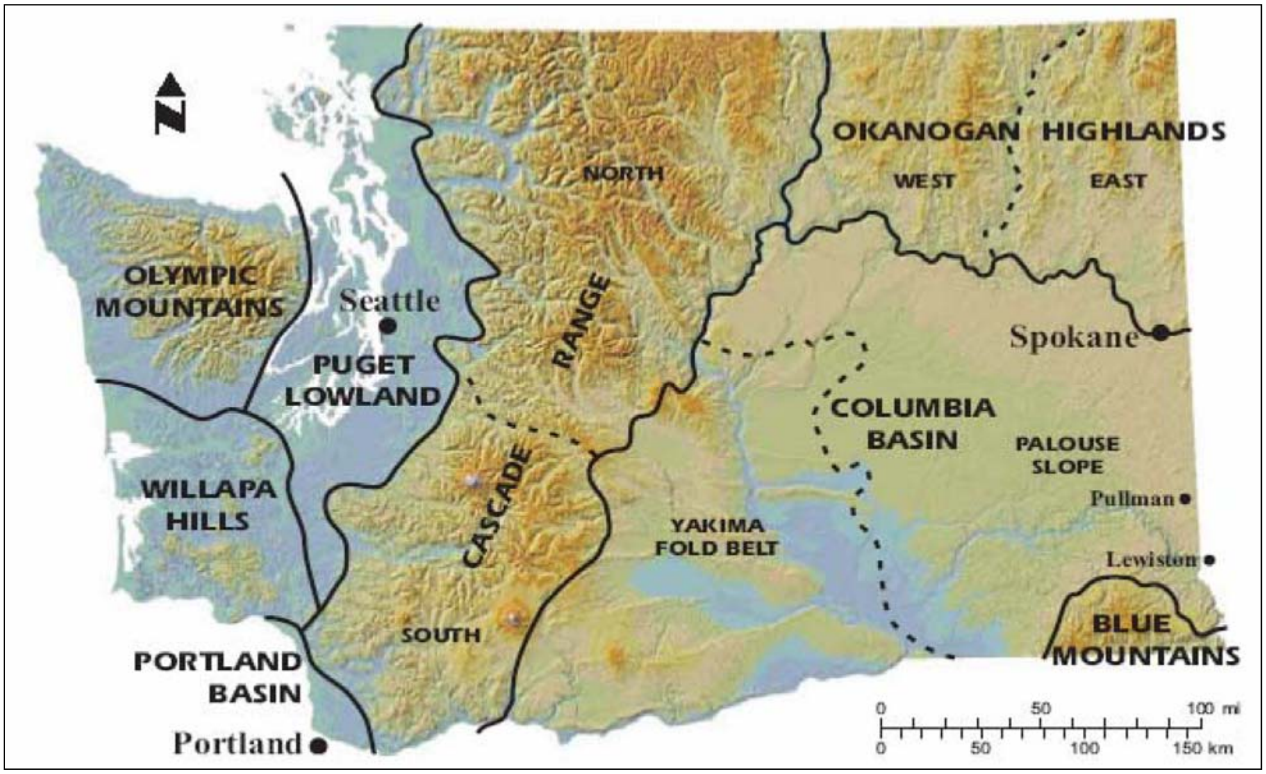


Figure 6-1. Physiographic Regions of Washington

The present landscape of Whitman County was formed relatively recently, beginning during the end of the last ice age about 15,000 years ago. The Palouse region's rich, dark, porous, moisture-retentive soil is composed of loess and volcanic ash overlaying basalt. Figure 6-2 shows general geology of Whitman County. Loess blown in as fine silt and dust during the end of the ice age settled on the basalt outcrops and formed as rolling hills resembling large dunes. The hills have a distinct look: gentle south facing slopes and steep north facing slopes aligned parallel to the prevailing southwesterly winds. In some places, the loess can be up to 100 feet deep. The fine-grained loess is highly erodible, and scientists believe that much of the loess deposited during the Holocene Epoch (the last 11,000 years of geological time) has been lost.

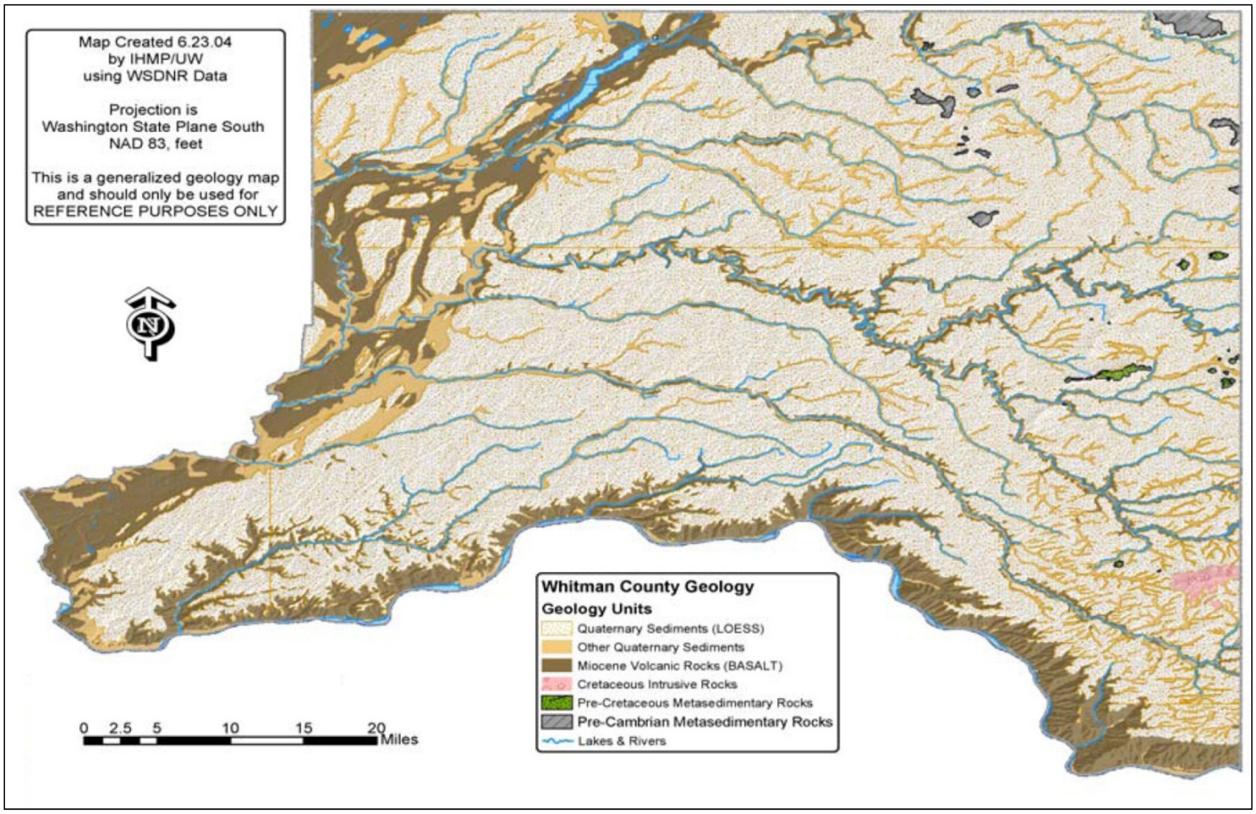


Figure 6-2. Whitman County Geology

6.4.2 Scablands

Between 13,000 and 15,000 years ago, melting glaciers across the northwest United States and southern Canada filled a huge lake held back by a glacial dam and covering a large area of what is now western Montana. At its largest volume, Glacial Lake Missoula held over 520 cubic miles of water, covered over 3,000 square miles, and was over 2,000 feet deep at the edge of the glacial dam.

Eventually the water cut underneath the glacial wall and the dam of ice collapsed over an expanse of about 100 miles. The water rushed over the ice and onto the land with great force. In about two days the water of Glacial Lake Missoula emptied through the breached dam. The amount of escaping water was equal to 10 times the discharge of all the Earth's rivers today. Water several hundred feet deep flooded the region and ripped up hundreds of feet of soil and rock. The flood cut channels and carved islands, leaving behind the scarred landscape now called the channeled scablands. A dramatic example of this is Palouse Falls, where water falls over 200 feet into a cirque surrounded by sheer basaltic canyons (see Figure 6-3). Similar canyon walls are frequent throughout Whitman County. The scablands can be found in the northwest part of Whitman County, where State Route (SR) 23 passes through.

The channeled scablands show evidence of repeated Missoula Floods. Some sedimentary deposits are stacked layer upon layer, indicating that dozens of floods escaped from Glacial Lake Missoula. Thin layers of volcanic ash help geologists gauge the approximate time of the floods. Between 17,000 and 13,000 years ago, the region was probably flooded every few years. Figure 6-4 shows the extent of Glacial Lake Missoula and the area swept by the Missoula Flood.

Figure 6-3. Palouse Falls

Source: Topinka, USGS/CVO, 2002

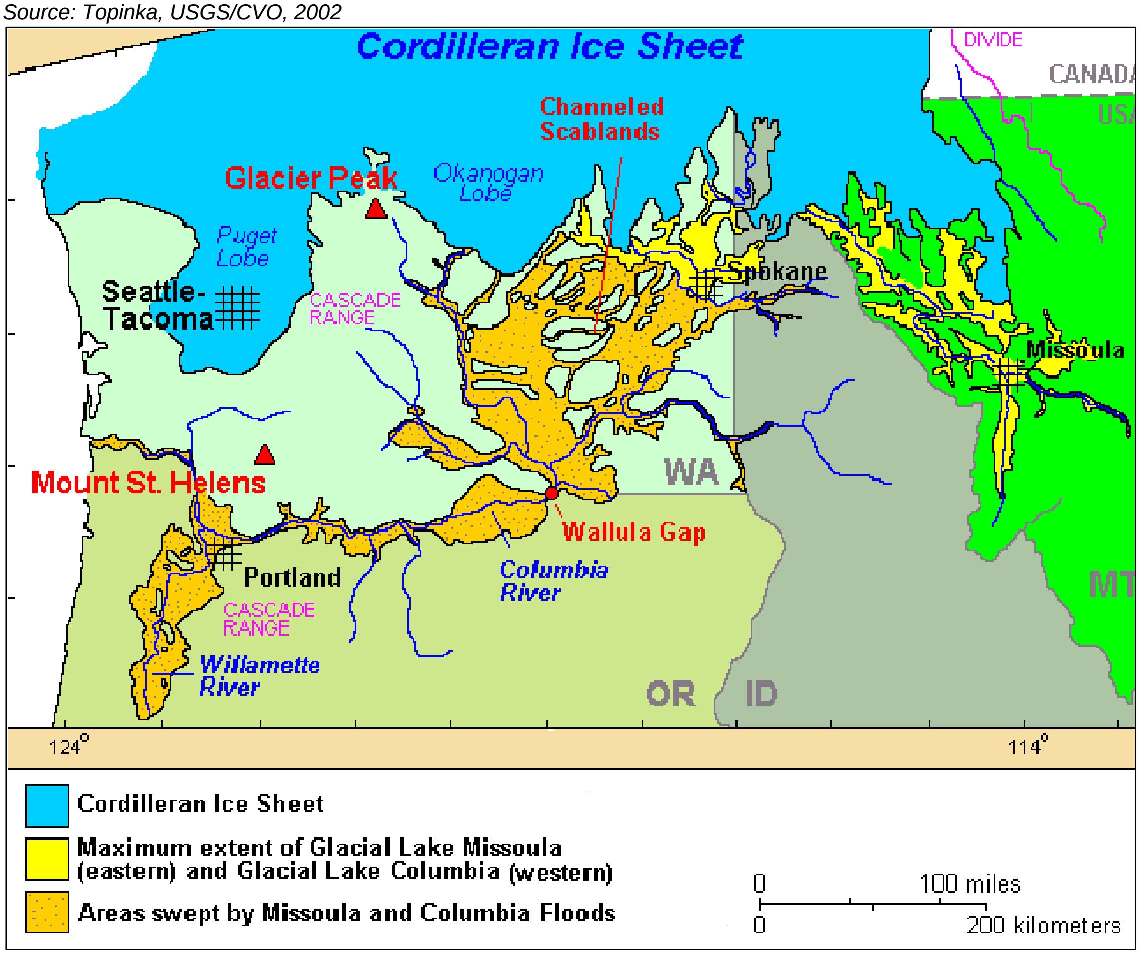


Figure 6-4. Missoula Flood Path

6.4.3 Soils

Most of Whitman County consists of good farming land and soils of better than average fertility. The best soils are largely found in the eastern and west-central parts of the County. The major soil series are the Ritzville, Walla Walla, Athena and Palouse series (see Table 6-2). All of these soils are rich in calcium and other soluble materials. They were deposited in this area by wind action and formed under semi-arid grassland conditions.

TABLE 6-2. SOIL SERIES IN WHITMAN COUNTY

Series	Regional Location	Description
Athena	Central Whitman County, from Rosalia to the Snake River.	Fine in texture , dark brown in color and well suited for wheat farming. Similar to Walla Walla soils except they are older and deeper and were formed under heavier grass cover and rainfall
Palouse	North to south in a wide belt along the Whitman County-Idaho border	Soil dark in color, deposited by wind in deep, large dunes which became rounded and grass covered under an annual precipitation of about 20 inches.
Ritzville	Class IV lands along the lower Palouse River.	Wind deposited, desert type , light brown in color, loams. Slightly alkaline soils suited for dry farming and grazing.
Walla Walla	Western edge of the Palouse Hills in Class II land	Fine in texture , dark brown in color and well suited for wheat farming. Similar to Athena soils except they are newer and more shallow soils

The wind-deposited soils of Whitman County are deep, moisture-absorbent and free of gravel, stones and clay. The topsoil zone is deep and fertile and has a high mineral content. The major problem with this soil is wind and water erosion on steeper slopes when slopes are tilled for farming. Prior to active farming in the region, the sod of the original grassland was sufficient to prevent erosion by rain and wind.

6.4.4 Climate

The climate in Whitman County is influenced by marine and continental weather patterns. The marine influence is most noticeable in winter when the prevailing westerly winds are strongest and most persistent. The County generally experiences seasonable weather patterns characteristic of eastern Washington. Warm, dry summers are usually experienced, although heavy rain and hail infrequently accompany thunderstorm activity. Mid-summer temperatures range in the middle and upper 80s°F; winter highs are usually in the 30s°F. Extreme temperatures can range from 110°F to –30°F. Snow, the dominant form of precipitation due to winter coinciding with the rainy season, accumulates to a depth of 10 to 15 inches and remains on the ground from December through February. Annual average precipitation increases from west to east, with the western portion of the County receiving less than 12 inches and the eastern part receiving over 24 inches. The average amount of snowfall that Whitman County receives annually is about 28 inches.

The climate pattern in the County is related to a gradual increase in elevation from west to east. The County lies between the Rocky Mountains on the east, the Cascade Mountains on the west, mountains near the Canadian border on the north and Blue Mountains on the south.

6.5 CRITICAL FACILITIES AND INFRASTRUCTURE

Critical facilities and infrastructure are those that are essential to the health and welfare of the population. These become especially important after a hazard event. Critical facilities typically include police and fire stations, schools and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need, and the utilities that provide water, electricity and communication services to the community. Also included are "Tier II" facilities and railroads, which hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event.

Through a facilitated exercise, the Steering Committee reviewed the definitions of critical facilities established for the initial plan and amended the definition to read as follows:

> Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event. Critical facilities include:
>
> – Structures or facilities that produce, use or store highly volatile, flammable, explosive, toxic or water-reactive materials
>
> – Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event
>
> – Police stations, fire stations, vehicle and equipment storage facilities and emergency operations centers that are needed for disaster response before, during and after hazard events
>
> – Public and private utilities, infrastructure and transportation systems that are vital to maintaining or restoring normal services to areas damaged by hazard events
>
> – Public gathering places that could be used as evacuation centers during large-scale disasters
>
> – Government and educational facilities central to governance and quality of life along with response and recovery actions taken as a result of a hazard event.

Map 6-1 shows the location of critical facilities in unincorporated areas of the county. Critical facilities within the cities participating in this plan are shown in maps for each city provided in Volume 2 of plan. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with each planning partner. Table 6-3 and Table 6-4 provide summaries of the general types of critical facilities and infrastructure, respectively, in each municipality and unincorporated county areas. All critical facilities/infrastructure were analyzed in HAZUS to help rank risk and identify mitigation actions. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

6.6 DEMOGRAPHICS

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. Research has shown that people living near or below the poverty line, the elderly (especially older single men), the disabled, women, children, ethnic minorities and renters all experience, to some degree, more severe effects from disasters than the general population. These vulnerable populations may vary from the general population in risk perception, living conditions, access to information before, during and after a hazard event, capabilities during an event, and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members would assist the County in extending focused public outreach and education to these most vulnerable citizens.

**TABLE 6-3.
WHITMAN COUNTY CRITICAL FACILITIES**

City	Medical and Health	Government Functions	Protective Functions	Schools	Hazmat	Other Critical Functions	**Total**
Albion	0	0	1	0	0	0	**1**
Colfax	1	2	4	0	0	2	**9**
Colton	0	0	0	2	0	0	**2**
Endicott	0	0	1	0	0	0	**1**
Farmington	0	0	0	1	0	0	**1**
Garfield	3	0	2	1	6	0	**12**
LaCrosse	0	0	0	2	0	0	**2**
Lamont	0	0	0	1	0	0	**1**
Malden	0	0	0	0	0	0	**0**
Oakesdale	0	0	1	2	0	0	**3**
Palouse	1	0	2	3	0	1	**7**
Pullman	2	2	6	8	0	4	**22**
Rosalia	0	1	3	1	0	1	**6**
St. John	0	0	1	1	3	0	**5**
Tekoa	0	0	1	1	0	1	**3**
Uniontown	0	0	0	0	0	0	**0**
Unincorporated	0	7	4	7	7	7	**32**
Total	**7**	**12**	**26**	**30**	**16**	**16**	**107**

**TABLE 6-4.
WHITMAN COUNTY CRITICAL INFRASTRUCTURE**

City	Bridges	Water Supply	Wastewater	Power	Communications	Other	**Total**
Albion	1	0	1	0	0	0	**2**
Colfax	7	0	0	0	1	0	**8**
Colton	2	0	1	0	0	0	**3**
Endicott	2	0	0	0	0	0	**2**
Farmington	5	2	1	0	0	0	**8**
Garfield	1	0	1	0	0	0	**2**
LaCrosse	0	0	0	0	0	0	**0**
Lamont	0	0	0	0	0	0	**0**
Malden	2	0	0	0	0	0	**2**
Oakesdale	8	0	0	0	0	0	**8**
Palouse	2	2	1	0	0	0	**5**
Pullman	14	25	1	0	2	1	**43**
Rosalia	1	0	0	0	0	1	**2**
St. John	1	0	1	0	0	0	**2**
Tekoa	5	0	1	0	0	0	**6**
Uniontown	0	0	0	0	0	0	**0**
Unincorporated	349	2	4	0	10	17	**382**
Total	**400**	**31**	**12**	**0**	**13**	**19**	**475**

6.6.1 Population Characteristics

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. Whitman County is the 23rd largest of Washington's 39 counties. The U.S. Census Bureau estimates Whitman County's population at 44,776 as of 2010 (U.S. Census, 2011a).

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Between 2000 and 2010, Washington's population grew by 14.1 percent (1.33 percent per year) while Whitman County's population increased by 9.9 percent (1.01 percent per year) (U.S. Census, 2011a). According to the Washington State Office of Financial Management (OFM), 66.5 percent, or nearly two-thirds, of the County's residents, live in Pullman.

Table 6-5 shows the population of incorporated municipalities and the combined unincorporated areas in Whitman County from 2000 to 2010. In 2000, 15.7 percent of Whitman County's residents lived outside incorporated areas; that percentage fell to 13.3 percent by 2010. Overall growth in incorporated areas was 13 percent from 2000 to 2010, while population in the unincorporated areas of the county fell by 6.8 percent during the same timeframe.

6.6.2 Income

In the United States, individual households are expected to use private resources to prepare for, respond to and recover from disasters to some extent. This means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. The events following Hurricane Katrina in 2005 illustrated that personal household economics significantly impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on U.S. Census Bureau estimates, per capita income in Whitman County for the period from 2005 to 2009 was $18,552, and the median household income in 2009 was $36,767. In 2009, 25.6 percent of the population in Whitman County was living below the poverty level (U.S. Census, 2011a). For 2005 through 2009, the Census Bureau estimated that 9.4 percent of households in the County received an income between $100,000 and $149,999 per year and 3.2 percent had incomes above $150,000 annually. (U.S. Census, 2011b)

6.6.3 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources for response to hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing and/or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as "critical facilities" by emergency managers because they require extra notice to implement evacuation.

TABLE 6-5.
CITY AND COUNTY POPULATION DATA

	Population		Growth Rate	
	2000[a]	2010[b]	10-Year	Annual Average
Albion	616	579	-6.01%	-0.58%
Colfax	2,844	2,805	-1.37%	-0.14%
Colton	386	418	8.29%	0.80%
Endicott	355	289	-18.59%	-1.72%
Farmington	153	146	-4.58%	-0.45%
Garfield	544	597	9.74%	0.93%
LaCrosse	380	313	-17.63%	-1.64%
Lamont	106	81	-23.58%	-2.14%
Malden	215	203	-5.58%	-0.54%
Oakesdale	420	422	0.48%	0.05%
Palouse	1,011	998	-1.29%	-0.13%
Pullman	24,948	29,799	19.44%	1.79%
Rosalia	648	550	-15.12%	-1.42%
St. John	548	543	-0.91%	-0.09%
Tekoa	826	778	-5.81%	-0.57%
Uniontown	345	294	-14.78%	-1.39%
Incorporated Total	***34,345***	***38,815***	***13.01%***	***1.23%***
Unincorporated	6,395	5,961	-6.79%	-0.66%
Whitman County Total	**40,740**	**44,776**	**9.9%**	**1.01%**

a. 2010 population data for incorporated areas from OFM, 2011a. County total from Census, 2011a.
b. 2010 population data from OFM, 2011b.

Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the American population.

Children under 14 are particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

Census estimates for Whitman County's overall age distribution for 2005 – 2009 are shown in Figure 6-5. Based on these estimates, 9.1 percent of Whitman County's population is 65 or older, compared to the state average of 11.8 percent. The estimates show that 6.9 percent of the County's over-65 population has income below the poverty line. Of the County's children under 18, 14.6 percent are below the poverty level. It is estimated that 12.8 percent of the County's population is 14 or younger, compared to the state average of 19.7 percent. (U.S. Census, 2011b)

Source: U.S. Census, 2011b

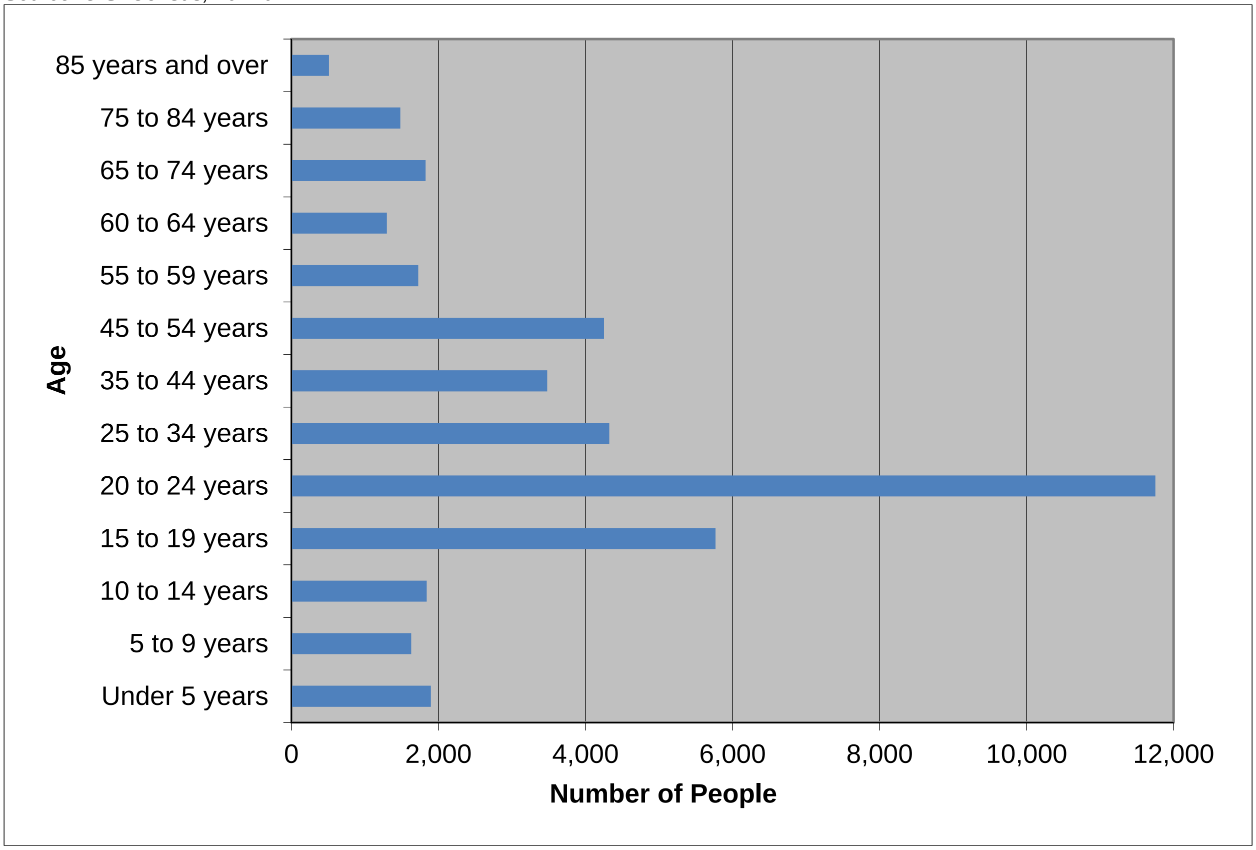


Figure 6-5. Whitman County Age Distribution

6.6.4 Race, Ethnicity and Language

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event. Post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability. According to the U.S. Census, the racial composition of Whitman County is predominantly white, at 86.0 percent. The largest minority population is Asian, at 7.0 percent. Figure 6-6 shows the racial distribution in Whitman County (U.S. Census, 2011b).

Whitman County has a 9.1-percent foreign-born population. Other than English, the most commonly spoken languages in Whitman County are Asian and Pacific Islander languages. The census estimates 3.6 percent of the county’s residents speak English “less than very well.”

6.7 ECONOMY

6.7.1 Industry, Businesses and Institutions

The Census-defined industry with the highest employment in Whitman County is education/health care/social assistance (47 percent of civilian employed population over 16), followed by retail trade (10 percent) and arts/entertainment/recreation/accommodation/food service (9 percent). The industries with the smallest percentages of employment are wholesale trade (1.1 percent) and information (1.7 percent). Figure 6-7 shows the breakdown of industry types in Whitman County (U.S. Census, 2011b).

Source: U.S. Census, 2011b

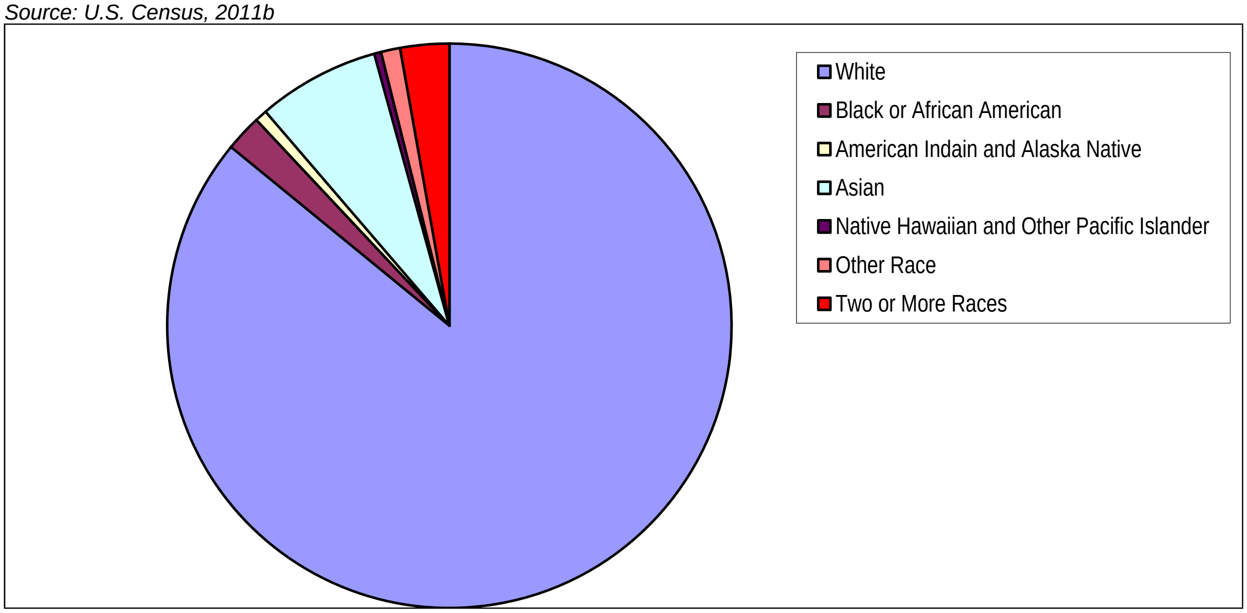


Figure 6-6. Whitman County Race Distribution

Source: U.S. Census, 2011b

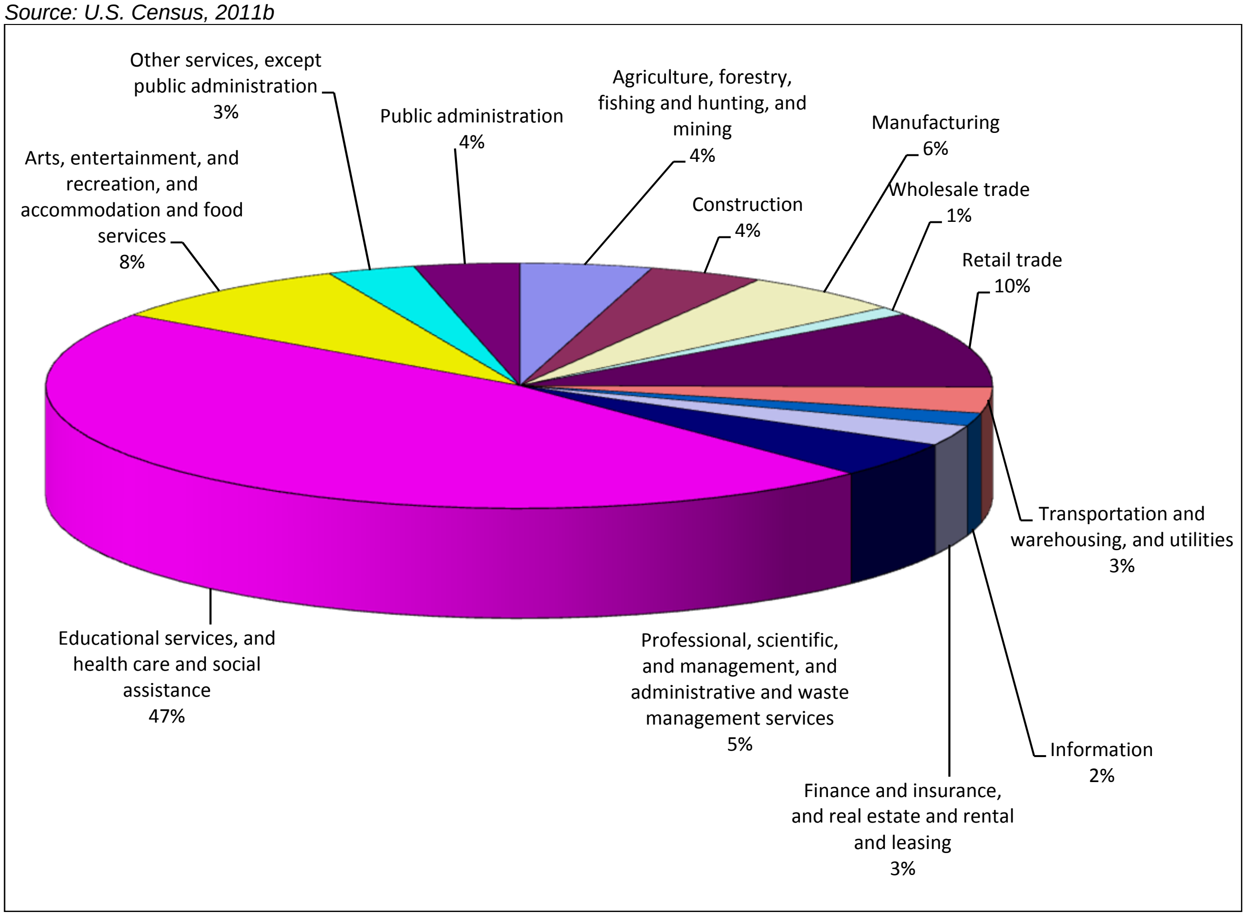


Figure 6-7. Industry in Whitman County

According to the Southeast Washington Economic Development Association, major employers in the county include Washington State University, Schweitzer Engineering, The McGregor Company, Pullman Regional Hospital, Whitman County, Wal-Mart, City of Pullman, Decagon Devices, The Bookie, and Safeway. Washington State University in Pullman is the only major educational institution in the County.

6.7.2 Employment Trends and Occupations

According to the American Community Survey, 56.4 percent of Whitman County's population is in the labor force (U.S. Census, 2011b). Figure 6-8 compares Washington's and Whitman County's unemployment trends from 2001 through 2010 (OFM, 2011c; U.S. BLS, 2011). Whitman County's unemployment rate was lowest in 2007 at 3.8 percent. County unemployment rates have been consistently lower than the statewide rates.

Sources: OFM, 2011c; U.S. BLS, 2011

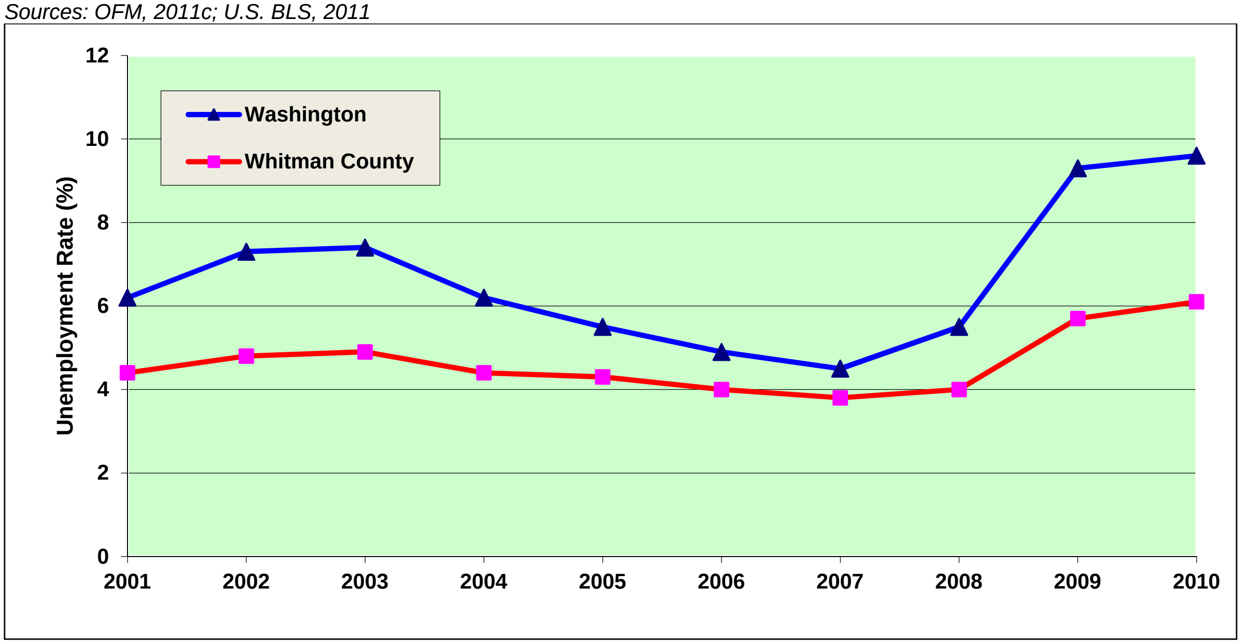


Figure 6-8. Washington and Whitman County Unemployment Rate

Whitman County's largest Census-defined occupation category is management/professional, making up 45 percent of the employed population (see Figure 6-9). Other significant occupation categories in the county are sales/office at 22 percent and service occupations at 20 percent. The largest employer in the county is Washington State University, with 4,792 employees, followed by Schweitzer Engineering, which employs 1,800.

The U.S. Census estimates that 60.7 percent of Whitman County workers commute alone by car, truck or van to work and that mean travel time to work is 15.2 minutes (the state average is 25.4 minutes) (U.S. Census, 2011b and 2011c).

6.8 FUTURE TRENDS IN DEVELOPMENT

The economic base of Whitman County has historically consisted mostly of agriculture and education. Although tax revenue from agricultural land has continued to increase, the responsibilities of regional (County) government have also grown, due to state legislative mandates and changed public expectations. This rise in the cost of providing County government services can no longer be borne by the agricultural sector alone.

Source: U.S. Census, 2011b

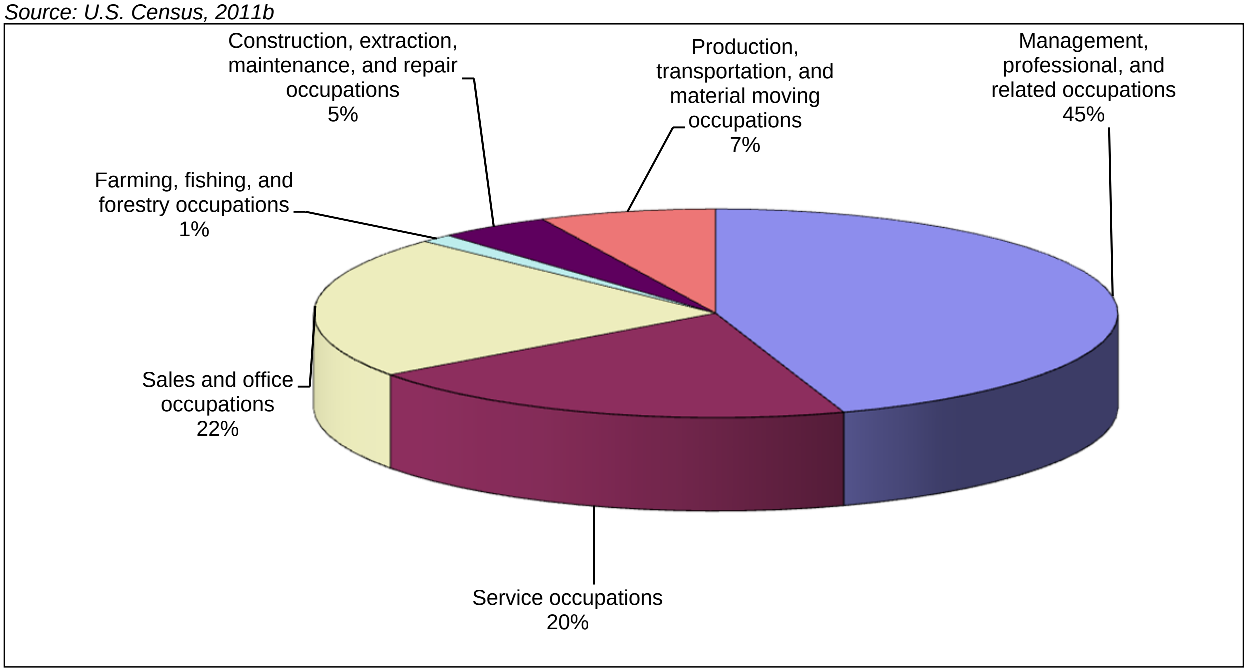


Figure 6-9. Occupations in Whitman County

Whitman County seeks opportunity for more diverse sources of tax revenue if County services to the public are to be continued at a level expected by all County residents. Because SR 270 links two university communities, which are becoming necessarily more interdependent, the South Pullman – Moscow Corridor now presents a distinct opportunity for economic development.

Whitman County and the following cities and towns have adopted comprehensive plans pursuant to the state Growth Management Act (see Section 6.9.2) that dictate land use for their jurisdictions:

- Town of Albion
- City of Colfax
- Town of Farmington
- Town of Garfield
- Town of Oakesdale
- City of Palouse
- City of Pullman
- Town of Rosalia
- Town of St. John
- Town of Tekoa
- Town of Uniontown.

All of these comprehensive plans include policies for preserving agricultural land use in the County. Whitman County's dry-land farms have long produced some of the highest yields in the United States. Since 1954, the number of separate family farms in Whitman County has decreased by over 25 percent due to economic conditions requiring larger farm and ranch management units for successful operation.

Uncoordinated non-agricultural development has serious impacts on the ability of farmers in Whitman County to maintain access to their many crop fields; the ability to carry out farm practices without threat of restriction; and the ability to lease and buy additional land necessary to continue economically feasible farming. These comprehensive plans promote urban and suburban development within incorporated areas, to preserve the agricultural uses of unincorporated areas.

Building codes represent the primary mechanism for ensuring that new development has a factor of safety for potential damage from natural hazards. The State of Washington mandates adoption of the International Building Code (IBC) as of July 1, 2004. Uniform implementation and enforcement of the standards specified under the IBC should be sufficient to ensure that new development is protected from the impacts of earthquakes. All municipal planning partners have adopted appropriate building codes pursuant to state mandates.

6.9 LAWS AND ORDINANCES

Existing laws, ordinances and plans at the federal, state and local level can support or impact hazard mitigation initiatives identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). Pertinent federal and state laws are described below. Each planning partner has individually reviewed existing local plans, studies, reports and technical information in its jurisdictional annex, presented in Volume 2.

6.9.1 Federal

Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Grant Program funds are available to communities. This Plan is designed to meet the requirements of DMA, improving the planning partners' eligibility for future hazard mitigation funds.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contains exceptions and exemptions. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:

- **Endangered** means that a species of fish, animal or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this may include subspecies and distinct population segments.)

- **Threatened** means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- **Critical habitat** means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

Five sections of the ESA are of critical importance to understanding it:

- **Section 4: Listing of a Species**—The National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.
- **Section 7: Consultation**—Federal agencies must ensure that any action they authorize, fund or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- **Section 9: Prohibition of Take—**It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding or sheltering.
- **Section 10: Permitted Take**—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- **Section 11: Citizen Lawsuits**—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

With the listing of salmon and trout species as threatened or endangered, the ESA has impacted most of the Pacific Coast states. Although some of these areas have been more impacted by the ESA than others due to the known presence of listed species, the entire region has been impacted by mandates, programs and policies based on the presumption of the presence of listed species. Most West Coast jurisdictions must now take into account the impact of their programs on habitat.

The Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical and biological integrity of the nation's surface waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. The County and most of the partner cities for this plan participate in the NFIP and have adopted regulations that meet the NFIP requirements. At the time of the preparation of this plan, all participating jurisdictions in the partnership were in good standing with NFIP requirements.

Presidential Policy Directive PPD-8

PPD-8 seeks to strengthen the security and resilience of the United States through preparation for threats that pose the greatest risk, including acts of terrorism, cyber-attacks, pandemics and catastrophic natural disasters. This directive addresses action by the federal government as well as facilitating an integrated, nationwide, capabilities-based approach to hazard preparedness. PPD-8 defines mitigation as follows:

> …capabilities necessary to reduce loss of life and property by lessening the impact of disasters. Mitigation capabilities include, but are not limited to, community-wide risk reduction projects; efforts to improve the resilience of critical infrastructure and key resource lifelines; risk reduction for specific vulnerabilities from natural hazards or acts of terrorism; and initiatives to reduce future risks after a disaster has occurred.

6.9.2 State

Washington State Enhanced Mitigation Plan

The Washington State Enhanced Hazard Mitigation Plan approved by FEMA in 2010 provides guidance for hazard mitigation throughout Washington. The plan identifies hazard mitigation goals, objectives, actions and initiatives for state government to reduce injury and damage from natural hazards. By meeting federal requirements for an enhanced state plan (44 CFR parts 201.4 and 201.5), the plan allows the state to seek significantly higher funding from the Hazard Mitigation Grant Program following presidential declared disasters (20 percent of federal disaster expenditures vs. 15 percent with a standard plan).

Growth Management Act

In 1990, the Washington Legislature adopted the Growth Management Act (GMA; Revised Code of Washington (RCW) Chapter 36.70A). The GMA requires local jurisdictions to adopt ordinances that classify, designate and regulate land use to protect critical areas, which include wetlands; areas with a critical recharging effect on aquifers used for potable water; fish and wildlife habitat conservation areas; frequently flooded areas; and geologically hazardous areas (RCW 36.70A.030).

Because its population has remained under GMA planning thresholds, Whitman County is not required to plan under the GMA. Nonetheless the County has a comprehensive plan that emphasizes maintaining its rural agricultural environment, while allowing for growth around the incorporated areas of the County.

Shoreline Management Act

The 1971 Shoreline Management Act (RCW 90.58) was enacted to manage and protect the shorelines of the state by regulating development in the shoreline area. A major goal of the act is to prevent the "inherent harm in an uncoordinated and piecemeal development of the state's shorelines." Its jurisdiction includes the Pacific Ocean shoreline and the shorelines of Puget Sound, the Strait of Juan de Fuca, and rivers, streams and lakes above a certain size. It also regulates wetlands associated with these shorelines.

Washington State Building Code

The Washington State Building Code Council adopted the 2006 editions of national model codes with some amendments. The Council also adopted changes to the Washington State Energy Code and Ventilation and Indoor Air Quality Code. Washington's state-developed codes are mandatory statewide for residential and commercial buildings. The residential code exceeds the 2006 International Energy Conservation Code standards for most homes, and the commercial code meets or exceeds standards of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE 90.1-2004). For residential construction covered by ASHRAE 90.1-2007 (buildings with four or more stories), the state code is more stringent. The 2009 IBC went into effect as the Washington model code on July 1, 2010.

Comprehensive Emergency Management Planning

Washington's Comprehensive Emergency Management Planning law (RCW 38.52) establishes parameters to ensure that preparations of the state will be adequate to deal with disasters, to ensure the administration of state and federal programs providing disaster relief to individuals, to ensure adequate support for search and rescue operations, to protect the public peace, health and safety, and to preserve the lives and property of the people of the state. It achieves the following:

- Provides for emergency management by the state and authorizes the creation of local organizations for emergency management in political subdivisions of the state.
- Confers emergency powers upon the governor and the executive heads of political subdivisions of the state.
- Provides for the rendering of mutual aid among political subdivisions of the state and with other states and for cooperation with the federal government with respect to the carrying out of emergency management functions.
- Provides a means of compensating emergency management workers who may suffer any injury or death, who suffer economic harm including personal property damage or loss, or who incur expenses for transportation, telephone or other methods of communication, and the use of personal supplies as a result of participation in emergency management activities.
- Provides programs, with intergovernmental cooperation, to educate and train the public to be prepared for emergencies.

It is policy under this law that emergency management functions of the state and its political subdivisions be coordinated to the maximum extent with comparable functions of the federal government and agencies of other states and localities, and of private agencies of every type, to the end that the most effective preparation and use may be made of labor, resources and facilities for dealing with disasters.

Washington Administrative Code 118-30-060(1)

Washington Administrative Code (WAC) 118-30-060 (1) requires each political subdivision to base its comprehensive emergency management plan on a hazard analysis, and makes the following definitions related to hazards:

- Hazards are conditions with potential to threaten human life, resulting from three factors:
  - Natural conditions, such as weather and seismic activity
  - Human interference with natural processes, such as a levee that displaces the natural flow of floodwater
  - Human activity and its products, such as homes on a floodplain.
- The definitions for hazard, hazard event, hazard identification, and flood hazard note that hazards are extreme events and may be connected to human activity.
- Hazards generally pose a risk of damage, loss, or harm to people and/or their property

Washington State Floodplain Management Law

Washington's floodplain management law (RCW 86.16, implemented through WAC 173-158) states that prevention of flood damage is a matter of statewide public concern and places regulatory control with the Department of Ecology. RCW 86.16 is cited in floodplain management literature, including FEMA's national assessment, as one of the first and strongest in the nation. A major challenge to the law in 1978, Maple Leaf Investors v. Ecology, is cited in legal references to floodplain management issues. The court upheld the law, declaring that denial of a permit to build residential structures in a floodway is a valid exercise of police power and did not constitute a taking. RCW Chapter 86.12 (Flood Control by Counties) authorizes county governments to levy taxes, condemn properties and undertake flood control activities directed toward a public purpose.

Flood Control Assistance Account Program

Washington's first flood control maintenance program was passed in 1951, and was called the Flood Control Maintenance Program. In 1984, RCW 86.26 (State Participation in Flood Control Maintenance) established the Flood Control Assistance Account Program (FCAAP), which provides funding for local flood hazard management. FCAAP rules are found in WAC 173-145. Ecology distributes FCAAP matching grants to cities, counties and other special districts responsible for flood control. This is one of the few state programs in the U.S. that provides grant funding to local governments for floodplain management. The program has been funded for $4 million per biennium since its establishment, with additional amounts provided after severe flooding events.

To be eligible for FCAAP assistance, flood hazard management activities must be approved by Ecology in consultation with the Washington Department of Fish and Wildlife. A comprehensive flood hazard management plan must have been completed and adopted by the appropriate local authority or be in the process of being prepared in order to receive FCAAP flood damage reduction project funds. This policy evolved through years of the Flood Control Maintenance Program and early years of FCAAP in response to the observation that poor management in one part of a watershed may cause flooding problems in another part.

Local jurisdictions must participate in the NFIP and be a member in good standing to qualify for an FCAAP grant. Grants up to 75 percent of total project cost are available for comprehensive flood hazard management planning. Flood damage reduction projects can receive grants up to 50 percent of total project cost, and must be consistent with the comprehensive flood hazard management plan. Emergency grants are available to respond to unusual flood conditions. FCAAP can also be used for the purchase of flood-prone properties, for limited flood mapping and for flood warning systems. Funding currently is running about 60 percent for planning and 40 percent for projects.

6.9.3 Cities and County

Each planning partner has prepared a jurisdiction-specific annex to this plan (see Volume 2). In preparing these annexes, each partner completed a capability assessment that looked at its regulatory, technical and financial capability to carry out proactive hazard mitigation. Refer to these annexes for a review of regulatory codes and ordinances applicable to each planning partner.

Map 6-1.

W H I T M A N   C O U N T Y

Critical Facilities

CHAPTER 7.
DAM FAILURE

7.1 GENERAL BACKGROUND

7.1.1 Causes of Dam Failure

Dam failures in the United States typically occur in one of four ways (see Figure 7-1):

- Overtopping of the primary dam structure, which accounts for 34 percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30 percent of all dam failures.
- Failure due to piping and seepage accounts for 20 percent of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10 percent of all failures.

The remaining 6 percent of U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States have been secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage. The most likely disaster-related causes of dam failure in Whitman County are earthquakes.

Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

<u>DEFINITIONS</u>

Dam—Any artificial barrier and/or any controlling works, together with appurtenant works, that can or does impound or divert water. (Washington Administrative Code, Title 173, Chapter 175.)

Dam Failure—An uncontrolled release of impounded water due to structural deficiencies in dam.

Emergency Action Plan—A document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. The plan specifies actions the dam owner should take to alleviate problems at a dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency situation. It also contains inundation maps to show emergency management authorities the critical areas for action in case of an emergency. (FEMA 64)

High Hazard Dam—Dams where failure or operational error will probably cause loss of human life. (FEMA 333)

Significant Hazard Dam—Dams where failure or operational error will result in no probable loss of human life but can cause economic loss, environmental damage or disruption of lifeline facilities, or can impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure. (FEMA 333)

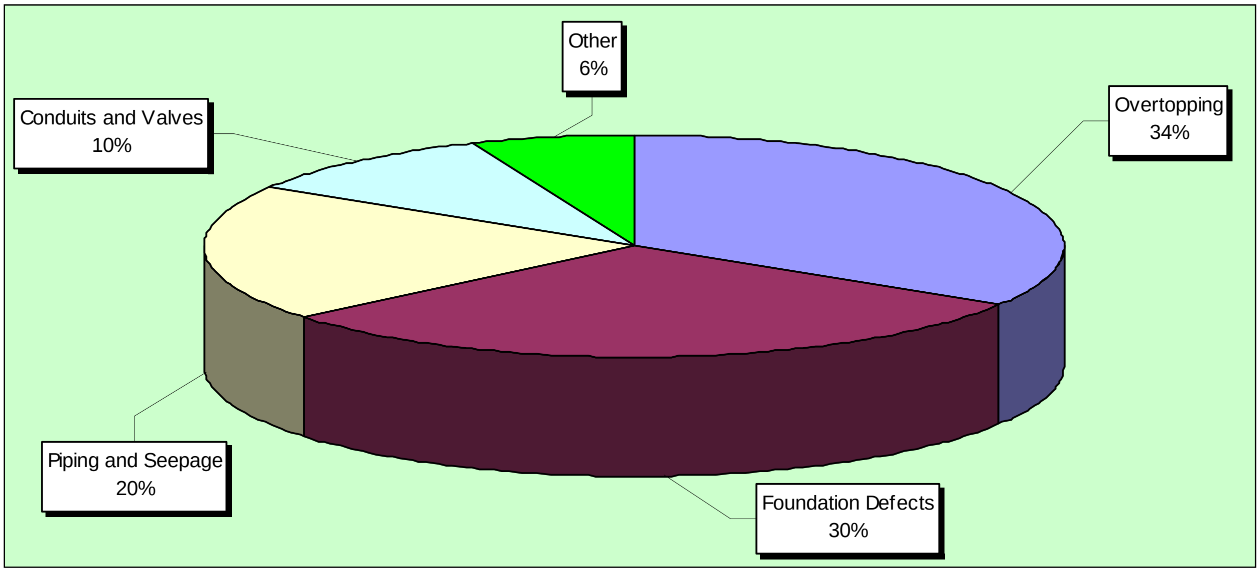


Figure 7-1. Historical Causes of Dam Failure

7.1.2 Regulatory Oversight

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

Washington Department of Ecology Dam Safety Program

The Dam Safety Office (DSO) of the Washington Department of Ecology regulates over 1,000 dams in the state that impound at least 10 acre-feet of water. The DSO has developed dam safety guidelines to provide dam owners, operators, and design engineers with information on activities, procedures, and requirements involved in the planning, design, construction, operation and maintenance of dams in Washington. The authority to regulate dams in Washington and to provide for public safety is contained in the following laws:

- State Water Code (1917)—RCW 90.03
- Flood Control Act (1935)—RCW 86.16
- Department of Ecology (1970)—RCW 43.21A .

Where water projects involve dams and reservoirs with a storage volume of 10 acre-feet or more, the laws provide for the Department of Ecology to conduct engineering review of the construction plans and specifications, to inspect the dams, and to require remedial action, as necessary, to ensure proper operation, maintenance, and safe performance. The DSO was established within Ecology's Water Resources Program to carry out these responsibilities.

The DSO provides reasonable assurance that impoundment facilities will not pose a threat to lives and property, but dam owners bear primary responsibility for the safety of their structures, through proper design, construction, operation, and maintenance. The DSO regulates dams with the sole purpose of reasonably securing public safety; environmental and natural resource issues are addressed by other state agencies. The DSO neither advocates nor opposes the construction and operation of dams.

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety (U.S. Army Corps of Engineers, 1997).

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

Every five years, an independent engineer approved by the FERC must inspect and evaluate projects with dams higher than 32.8 feet (10 meters), or with a total storage capacity of more than 2,000 acre-feet.

FERC monitors and evaluates seismic research and applies it in investigating and performing structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations.

7.2 HAZARD PROFILE

7.2.1 Past Events

According to DSO records, 15 notable dam failure events occurred in Washington between 1918 and 2003. None of these occurred within or impacted Whitman County.

7.2.2 Location

The DSO oversees 11 dams in Whitman County, as listed in Table 7-1. Two are operated by federal agencies, and the remainder are under the jurisdiction of the state. Two of the dams are listed as high hazard, which means there are seven or more lives at risk downstream of the dam. The remainder of the dams are ranked as low risk, with no lives at risk downstream of the dam.

**TABLE 7-1.
DAMS IN WHITMAN COUNTY**

Name	National ID #	Water Course	Owner	Year Built	Dam Type[a]	Crest Length (feet)	Height (feet)	Surface Area (acres)	Drainage area (sq. mi.)	Hazard Class[b]
Lower Granite	WA00349	Snake River	U.S. Army Corps of Engineers	1967	CN, PG, RE	3200	228	8,900	103,200	1A
Little Goose	WA00331	Snake River	U.S. Army Corps of Engineers	1970	CN, PG, RE	2655	226	10,025	103,900	1B
Horn School Rest Area Sewage Lagoon	WA01766	Off-stream	Washington Department of Transportation	1996	RE	122	9	2.6	0.00	2
Albion Sewage Treatment Lagoons	WA01962	South Fork Palouse River, Off-stream	Albion Public Works Department	1972	RE	2,300	8	—	0.01	3
Bennett Pond Dam	WA01557	Pine Creek	John C Bennett	1960	RE	500	8	4.0	0.00	3
Farmington Sewage Lagoon Dike No. 1	WA01430	Pine Cr. Tributary, Off-stream	Town of Farmington	1982	RE	1100	7	9.0	0.01	3
Farmington Sewage Lagoon Dike No. 2	WA01431	Pine Cr. Tributary, Off-stream	Town of Farmington	1982	RE	1400	7	7.0	0.01	3
LaCrosse Sewage Treatment Lagoon	WA01963	Off-stream	Town of LaCrosse	1963	RE	1,900	7	6.0	0.01	3
Uniontown Sewage Pond No. 1	WA01448	Union Flat Creek, Off-stream	Town of Uniontown	1982	RE	600	8	9.0	0.01	3
Uniontown Sewage Pond No. 2	WA01449	Union Flat Creek, Off-stream	Town of Uniontown	1982	RE	600	7	11.0	0.01	3
Uniontown Sewage Pond No. 3	WA01450	Union Flat Creek, Off-stream	Town of Uniontown	1982	RE	600	6	30.0	0.03	3

a. RE = Earth Fill; CN = Concrete, PG = Concrete Gravity
b. See Section 7.2.4 for definition of hazard classes

The DSO has prepared dam failure inundation mapping for the Hazard Class 1A and 1B dams. None of the mapping for high hazard dams was made available to the planning team for this effort. Therefore, a complete exposure and vulnerability analysis was not able to be performed.

7.2.3 Frequency

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

7.2.4 Severity

The DSO classifies dams and reservoirs in a hazard rating system based solely on the potential consequences to downstream life and property that would result from a failure of the dam and sudden release of water. The following codes are used as an index of the potential consequences in the downstream valley if the dam were to fail and release the reservoir water:

- 1A = Greater than 300 lives at risk (High hazard)
- 1B = From 31 to 300 lives at risk (High hazard)
- 1C = From 7 to 30 lives at risk (High hazard)
- 2 = From 1 to 6 lives at risk (Significant hazard)
- 3 = No lives at risk (Low hazard).

The Corps of Engineers developed the hazard classification system for dam failures shown in Table 7-2. The Washington and Corps of Engineers hazard rating systems are both based only on the potential consequences of a dam failure; neither system takes into account the probability of such failures.

7.2.5 Warning Time

Warning time for dam failure varies depending on the cause of the failure. In events of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be no warning time. A dam's structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted or the breach resists further erosion. Concrete gravity dams also tend to have a partial breach as one or more monolith sections are forced apart by escaping water. The time of breach formation ranges from a few minutes to a few hours (U.S. Army Corps of Engineers, 1997).

Whitman County and its planning partners have established protocols for flood warning and response to imminent dam failure in the flood warning portion of adopted emergency operations plans. These protocols are tied to emergency action plans created by the dam owners. Not all dams have emergency action plans; only those rated as high hazard are mandated to do so by state and federal regulations.

7.3 SECONDARY HAZARDS

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

**TABLE 7-2.
CORPS OF ENGINEERS HAZARD POTENTIAL CLASSIFICATION**

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

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

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

7.4 CLIMATE CHANGE IMPACTS

Potential changes to the hydrographs used to design dams due to the impacts of climate change are a growing concern for the safety of our nation’s dams. Dams are designed partly based on assumptions about a river’s flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream. Throughout the west, communities downstream of dams are already increases in stream flows from earlier releases from dams.

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

7.5 EXPOSURE

No exposure analysis was performed for this assessment due to the lack of available inundation mapping. Currently, emergency action plan maps exist for only two of the nine dams within the planning area. The owners of these dams declined to release this information for security purposes. The remaining dams do not have sufficient risk to warrant inundation mapping.

7.6 VULNERABILITY

7.6.1 Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system. The potential for loss of life is also affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation.

7.6.2 Property

Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect. Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

7.6.3 Critical Facilities

Critical facilities within the dam inundation area could receive significant damage from an event. This could result in significant down-time of identified critical facilities and infrastructure. Damage to roads and bridges could isolate populations. The Whitman County port facilities would be very vulnerable, which could have significant economic impacts on the planning area.

7.6.4 Environment

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

7.7 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by comprehensive plans adopted under Washington's GMA. These comprehensive plans, in conjunction with critical-area regulations adopted by municipal planning partners, provide the regulatory and planning capability to address the risks associated with dam failures. Dam failure is currently not addressed as a standalone hazard under these programs, but flooding is. Municipal planning partners have established comprehensive policies regarding sound land use in identified flood hazard areas. Most of the areas vulnerable to severe impacts from dam failure intersect the mapped flood hazard areas. Flood-related policies in the comprehensive plans will help reduce the risk associated with the dam failure hazard for all future development in the planning area.

7.8 SCENARIO

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

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

7.9 ISSUES

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

- Federally regulated dams have an adequate level of oversight and sophistication in the development of emergency action plans for public notification in the unlikely event of failure. However, the protocol for notification of downstream citizens of imminent failure needs to be tied to local emergency response planning.
- Mapping for federally regulated dams is already required and available; however, mapping for non-federal-regulated dams that estimates inundation depths is needed to better assess the risk associated with dam failure from these facilities. Future updates to this assessment should attempt to obtain any an inundation mapping that is available within the planning area. This will require coordination between the County and the dam owners.
- Most dam failure mapping required at federal levels requires determination of the probable maximum flood. While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. For non-federal-regulated dams, mapping of dam failure scenarios that are less extreme than the probable maximum flood but have a higher probability of occurrence can be valuable to emergency managers and community officials downstream of these facilities. This type of mapping can illustrate areas potentially impacted by more frequent events to support emergency response and preparedness.
- The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.

CHAPTER 8.
DROUGHT

8.1 GENERAL BACKGROUND

Drought is a normal phase in the climatic cycle of most geographical regions. According to the National Drought Mitigation Center, drought originates from a deficiency of precipitation over an extended period of time, usually a season or more. This results in a water shortage for some activity, group or environmental sector. Drought is the result of a significant decrease in water supply relative to what is "normal" in a given location. Unlike most disasters, droughts normally occur slowly but last a long time.

There are four generally accepted operational definitions of drought (National Drought Mitigation Center, 2006):

- **Meteorological drought** is an expression of precipitation's departure from normal over some period of time. Meteorological measurements are the first indicators of drought. Definitions are usually region-specific, and based on an understanding of regional climatology. A definition of drought developed in one part of the world may not apply to another, given the wide range of meteorological definitions.
- **Agricultural drought** occurs when there is not enough soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought happens after meteorological drought but before hydrological drought. Agriculture is usually the first economic sector to be affected by drought.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow and as lake, reservoir, and groundwater levels. There is a time lag between lack of rain and less water in streams, rivers, lakes and reservoirs, so hydrological measurements are not the earliest indicators of drought. After precipitation has been reduced or deficient over an extended period of time, this shortage is reflected in declining surface and subsurface water levels. Water supply is controlled not only by precipitation, but also by other factors, including evaporation (which is increased by higher than normal heat and winds), transpiration (the use of water by plants), and human use.
- **Socioeconomic drought** occurs when a physical water shortage starts to affect people, individually and collectively. Most socioeconomic definitions of drought associate it with the supply and demand of an economic good.

Washington has a statutory definition of drought (RCW 43.83B.400), defining an area as being in a drought condition when the water supply for the area is below 75 percent of normal and water uses and users in the area are likely to incur undue hardships because of the water shortage

DEFINITIONS

Drought—The cumulative impacts of several dry years on water users. It can include deficiencies in surface and subsurface water supplies and generally impacts health, well-being, and quality of life.

Hydrological Drought—Deficiencies in surface and subsurface water supplies.

Socioeconomic Drought—Drought impacts on health, well-being and quality of life.

8.2 HAZARD PROFILE

Whitman County is not as vulnerable to drought as many other central and eastern Washington counties, although it has had drought for at least 10 to 15 percent of the time over the last 100 years. The main reason for the County's low vulnerability is a minimal reliance on irrigation for crops and water supplies.

8.2.1 Past Events

In the past century, Washington has experienced a number of droughts, including several that lasted for more than a single season – 1928 to 1932, 1992 to 1994, and 1996 to 1997. The droughts of 1977 and 2001, the worst and second worst in state history, provide good examples of how drought can affect the state. The most recent drought in the state occurred in 2005. In general, Whitman County was not affected as severely by these droughts as much of the rest of Eastern Washington (Washington EMD, 2010).

8.2.2 Location

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure drought impacts and severity and to map their extent and locations:

- The ***Palmer Crop Moisture Index*** measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season.
- The ***Palmer Z Index*** measures short-term drought on a monthly scale. Figure 8-1 shows this index for March 2011.
- The ***Palmer Drought Index (PDI)*** measures the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month is dependent on the current weather patterns plus the cumulative patterns of previous months. Weather patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and the PDI can respond fairly rapidly. Figure 8-2 shows this index for March 2011.
- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The ***Palmer Hydrological Drought Index (PHDI)***, another long-term index, was developed to quantify hydrological effects. The PHDI responds more slowly to changing conditions than the PDI. Figure 8-3 shows this index for March 2011.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the ***Standardized Precipitation Index (SPI)*** considers only precipitation. In the SPI, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The SPI is computed for time scales ranging from one month to 24 months. Figure 8-4 shows the 24-month SPI map for April 2009 through March 2011.

8.2.3 Frequency

Based on Washington's drought history from 1895 to 1995, the state as a whole experiences severe or extreme drought about 5 percent of the time. According to the *Washington State Enhanced Hazard Mitigation Plan*, all of Eastern Washington, except for the Cascade Mountain foothills, experiences severe or extreme drought 10 to 15 percent of the time—at least once per decade on average. (Washington EMD, 2010). This includes Whitman County. This may be changing however. For the period of 1985 to 1995, Whitman County experienced the effects of drought 20 to 30 percent of the time, and during the 1977 drought, the County experienced its effect 30 to 40 percent of the time. However, the state's enhanced mitigation plan does not identify Whitman County as one of the Washington counties most vulnerable to drought.

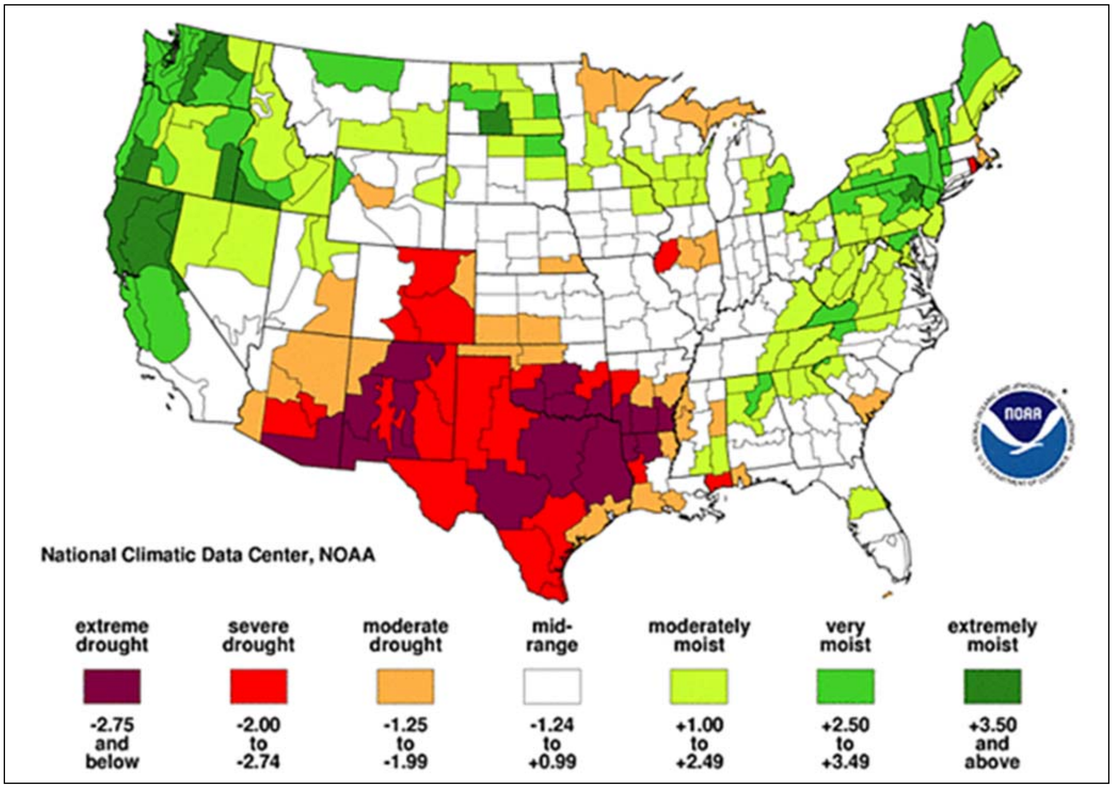


Figure 8-1. Palmer Z Index Short-Term Drought Conditions (March 2011)

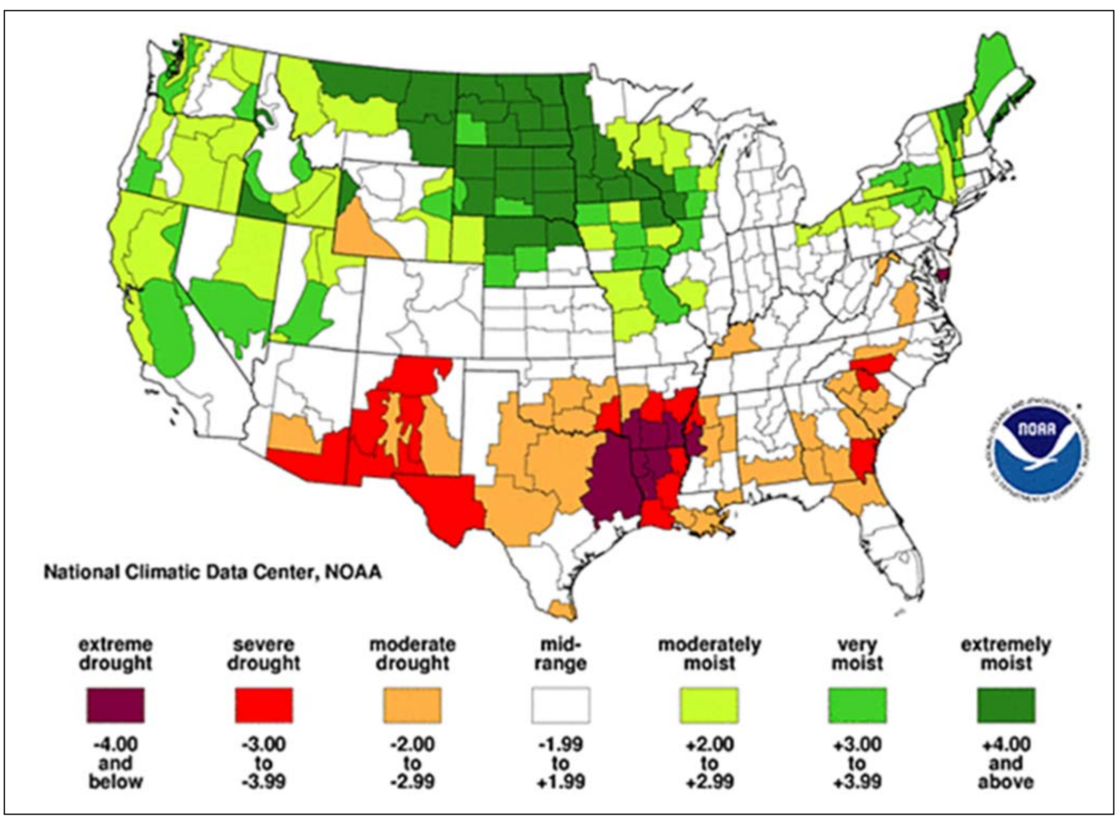


Figure 8-2. Palmer Drought Index Long-Term Drought Conditions (March 2011)

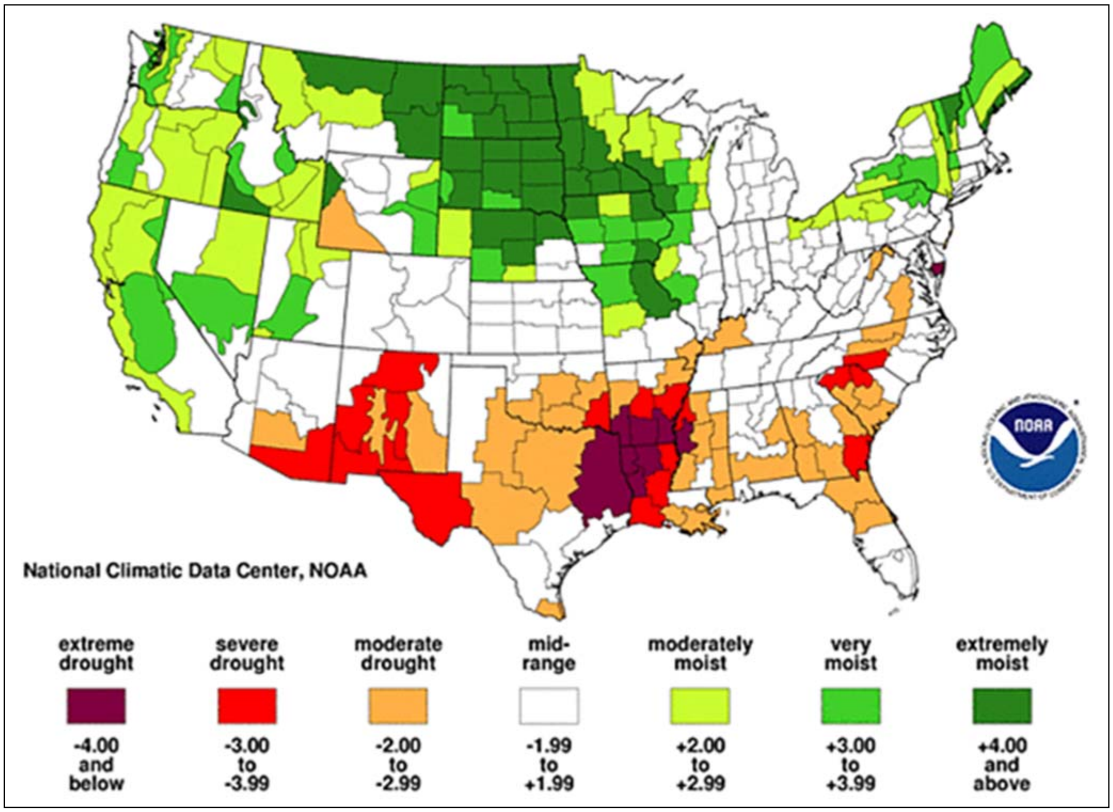


Figure 8-3. Palmer Hydrological Drought Index Long-Term Hydrologic Conditions (March 2011)

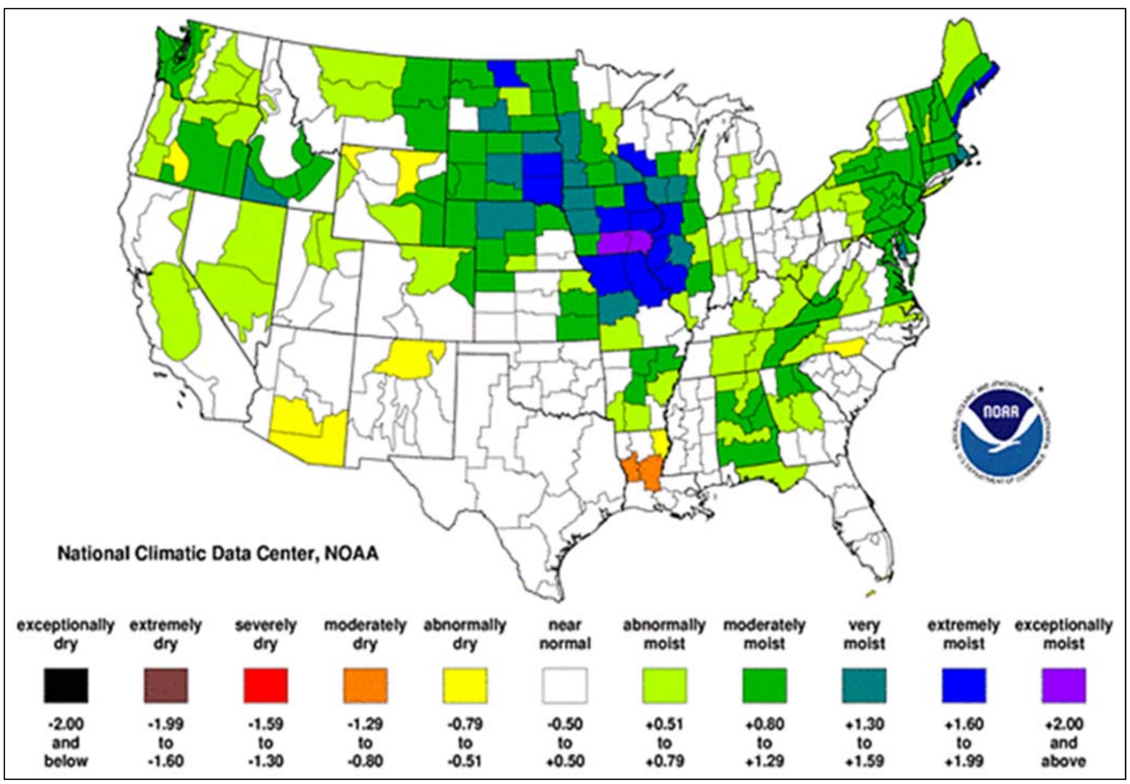


Figure 8-4. 24-Month Standardized Precipitation Index (April 2009—March 2011)

8.2.4 Severity

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

- Agricultural—Drought threatens crops that rely on natural precipitation.
- Water supply—Drought threatens supplies of water for irrigated crops and for communities.
- Fire hazard—Drought increases the threat of wildfires from dry conditions in forest and rangelands.

On average, the nationwide annual impacts of drought are greater than the impacts of any other natural hazard. They are estimated to be between $6 billion and $8 billion annually in the United States and occur primarily in the agriculture, transportation, recreation and tourism, forestry, and energy sectors. Social and environmental impacts are also significant, although it is difficult to put a precise cost on these impacts.

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. Droughts are not usually associated with direct impacts on people or property, but they can have significant impacts on agriculture, which can impact people indirectly. Due to its dry-land farming practices and reliance on ground water, Whitman County does not experience the severity of drought experienced in the central parts of the state that rely heavily on irrigation.

When measuring the severity of droughts, analysts typically look at economic impacts on a planning area. A drought directly or indirectly impacts all people in affected areas. Agricultural impacts can result in loss of work for farm workers and those in related food processing jobs. Other water- or electricity-dependent industries are commonly forced to shut down all or a portion of their facilities, resulting in further layoffs. A drought can harm recreational companies that use water (e.g., swimming pools, water parks, and river rafting companies) as well as landscape and nursery businesses because people will not invest in new plants if water is not available to sustain them. In Washington, where hydroelectric power plants generate nearly three-quarters of the electricity produced, drought also threatens the supply of electricity. With much of Washington’s energy coming from hydroelectric plants, a drought means less inexpensive electricity coming from dams and probably higher electric bills. All people could pay more for water if utilities increase their rates.

Drought generally does not affect groundwater sources as quickly as surface water supplies, but groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. About 16,000 drinking water systems in Washington get water from the ground; these systems serve about 5.2 million people.

Most potable water in Whitman County comes from two major aquifers found in the layers of basalt underlying the County: the Grand Ronde and Wanapum aquifers. According to the Columbia Institute, the Grand Ronde is the sole drinking water supply for the communities of Pullman and Moscow. The County has a low population and does not expect much growth, so there is not expected to be a significant increase in domestic demand for water that could rapidly diminish the supply of water in the aquifers. However, groundwater levels in the two major aquifers are slowly declining from present water usage (see Figure 8-5)

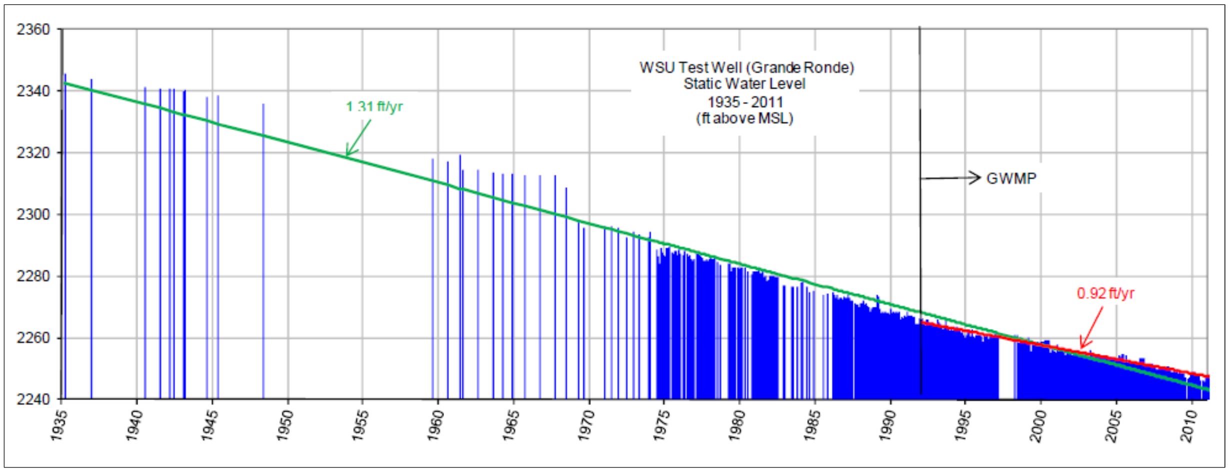


Figure 8-5. Declining Water Levels in Grande Ronde Aquifer, 1935 – 2010

Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest.

8.2.5 Warning Time

Droughts are climatic patterns that occur over long periods of time. Only generalized warning can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions.

Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature; these include global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast with warm, dry air resulting in less precipitation.

Scientists at this time do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale.

8.3 SECONDARY HAZARDS

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

8.4 CLIMATE CHANGE IMPACTS

Research conducted by the Climate Impacts Group at the University of Washington indicates that the temperature of Eastern Washington is increasing. As temperatures increase there will be less water stored as ice and snow. This reduction may not result in a net change in annual precipitation, but it will result in lower late spring and summer river flows. Accordingly there will be increased competition between power, sport fishing and environmentalists, and farmers dependent on irritation.

The long-term effects of climate change on regional water resources are unknown, but global water resources are already experiencing the following stresses without climate change:

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

With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. From 1987 to 1989, losses from drought in the U.S. totaled $39 billion (OTA, 1993). More frequent extreme events such as droughts could end up being more cause for concern than the long-term change in temperature and precipitation averages.

The best advice to water resource managers regarding climate change is to start addressing current stresses on water supplies and build flexibility and robustness into any system. Flexibility helps to ensure a quick response to changing conditions, and robustness helps people prepare for and survive the worst conditions. With this approach to planning, water system managers will be better able to adapt to the impacts of climate change.

8.5 EXPOSURE

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

8.6 VULNERABILITY

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to the ability to produce goods and provide services. Drought can affect a wide range of economic, environmental and social activities. The vulnerability of an activity to the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand.

The Washington State Enhanced Hazard Mitigation plan defines counties as being vulnerable to drought if they meet at least five of the following criteria:

- History of severe or extreme drought conditions:
    1. The county must have been in serious or extreme drought at least 10-15 percent of the time from 1895 to 1995.
- Demand on water resources based on:
    2. Acreage of irrigated cropland. The acreage of the county’s irrigated cropland must be in top 20 in the state.
    3. Percentage of harvested cropland that is irrigated. The percentage of the county’s harvested cropland that is irrigated must be in top 20 in the state.

4. Value of agricultural products. The value of the county's crops must be in the top 20 in the state.
5. Population growth greater than the state average. The county's population growth from 2000 to 2006 must be greater than state average of 8.17 percent.

- A County's inability to endure the economic conditions of a drought, based on:

6. The county's median household income being less than 75 percent of the state median income of $44,776 in 2005.
7. The county being classified as economically distressed in 2005 because its unemployment rate was 20 percent greater than the state average from January 2002 through December 2004.

As summarized in Table 8-1, Whitman County meets only three of the criteria and therefore is not considered to be vulnerable to drought.

**TABLE 8-1.
WHITMAN COUNTY VULNERABILITY TO DROUGHT**

Criterion	Value for Whitman County	Meets Drought Vulnerability Criterion?
Percent of Time in Serious or Extreme Drought, 1895 – 1995	10 – 15	**Yes**
Statewide Ranking for Irrigated Cropland Area	>20	No
Statewide Ranking for Irrigated Cropland Percentage	>20	No
Market Value of Crops Statewide Ranking for Market Value of Crops	$155,249,000 7	**Yes**
Population Growth, 2000 – 2006	<8.17%	No
2005 Median Household Income	$28,584	**Yes**
Unemployment Rate 20% Greater Than State Average	No	No

Source: Washington EMD, 2010

8.6.1 Population

The planning partnership has the ability to minimize any impacts on residents and water consumers in the county should several consecutive dry years occur. No significant life or health impacts are anticipated as a result of drought within the planning area.

8.6.2 Property

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

8.6.3 Critical Facilities

Critical facilities as defined for this plan will continue to be operational during a drought. Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the planning area's critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

8.6.4 Environment

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

8.6.5 Economic Impact

Economic impact will be largely associated with industries that use water or depend on water for their business. For example, landscaping businesses were affected in the droughts of the past as the demand for service significantly declined because landscaping was not watered. Agricultural industries will be impacted if water usage is restricted for irrigation.

8.7 FUTURE TRENDS IN DEVELOPMENT

The U.S. Geological Survey's water use figures for Washington State show that public supply—domestic, commercial, industrial, and thermoelectric generation—uses about one gallon of every eight. Growing counties will find their rate of water use grow as their population grows. Whitman County's average annual growth rate of 0.95 percent between 2000 and 2010 was well below the state average of 1.33 percent for that time frame. This rate of growth is not anticipated to significantly increase during the performance period of this plan update.

Each municipal planning partner in this effort has an established comprehensive plan that includes policies directing land use and dealing with issues of water supply and the protection of water resources. These plans provide the capability at the local municipal level to protect future development from the impacts of drought. All planning partners reviewed their general plans under the capability assessments performed for this effort. Deficiencies identified by these reviews can be identified as mitigation actions to increase the capability to deal with future trends in development.

8.8 SCENARIO

An extreme multiyear drought more intense than the 1977 drought could impact the region with little warning. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out throughout Whitman County, increasing the need for water. Surrounding communities, also in drought conditions, could increase their demand for water supplies relied upon by the planning partnership, causing social and political conflicts. If such conditions persisted for several years, the economy of Whitman County could experience setbacks, especially in water dependent industries.

8.9 ISSUES

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

- Identification and development of alternative water supplies
- Use of groundwater recharge techniques to stabilize the groundwater supply
- The probability of increased drought frequencies and durations due to climate change
- The promotion of active water conservation even during non-drought periods.

CHAPTER 9.
EARTHQUAKE

9.1 GENERAL BACKGROUND

9.1.1 How Earthquakes Happen

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

Earthquakes tend to reoccur along faults, which are zones of weakness in the crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur.

Geologists classify faults by their relative hazards. Active faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). Potentially active faults are those that displaced layers of rock from the Quaternary period (the last 1,800,000 years). Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault. Although there are probably still some unrecognized active faults, nearly all the movement between the two plates, and therefore the majority of the seismic hazards, are on the well-known active faults.

Faults are more likely to have earthquakes on them if they have more rapid rates of movement, have had recent earthquakes along them, experience greater total displacements, and are aligned so that movement can relieve accumulating tectonic stresses. A direct relationship exists between a fault's length and location and its ability to generate damaging ground motion at a given site. In some areas, smaller, local faults produce lower magnitude quakes, but ground shaking can be strong, and damage can be significant as a result of the fault's proximity to the area. In contrast, large regional faults can generate great magnitudes but, because of their distance and depth, may result in only moderate shaking in the area.

It is generally agreed that three source zones exist for Pacific Northwest quakes: a shallow (crustal) zone; the Cascadia Subduction Zone; and a deep, intraplate "Benioff" zone. These are shown in Figure 9-1. More than 90 percent of Pacific Northwest earthquakes occur along the boundary between the Juan de Fuca plate and the North American plate.

DEFINITIONS

Earthquake—The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates.

Epicenter—The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

Fault—A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.

Focal Depth—The depth from the earth's surface to the hypocenter.

Hypocenter—The region underground where an earthquake's energy originates

Liquefaction—Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

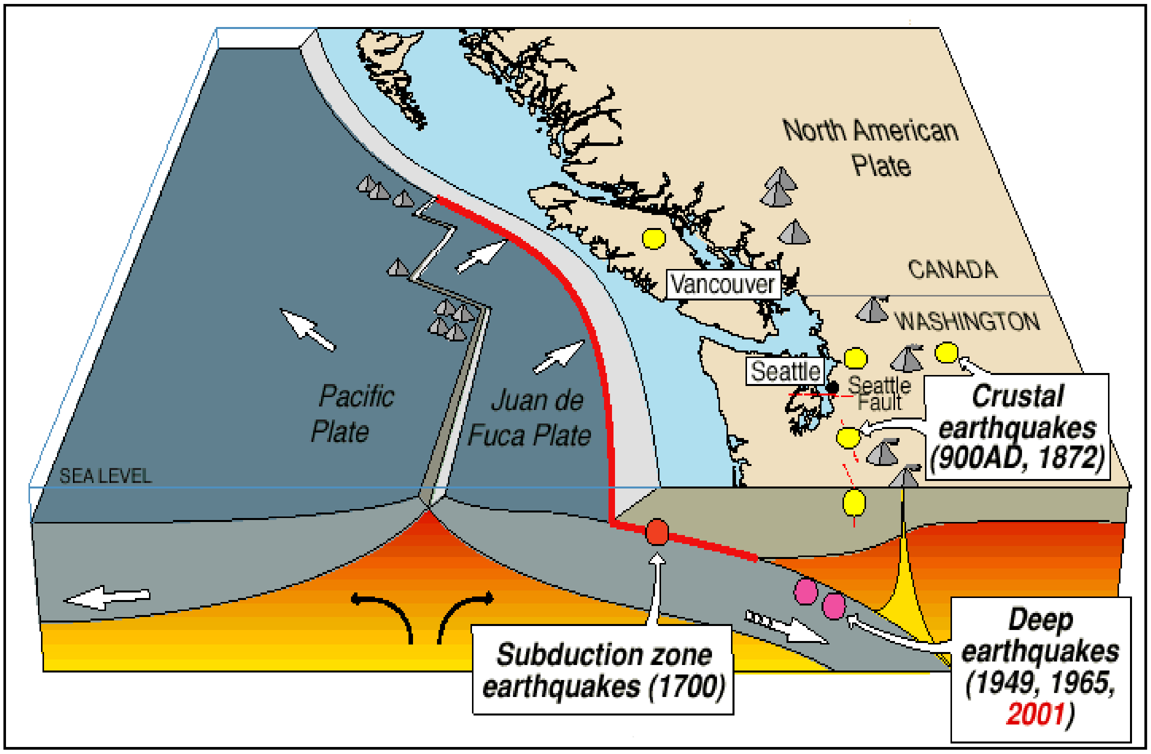


Figure 9-1. Earthquake Types in the Pacific Northwest

9.1.2 Earthquake Classifications

Earthquakes are classified according to the amount of energy released as measured by magnitude or intensity scales. Currently the most commonly used scales are the moment magnitude (Mw) scale, and the modified Mercalli intensity scale. Estimates of moment magnitude roughly match the local magnitude scale (ML) commonly called the Richter scale. One advantage of the moment magnitude scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no value beyond which all large earthquakes have about the same magnitude. For this reason, moment magnitude is now the most often used estimate of large earthquake magnitudes. Table 9-1 presents a classification of earthquakes according to their magnitude. Table 9-2 compares the moment magnitude scale to the modified Mercalli intensity scale.

**TABLE 9-1.
EARTHQUAKE MAGNITUDE CLASSES**

Magnitude Class	Magnitude Range (M = magnitude)
Great	M > 8
Major	7 <= M < 7.9
Strong	6 <= M < 6.9
Moderate	5 <= M < 5.9
Light	4 <= M < 4.9
Minor	3 <= M < 3.9
Micro	M < 3

TABLE 9-2.
EARTHQUAKE MAGNITUDE AND INTENSITY

Magnitude (Mw)	Intensity (Modified Mercalli)	Description
1.0—3.0	I	I. Not felt except by a very few under especially favorable conditions
3.0—3.9	II—III	II. Felt only by a few persons at rest, especially on upper floors of buildings. III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
4.0—4.9	IV—V	IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
5.0—5.9	VI—VII	VI. Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. VII. Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.
6.0—6.9	VII—IX	VIII. Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
7.0 and higher	VIII and higher	X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent. XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly. XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

9.1.3 Ground Motion

Earthquake hazard assessment is also based on expected ground motion. This involves determining the annual probability that certain ground motion accelerations will be exceeded, then summing the annual probabilities over the time period of interest. The most commonly mapped ground motion parameters are the horizontal and vertical peak ground accelerations (PGA) for a given soil or rock type. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 9-3 lists damage potential by PGA factors compared to the Mercalli scale.

TABLE 9-3.
MERCALLI SCALE AND PEAK GROUND ACCELERATION COMPARISON

Mercalli Scale	Potential Damage	Estimated PGA
I	None	0.017
II-III	None	0.017
IV	None	0.014-0.039
V	Very Light	0.039-0.092
VI	None to Slight; USGS-Light	0.02-0.05
	Unreinforced Masonry-Stair Step Cracks; Damage to Chimneys; Threshold of Damage	0.04-0.18
VII	Slight-Moderate; USGS-Moderate	0.05-0.10
	Unreinforced Masonry-Significant; Cracking of parapets	0.08-0.16
	Masonry may fail; Threshold of Structural Damage	0.10-0.34
VIII	Moderate-Extensive; USGS: Moderate-Heavy	0.10-0.20
	Unreinforced Masonry-Extensive Cracking; fall of parapets and gable ends	0.16-0.65
IX	Extensive-Complete; USGS-Heavy	0.20-0.50
	Structural collapse of some un-reinforced masonry buildings; walls out of plane. Damage to seismically designed structures	0.32-1.24
X	Complete ground failures; USGS- Very Heavy (X+); Structural collapse of most un-reinforced masonry buildings; notable damage to seismically designed structures; ground failure	0.50-1.00

9.1.4 Effect of Soil Types

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, distance from the source of the quake, and liquefaction, a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 9-4 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. In general, these areas are also most susceptible to liquefaction.

**TABLE 9-4.
NEHRP SOIL CLASSIFICATION SYSTEM**

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	

9.2 HAZARD PROFILE

Earthquakes can last from a few seconds to over five minutes; they may also occur as a series of tremors over several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris, because the shocks shake, damage or demolish buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides or releases of hazardous material, compounding their disastrous effects.

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

9.2.1 Past Events

The U.S. Geological Survey's National Earthquake Information Center has records of almost 2,700 earthquakes within 250 miles of the center of Whitman County between 1973 and 2011 (see Figure 9-2). Washington's two largest crustal earthquakes since European settlement occurred in Eastern Washington: the 1872 quake near Lake Chelan and the 1936 earthquake near Walla Walla. Of these two, only the Walla Walla earthquake caused any damage in Whitman County. Residents of Spokane felt a swarm of earthquakes in 2001; the largest earthquake in the swarm had a magnitude of 4.0. Significant earthquakes near Whitman County are described in the following sections.

Lake Chelan, December 14, 1872

The magnitude 6.8 (estimated) Lake Chelan earthquake occurred about 9:40 p.m. and was felt from British Columbia to Oregon and from the Pacific Ocean to Montana. It occurred in a wilderness area that had only a few inhabitants. Reported effects included the following:

- Extensive landslides occurred on shorelines of the Columbia River. One slide, at Ribbon Cliff between Entiat and Winesap, blocked the Columbia River for several hours. Other slides occurred throughout the Cascade Mountains.
- Ground fissures occurred at the east end of Lake Chelan in the area of the Indian camp area; in the Chelan Landing-Chelan Falls area; on a mountain about 12 miles west of the Indian camp area; on the east side of the Columbia River (where three springs formed); and near the top of a ridge on the east side of the Columbia River.

Source: USGS NEIC, 2011

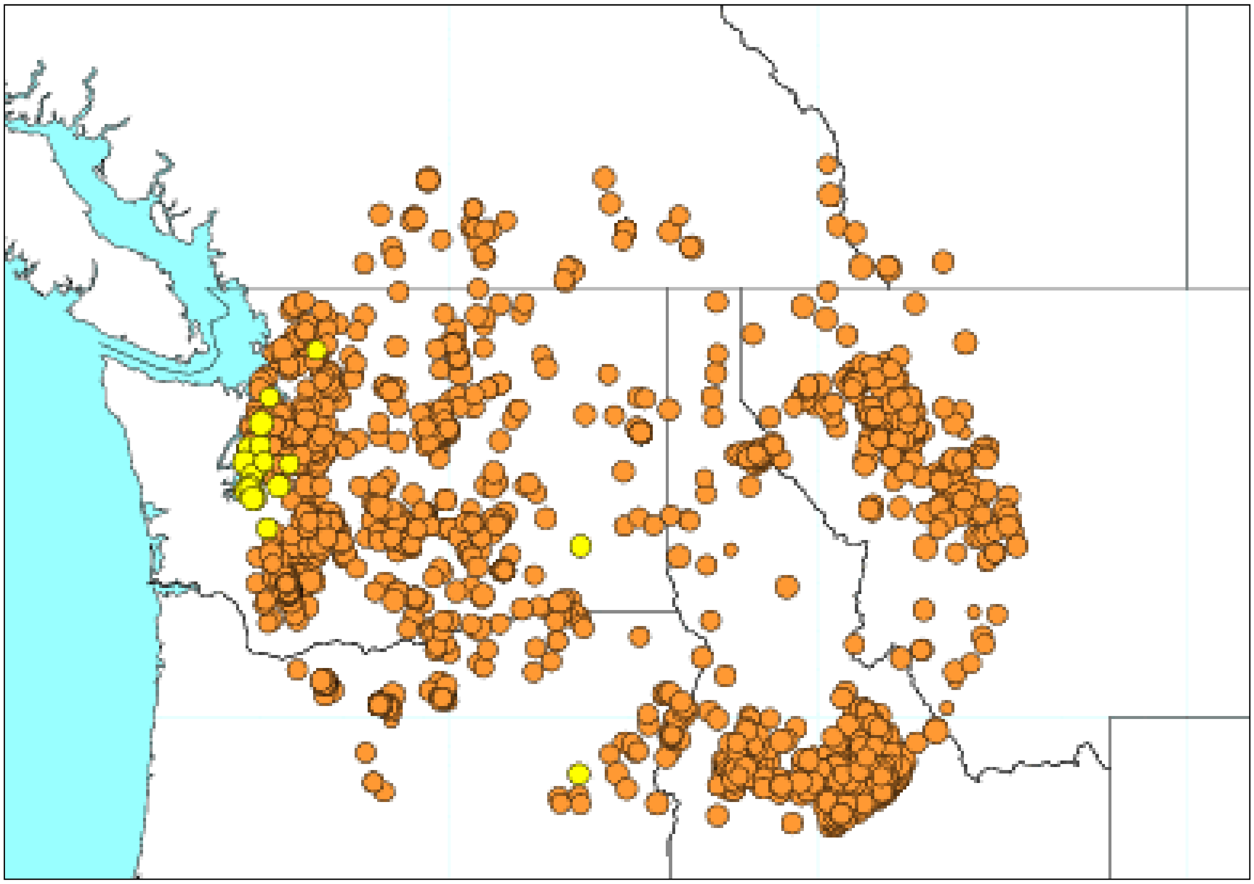


Figure 9-2. Earthquakes within 250 miles of Whitman County Center, 1973 – 2011

- Water spouted as much as 27 feet in the air from a fissure at Chelan Falls. The geyser activity continued for several days, and, after diminishing, left permanent springs.
- In the area of the epicenter, the quake damaged one log building near the mouth of the Wenatchee River. Ground shaking threw people to the floor, waves were observed in the ground, and loud detonations were heard. The logs on another cabin caved in about 2 miles above the Ribbon Cliff slide area.
- Damaging ground shaking of intensity VI extended to the west throughout the Puget Sound basin and to the southeast beyond the Hanford Site. Individuals in Idaho, Montana, Oregon and Canada felt the earthquake. Aftershocks occurred in the area for two years.

Walla Walla Earthquake, July 15, 1936

This magnitude-6.1 earthquake occurred at 11:05 a.m. about 5 miles south-southeast of Walla Walla. It was widely felt through Oregon, Washington and northern Idaho, with the greatest shaking in northeast Oregon. Property damage was estimated at $100,000 (about $1.35 million in 2004 dollars).

The earthquake moved small objects, rattled windows, and cracked plaster in Colfax, Hooper, Page, Pomeroy, Prescott, Touchet, Wallula and Wheeler; most of the impact and damage was near Walla Walla.

The earthquake knocked down a few chimneys and many loose chimney bricks; damaged a brick home used by the warden at the State Penitentiary that was condemned and declared unsafe; and damaged the local railroad station. Several homes moved an inch or less on their foundations. Five miles southwest of Walla Walla, the quake restored the flow of a weakened 600-foot deep artesian well to close to original strength; the flow had not diminished after several months. Walla Walla residents reported about 15 or 20 aftershocks.

Hebgen Lake (Montana), August 18, 1959

The Hebgen Lake earthquake in Montana was felt in parts of eastern Washington. The magnitude-7.5 event generated Intensity X shaking, killed 28 people as a result of a landslide, formed "Quake Lake," and did $11 million in damage to roads and timber. Many campers in the Yellowstone area were trapped for days and a fishing lodge dropped into a lake. There were six aftershocks of magnitude 5.5 or greater within one day. The initial earthquake was felt in an area of over 450,000 square miles.

Borah Peak (Idaho), October 28, 1983

The Borah Peak earthquake was the largest recorded in Idaho, both in magnitude and in the amount of property damage. At a magnitude of 7.3, it was also the largest earthquake to hit the continental United States since the Hebgen Lake quake. The epicenter was in the Barton Flats area, 10 miles northwest of Mackay and 30 miles southeast of Challis. The maximum observed Intensity was IX (based on surface faulting), and the earthquake was felt in an area over 330,000 square miles. Four aftershocks of magnitude 5.5 or greater were recorded within 1 year.

Spokane Earthquake Swarm, 2001

Spokane in 2001 had the most noticed earthquake swarm in the Northwest in recent decades. Dozens of earthquakes occurred over nearly a year. Scientists at the Pacific Northwest Seismograph Network in Seattle said the epicenter of the events was 1 mile north of Gonzaga University and 2.9 miles underground. The largest of the quakes was only a Magnitude 4 event, so little damage done. No major property damage or casualties were caused by the events. However, because the fault whose movement caused the swarm was very shallow, even earthquakes of Magnitude 2 and less were felt. In June and November, there were days with numerous felt events.

9.2.2 Location

In Eastern Washington, geologists have uncovered evidence of a number of surface faults; however, they have not yet determined how active the faults are, nor determined the extent of the risk they pose to the public. One fault, Toppenish Ridge, appears to have been the source of two earthquakes with magnitudes of 6.5 to 7.3 in the past 10,000 years. The 2001 Spokane earthquakes were very shallow, with most events within a few miles of the surface. The events occurred near a suspected fault informally called the Latah Fault; however, the relation between the fault and the swarm is uncertain. Geologists have mapped the Spokane area, but none confirmed the presence of major faults that might be capable of producing earthquakes. State geologists continue to investigate the geology and earthquake risk in Spokane.

Identifying the extent and location of an earthquake is not as simple as it is for other hazards such as flood, landslide or wild fire. The impact of an earthquake is largely a function of the following components:

- Ground shaking (ground motion accelerations)
- Liquefaction (soil instability)
- Distance from the source (both horizontally and vertically).

Mapping that shows the impacts of these components was used to assess the risk of earthquakes within the planning area. While the impacts from each of these components can build upon each other during an earthquake event, the mapping looks at each component individually. The mapping used in this assessment is described below.

Shake Maps

A shake map is a representation of ground shaking produced by an earthquake. The information it presents is different from the earthquake magnitude and epicenter that are released after an earthquake because shake maps focus on the ground shaking resulting from the earthquake, rather than the parameters describing the earthquake source. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A shake map shows the extent and variation of ground shaking in a region immediately following significant earthquakes.

Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. Two types of shake map are typically generated from the data:

- A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10-percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas. Maps 9-1 and 9-2 show the estimated ground motion for the **100-year and 500-year probabilistic earthquakes** in Whitman County.
- Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. Maps of these scenarios can be used to support all phases of emergency management. The scenario chosen for this plan is the **Latah Creek Fault Scenario**—a Magnitude 6.0 event with a shallow depth and epicenter in Spokane County, 10 miles north of Steptoe Butte (see Map 9-3).

NEHRP Soil Maps

NEHRP soil types define the locations that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. The areas that are most commonly affected by ground shaking have NEHRP Soils D, E and F. Map 9-4 shows NEHRP soil classifications in the county.

Liquefaction Maps

Soil liquefaction maps are useful tools to assess potential damage from earthquakes. When the ground liquefies, sandy or silty materials saturated with water behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and building foundations to be damaged. In general, areas with NEHRP Soils D, E and F are also susceptible to liquefaction. If there is a dry soil crust, excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it, creating sand boils. Map 9-5 shows the liquefaction susceptibility in Whitman County.

9.2.3 Frequency

The USGS estimated that a Cascadia Subduction Zone earthquake has a 10 to 15 percent probability of occurrence in 50 years, and a crustal zone earthquake has a recurrence interval of about 500 to 600 years. In general, it is difficult to estimate the probability of occurrence of crustal earthquake events. The best estimate for a major crustal earthquake to occur is once every 1000 years. A Benioff zone earthquake has an 85 percent probability of occurrence in 50 years, making it the most likely of the three types.

9.2.4 Severity

The severity of an earthquake can be expressed in terms of intensity or magnitude. Intensity represents the observed effects of ground shaking on people, buildings and natural features. The USGS has created ground motion maps based on current information about several fault zones. These maps show the PGA that has a certain probability (2 percent or 10 percent) of being exceeded in a 50-year period. The PGA is measured in numbers of g's (the acceleration associated with gravity). Figure 9-3 shows the PGAs with a 2-percent exceedance chance in 50 years in Washington. The Eastern Washington area, including Whitman County, is in a low-risk area, with a 2 percent probability in a 50-year period of ground shaking from a seismic event exceeding 0.15 g.

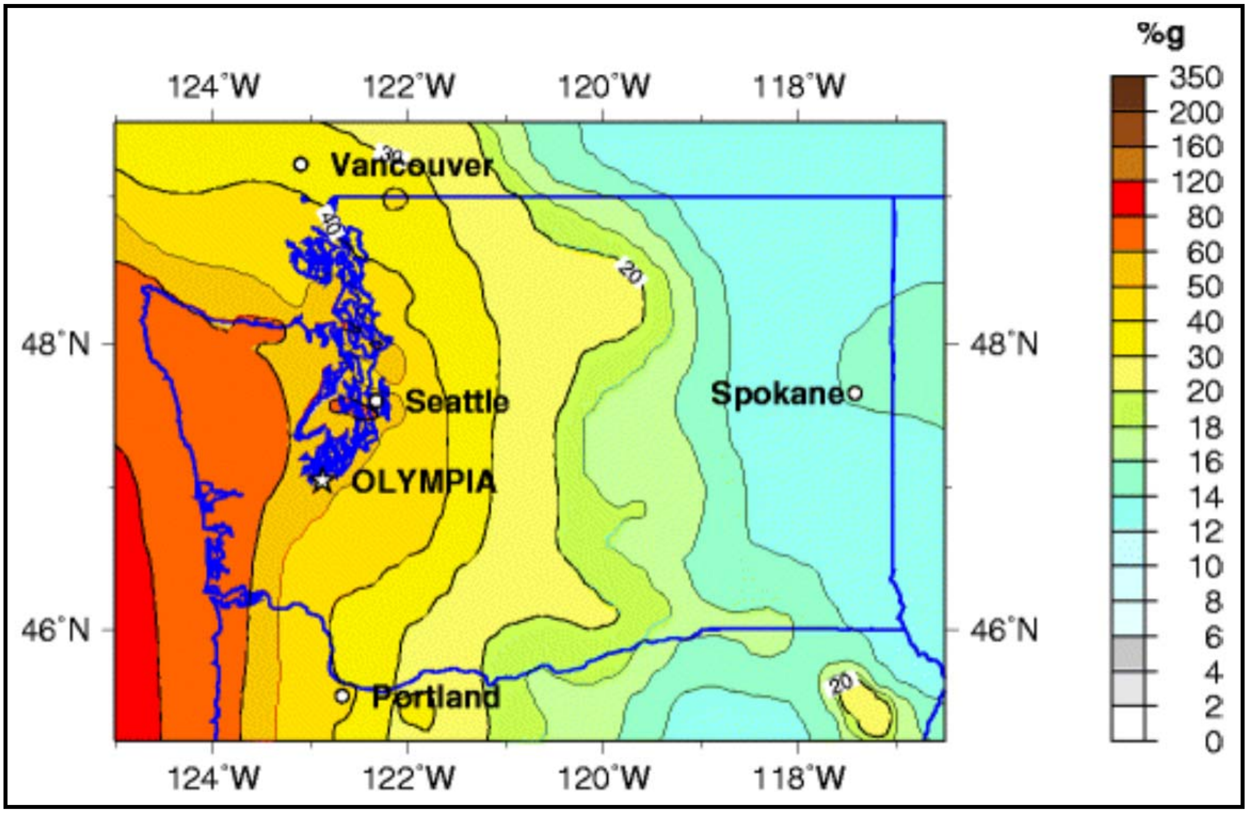


Figure 9-3. PGA with 2-Percent Probability of Exceedance in 50 Years, Northwest Region

Magnitude is related to the amount of seismic energy released at the hypocenter of an earthquake. It is determined by the amplitude of the earthquake waves recorded on instruments. Whereas intensity varies depending on location with respect to the earthquake epicenter, magnitude is represented by a single, instrumentally determined value for each earthquake event.

In simplistic terms, the severity of an earthquake event can be measured in the following terms:

- How hard did the ground shake?
- How did the ground move? (Horizontally or vertically)
- How stable was the soil?
- What is the fragility of the built environment in the area of impact?

Past events have indicated that an earthquake in the Whitman County area would cause little or no damage. Most crustal earthquakes are in 5.0 to 5.5 magnitude range, and do not have a history of occurrence in the County proper. Nonetheless severity can increase in areas that have softer soils, such as the unconsolidated sediments found in the Palouse River Valley.

9.2.5 Warning Time

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short but it could allow for someone to get under a desk, step away from a hazardous material they are working with, or shut down a computer system.

9.3 SECONDARY HAZARDS

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes.

9.4 CLIMATE CHANGE IMPACTS

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth’s crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA, 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

9.5 EXPOSURE

9.5.1 Population

The entire population of Whitman County is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soil type their homes are constructed on, their proximity to fault location, etc. Whether directly impacted or indirectly impact, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

9.5.2 Property

According to the 2010 U.S. Census and Whitman County Assessor estimates, there are 19,354 buildings in Whitman County, with a total assessed value of $4.768 billion. Since all structures in the planning area are susceptible to earthquake impacts to varying degrees, this total represents the county-wide property exposure to seismic events. Most of the buildings (89 percent) are residential.

9.5.3 Critical Facilities and Infrastructure

All critical facilities in Whitman County are exposed to the earthquake hazard. Table 6-3 and Table 6-4 list the number of each type of facility by jurisdiction. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

9.5.4 Environment

Secondary hazards associated with earthquakes will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly impact surrounding habitat. It is also possible for streams to be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

9.6 VULNERABILITY

Earthquake vulnerability data was generated using a Level 2 HAZUS-MH analysis. Once the location and size of a hypothetical earthquake are identified, HAZUS-MH estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

9.6.1 Population

Three population groups are particularly vulnerable to earthquake hazards:

- **Linguistically Isolated Populations**—–Approximately 1,200 residents in the planning area census blocks on NEHRP D and E soils do not speak English as their native language. This is about 3 percent of all residents in these census blocks. Problems arise when there is an urgent need to inform non-English speaking residents of an earthquake event. They are vulnerable because of difficulties in understanding hazard-related information from predominantly English-speaking media and government agencies.
- **Population Below Poverty Level**—Approximately 1,600 households in the planning area census blocks on NEHRP D and E soils are listed as being below the poverty level. This is about 14 percent of all households in these census blocks. These households may lack the

financial resources to improve their homes to prevent or mitigate earthquake damage. Poorer residents are also less likely to have insurance to compensate for losses in earthquakes.

- **Population Over 65 Years Old**—Approximately 1,300 residents in the planning area census blocks on NEHRP D and E soils are over 65 years old. This is about 4 percent of all residents in these census blocks. This population group is vulnerable because they are more likely to need special medical attention, which may not be available due to isolation caused by earthquakes. Elderly residents also have more difficulty leaving their homes during earthquake events and could be stranded in dangerous situations.

Impacts on persons and households in the planning area were estimated for the 100-year and 500-year earthquakes and the Latah Creek scenario event through the HAZUS-MH analysis. Table 9-5 summarizes the results.

TABLE 9-5.
ESTIMATED EARTHQUAKE IMPACT ON PERSON AND HOUSEHOLDS

	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
100-Year Earthquake	1	1
500-Year Earthquake	18	18
Latah Creek Earthquake Scenario	6	5

9.6.2 Property

Building Age

Structures that are in compliance with the Uniform Building Code (UBC) of 1970 or later are generally less vulnerable to seismic damage because 1970 was when the UBC started including seismic construction standards based on regional location. This stipulated that all structures be constructed to at least seismic risk Zone 2 standards. The State of Washington adopted the UBC as its state building code in 1972, so it is assumed that buildings in the planning area built after 1972 were built in conformance with UBC seismic standards and have less vulnerability. Issues such as code enforcement and code compliance could impact this assumption. Construction material is also important when determining the potential risk to a structure. However, for planning purposes, establishing this line of demarcation can be an effective tool for estimating vulnerability. In 1994, seismic risk Zone 3 standards of the UBC went into effect in Washington, requiring all new construction to be capable of withstanding the effects of 0.3 times the force of gravity. More recent housing stock is in compliance with Zone 3 standards. In July 2004, the state again upgraded the building code to follow International Building Code Standards.

Based on Census data, the median date of construction for the planning area is 1966. It is estimated that approximately 55 percent of the building stock in the planning area was constructed prior to 1970. Due to the lack of parcel-based information in GIS format for the planning area, a detailed analysis of the building stock was not possible. As better data and technology become available, this degree of analysis is recommended to determine seismic vulnerability in the planning area.

Soft-Story Buildings

A soft-story building is a multi-story building with one or more floors that are “soft” due to structural design. If a building has a floor that is 70-percent less stiff than the floor above it, it is considered a soft-story building. In earthquakes, soft stories cannot cope with the lateral forces caused by swaying of the building. Since soft stories are typically associated with retail spaces and parking garages, they are often on the lower stories of a building. When they collapse, they can take the whole building down with them, causing serious structural damage that may render the structure totally unusable (see Figure 9-4). Soft-story collapse is one of the leading causes of earthquake damage to private residences. Exposure associated with soft story construction in the planning area is not currently known. This type of data will need to be generated to support future risk assessments of the earthquake hazard.

Figure 9-4. Soft-Story Damage from 1989 Earthquake in California

Loss Potential

Property losses for the 100-year and 500-year earthquakes and the scenario event were estimated through the HAZUS-MH analysis. Table 9-6 and Table 9-7 show the results for two types of property loss:

- Structural loss, representing damage to building structures
- Non-structural loss, representing the value of lost contents and inventory, relocation, income loss, rental loss, and wage loss.

The total of the two types of losses is also shown in the tables. A summary of the property-related loss results is as follows:

- For a 100-year probabilistic earthquake, the estimated damage potential is $1.275 million, or 0.026 percent of the total assessed value for the planning area.
- For a 500-year probabilistic earthquake, the estimated damage potential is $19.38 million, or 0.406 percent of the total assessed value for the planning area.
- For the scenario event, the estimated damage potential is $12.175 million, or 0.255 percent of the total assessed value for the planning area.

The HAZUS-MH analysis also estimated the amount of earthquake-caused debris in the planning area for the 100-year and 500-year earthquakes and the two scenario events, as summarized in Table 9-8.

**TABLE 9-6.
EARTHQUAKE BUILDING LOSS POTENTIAL—PROBABILISTIC**

	Estimated Earthquake Loss Value					
	100- Year Probabilistic Earthquake			500- Year Probabilistic Earthquake		
Jurisdiction	Structural	Non-Structural	**Total**	Structural	Non-Structural	**Total**
Albion	$25,396	$3,161	**$28,557**	$313,340	$78,877	**$392,217**
Colfax	$86,544	$11,909	**$98,453**	$1,368,428	$344,476	**$1,712,904**
Colton	$10,119	$1,260	**$11,378**	$129,335	$32,557	**$161,892**
Endicott	$11,965	$1,489	**$13,454**	$172,426	$43,405	**$215,831**
Farmington	$3,255	$405	**$3,660**	$14,277	$3,594	**$17,871**
Garfield	$15,758	$1,962	**$17,720**	$69,115	$17,398	**$86,514**
LaCrosse	$11,318	$1,409	**$12,727**	$144,654	$36,414	**$181,068**
Lamont	$2,620	$326	**$2,946**	$36,075	$9,081	**$45,156**
Malden	$7,125	$887	**$8,012**	$102,673	$25,846	**$128,519**
Oakesdale	$10,817	$1,347	**$12,164**	$47,478	$11,952	**$59,430**
Palouse	$20,545	$2,558	**$23,103**	$109,999	$27,690	**$137,689**
Pullman	$534,199	$71,916	**$606,115**	$8,056,559	$2,028,084	**$10,084,643**
Rosalia	$18,703	$2,328	**$21,031**	$260,227	$65,507	**$325,735**
St. John	$19,413	$2,417	**$21,830**	$279,743	$70,420	**$350,163**
Tekoa	$23,608	$2,939	**$26,547**	$340,188	$85,636	**$425,824**
Uniontown	$10,649	$1,326	**$11,975**	$136,102	$34,261	**$170,363**
Unincorporated	$322,074	$33,541	**$355,615**	$3,902,147	$982,291	**$4,884,438**
Total	**$1,134,108**	**$141,180**	**$1,275,287**	**$15,482,766**	**$3,897,489**	**$19,380,257**

**TABLE 9-7.
EARTHQUAKE BUILDING LOSS POTENTIAL—LATAH CREEK SCENARIO EVENT**

	Estimated Earthquake Loss Value		
Jurisdiction	Structural	Non-Structural	**Total**
Albion	$213,240	$59,414	**$272,654**
Colfax	$726,670	$223,810	**$950,480**
Colton	$84,961	$23,672	**$108,633**
Endicott	$100,463	$27,992	**$128,455**
Farmington	$27,329	$7,615	**$34,943**
Garfield	$132,314	$36,866	**$169,181**
LaCrosse	$95,036	$26,479	**$121,515**
Lamont	$21,997	$6,129	**$28,126**
Malden	$59,826	$16,669	**$76,495**
Oakesdale	$90,826	$25,306	**$116,132**
Palouse	$172,508	$48,065	**$220,574**
Pullman	$4,485,432	$1,351,558	**$5,836,990**
Rosalia	$157,040	$43,756	**$200,796**
St. John	$163,004	$45,417	**$208,421**
Tekoa	$198,227	$55,231	**$253,459**
Uniontown	$89,417	$24,914	**$114,331**
Unincorporated	$2,704,315	$630,357	**$3,334,672**
Total	**$9,522,605**	**$2,653,250**	**$12,175,857**

TABLE 9-8.
ESTIMATED EARTHQUAKE-CAUSED DEBRIS

Debris to Be Removed (tons)		
100-Year Earthquake	500-Year Earthquake	Latah Creek Scenario Event Earthquake
0.95	8.88	5.37

9.6.3 Critical Facilities and Infrastructure

Level of Damage

HAZUS-MH classifies the vulnerability of critical facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a vulnerability category to each critical facility in the planning area except hazmat facilities and "other infrastructure" facilities, for which there are no established damage functions. The analysis was performed for the 100-year event and the scenario earthquake, which have, respectively, the highest probability of occurrence and the largest potential impact on the planning area. Table 9-9 and Table 9-10 summarize the results.

Time to Return to Functionality

HAZUS-MH estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, HAZUS-MH may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. The analysis of critical facilities in the planning area was performed for the 100-year and scenario earthquake events. Table 9-11 and Table 9-12 summarize the results.

TABLE 9-9.
CRITICAL FACILITY VULNERABILITY TO 100-YEAR EARTHQUAKE EVENT

Category[a]	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	7	0	0	0	**0**
Government Functions	4	8	0	0	**0**
Protective Functions	26	0	0	0	**0**
Schools	30	0	0	0	**0**
Other Critical Functions	25	16	0	0	**0**
Bridges	400	0	0	0	**0**
Water supply	29	0	0	0	**0**
Wastewater	14	0	0	0	**0**
Power	22	0	0	0	**0**
Communications	14	0	0	0	**0**
Total	**571**	**24**	**0**	**0**	**0**

a. Vulnerability not estimated for hazmat facilities or for "other infrastructure" facilities due to lack of established damage functions for these type facilities.

TABLE 9-10.
CRITICAL FACILITY VULNERABILITY TO LATAH CREEK SCENARIO EARTHQUAKE EVENT

Category[a]	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	5	2	0	0	0
Government Functions	4	6	2	0	0
Protective Functions	17	5	2	0	2
Schools	19	7	4	0	0
Other Critical Functions	15	14	10	2	0
Bridges	291	10	51	41	7
Water supply	10	19	0	0	0
Wastewater	4	8	2	0	0
Power	10	12	0	0	0
Communications	11	3	0	0	0
Total	**386**	**86**	**71**	**43**	**9**

a. Vulnerability not estimated for hazmat facilities or for "other infrastructure" facilities due to lack of established damage functions for these type facilities.

TABLE 9-11.
FUNCTIONALITY OF CRITICAL FACILITIES FOR 100-YEAR EVENT

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health	7	99.29	99.30	99.86	99.86	99.90	99.90
Government Functions	12	99.25	99.25	99.85	99.9	99.9	99.9
Protective Functions	26	99.14	99.14	99.85	99.86	99.90	99.90
Schools	30	99.28	99.28	99.87	99.90	99.90	99.90
Other Critical functions	41	99.88	99.90	99.90	99.90	99.90	99.90
Bridges	400	99.99	100.00	100.00	100.00	100.00	100.00
Water supply	29	99.62	99.90	99.90	99.90	99.90	99.90
Wastewater	14	98.44	99.73	99.90	99.90	99.90	99.90
Power	22	99.99	100.00	100.00	100.00	100.00	100.00
Communications	14	99.9	99.9	99.9	99.9	99.9	99.9
Total/Average	**595**	**99.42**	**99.60**	**99.89**	**99.90**	**99.91**	**99.91**

**TABLE 9-12.
FUNCTIONALITY OF CRITICAL FACILITIES FOR SCENARIO EARTHQUAKE EVENT**

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%) at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health	7	92.21	92.33	97.41	97.55	98.54	98.66
Government Functions	12	89.575	89.75	97.025	97.175	98.35	98.525
Protective Functions	26	85.94	86.13	94.66	94.87	97.56	97.79
Schools	30	87.08	87.23	94.79	95.00	96.81	96.94
Other Critical functions	41	93.64	97.49	98.07	98.24	99.45	99.90
Bridges	400	96.41	96.77	97.05	97.14	97.33	98.68
Water supply	29	99.06	99.56	99.69	99.71	99.75	99.84
Wastewater	14	94.69	98.26	98.71	98.83	99.65	99.90
Power	22	93.64	97.49	98.07	98.24	99.45	99.90
Communications	14	99.79	97.49	98.07	98.24	99.45	99.90
Total/Average	**595**	**93.16**	**94.16**	**97.48**	**97.60**	**98.59**	**98.90**

9.6.4 Environment

The environment vulnerable to earthquake hazard is the same as the environment exposed to the hazard.

9.7 FUTURE TRENDS IN DEVELOPMENT

The land use elements of the comprehensive plans adopted by the municipal planning partners provide a long-range guide to the physical development of the planning area and its urban growth area. As the planning area begins to experience growth, Whitman County and its planning partners will need to manage growth in a way that accounts for impacts from potential earthquakes. With tools such as the Washington State Building Code and local critical-area ordinances that define seismic hazard areas, the planning partners are prepared to deal with future growth.

Once the technological capability of the planning partnership is enhanced with tools such as GIS, this assessment should be revisited to provide a better gauge of vulnerability, looking at parameters such as zoned land use and age of structures.

9.8 SCENARIO

Any seismic activity of Magnitude 6.0 or greater on faults within the planning area would have significant impacts. The seismic event likely to have the largest impact is a Magnitude 5.5 or greater event on the Latah Creek Fault. Potential warning systems could give 40 seconds' notice that a major earthquake is about to occur; this would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to significant structural failure of property on unstable soils. With the abundance of floodplain within the planning area, liquefaction impacts in these areas could be widespread.

There are numerous crustal faults throughout the Columbia Plateau and in areas north and south. These have not been mapped sufficiently for scientists to make any conclusions about the effect they can have on earthquakes, but it is possible that a fault near Whitman County could rupture, causing a shallow crustal earthquake in the County. Damage would most likely occur to older structures in the downtown areas of some communities located on softer (NEHRP D and E) soils. Injuries may occur from debris, such as parapets and chimneys that could topple or be shaken loose and fall on those walking or driving below. An earthquake may also cause minor landslides along unstable slopes. This would be even more likely if the earthquake occurred during the rainy or snowy winter and early spring months.

9.9 ISSUES

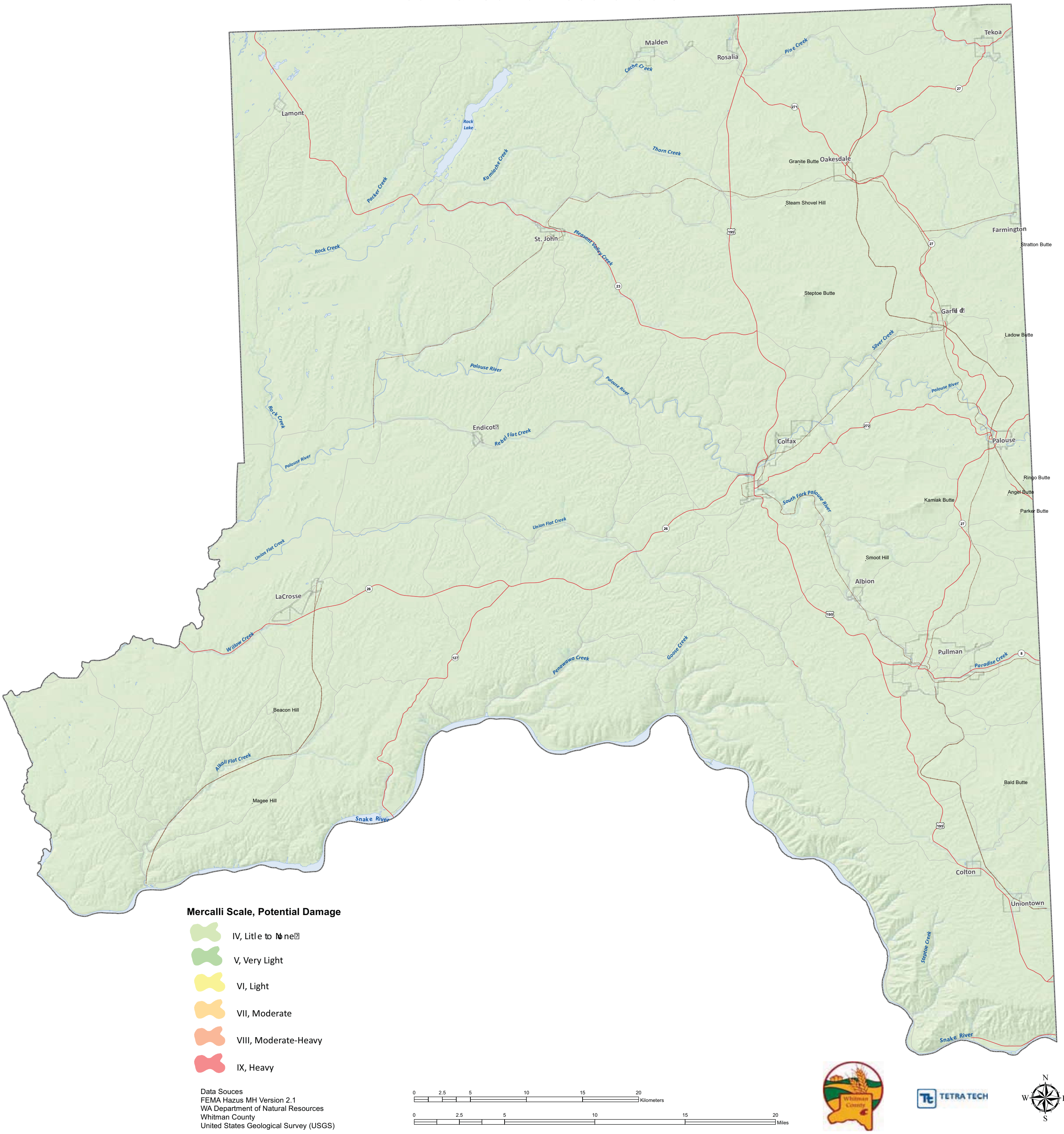
More research needs to be conducted to determine the exposure and vulnerability of Whitman County and the Columbia Plateau region in general to earthquakes. The County and its communities should inventory and assess older structures and seek ways to retrofit those that are determined most likely to be damaged during an earthquake. Until additional data on the impacts of events typical for this region are developed, non-structural retrofitting techniques should be considered and promoted by the partnership. Important issues associated with an earthquake include but are not limited to the following:

- A more robust assessor data set would significantly enhance the partnership's ability to assess seismic risk.
- More scenario-based shake map data is need for the region.
- More information is needed on the exposure and performance of soft-story construction within the planning area.
- According to the 2010 U.S. census, more than 43 percent of the planning area's building stock was built prior to 1970, when seismic provisions became uniformly applied through building code applications.
- Critical facility owner should be encouraged to create or enhance Continuity of Operations Plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- Earthquakes could trigger other natural hazard events such as dam failures and landslides, which could severely impact the county.

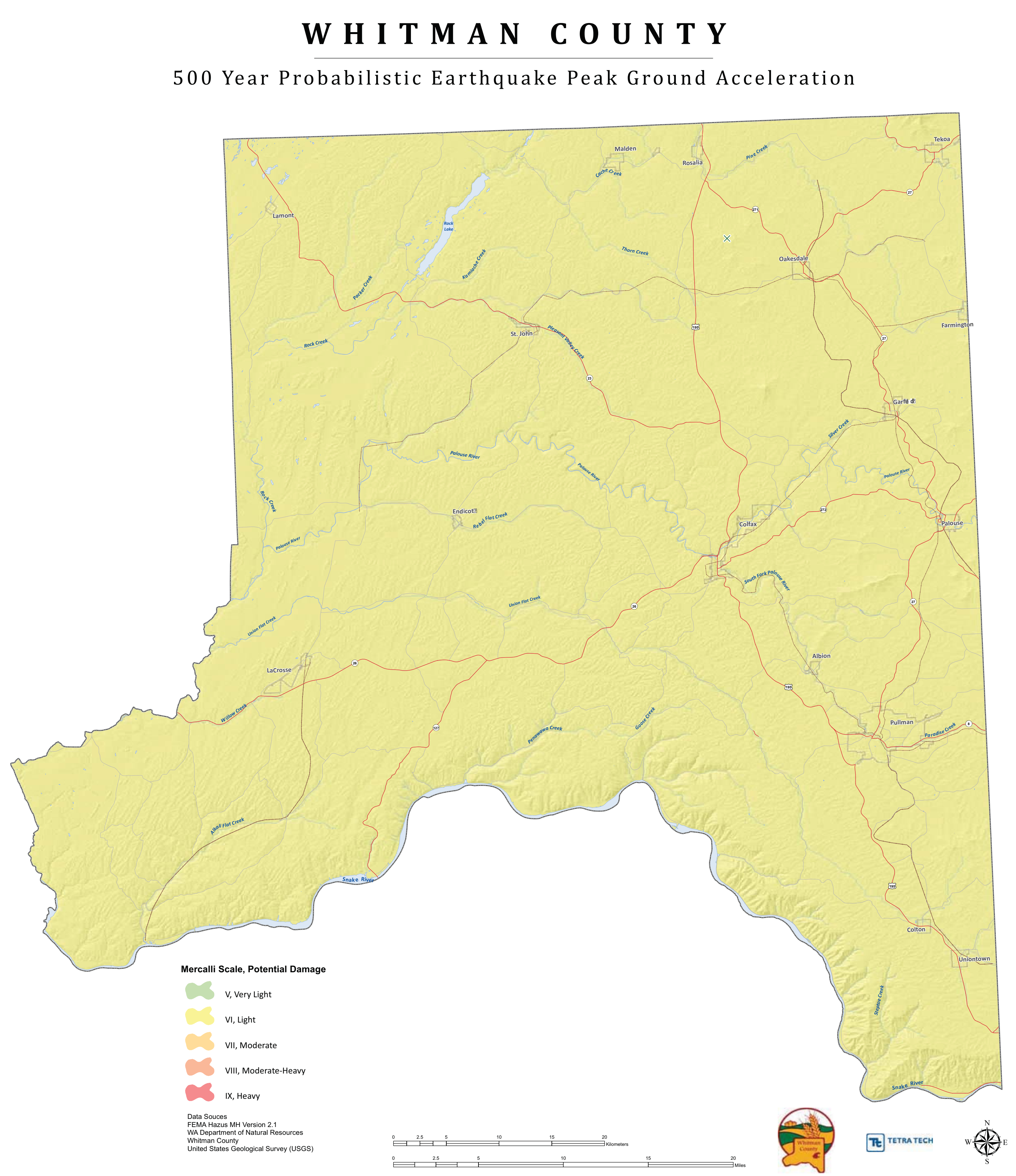
Map 9-1.

WHITMAN COUNTY

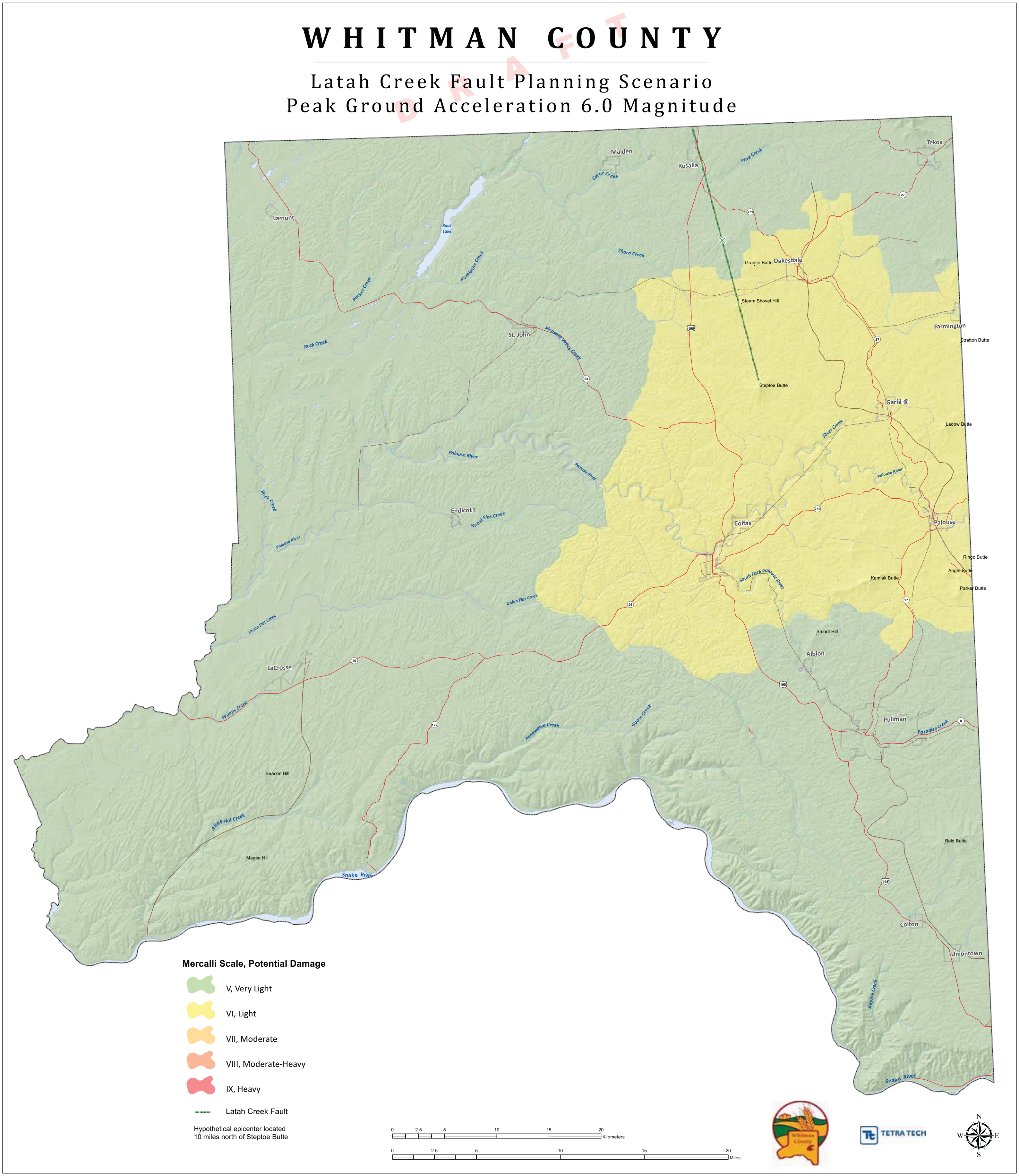
100 Year Probabilistic Earthquake
Peak Ground Acceleration



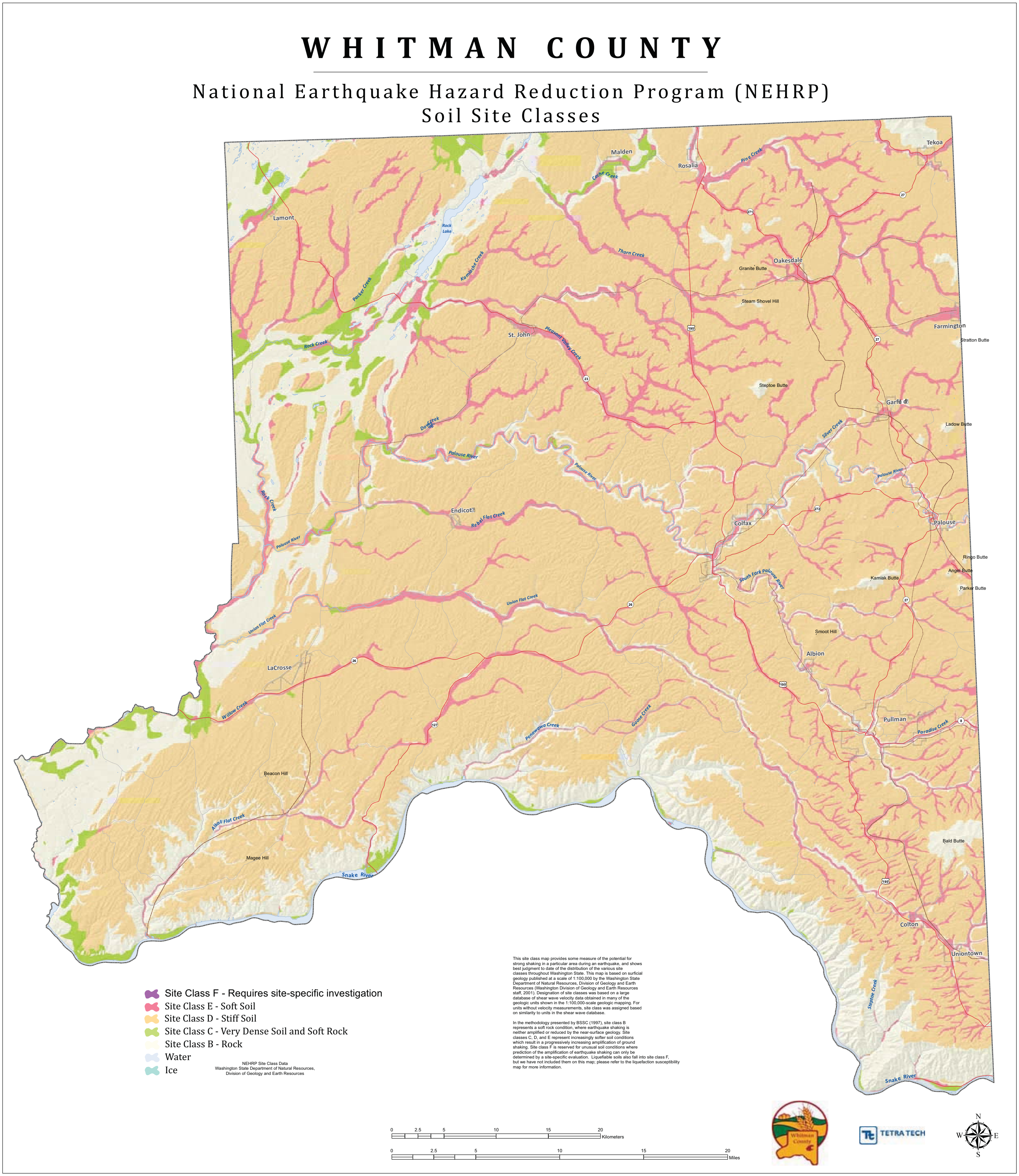
Map 9-2.


WHITMAN COUNTY
500 Year Probabilistic Earthquake Peak Ground Acceleration
Malden
Rosalia
Tekoa
Pine Creek
Cache Creek
Lamont
Rock Lake
Kamiache Creek
Thorn Creek
Oakesdale
Packer Creek
Farmington
Rock Creek
St. John
Pleasant Valley Creek
Garfield
Silver Creek
Palouse River
Palouse River
Palouse River
Rock Creek
Endicott
Rebel Flat Creek
Colfax
Palouse
Palouse River
South Fork Palouse River
Union Flat Creek
Union Flat Creek
LaCrosse
Albion
Willow Creek
Pullman
Paradise Creek
Penawawa Creek
Goose Creek
Alkali Flat Creek
Snake River
Colton
Uniontown
Steptoe Creek
Snake River
Mercalli Scale, Potential Damage
V, Very Light
VI, Light
VII, Moderate
VIII, Moderate-Heavy
IX, Heavy
Data Souces
FEMA Hazus MH Version 2.1
WA Department of Natural Resources
Whitman County
United States Geological Survey (USGS)
Kilometers
Miles
TETRA TECH
N
W
E
S

Map 9-3.


WHITMAN COUNTY
Latah Creek Fault Planning Scenario
Peak Ground Acceleration 6.0 Magnitude
DRAFT
Malden
Rosalia
Tekoa
Pine Creek
Cache Creek
Lamont
Rock Lake
Kamiache Creek
Packer Creek
Thorn Creek
Granite Butte
Oakesdale
Steam Shovel Hill
Farmington
Stratton Butte
St. John
Pleasant Valley Creek
Rock Creek
Steptoe Butte
Garfield
Ladow Butte
Silver Creek
Palouse River
Rock Creek
Endicott
Rebel Flat Creek
Colfax
Palouse
Palouse River
Ringo Butte
Angel Butte
South Fork Palouse River
Kamiak Butte
Parker Butte
Union Flat Creek
Union Flat Creek
Smoot Hill
Albion
LaCrosse
Willow Creek
Pullman
Paradise Creek
Penawawa Creek
Goose Creek
Beacon Hill
Alkali Flat Creek
Magee Hill
Snake River
Bald Butte
Colton
Uniontown
Steptoe Creek
Snake River
Mercalli Scale, Potential Damage
V, Very Light
VI, Light
VII, Moderate
VIII, Moderate-Heavy
IX, Heavy
Latah Creek Fault
Hypothetical epicenter located
10 miles north of Steptoe Butte
0 2.5 5 10 15 20 Kilometers
0 2.5 5 10 15 20 Miles
TETRA TECH
N
S
E
W

Map 9-4.

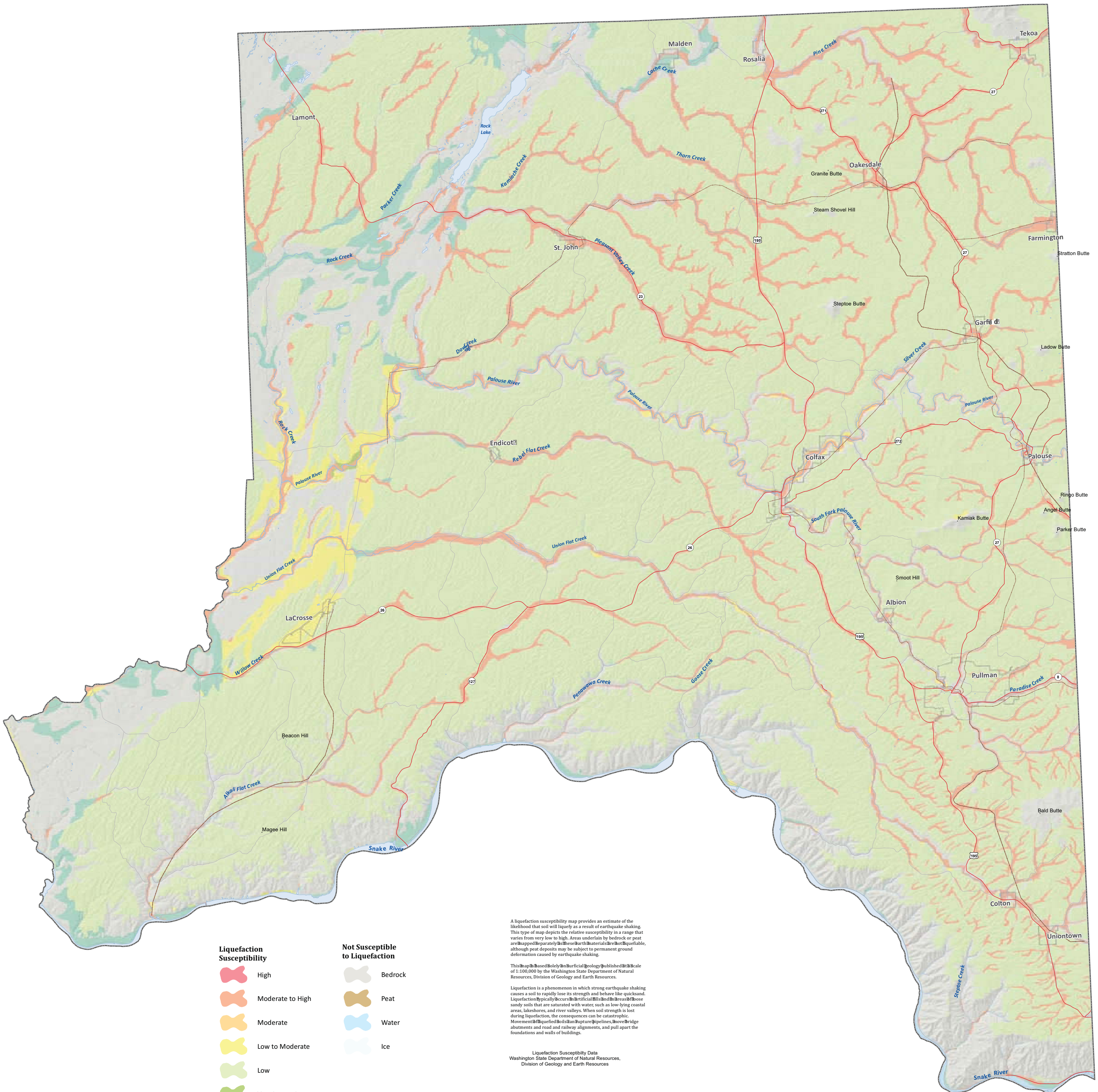


WHITMAN COUNTY
National Earthquake Hazard Reduction Program (NEHRP)
Soil Site Classes
Malden
Rosalia
Pine Creek
Tekoa
Cache Creek
Lamont
Rock Lake
Kamiache Creek
Thorn Creek
Oakesdale
Granite Butte
Steam Shovel Hill
Packer Creek
Farmington
Stratton Butte
Rock Creek
St. John
Pleasant Valley Creek
Steptoe Butte
Garfield
Ladow Butte
Silver Creek
Palouse River
Rock Creek
Endicott
Rebel Flat Creek
Colfax
Palouse
Ringo Butte
Angel Butte
Parker Butte
Kamiak Butte
South Fork Palouse River
Union Flat Creek
Smoot Hill
Albion
LaCrosse
Willow Creek
Pullman
Paradise Creek
Penawawa Creek
Goose Creek
Beacon Hill
Alkali Flat Creek
Magee Hill
Snake River
Bald Butte
Colton
Uniontown
Steptoe Creek
Site Class F - Requires site-specific investigation
Site Class E - Soft Soil
Site Class D - Stiff Soil
Site Class C - Very Dense Soil and Soft Rock
Site Class B - Rock
Water
Ice
NEHRP Site Class Data
Washington State Department of Natural Resources,
Division of Geology and Earth Resources
This site class map provides some measure of the potential for strong shaking in a particular area during an earthquake, and shows best judgment to date of the distribution of the various site classes throughout Washington State. This map is based on surficial geology published at a scale of 1:100,000 by the Washington State Department of Natural Resources, Division of Geology and Earth Resources (Washington Division of Geology and Earth Resources staff, 2001). Designation of site classes was based on a large database of shear wave velocity data obtained in many of the geologic units shown in the 1:100,000-scale geologic mapping. For units without velocity measurements, site class was assigned based on similarity to units in the shear wave database.
In the methodology presented by BSSC (1997), site class B represents a soft rock condition, where earthquake shaking is neither amplified or reduced by the near-surface geology. Site classes C, D, and E represent increasingly softer soil conditions which result in a progressively increasing amplification of ground shaking. Site class F is reserved for unusual soil conditions where prediction of the amplification of earthquake shaking can only be determined by a site-specific evaluation. Liquefiable soils also fall into site class F, but we have not included them on this map; please refer to the liquefaction susceptibility map for more information.
0 2.5 5 10 15 20 Kilometers
0 2.5 5 10 15 20 Miles
TETRA TECH
N
W
E
S

Map 9-5.

WHITMAN COUNTY

Liquefaction Susceptibility



Liquefaction Susceptibility

- High
- Moderate to High
- Moderate
- Low to Moderate
- Low
- Very Low to Low
- Very Low

Not Susceptible to Liquefaction

- Bedrock
- Peat
- Water
- Ice

A liquefaction susceptibility map provides an estimate of the likelihood that soil will liquefy as a result of earthquake shaking. This type of map depicts the relative susceptibility in a range that varies from very low to high. Areas underlain by bedrock or peat are mapped separately as these earth materials are not liquefiable, although peat deposits may be subject to permanent ground deformation caused by earthquake shaking.

This map is based solely on surficial geology published at a scale of 1:100,000 by the Washington State Department of Natural Resources, Division of Geology and Earth Resources.

Liquefaction is a phenomenon in which strong earthquake shaking causes a soil to rapidly lose its strength and behave like quicksand. Liquefaction typically occurs in artificial fills and in areas of loose sandy soils that are saturated with water, such as low-lying coastal areas, lakeshores, and river valleys. When soil strength is lost during liquefaction, the consequences can be catastrophic. Movement of liquefied soils can rupture pipelines, move bridge abutments and road and railway alignments, and pull apart the foundations and walls of buildings.

Liquefaction Susceptibilty Data
Washington State Department of Natural Resources,
Division of Geology and Earth Resources

0 2.5 5 10 15 20 Kilometers

0 2.5 5 10 15 20 Miles

TETRA TECH

N W E S

CHAPTER 10.
FLOOD

10.1 GENERAL BACKGROUND

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

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

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

DEFINITIONS

Flood—The inundation of normally dry land resulting from the rising and overflowing of a body of water.

Floodplain—The land area along the sides of a river that becomes inundated with water during a flood.

100-Year Floodplain—The area flooded by a flood that has a 1-percent chance of being equaled or exceeded each year. This is a statistical average only; a 100-year flood can occur more than once in a short period of time. The 1-percent annual chance flood is the standard used by most federal and state agencies.

Return Period—The average number of years between occurrences of a hazard (equal to the inverse of the annual likelihood of occurrence).

Riparian Zone—The area along the banks of a natural watercourse.

10.1.1 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability, which is a statistical tool used to define the probability that a certain river discharge (flow) level will be equaled or exceeded within a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1-percent chance of being equaled or exceeded in any given year. The "annual flood" is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a 1-percent annual probability of occurrence (the base flood or 100-year flood) is used as the regulatory boundary by many agencies. Also referred to as the special flood hazard area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

10.1.2 Floodplain Ecosystems

Floodplains can support ecosystems that are rich in quantity and diversity of plant and animal species. A floodplain can contain 100 or even 1000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly; however the surge of new growth endures for some time. This makes floodplains particularly valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

10.1.3 Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

10.1.4 Federal Flood Programs

National Flood Insurance Program

The NFIP makes federally backed flood insurance available to homeowners, renters and business owners in participating communities. For most participating communities, FEMA has prepared a detailed Flood Insurance Study. The study presents water surface elevations for floods of various magnitudes, including the 1-percent annual chance flood and the 0.2-percent annual chance flood (the 500-year flood). Base flood elevations and the boundaries of the 100- and 500-year floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principle tool for identifying the extent and location of the flood hazard. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under their floodplain management program.

Participants in the NFIP must, at a minimum, regulate development in floodplain areas in accordance with NFIP criteria. Before issuing a permit to build in a floodplain, participating jurisdictions must ensure that three criteria are met:

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 100-year flood.
- New floodplain development must not aggravate existing flood problems or increase damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

Whitman County entered the NFIP on May 1, 1980. Structures permitted or built in the County before then are called "pre-FIRM" structures, and structures built afterwards are called "post-FIRM." The insurance rate is different for the two types of structures. The current FIRM effective date for Whitman County is May 1, 1980.

Of Whitman County's 16 incorporated cities and towns, 14 participate in the NFIP, as shown in Table 10-1. According to the Washington Department of Ecology, the county and cities are in good standing with the provisions of the NFIP as of this plan update. Maintaining compliance under the NFIP is an important component of flood risk reduction. All planning partners that participate in the NFIP have identified initiatives to maintain their compliance and good standing.

TABLE 10-1.
NFIP STATUS OF WHITMAN COUNTY AND INCORPORATED MUNICIPALITIES

City	CID	Date of Entry into the NFIP	Current FIRM Effective Date
Albion	530206	08/01/1978	08/01/1978
Colfax	530207	08/01/1978	08/01/1978
Colton	530244	07/02/1979	07/02/1979
Endicott	530208	07/17/1978	07/17/1978
Farmington	530295	07/03/1985	07/03/1985 (M)
Garfield	530209	08/01/1978	08/01/1978
Malden	530250	05/01/2010	05/01/2010 (L)
Oakesdale	530210	09/29/1978	09/29/1978
Palouse	530211	07/17/1978	07/17/1978
Pullman	530212	07/02/1979	05/19/1981
Rosalia	530213	07/17/1978	07/17/1978
St. John	530214	5/26/1981	5/26/1981 (M)
Tekoa	530215	08/01/1979	08/01/1979
Uniontown	530216	08/01/1978	08/01/1978
Whitman County	530205	05/01/1980	05/01/1980

(M) = No elevations determined; All Zone A, C and X.
(L) = Original FIRM by letter; All Zone A, C and X

The Community Rating System

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses.
- Facilitate accurate insurance rating.
- Promote awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness.

Figure 10-1 shows the nationwide number of CRS communities by class as of May 1, 2012, when there were 1,211 communities receiving flood insurance premium discounts under the CRS program.

Figure 10-1. CRS Communities by Class Nationwide as of May 1, 2012

CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk; over 66 percent of the NFIP's policy base is located in these communities. Communities receiving premium discounts through the CRS represent a broad mixture of flood risks, including both coastal and riverine flood risks. None of the NFIP participating communities in Whitman County are currently participating in the CRS program.

10.2 HAZARD PROFILE

The principal cause of flooding in Whitman County is heavy rainfall brought in with warm Chinook winds, usually in combination with snowmelt over a frozen impermeable ground during the winter or early spring. The sudden increase in runoff overwhelms rivers and creeks, which typically overtop. The South Fork Palouse River, for instance, has an average annual flow of about 40 cubic feet per second (cfs), but can experience peak flows of 3,000 to 5,000 cfs. Floods can also be intensified by ice jams against low clearance railroad and road bridges. Floods in Whitman County are typically of short duration, usually less than one day, and flood stages rise and fall rapidly.

Erosion and transported sediment are major secondary hazards of flooding. The intense runoff can strip away topsoil and deposit it elsewhere, usually where it is impeded, such as at bridge abutments. Sediment deposits have been a major effect of flooding in Pullman. The erosion can deposit sediment in river and creek beds, decreasing their capacity to transport water.

Most watercourses in Whitman County are intermittent drainages that flow only in winter and spring. Few of these drainages have naturally armored channels, and if they are not fully vegetated they become major sources of eroded sediment. These drainages and the sediment they transport are particularly problematic to downstream developments if vegetation has been removed from the upstream watershed and floodplains. Brush fires, tilling and the grazing of large animals can remove vegetation from these critical areas. Such transported sediment has contributed to the flood hazard in most local communities. Of particular concern are Pullman and Colfax, located on the South Fork Palouse; Palouse located on the North Fork of the Palouse River; Colton and Uniontown located on Union Flat Creek; Endicott, located on Rebel Flat Creek; and Rosalia, located on Pine Creek. In the specific watersheds transporting sediment into these communities, extraordinary measures should be taken to manage agricultural and grazing practices. Every effort should be taken to maintain a vegetative cover, especially along the floodplains of these intermittent streams, and to manage the riparian zone to reduce velocity.

This section presents flood profile information for all of Whitman County and for individual communities within the county. Information was taken from the 1979 FEMA Flood Insurance Studies for Whitman County and its communities, supplemented with information from County and municipal officials for events and changing conditions after the adoption of these reports. Data for Pullman was also taken from the 2003 City of Pullman Comprehensive Flood Hazard Management Plan. Data from the Rosalia and Palouse Flood Mitigation Plans, prepared by Eastern Washington University, was also used. Additional jurisdiction-specific information can be found in Volume 2 of this plan.

10.2.1 Countywide Profile

Past Events

Since settlement began in the 1870s, Whitman County and its small farming communities have experienced frequent flooding. Efforts have been made over the last half-century to mitigate flooding, but these efforts have often proven to be environmentally detrimental over the long term (river channelization in Colfax) or expensive to maintain (dredging and maintenance in Pullman). Table 10-2 summarizes presidential declared disasters related to flooding in Whitman County. Some of the significant past flood events in Whitman County occurred as follows:

- **Floods Prior to 1964**—Little data is available on floods prior to 1964. Extensive flooding in the Oakesdale area as a result of the overflow of McCoy Creek and its tributaries occurred in 1948 and again in 1963. Periodic overflow of Hangman and Little Hangman Creeks occurred near Tekoa in 1948 as a result of excessive precipitation and ice jams at bridges. Serious flooding occurred in the Garfield area along Silver Creek in 1948. Major flooding as a result of overflow of the South Fork of the Palouse River occurred in 1910, 1933 and 1948. Based on estimates from gauging stations in the City of Pullman, the 1910 flood event was considered to be the 125-year event prior to 1964.
- **January 1972 Flood Event—**This was a “rain-on-snow” event typical for the region. Significant flooding in Whitman County was in the southeastern portion of the County along the Palouse River. Albion and Pullman experienced significant flooding along the South Fork of the Palouse River. This event was estimated to be a 30-year flood event.

**TABLE 10-2.
WHITMAN COUNTY FLOOD EVENTS**

Date	Declaration #	Type of event	Estimated Damage[a]
March 1963	146	Flooding	$62,500
December 1964	185	Washington Heavy Rains & Flooding	$150,000
January, 1972	322	Severe Storms, Flooding	$75,321
January 1974	414	Severe Storms, Snowmelt, Flooding	—
July 1975	—	Thunderstorm/Flash flooding	$50,000
December 1977	545	Severe Storms, Mudslides, and Flooding	—
May 1980	—	Thunderstorms, flooding	$50,000
July 1987	—	Flash Flood	$25,000
March 1989	822	Heavy Rains, Flooding, Mudslides	$153,000
May 1990	—	Flash flooding	$12,500
January 1991	—	Flash flood	$50,000
February 1996	1100	Severe Storms/Flooding	—
January 1997	1159	Severe Storms/Flooding	—
June 1998	—	Flash Flood	$500,000
January 1999	—	Flooding	$300,000
February 2000	—	Urban, small streams flooding	$50,000
May 2004	—	Flooding	$100,000
January 2007	—	Flooding	$25,000
January 2009	—	Flooding	$10,000

a. Data obtained from Spatial Hazard Events and Losses Database for the United States (SHELDUS)

- **January 1974 Flood Event**— The major factor for this one-day flood event was the formation of ice jams. A heavy rainfall during a period of significant snow accumulation created frozen, impenetrable soils. The principal ice jam formed at the Union Pacific Railroad trestle west of the Town of Garfield. This caused significant flooding along Silver Creek. Flooding was also experienced along the Palouse River and along Little Hangman Creek at Tekoa. The 1974 flood event is considered to be the flood of record for this region.
- **February 1996 Flood Event**—Severe rainstorms and a warming trend caused many rivers in Washington to flood between November 1995 and February 1996, resulting in two presidential disaster declarations for the state. The event in February 1996 included severe flooding and mud flows in Whitman County. Flooding was experienced along the South Fork of the Palouse River.
- **December 1996 Flood Event**—Eastern Washington experienced generally cold and snowy weather before the last week of December 1996, when warmer temperatures and moist air moved into the region. Many areas experienced 1 to 2 inches of rainfall over two to three days, which melted snow and led to flooding. This condition was made worse by frozen ground, preventing precipitation from infiltrating the ground. Major flooding occurred along Pine Creek and the South Fork of the Palouse River. The flooding along the South Fork Palouse River was estimated to be a 10-year recurrence interval.

- **January 2007 Flood Event**—A prolonged period of moderate to heavy rain and snow melt led to flooding in the County, with basement flooding in Colfax. Precipitation of 1 to 2 inches was common. McCoy and Spring Creeks in and near Oakesdale rose rapidly out of their banks, with water reaching the foundations of nine homes, flooding basements and crawl spaces. Flooding of Pine Creek shut down both lanes of State Route 27 south of Tekoa. In Colfax, Clay Street was flooded as runoff filled storm drains with mud. Several other streets were flooded as well. The run-off also entered into the basements of some homes. The North Fork of the Palouse River reached 14 feet, resulting in flooding of Lion's Club Park.

Location

The November 1979 Flood Insurance Study is the primary source of data used in this risk assessment to map the extent and location of the flood hazard, as shown in Map 10-1. FEMA mapping generates flood insurance rate maps only for water courses that drain a half square mile or larger. To estimate the potential extent and locations of flood hazard areas not mapped by FEMA, HAZUS was used to generate approximate floodplains on unmapped water courses. Map 10-2 shows the floodplains mapped using this approach. This map was not used in the vulnerability analysis because no flood depths were established.

Flooding does not occur on the Snake River due to its location in a deep, steep gorge and two major flood control structures: the Little Goose Dam, and the Lower Granite Dam. The rivers and streams that have caused the greatest flood damage are the South Fork Palouse, the North Fork Palouse, Paradise Creek and Pine Creek. Union Flat Creek may also experience flooding. Although these streams can overtop anywhere, they typically cause damaging flooding in the communities that have development and infrastructure in the floodplains. The most severe flooding, in terms of economic cost and damage, occur in Pullman, the largest city in the County. Most of the floodplain in this city is developed, and includes the downtown business district. There are also numerous structures, such as buildings and bridges, that constrict the flow of water during storms, and can aggravate flooding. Palouse, with much of its downtown in a formerly marshy floodplain, has also experienced severe flooding and is the second most vulnerable community to flooding in the County.

Frequency

The Washington State Hazard Mitigation Plan (2010) lists Whitman County among the counties with the most frequent flooding in eastern Washington. Major flooding in Whitman County can be expected on average every six to seven years. Figure 10-2 shows the frequency of flooding in Washington by county.

Severity

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges; Table 10-3 lists peak flows used by FEMA to map the floodplains of Whitman County. These discharges are based on historical data and have been identified for different recurrence intervals.

Warning Time

Flooding in Whitman County tends to occur as flash flooding, when warm Chinook winds drop rain on frozen snow cover and cause massive wash-off, quickly filling small creeks and rivers beyond capacity. Potentially severe storms can be predicted days in advance, but actual flooding may be predicted only hours in advance. In most cases, there is ample warning of pending flood threats in Whitman County. Previous flood damage in the region was usually caused by lack of time for preparedness or response.

Source: Washington EMD, 2010

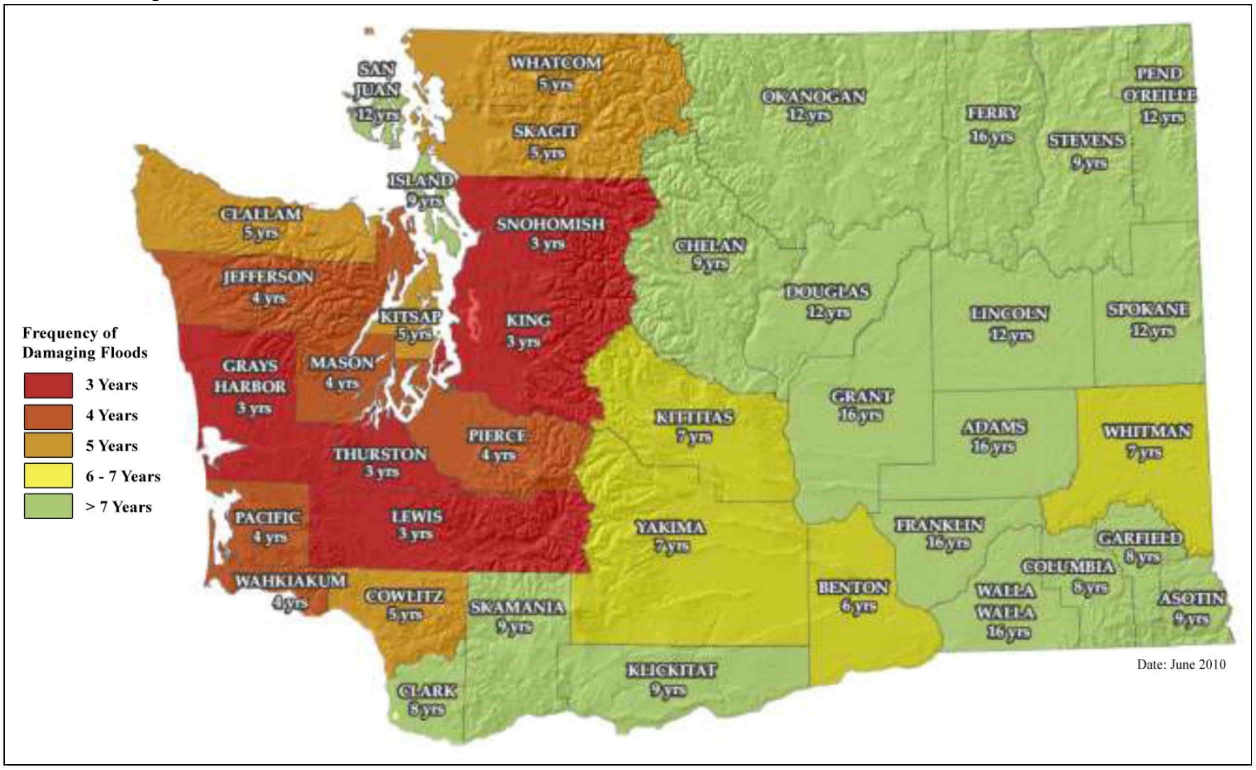


Figure 10-2. Frequency of Major Flooding in Washington by County

Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding danger. The National Weather Service uses a two-tiered warning system for flash flooding:

- A Flash Flood Watch covers a large area (a thousand square miles or greater, usually several counties) for up to 12 hours. A Flash Flood Watch is issued when conditions are favorable to produce flash flooding within the next 12 hours.
- A Flash Flood Warning generally covers a very small area (a few square miles to several hundred square miles) for up to 6 hours.

Whitman County Emergency Management has established flood warning protocols outlining the response to flooding in the planning area. County emergency managers use these scenarios to help dictate response to flooding.

10.2.2 Town of Albion

Albion, a residential community of 555 people, is about 6 miles northwest of Pullman on the South Fork of the Palouse River. Factors contributing to flooding are heavy rains, rapid snowmelt, and ice jams at the Union Pacific Railroad Bridge.

Past Events

Albion has experienced flooding as a result of the overflow of the South Fork Palouse River. Major floods have occurred in 1910, 1933, 1948, and 1972. The town also experienced flooding in 1996.

TABLE 10-3.
SUMMARY OF PEAK DISCHARGES WITHIN WHITMAN COUNTY

Source/Location	Drainage Area (square miles)	Discharge (cubic feet/second) 10-Year	50-Year	100-Year	500-Year
S. Fork Palouse River					
At S.E. Pullman Corporate limits	84	2,120	3,970	5,030	7,800
Upstream of Paradise Creek	84	2,122	3,967	5,028	7,800
Above Missouri Flat Creek	--	2,710	5,310	6,860	11,900
Downstream of Missouri Flat Creek	164	4,138	7,740	9,813	16,000
At West Pullman Corporate limits	164	4,140	7,740	9,810	16,000
At U.P. Railroad Bridge	182	4,640	8,720	11,070	17,000
Palouse River					
Above the north City limits of Palouse	360	7,300	11,410	13,430	18,000
Downstream of Colfax	796	15,400	24,700	29,200	41,000
Union Flat Creek					
Above the S. Fork Union Flat Creek	96	1,730	2,860	3,400	4,900
Below Uniontown	109	1,940	3,180	3,790	5,400
Downstream of Colton Corporate limits	125	2,180	3,570	4,250	6,100
South Fork Union Flat Creek					
At Mouth	12	260	450	550	830
Rebel Flat Creek					
At Endicott	57	1,020	1,730	2,070	3,000
Silver Creek					
At Garfield	30.8	1,230	2,410	3,130	5,000
McCoy Creek					
Above Spring Creek	8.44	204	353	431	650
Above East corporate limits of Oakesdale	17.19	381	650	789	1,150
Spring Creek					
At confluence with McCoy Creek	7.34	180	313	383	570
Pine Creek					
Downstream limit of flooding affecting Rosalia	194	4,980	9,940	12,940	21,500
Hangman Creek					
Below confluence with Little Hangman Creek	200	3,950	6,540	7,870	11,000
Above confluence with Little Hangman Creek	130	2,820	4,630	5,570	7,800
Little Hangman Creek					
At confluence with Hangman Creek	60	1,260	2,230	2,750	4,100
Missouri Flat Creek					
At S. Fork Palouse River	27.1	810	1,270	1,500	2,130
Airport Rd. Creek					
At State HWY 270	--	230	510	680	1,260
Wawawai Creek					
At U.S. Highway 195	--	60	140	200	410
Dry Fork Creek					
At S. Fork Palouse River	7.5	260	640	890	1,750
Paradise Creek					
At S. Fork Palouse River	34.5	1,060	2,000	2,560	4,000

Location

Hills rise on all sides of Albion, with the South Fork Palouse passing through the southwest part of town in a narrow floodplain. Flooding typically occurs in this area. There is also a small, unnamed intermittent creek, contained in a drainage ditch that passes through the town from the northeast and joins the South Fork Palouse near D Street. This stream does not normally flood at the same time as the South Fork Palouse.

Frequency

Past events have shown that major flooding can occur in Albion at a frequency of about 20 years.

Severity

The events of 1910, 1933, 1948 and 1972 had estimated recurrence intervals of 100, 10, 50 and 30 years, respectively. During the 1972 event, one home at Front and C Streets was evacuated, although it was not damaged. Flooding caused furnace ductwork damage beneath a home at Front and G Streets, and two homes south of the river were slightly damaged. The unnamed stream usually overtops due to flash flooding, but flooding does not usually exceed more than a foot in depth. The 1996 flood caused about $38,000 in damage to public facilities and five residents received federal Individual Assistance (IA) grants.

10.2.3 City of Colfax

Colfax is the county seat of Whitman County. There is no Flood Insurance Study for Colfax. Research has indicated that flooding on the South Fork Palouse, which meanders through the city, caused problems in the past. During the 1960s, the Army Corps of Engineers channelized the river through the downtown, which has mitigated flooding to the present. Damage does occur just outside of town where the North and South Forks of the Palouse join. It is theorized that the cement-lined river channel of the South Fork speeds up sediment transport through the city during a flood event, but then deposits it just outside of the city, causing flooding. Colfax has 11 National Flood Insurance Policies. After the 1996 flood event, the town received $241,000 in federal Public Assistance (PA) grants. There were also 22 IA grants. It is difficult to determine whether the damage occurred within city limits, or was assigned to Colfax due to proximity.

10.2.4 City of Colton

Colton is a farming community of 425 people located on Union Flat Creek and U.S. Highway 195. It is in southeast Whitman County, about 16 miles south of Pullman and 4 miles west of the Idaho border. Flash flooding and a flat creek bed are responsible for severe flooding during winter and early spring.

Past Events

In past years, Colton has experienced flooding as a result of the overflow of Union Flat Creek. Extensive flooding occurred in 1910 and 1948, and minor flooding occurred in 1956, 1958, 1963 and 1965.

Location

Union Flat Creek flows through the northern section of Colton. Two small intermittent streams flow north through the town before emptying into Union Flat Creek. The first of these streams flows through the city in a well-defined channel before joining Union Flat Creek east of Steptoe Street and north of Depot Street. The second stream has its confluence with Union Flat Creek near the western city limit near Depot Street. The two forks of the second stream (one from the south and the other from the west) come together south of Broadway Street and flow north through low undeveloped land between Broadway and Depot streets. A third unnamed stream flows from the north in a well-defined channel west of the Burlington Northern Railroad tracks that joins Union Flat Creek west of Steptoe Street.

Frequency

Past events have shown that severe flooding can occur every 40 years and minor flooding can occur every decade.

Severity

A lack of detailed past event data indicates that flooding may not have been severe in Colton.

10.2.5 Town of Endicott

Endicott is an agricultural community of 293 people located about 14 miles west of Colfax. Rebel Flat Creek passes through the town. Flooding in the past was generally caused by the creek being blocked by ice and debris at the bridges crossing the creek.

Past Events

Two floods have been recorded in Endicott. Both occurred prior to the construction of a new bridge over Rebel Flat Creek on County Road 6140. In 1948, ice jammed against the old bridge and the creek overflowed, flooding G Street, Dean Street and Alkali Street. The water was about 18 inches deep and entered one house and a shop owned by the County. Basements were also flooded. A large tree impeded creek flow downstream of the Third Street Bridge. The second flood, which occurred in 1963, was considered a minor flood by local observers. The town experienced some flooding in 1996, as one resident received an IA grant.

Location

Rebel Flat Creek is the sole source of flooding in Endicott, and flows west through the southwest part of town.

Frequency

Flooding is extremely infrequent in Endicott, occurring only twice in the last century, and generally due to low bridge structures.

Severity

The 1948 flood flooded basements and damaged two structures. The 1963 flood caused no damage, but had a 20-year recurrence interval.

10.2.6 Town of Farmington

There is currently no flood insurance study for Farmington. FEMA provided mapping data for Farmington with initial flood hazard boundary identification in November 1975, and a Flood Insurance Rate Map in July 1985. In August 1997, The U.S. Army Corps of Engineers performed a re-study to identify a regulatory floodway at the request of Whitman County and the Town of Farmington. This data has not been reflected on a FIRM prepared by FEMA. The sources of flooding for Farmington are the north and south forks of Pine Creek, which converge just outside the town limits. Although historical records of flooding in Farmington are not prevalent, flooding has occurred along both forks of Pine Creek, most recently in 1996. This suggests that there is some exposure to flooding in the Town of Farmington, although the severity of this exposure is not known at this time.

10.2.7 Town of Garfield

Garfield is a farming community of 620 located in the northeast part of Whitman County near the Idaho border. It is about 15 miles northeast of Colfax. The town is located on Silver Creek. Flooding is caused by the overflowing of Silver Creek. A major contributor of flooding is ice jams at the railroad trestle.

Past Events

Serious flooding occurred in Garfield in 1948, 1972, and 1974. During the 1974 event, which lasted only one day, floodwaters entered numerous buildings in the downtown area. The major factor contributing to this flooding was an ice jam at the railroad trestle near B and Idaho Streets. Flooding occurred in 1996, as there were four IA grants in Garfield.

Location

Silver Creek, which flows intermittently east through the southern part of Garfield, is the source of flooding for the community. The topography rises both to the north and south of the creek, but the downtown is relatively low in relation to the creek. In this area, the floodplain widens to the north to encompass most of the downtown.

Frequency

Flooding is infrequent in Garfield, with only four events recorded in the 20th century.

Severity

None of the buildings in downtown Garfield have basements, so flooding generally occurs on the ground floor of structures located in the floodplain within the business district. This flooding can damage personal property within these buildings, but does no major harm to the structures themselves.

10.2.8 Town of LaCrosse

La Crosse (population 315) is located about a mile north of SR 26 in western Whitman County. It is not located on any rivers or creeks and has had no flood risk identified through mapping or other means.

10.2.9 Town of Lamont

Lamont (population 80) is located in the scablands of northwest Whitman County, about a mile southwest of SR 23. It does not lie near any creek or river and does not have any flood risks. However, the town has experienced nuisance flooding due to sheet flow and ponding from heavy rainfall events. Damage from these events has included flooded basements and sediment deposits on streets and public open spaces. More detailed mapping of flooding is needed to gage the town’s vulnerability to the flood hazard.

10.2.10 City of Malden

Malden (population 205) is a former railroad town on the north side of a hill on the south side of Pine Creek. Malden is a “sanctioned” community under the National Flood Insurance Program and currently has no mapped special flood hazard area. Sanctions were imposed in 1976 due to non-compliance with programmatic requirements of the NFIP, so flood insurance is not available in Malden. Full compliance under the NFIP is a requirement of grant eligibility for programs authorized under the Robert T. Stafford Act. Interpolation of County floodplain boundaries by the HAZUS-MH model suggest that there is some exposure to flooding in Malden, although it would be considered minimal.

10.2.11 Town of Oakesdale

Oakesdale is a farming community of 425 located in northwest Whitman County, approximately 17 miles north of Colfax. It is located on the confluence of McCoy and Spring Creeks. Spring Creek drains to Pine Creek. Flooding is generally caused by the overflow of McCoy Creek and its tributaries due to flash flooding and low creek capacity.

Past Events

Extensive flooding occurred in 1948, 1963 and 1996. Damage to property and infrastructure was minimal. Records indicate that one IA grant was awarded following the 1996 flood event.

Location

The principal flooding problems in Oakesdale are caused by McCoy Creek. McCoy Creek is an intermittent stream that flows southeast into Oakesdale roughly parallel to SR 271 and flows through the eastern part of the town where it joins Spring Creek just north of Jackson and 1st (SR 271) Streets. Spring Creek is also an intermittent stream and flows northeast through Oakesdale.

Three smaller unnamed tributaries and a drainage swale to McCoy and Spring Creeks are also located in Oakesdale. One tributary is on the west side of town and joins Spring Creek near the intersection of McCoy and Brown Streets. A second flows from the north, near the eastern town limit, and joins McCoy Creek near Bartlet and Idaho Streets. The third tributary also flows from the north, and joins McCoy Creek 1.4 miles upstream of its confluence with Spring Creek. The drainage swale flows north along Bush Street and drains into Spring Creek.

Frequency

Three minor flooding events (in terms of damage) occurred in Oakesdale during the 20th century.

Severity

No detailed information is available about the severity of flooding in Oakesdale. Past events were described as “extensive” but only causing “minimal” damage. Photographs in the Oakesdale Flood Insurance Study show shallow flooding from the 1963 event in the streets around the confluence of Spring and McCoy Creeks.

10.2.12 City of Palouse

Palouse is an agricultural and farming community of 1,005 people located in eastern Whitman County about 2 miles from the Idaho border. It is on the North Fork Palouse River and is accessible to Pullman, 16 miles to the south, via SR 27. Flood damage is usually caused by the Palouse River overflowing into the downtown area, which is on the north side of the river. After Pullman, Palouse is the most vulnerable community to flooding in the County. The City of Palouse Flood Mitigation Plan, prepared in 1997 by the Department of Urban and Regional Planning at Eastern Washington University, was used to prepare the Palouse flood profile.

Past Events

The FEMA Flood Insurance Study for Palouse indicates two flooding events, in 1972 and 1974. The Palouse Flood Mitigation Plan indicated that a flood in 1933 inundated most of the area along Main Street and may be attributed to heavy logging in the Moscow Mountains, which can increase erosion and runoff, and by the removal of dams on the Palouse River. The January 16, 1974 flood was more severe than the 1933 flood. During this event Main Street was flooded, damaging shops and businesses located along it.

Palouse experienced its most severe flooding in 1996. The river expanded to a 400-foot-wide silt-laden surge, flooding nearly everything along and near Main Street. There was also damage to homes and businesses on the south side of the river. The sewerage treatment plant, built above the 100-year floodplain, was inundated. The flood damaged at least 20 businesses and forced many residents to evacuate.

Location

The Palouse River, which begins as a small perennial stream in Idaho, flows west through the southern part of Palouse. Flooding occurs in the floodplains adjacent to it when it overflows due to heavy rain or rainfall over snow cover in winter or early spring. The downtown of Palouse is built on a low, formerly marshy area that was subject to flooding but was developed due to demand for expansion of the city from its original location on the south side of the river on steep hills.

The City of Palouse also contains two unnamed intermittent steams that flow from the south. The first of these streams joins the Palouse River west of the intersection of Almota Road and the BNSF Railway tracks. The second unnamed stream joins the Palouse River north of the intersection of Almota and Moscow Streets after flowing from the south along the BNSF Railway tracks.

Frequency

Flooding can occur more frequently in Palouse than in many other communities in the County due to its receiving higher rainfall and being located on a permanent river. Three major floods occurred during the 20th century, giving the town a probability of a major flood at least every 33 years. Palouse has flood threat recognition capability on the Palouse River via an early warning system that was funded by a Flood Control Account Assistance Program grant in 1997-1999.

Severity

The 1972 and 1974 events had recurrence intervals of 10 and 30 years, respectively. The latter flood caused extensive damage along Main Street in downtown Palouse. Thus any event equal to or greater than a 30-year recurrence interval can be expected to cause flooding. The 1996 flood was greater than a 100-year event. The flood level of 18.3 feet was 2 feet higher than that of the 1974 flood. The peak stream discharge of the 1996 flood was 14,200 cfs. The estimated 100-year flood discharge is 13,340 cfs. The 1996 event was severe in terms of damage. In the public sector, the city sustained $163,742 in damage and received $122,000 in public assistance grants; a survey of private property owners found that 67 properties sustained damage totaling $1.6 million, an average of $24,000 per property. Twenty-four residents received IA grants.

10.2.13 City of Pullman

Pullman, located about 15 miles southeast of Colfax, is the principal city of Whitman County. It is home to 29,820 people, over 66 percent of the County’s total population. Of this, about 19,255 attend Washington State University, which is located in the city. The city also has numerous professional services and retail businesses that serve the university and its population.

Pullman, originally named Three Forks, lies on rolling hills above the floodplains of the South Fork Palouse River, Paradise Creek and Missouri Flat Creek. Much of the commercial and industrial development lies in the flat bottomlands where these creeks converge. Pullman has the worst flood problem of all the communities in Whitman County. Flooding is usually caused by heavy rainfall in winter or early spring, typically on snow over frozen ground. Rapid snowmelt and heavy rainfall can combine to create flash flooding events, in which the generally low-capacity creeks overtop their banks, spilling into the adjacent floodplains. Overflows can also be caused by debris and ice flows blocking drainage at bridges and abutments. The rapid, high-flow events typically cause massive erosion and carry high levels of sediment, much of which is deposited in the highly developed floodplains after the floods have receded.

Past Events

Pullman has had extensive flooding since its founding around 1876. The first major event occurred in 1884 and is still the second biggest flood on record. The March 1910 flood was the largest flood of record, with a peak flow of 7,500 cfs. The peak flow of 1910 was equivalent to a 125-year flood. These flows inundated nearly all the bottomland area, destroyed several buildings and bridges, and badly damaged a number of downtown buildings, roads and railroads. The floodwaters also eroded streets and yards and deposited massive amounts of sediment and debris in Pullman. The flood caused isolation and the water supply was contaminated. Damage was estimated at $250,000, or about $5,700,000 in 2012 dollars. Other floods occurred in 1933, 1948, 1964 and 1972. The most recent event occurred in 1996, which caused over $250,000 in damage.

Location

Flooding occurs in the developed bottomlands of the creeks that flow through Pullman. The South Fork Palouse River is the main river in Pullman. It originates in the Moscow Mountains in Idaho and flows northwest through the center of Pullman to Colfax, where it joins the North Fork to form the Palouse River. Paradise Creek and Missouri Flat are two of the largest tributaries of the South Fork Palouse River. They originate east of Pullman in Idaho and flow west to join the South Fork at Pullman, hence the city's original name of Three Forks. Other minor creeks in Pullman include Airport Road Creek, Dry Fork Creek and Wawawai Creek, all of which can experience some flooding.

The South Fork Palouse drains areas of 85 square miles above Paradise Creek, 132 square miles above Missouri Flat Creek. Missouri Flat Creek drains an area of 27.1 square miles. The drainage areas are mostly rolling plateau lands, extensively developed for dry farming. Headwater reaches of the areas extend into forested slopes of the Moscow Mountains.

Frequency

Minor flooding can occur every 5 to 10 years, and major flooding has typically occurred at least once every 20 years.

Severity

Events of 1910, 1948, 1972 and 1996 recorded peak flows of 7,500, 5,200, 4,570 and 4,500 cfs in the South Fork Palouse River, respectively. Floodwaters exceeded depths of 3 feet in the downtown corridor during each of these events. These events can cause extensive damage to downtown, including sediment deposition. Minor flooding can also block roads, disrupting commerce and transportation and isolating Washington State University. Due to sedimentation and debris in the creeks, lesser events can sometimes cause more flooding than higher peak-flow events. The 1996 flood required about $250,000 in public assistance, and 37 IA grants were given out to residents.

The City of Pullman Comprehensive Flood Hazard Management Plan reevaluated the conditions of flooding by modeling changes in stream channel conditions. These analyses identified changes in severity due to increases in the projected depth of flooding. The City views these findings as incomplete because the modeling did not include new hydrology that reflects existing conditions and scenarios typical for the watershed. Data from the comprehensive flood hazard management plan is used for planning purposes only and for evaluating the relative benefits of proposed flood reduction measures; it is not the basis for regulatory floodplain management in Pullman.

10.2.14 Town of Rosalia

Rosalia is a farming community and commuter suburb to Spokane of 555 people, located in north central Whitman County near the Spokane County border. Pine Creek flows north through the town and SR 195 passes just east of the town. Spokane is about 35 miles north of Rosalia, and Colfax is about 25 miles south. Flooding is caused by the overflow of Pine Creek into the adjacent floodplain.

Rosalia has a Flood Mitigation Plan that was prepared in 1997 by Eastern Washington University. Information from this plan was used for the flood profile below.

Past Events

Rosalia has had a well-documented history of flooding dating back to the town's earliest history. Flood events occurred in 1881, 1910, 1948, 1963, 1974, 1979, 1996 and 1997. The flood of 1963 was the highest recorded in the town, with a stream flow of 10,600 cfs. The New Year's Flood of 1997, which caused extensive damage elsewhere in the County, also caused extensive damage in Rosalia during its short duration. After the flood receded, 21 buildings, as well as the town's park, swimming pool and roads, were damaged. Total damage from the flood was about $272,000. Of this, about $46,000 was to public facilities and infrastructure. The town received about $6,000 in PA grants.

Location

Pine Creek is the sole cause of flooding in Rosalia. It flows north through the western portion of town after originating in the Mission Mountain area of Idaho. Flood damage occurs to property within the 100-year floodplain of the river.

Frequency

Flooding in Rosalia can be expected at least once every five to ten years. Past events have shown that, except for the 1980s, Rosalia has experienced at least two floods every decade since the 1960s.

Severity

The 1997 event can be used as a best estimate of the severity of flooding in Rosalia. This event damaged 21 buildings and infrastructure and caused about $272,000 in damage. Flooding usually occurs during 10-year events, which have a peak discharge of 4,980 cfs. Discharges at and above this amount will typically cause the river to overflow and flood the surrounding floodplain.

10.2.15 Town of St. John

St. John is a town of 523 people located in the Pleasant Valley along Pleasant Valley Creek. SR 23 passes through the town and connects it with U.S. 195 and I-90. There is no flood insurance study available for St. John, but flood maps indicate that Paradise Creek has a floodplain that roughly parallels SR 23 and exposes some commercial and residential structures behind downtown to flooding. The town has one NFIP policy. After the 1996 floods, there was one IA grant in St. John.

10.2.16 City of Tekoa

Tekoa is an agricultural community of 775 people located in northeast Whitman County near the border with Spokane County and the State of Idaho. It is located about 35 miles north of Pullman. Hangman Creek flows through the city, draining into the Spokane River. Flooding usually results from overflows on Hangman and Little Hangman Creeks caused by high precipitation, ice jams at bridges and inadequate channel capacity.

Past Events

Flooding occurred in Tekoa in 1948, 1969, 1970, 1974 and 1996. The flood of 1969 is considered by some local residents to be the most severe. During this flood, water rose above the Union Pacific Railroad tracks and flowed into the area in the vicinity of Main and Ramsey Streets.

Location

Hangman Creek originates near Tensed, Idaho and flows northwest through Tekoa before joining the Spokane River just below the falls in Spokane. A small tributary, Little Hangman Creek, flows from the northeast through Tekoa before joining Hangman Creek in the western part of town. Two unnamed intermittent streams flow through Tekoa before joining Hangman Creek. One flows through the east portion of town before joining Hangman Creek near Park and Leslie Streets. The other flows from the southwest and joins Hangman Creek near Elizabeth Street.

Frequency

Past events indicate that flooding can occur every 10 to 20 years, with severe flooding occurring once every century.

Severity

Most of the city, including the downtown business district, is located on high hills above the river and does not experience the effects of flooding. Most development exposed to flooding is sparse agriculture and commercial structures. On average, flooding is not very severe in Tekoa. The city received $7,500 in PA grants for the 1996 flood and there were four IA grants.

10.2.17 Town of Uniontown

Uniontown has a population of about 300. It is located in southeast Whitman County on Union Flat Creek and the South Fork of Union Flat Creek. U.S. Highway 195 passes north through the town toward Pullman, which is about 15 miles northwest of Uniontown. The Idaho border is about 1.5 miles to the east. Flooding in Uniontown is caused by the overflow of Union Flat Creek and its South Fork. The overflows generally occur at the convergence of the two creeks as a result of heavy precipitation, rapid snow melt and inadequate channel capacity.

Past Events

Extensive flooding occurred in 1910 and 1948, and minor flooding occurred in 1956, 1958, 1963,1965 and 1996. The amount of damage from these events is not known.

Location

Flooding in Uniontown usually occurs in the northern part of town where the South Fork of Union Flat Creek joins Union Flat Creek. Union Flat Creek, which flows through the northern section of town, originates about 4 miles to the east of Union in Idaho. The South Fork of Union Flat Creek flows north through the town from its source about 2 miles south of Uniontown. The South Fork parallels SR 195 and Washington Street before swinging northeast to join Union Flat Creek. Spring Creek, which also may cause minor flooding, flows from the west before joining the South Fork near Spring Street.

Frequency

Past events have shown that extensive flooding can occur every 50 years, while minor flooding can occur at least once every 5 to 10 years.

Severity

Flood discharge rates of the creeks and the extent of damage from past floods are not known. Two events during the first half of the 20th century were described as "extensive" while more recent events have been described as "minor."

10.2.18 Unincorporated Whitman County

The vast majority of Whitman County is unincorporated land used mostly for farming and grazing. About 5,974 people, or about 13 percent of the total County population, live in the unincorporated areas. There are also some small, agriculturally related communities within the unincorporated areas, such as Pine City, Hooper, Steptoe, Winona, Hay, and Elberton. Most flood events result from the overtopping of rivers and creeks, but due to the sparse development, damage is usually limited to scattered sites around the County and specific problem streams.

Damage is more often the result of the effects of stream-laden sediment. The abrasiveness and increased mass of sediment-laden water increases erosion and scouring as well as cleanup costs. These impacts are more costly than the direct impact of structures becoming wet. In past flooding events, damage has typically included blocked culverts, stream bank erosion, flooded roads, and sediment deposition on roads and property. Flooding on the rural stretches of streams can also cause minor landslides near roads and on some adjacent properties.

Past Events

Flooding is not as well-documented for the unincorporated parts of the County as it is for the towns and cities, but the dates tend to coincide. Different creeks flood during different events, but the 1948 floods are cited as among the most widespread in the County. The 1996 floods also resulted in countywide damage, with unincorporated areas experiencing as much flooding as some of the towns. Nonetheless, damage was much less. The County received $892,000 in Public Assistance for the 1996 flood.

Location

All of the rivers and creeks in the County have the potential to flood, but three major areas were identified by County officials as particularly susceptible: The stretch of the North Fork Palouse River between Colfax and Elberton, all of Union Flat Creek, and Rebel Flat Creek from near Colfax downstream to Endicott. Other creeks and rivers in unincorporated areas subject to flooding include Paradise Creek east of Pullman and the South Fork Palouse River upstream of Pullman.

Frequency

Minor flooding can be expected in the unincorporated parts of the County at least every five years, if not more. Major, damaging flooding does not occur in the unincorporated parts of the County.

Severity

Estimated recurrence intervals for many of the floods have ranges from a 30-year flood to a 100-year flood. Less severe floods may also cause minor flooding in the unincorporated areas, but detailed information is not available. Due to the high levels of erosion associated with flood events, sedimentation of stream channels is constantly reducing capacity, thus making lesser flood events more severe in terms of areas inundated and/or damaged.

10.3 SECONDARY HAZARDS

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

10.4 CLIMATE CHANGE IMPACTS

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted. Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more mountain area to contribute to peak storm runoff. High frequency flood event s (e.g. 10 -year floods) in particular will likely increase with a changing climate. Along with reductions in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 100-year flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation and regulation of flood protection facilities such as dams, floodways, bypass channels and levees, as well as the design of local sewers and storm drains.

10.5 EXPOSURE

The Level 2 HAZUS-MH protocol was used to assess the risk and vulnerability to flooding in the planning area. The model used census data at the block level and FEMA floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the HAZUS-MH default data was enhanced using local GIS data from county, state and federal sources.

10.5.1 Population

Population counts of those living in the floodplain were generated by analyzing census blocks that intersect with the 100-year floodplain identified on FIRMs. Census blocks do not follow the boundaries of the floodplain. Therefore, the methodology used to generate these estimates counted census block groups whose centers are in the floodplain or where the majority of the population most likely lives in or near the floodplain. HAZUS-MH estimated the number of buildings within the floodplain in each block, and then estimated the total population by multiplying the number of residential structures by the average Whitman County household size of 2.34 persons per household (U.S. Census, 2011a).

Using this approach, it was estimated that the exposed population for the entire county is 11,503 within the 100-year floodplain (25.7 percent of the total county population). For the unincorporated portions of the county, it is estimated that the exposed population is 4,263 within the 100-year floodplain (67.9 percent of the total unincorporated county population).

10.5.2 Property

Structures in the Floodplain

Table 10-4 summarize the total area and number of structures in the floodplain by municipality. The HAZUS-MH model determined that there are 4,916 structures within the 100-year floodplain. About 39 percent of these structures are in unincorporated areas. Approximately 76 percent are residential, with the remainder being commercial, industrial or agricultural type occupancies.

Exposed Value

Table 10-5 summarize the estimated value of exposed buildings in the planning area. This methodology estimated $1.4 million worth of building-and-contents exposure to the 100-year flood, representing 30 percent of the total assessed value of the planning area.

Land Use in the 100-Year Floodplain

Some land uses are more vulnerable to flooding, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Most of unincorporated Whitman County is zoned Agricultural District. Most land use in this zone is farming or ranching, but rural residences and certain other conditional uses may be allowed. All of these uses are subject to flood hazard review.

The other zones are Heavy Commercial, Airport Commercial, Light Industrial, Heavy Industrial, Highway-Waterway Commercial, Pullman-Moscow Corridor—North, Pullman-Moscow Corridor—South, Cluster Residential, and Rural Community Residential, Center and Commercial Districts. The latter three zones are limited to a dozen very small designated unincorporated communities that were platted long ago. About 14 developments were recognized as Heavy Commercial, Light Industrial, or Heavy Industrial zones when the code was adopted in 1979. Since then, a few zones may have been added each year. Generally, when land is rezoned, flood hazard sites are not included. Some speculative large area zones have been approved where they do include some flood hazard, but County codes will ensure that future development in those areas will comply with flood hazard regulations.

Within Whitman County, adherence to flood hazard regulations tends to locate development away from the floodplain. This is because in many cases, the land parcel sizes are larger than typical urban lots, and there is room for the owner to move. In cases where lot size or other reasons prevent location out of flood hazard areas, it is possible for a development to be given a floodplain development permit for fill, construction, or both, as long as engineering satisfactory to the County Engineer is provided. Rather than pay the engineering costs, most people find it possible to find a higher elevation.

TABLE 10-4.
AREA AND STRUCTURES WITHIN THE 100-YEAR FLOODPLAIN

	Area in Floodplain (Acres)	Number of Structures in Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	**Total**
Albion	54.12	78	0	0	0	0	0	0	**78**
Colfax	284.42	25	1	0	0	0	0	0	**26**
Colton	82.16	27	0	0	0	0	0	0	**27**
Endicott	33.03	36	0	0	0	0	0	0	**36**
Farmington	22.11	18	0	0	0	0	0	0	**18**
Garfield	70.06	70	2	1	0	0	0	0	**73**
LaCrosse	0	0	0	0	0	0	0	0	**0**
Lamont	0	0	0	0	0	0	0	0	**0**
Malden	6.15	6	0	0	0	0	0	0	**6**
Oakesdale	112.51	77	1	1	0	0	2	0	**81**
Palouse	99.32	63	3	1	0	0	0	0	**67**
Pullman	361.86	247	67	5	1	1	0	0	**321**
Rosalia	71.29	26	1	0	0	0	0	0	**27**
St. John	26.15	21	0	1	0	0	0	0	**22**
Tekoa	98.04	28	0	0	0	0	0	0	**28**
Uniontown	196	27	0	1	0	0	0	0	**28**
Unincorporated	49,788.67	1,665	95	27	31	1	1	2	**1,822**
Total	**51,305.89**	**2,414**	**170**	**37**	**32**	**2**	**3**	**2**	**2,660**

TABLE 10-5.
VALUE OF EXPOSED BUILDINGS WITHIN 100-YEAR FLOODPLAIN

	Estimated Flood Exposure			% of Total Assessed Value
	Structure	Contents	**Total**	
Albion	$13,696,500	$7,404,000	$21,100,500	33.99%
Colfax	$126,426,750	$83,262,000	$209,688,750	48.58%
Colton	$4,917,000	$2,840,250	$7,757,250	19.77%
Endicott	$3,958,500	$2,068,500	$6,027,000	10.53%
Farmington	$2,205,000	$1,233,750	$3,438,750	26.43%
Garfield	$10,037,250	$6,483,000	$16,520,250	28.97%
LaCrosse	$0	$0	$0	0.00%
Lamont	$1,005,000	$846,750	$1,851,750	18.99%
Malden	$695,250	$619,500	$1,314,750	6.38%
Oakesdale	$14,861,250	$9,468,000	$24,329,250	52.91%
Palouse	$8,789,250	$5,142,000	$13,931,250	15.77%
Pullman	$430,319,250	$287,182,500	$717,501,750	27.39%
Rosalia	$2,238,750	$1,257,000	$3,495,750	6.04%
St. John	$13,498,500	$9,492,000	$22,990,500	34.75%
Tekoa	$10,956,750	$6,772,500	$17,729,250	21.94%
Uniontown[a]	0	0	0	0
Unincorporated	$203,823,000	$140,471,250	**$1,067,676,750**	31.85
Total	**$847,428,000**	**$564,543,000**	**$2,135,353,500**	**29.61**

a. Uniontown data not available from County Assessor

The code requires that all building permits, except internal remodeling and roofs, be reviewed for compliance with County land use codes including flood hazard. In addition, developments that must undergo State Environmental Policy Act review may be required by policy to provide stormwater runoff control for a 25-year storm event. In the Pullman-Moscow Corridor zones, that requirement is set by code for a 50-year storm event.

Land uses based on zoning differ in the incorporated areas that have their own land use regulations. A detailed analysis of existing land use within identified floodplains on a parcel-by-parcel basis was not performed under this risk assessment, due to the lack of GIS-based information at a parcel level. Based on a qualitative review of County and city policy, it can be assumed that floodplain land use in the planning area is predominately agricultural, with residential and light commercial uses possible in the incorporated areas. Agricultural, low-density uses typically have a lesser degree of exposure to flood risk and should continue to be promoted within the identified floodplains of the planning area.

10.5.3 Critical Facilities and Infrastructure

Table 10-6 summarizes the critical facilities in the 100-year floodplain of Whitman County. Details are provided in the following sections.

**TABLE 10-6.
CRITICAL FACILITIES IN THE 100-YEAR FLOODPLAIN**

Jurisdiction	Medical and Health Services	Government Function	Protective	Hazardous Materials	Schools	Other	**Total**
Albion	0	0	0	0	0	0	**0**
Colfax	0	0	1	0	0	0	**1**
Colton	0	0	0	0	0	0	**0**
Endicott	0	0	0	0	0	0	**0**
Farmington	0	0	0	0	0	0	**0**
Garfield	1	0	1	1	0	0	**3**
LaCrosse	0	0	0	0	0	0	**0**
Lamont	0	0	0	0	0	0	**0**
Malden	0	0	0	0	0	0	**0**
Oakesdale	0	2	0	1	0	0	**3**
Palouse	1	0	1	0	0	0	**2**
Pullman	0	0	1	1	0	1	**3**
Rosalia	0	0	0	0	0	0	**0**
St. John	0	0	0	1	0	0	**1**
Tekoa	0	0	0	0	0	0	**0**
Uniontown	0	0	0	1	0	0	**1**
Unincorporated	0	3	0	2	2	2	**9**
Total	**2**	**5**	**4**	**7**	**2**	**3**	**23**

Tier II Facilities

Tier II facilities are those that can harm the surrounding environment if damaged by a flood due to the release of hazardous materials. Seven businesses in the 100-year floodplain are considered to contain Tier II hazardous materials. During a flood event, containers holding these materials could rupture and leak into the surrounding area, having a disastrous effect on the environment as well as residents.

Utilities/Infrastructure

Roads or railroads that are blocked or damaged can prevent access throughout the County and can isolate residents and emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris from floods also can cause isolation. Water and sewer systems can be flooded or backed up, causing further health problems. Underground utilities can also be damaged during flood events. Thus it is critical to identify which infrastructure is exposed to flooding to determine what is vulnerable and who may be at risk if that infrastructure is damaged. Due to the lack of GIS information, a detailed analysis was not performed to identify potentially vulnerable utilities. There are two large gas pipelines that cross Whitman County. The exposure of these pipelines to flooding is not known at this time.

Railroads

Railroads in Whitman County can be exposed to flood hazards. The Blue Mountain/Coulee City Short Line Railroad runs through a significant portion of the County. Portions of this railroad cross identified floodplains. Nonetheless the railroad tracks tend to be well protected from flooding because the railroad routes are built as levees or as embankments 10 to 15 feet above the surrounding area. In some instances, railroads can worsen flooding because they can prevent drainage of flooded areas.

Roads

Several roads in Whitman County have been affected by past flood events, both inside and outside the 100-year floodplain. Many of these roads, such as portions of U.S. 195 and SR 26 are built above the flood level, and many others function as levees to prevent flooding. Nonetheless, in certain events these roads may be blocked or damaged by flooding, preventing access to many areas. The majority of Public Assistance funds requested by Whitman County for the 1996 flood events (DR-1100 and DR-1159) was for repair to damaged roads that were flooded or undercut due to severe erosion.

Bridges

Flooding events can significantly impact road bridges. These are important because they often provide the only ingress and egress to some neighborhoods or rural areas. An analysis showed that there are approximately 100 bridges that are in or cross over the floodplain. The HAZUS-MH model includes default inventories of roads and bridges. The basis of these inventories would be facilities with a federal interest due to funding or jurisdiction. A large percentage of bridges with potential vulnerability to flooding are County-owned and maintained and fall outside the scope of the default inventory. A GIS-based inventory of County-owned facilities was not available for this analysis; therefore estimated vulnerability is based solely on default parameters.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding events. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can also be backed up, causing wastes to spill into homes, neighborhoods, rivers and streams.

Environment

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

The listing of salmon and trout species as threatened or endangered under the Endangered Species Act has had a significant impact on rural counties such as Whitman County in that they must now take into account the impact of their programs on habitat. This can affect the implementation of flood mitigation alternatives such as stream channel maintenance, stream channel modification or watershed management.

Due to the rural, agricultural nature of the planning area, much of the identified floodplain in Whitman County is in or approximates its natural state. This allows for these floodplains to provide beneficial functions such as floodwater storage, water quality and enhancement of habitat. Whitman County and its planning partners have adopted critical areas regulations that strive to preserve and enhance these areas through regulated land use.

10.6 VULNERABILITY

Many of the areas exposed to flooding may not experience serious flooding or flood damage. This section describes vulnerabilities in terms of population, property, infrastructure and environment.

10.6.1 Population

A geographic analysis of demographics, using the HAZUS-MH model and data from the U.S. Census Bureau and Dun & Bradstreet, identified populations vulnerable to the flood hazard as follows:

- **Economically Disadvantaged Populations**—It is estimated that 12 percent of the people within the 100-year floodplain are economically disadvantaged, defined as having household incomes of $10,000 or less.
- **Population over 65 Years Old**—It is estimated that 5.4 percent of the population in the census blocks that intersect the 100-year floodplain are over 65 years old. Approximately 9.5 percent of the over-65 population in the floodplain also have incomes considered to be economically disadvantaged and are considered to be extremely vulnerable.
- **Population under 16 Years Old**—It is estimated that 8.4 percent of the population within census blocks located in or near the 100-year floodplain are under 16 years of age.

HAZUS estimated that a 100-year flood could displace up to 2,143 people, with 790 of those people needing short-term shelter.

10.6.2 Property

HAZUS-MH calculates losses to structures from flooding by looking at depth of flooding and type of structure. Using historical flood insurance claim data, HAZUS-MH estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, local data on facilities was used instead of the default inventory data provided with HAZUS-MH.

The analysis is summarized in Table 10-7 for the 100-year flood event. It is estimated that there would be up to $96 million of flood loss from a 100-year flood event in the planning area. This represents 6.8 percent of the total exposure to the 100-year flood and 2.01 percent of the total assessed value for the county. HAZUS also estimated that approximately 8.9 million tons of debris could be generated from a 100-year flood within the planning area.

TABLE 10-7.
ESTIMATED FLOOD LOSS FOR THE 100-YEAR FLOOD EVENT

	Estimated Flood Loss			% of Total Assessed Value
	Structural	Contents	**Total**	
Albion	$901,000	$882,000	$1,783,000	2.87%
Colfax	$19,109,000	$28,700,000	$47,809,000	11.08%
Colton	$234,000	$257,000	$491,000	1.25%
Endicott	$273,000	$195,000	$468,000	0.82%
Farmington	$100,000	$74,000	$174,000	1.34%
Garfield	$406,000	$548,000	$954,000	1.67%
LaCrosse	$0	$0	$0	0.00%
Lamont	$68,000	$196,000	$264,000	2.71%
Malden	$39,000	$82,000	$121,000	0.59%
Oakesdale	$295,000	$463,000	$758,000	1.65%
Palouse	$1,643,000	$1,634,000	$3,277,000	3.71%
Pullman	$9,187,000	$18,904,000	$28,091,000	1.07%
Rosalia	$120,000	$89,000	$209,000	0.36%
St. John	$1,056,000	$2,339,000	$3,395,000	5.13%
Tekoa	$612,000	$881,000	$1,493,000	1.85%
Uniontown[a]	0	0	**0**	—
Unincorporated	$2,749,000	$3,968,000	**$89,287,000**	0.62
Total	**$36,792,000**	**$59,212,000**	**$178,574,000**	**2.01**

a. Uniontown data not available from County Assessor

National Flood Insurance Program

Table 10-8 lists flood insurance statistics for Whitman County. Fifteen communities in the planning area participate in the NFIP, with 133 flood insurance policies in force providing $18.9 million in insurance coverage. According to FEMA statistics, 49 flood insurance claims were paid between January 1, 1978 and May 31, 2012, for a total of $474,533, an average of $9,684 per claim.

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were adopted to decrease vulnerability. Properties built before a FIRM is adopted are more vulnerable to flooding because they do not meet code or are located in hazardous areas. The first FIRMs in Whitman County were available in 1978.

**TABLE 10-8.
FLOOD INSURANCE STATISTICS FOR WHITMAN COUNTY**

Jurisdiction	Date of Entry Initial FIRM Effective Date	# of Flood Insurance Policies as of 5/31/2012	Insurance In Force	Total Annual Premium	Claims, 11/1978 to 5/31/2012	Value of Claims paid, 11/1978 to 5/31/2012
Albion	8/1/1978	11	$1,259,600	$9,114	4	$38,034
Colfax	8/1/1978	7	$1,645,000	$2,327	0	$0
Colton	7/2/1979	2	$176,600	$992	0	$0
Endicott	7/17/1978	5	$442,800	$4,774	1	$1,433
Farmington	7/3/1985	1	$27,200	$347	0	0
Garfield	8/1/1978	8	$883,400	$6,266	2	24,666
LaCrosse	NP	—	—	—	—	—
Lamont	NP	—	—	—	—	—
Malden	5/01/2010	0	0	0	0	$0
Oakesdale	9/29/1978	5	$525,500	$3,775	0	$0
Palouse	7/17/1978	16	$1,964,200	$16,042	4	$262,593
Pullman	7/2/1979	49	$8,923,700	$54,411	29	$136,666
Rosalia	7/17/1978	5	$613,500	$2,337	3	$9,183
St. John	5/26/1981	0	0	0	0	$0
Tekoa	8/1/1979	0	0	0	0	$0
Uniontown	8/1/1978	1	$120.000	$987	0	$0
Unincorporated	5/1/1980	23	$2,536,800	$11,548	6	$1,957
Total		**99**	**$14,563,820**	**$89,100**	**42**	**$410,399**

The following information from flood insurance statistics is relevant to reducing flood risk:

- The use of flood insurance in Whitman County is well below the national average. Only 2.7 percent of insurable buildings in the county are covered by flood insurance. According to an NFIP study, about 49 percent of single-family homes in special flood hazard areas are covered by flood insurance nationwide.
- The average claim paid in the planning area represents about 3.4 percent of the 2010 average assessed value of structures in the floodplain.
- The percentage of policies and claims outside a mapped floodplain suggests that not all of the flood risk in the planning area is reflected in current mapping. Based on information from the NFIP, 53.5 percent of policies in the planning area are on structures within an identified SFHA, and 46.5 percent are for structures outside such areas. Of total claims paid, 18.5 percent were for properties outside an identified 100-year floodplain.

Repetitive Loss

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

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

Repetitive loss properties make up only 1 to 2 percent of flood insurance policies in force nationally, yet they account for 40 percent of the nation's flood insurance claim payments. In 1998, FEMA reported that the NFIP's 75,000 repetitive loss structures have already cost $2.8 billion in flood insurance payments and that numerous other flood-prone structures remain in the floodplain at high risk. The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. A recent report on repetitive losses by the National Wildlife Federation found that 20 percent of these properties are outside any mapped 100-year floodplain. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies.

FEMA-sponsored programs, such as the CRS, require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss. Map 10-3 shows the repetitive loss areas in Whitman County.

FEMA's list of repetitive loss properties identifies four such properties in the Whitman County planning area as of December 31, 2011. All are within the City of Pullman, and none have been mitigated to date. All are within the City's special flood hazard area. Therefore it can be concluded that the overall cause of repetitive flooding is consistent with the flood events reflected on the FIRM for the City of Pullman.

10.6.3 Critical Facilities and Infrastructure

HAZUS-MH was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities, HAZUS-MH correlates these estimates into an estimate of functional down-time (the estimated time it will take to restore a facility to 100 percent of its functionality). This helps to gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery.

The HAZUS critical facility analysis found that, on average, critical facilities would receive 14.5 percent damage to the structure and 41 percent damage to the contents during a 100-year flood event. The estimated time to restore these facilities to 100 percent of their functionality would be 548 days.

10.6.4 Environment

The environment vulnerable to flood hazard is the same as the environment exposed to the hazard. Loss estimation platforms such as HAZUS-MH are not currently equipped to measure environmental impacts of flood hazards. The best gauge of vulnerability of the environment would be a review of damage from past flood events. Loss data that segregates damage to the environment was not available at the time of this plan. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

10.7 FUTURE TRENDS IN DEVELOPMENT

The Whitman County planning area has experienced a relatively moderate rate of growth in recent years. Extrapolating from these historical trends, anticipated development trends for the planning area are considered low to moderate, consisting primarily of residential development with the exception of the

Pullman vicinity (see Volume 2 for jurisdiction-specific growth trends). Higher rates of growth tend to increase demand for new development. With this fact in mind, it would be assumed that development/redevelopment trends within Whitman County are not such that there is major concern toward development within identified flood hazard areas.

Whitman County is not subject to the full planning requirements of the state Growth Management Act. The County and its cities have adopted critical areas and resources lands regulations pursuant to the Growth Management Act requirements for jurisdictions not mandated to fully plan. Maintaining the agricultural heritage of Whitman County is a high priority for its land use programs and managers. However, with the changed tax structure of Washington State severely affecting the budgets of small cities, towns and rural counties, municipalities are often forced into positions to revise their land use policies in order to optimize financial resources. It has been Whitman County's policy in the past to not allow for an increase in exposure within its floodplains. Flood loss history and the current land use trends support these policies. The information in this plan provides Whitman County and its Planning Partners a tool to ensure that there is no increase in exposure within the floodplains of the planning area.

10.8 SCENARIO

The worst flooding in Whitman County would occur during winter or early spring when heavy rainfall is accompanied by warm Chinook winds. This heavy rainfall in conjunction with the warm air causes snowmelt and rapid runoff on frozen ground. The top layers of the loess soil have the potential to erode away during this rapid runoff. The extent of erosion will depend on the extent of ground cover and agricultural management regimes in practice at the time of the event. The more ground cover and accompanying measures reducing velocity, the less erosion and less transported sediment.

The sudden increase in runoff overwhelms rivers and creeks, which typically overtop, flooding areas where the rivers are blocked or channel capacity is otherwise reduced, such as in towns that have numerous bridges. The runoff also carries debris, ice and sediment, which can be deposited where the rivers overflow and contribute to scour. Minor flooding can occur along numerous roadways, leaving sediment and minor landslides that are costly and time-consuming to clean up. Not all rivers flood at the same time as others, or during the same events, so it is difficult to predict where flooding may actually occur during any given predicted storm event. All of these impacts could be significantly exacerbated due to the impacts of climate change.

10.9 ISSUES

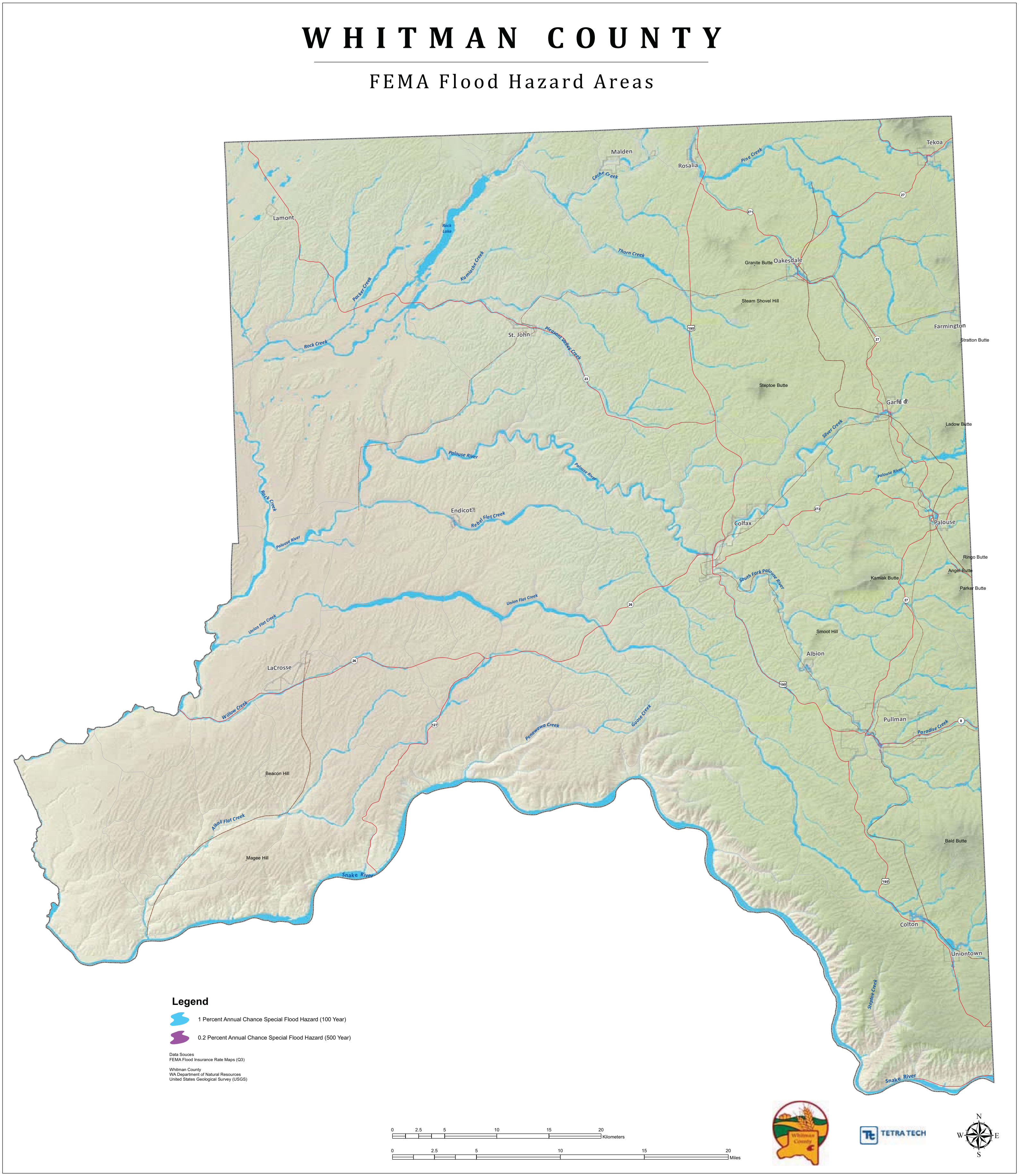
The streams and rivers of Whitman County are generally low-flow rivers. However, during severe weather events in conjunction with accumulated snow on the ground, rivers that have average discharges of 40 cfs can swell to 15,000 cfs. Except in the most severe events, or when exacerbated by human-built structures such as bridge abutments, the rivers typically have handled the added flow without overtopping. However, stream capacities are diminishing due to sedimentation. Rivers that previously overtopped during 50-year events may now overtop during 10- or 30-year events. Much of this erosion can be attributed to cultivation of the rich, dry and highly erodible soil for wheat and other grain farming; although erosion of the soil is a natural occurrence, intense cultivation over the last 130 years has sped up the process. In addition to maintenance and dredging of problem rivers, it is recommended that watersheds whose streams drain into flood-prone communities be designated as target watersheds where farming practices should be implemented to reduce erosion and lessen the flood vulnerability of the most at-risk communities.

Accurate hazard identification allows hazard mitigation planners to accurately reflect the benefits of a proposed initiative, which can be crucial when prioritizing an action plan. The risk assessment in this plan is based on the FIRMs produced for the planning area by FEMA, the average age of which is 30 years. At the time of this planning process, this was the best available information to identify the extent and location of flooding in Whitman County. Even with the low rate of growth in the planning area, stream channel conditions and hydrology changes have occurred within this region to draw into question the accuracy of these maps. Although new mapping would not significantly alter the mitigation recommendations of this plan, it would provide a much more accurate assessment of risk and may be able to provide a better gauge of where these initiatives should be implemented to maximize the net benefits. Future enhancements and revisions to this plan should focus on using or obtaining the best available science and technology to accurately identify the flood hazards within Whitman County.

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

- The accuracy of the existing flood hazard mapping produced by FEMA in reflecting the true flood risk within the planning area is questionable. Flood maps need to be updated using the best available data, science and technology.
- Information on the assets exposed to flooding in a digital format would significantly enhance the flood hazard risk assessment for this plan.
- The risk associated with the flood hazard overlaps the risk associated with other hazards such as earthquake and landslide. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- There is no consistency of land-use practices within the planning area or the scope of regulatory floodplain management beyond the minimum requirements of the NFIP.
- Potential climate change could alter flood conditions in Whitman County.
- More information is needed on flood risk to support the concept of risk-based analysis of capital projects.
- There needs to be a sustained effort to gather historical damage data, such as high water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between jurisdictions affected by flood hazards in the county.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained. There is constant pressure to convert these existing uses to more intense uses within the planning area during times of moderate to high growth.
- The economy affects a jurisdiction’s ability to manage its floodplains. Budget cuts and personnel losses can strain resources needed to support floodplain management.
- A buildable-lands analysis that looks at vacant lands and their designated land use would be a valuable tool in helping decision-makers make wise decisions about future development. This could be made possible by digitizing the land use zoning designations for the entire planning area in a parcel level database

Map 10-1.

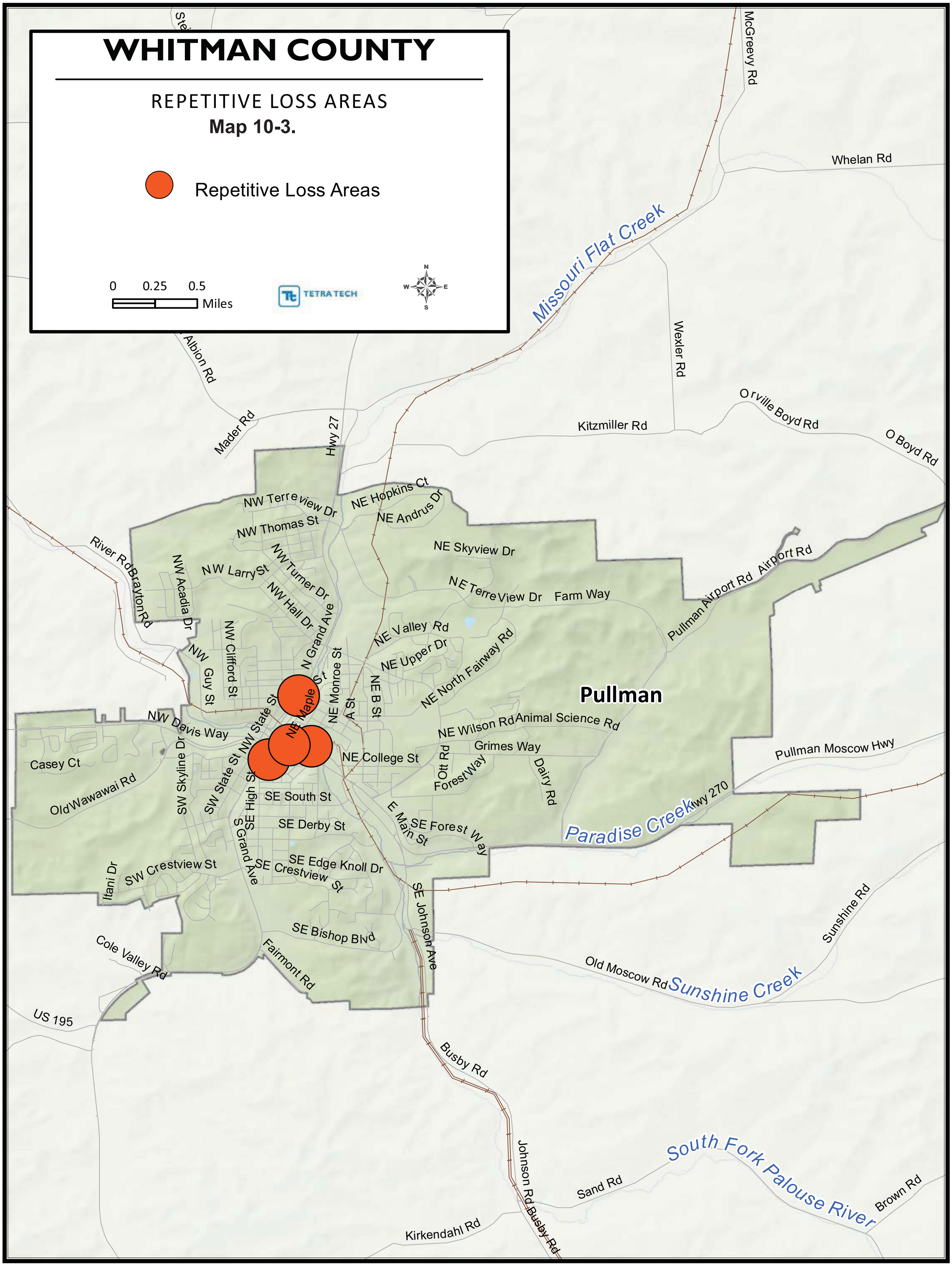


WHITMAN COUNTY
FEMA Flood Hazard Areas
Malden
Rosalia
Tekoa
Pine Creek
Cache Creek
Lamont
Rock Lake
Thorn Creek
Kamiache Creek
Packer Creek
Granite Butte
Oakesdale
Steam Shovel Hill
Farmington
Stratton Butte
St. John
Pleasant Valley Creek
Rock Creek
Steptoe Butte
Garfield
Ladow Butte
Silver Creek
Palouse River
Endicott
Rebel Flat Creek
Colfax
Palouse
Ringo Butte
Angel Butte
Parker Butte
Kamiak Butte
South Fork Palouse River
Union Flat Creek
Smoot Hill
Albion
LaCrosse
Willow Creek
Penawawa Creek
Goose Creek
Pullman
Paradise Creek
Beacon Hill
Alkali Flat Creek
Magee Hill
Snake River
Bald Butte
Colton
Uniontown
Steptoe Creek
Legend
1 Percent Annual Chance Special Flood Hazard (100 Year)
0.2 Percent Annual Chance Special Flood Hazard (500 Year)
Data Souces
FEMA Flood Insurance Rate Maps (Q3)
Whitman County
WA Department of Natural Resources
United States Geological Survey (USGS)
0 2.5 5 10 15 20 Kilometers
0 2.5 5 10 15 20 Miles
TETRA TECH
N E S W

Map 10-2.

WHITMAN COUNTY

Hazus Generated Flood Hazard Area


WHITMAN COUNTY
REPETITIVE LOSS AREAS
Map 10-3.
Repetitive Loss Areas
0
0.25
0.5
Miles
TETRA TECH
N
S
E
W
Pullman
Missouri Flat Creek
Paradise Creek
Sunshine Creek
South Fork Palouse River
McGreevy Rd
Whelan Rd
Wexler Rd
Albion Rd
Mader Rd
Hwy 27
Kitzmiller Rd
Orville Boyd Rd
O Boyd Rd
NW Terreview Dr
NE Hopkins Ct
NE Andrus Dr
NW Thomas St
NE Skyview Dr
River Rd
Brayton Rd
NW Acadia Dr
NW Larry St
NW Turner Dr
NW Hall Dr
NE Terre View Dr
Farm Way
Airport Rd
Pullman Airport Rd
NE Valley Rd
NE Upper Dr
NE North Fairway Rd
NW Guy St
NW Clifford St
N Grand Ave
NE Monroe St
NE B St
A St
NE Maple St
NW State St
NW Davis Way
NE Wilson Rd
Animal Science Rd
Grimes Way
NE College St
Ott Rd
Forest Way
Dairy Rd
Pullman Moscow Hwy
Hwy 270
Casey Ct
Old Wawawai Rd
SW Skyline Dr
SW State St
SE High St
SE South St
SE Derby St
E Main St
SE Forest Way
S Grand Ave
SE Edge Knoll Dr
SE Crestview St
SW Crestview St
Itani Dr
SE Johnson Ave
SE Bishop Blvd
Fairmont Rd
Cole Valley Rd
US 195
Old Moscow Rd
Sunshine Rd
Busby Rd
Johnson Rd
Sand Rd
Kirkendahl Rd
Brown Rd

CHAPTER 11.
LANDSLIDE

11.1 GENERAL BACKGROUND

A landslide is a mass of rock, earth or debris moving down a slope. Landslides may be minor or very large, and can move at slow to very high speeds. They can be initiated by storms, earthquakes, fires, volcanic eruptions or human modification of the land.

Mudslides (or mudflows or debris flows) are rivers of rock, earth, organic matter and other soil materials saturated with water. They develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud or "slurry." A debris flow or mudflow can move rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds. The slurry can travel miles from its source, growing as it descends, picking up trees, boulders, cars and anything else in its path. Although these slides behave as fluids, they pack many times the hydraulic force of water due to the mass of material included in them. Locally, they can be some of the most destructive events in nature.

DEFINITIONS

Landslide—The sliding movement of masses of loosened rock and soil down a hillside or slope. Such failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.

Mass Movement—A collective term for landslides, debris flows, falls and sinkholes.

Mudslide (or Mudflow or Debris Flow)—A river of rock, earth, organic matter and other materials saturated with water.

All mass movements are caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. Vulnerable natural conditions are affected by human residential, agricultural, commercial and industrial development and the infrastructure that supports it.

11.2 HAZARD PROFILE

Landslides are caused by one or a combination of the following factors: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

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

Flows and slides are commonly categorized by the form of initial ground failure. Common types of slides are shown in Figure 11-1 through Figure 11-4. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less common than other types.

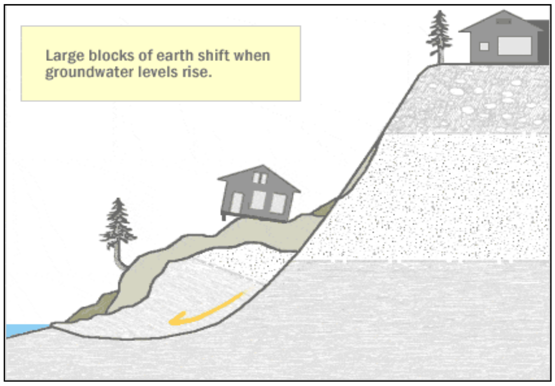


Figure 11-1. Deep Seated Slide

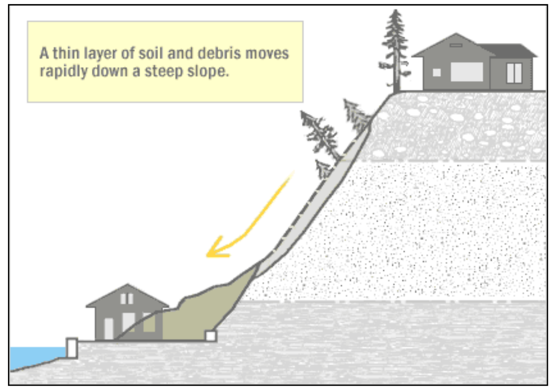


Figure 11-2. Shallow Colluvial Slide

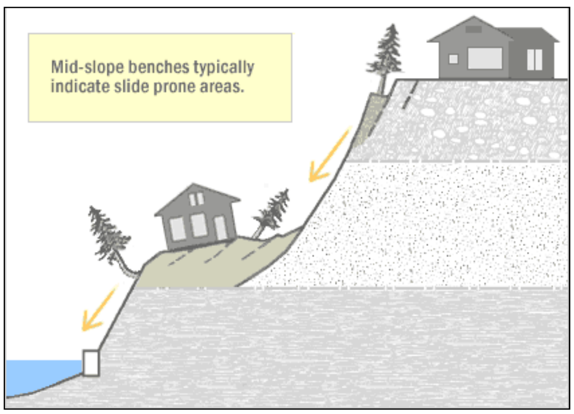


Figure 11-3. Bench Slide

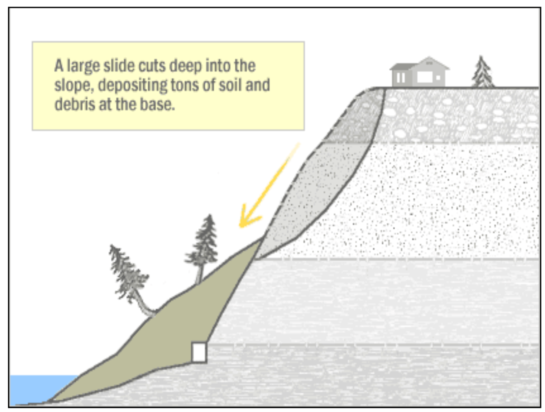


Figure 11-4. Large Slide

Slides and earth flows can pose serious hazard to property in hillside terrain. They tend to move slowly and thus rarely threaten life directly. When they move—in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support—they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, breaking of underground pipes, or overriding of downslope property and structures.

11.2.1 Past Events

There is little recorded information regarding landslides in Whitman County. The Spatial Hazard Events and Losses Database for the United States (SHELDUS) has a record of one landslide event in Whitman County since 1960—on January 26, 1965. This event coincided with a presidential disaster declaration for severe storms and flooding. There are no records in the county of fatalities attributed to mass movement. However, deaths as a result of slides and slope collapses have occurred across the west coast.

11.2.2 Location

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

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

Identifying unstable slopes to aid in mitigating landslide hazards is an integral part of land management and regulation in Washington through the Landslide Hazard Zonation Project prepared by the Forest Practices Division of the Washington Department of Natural Resources. Permanent rules adopted by the Washington Forest Practices Board in 2001 address landslide hazards from specific landforms across the state (WAC 222-16-050 (1)(d)). This methodology was developed to provide standardized methods for landslide inventories and for producing hazard maps to identify unstable slopes in support of forest practices rules. It also provides a framework for monitoring the success of new forest practices related to unstable slopes. Currently, there are no Landslide Hazard Zonation maps for the Whitman County planning area. Future landslide risk assessments should use this data once it becomes available.

The landslide risk assessment for this plan identified areas with landslide potential based on steepness and soil type. Landslide hazard areas were defined as all areas with slopes of 15 percent or more and with NEHRP Soil Types D or E. Map 11-1 shows the hazard areas based on these criteria.

11.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide frequency is related to the frequency of these other hazards. In Whitman County, landslides typically occur during and after major storms when agricultural lands have been tilled and are free of vegetative cover. Therefore, the potential for landslides coincides with the potential for sequential severe storms that saturate steep, vulnerable soils as well as with agricultural production. According to SHELDUS records, the planning area has been impacted by severe storms at least once every other year since 1960. Until better data is generated specifically for landslide hazards, this severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard.

In general, landslides are most likely during periods of higher than average rainfall. The ground must be saturated prior to the onset of a major storm for significant landsliding to occur. Water is involved in nearly all cases; and human influence has been identified in more than 80 percent of reported slides.

11.2.4 Severity

Landslide disasters occur on a regular basis. A landslide can destroy homes, chew apart a highway, or trigger more catastrophic events such as flooding if it happens in the wrong place at the wrong time. Human settlements around the world are built near landslide-prone cliffs and mountains, which can result in tragic consequences. Geologic history has a number of examples of landslides that were large enough to move entire mountains. In the modern era, landslide disasters such as the Monte Toc landslide in Italy, the 1991 Pubjabi landslide in India, and the Khait landslide in Russia have claimed thousands of casualties and caused considerable damage. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost to society of about $1.5 billion.

11.2.5 Warning Time

Mass movements can occur suddenly or slowly. The velocity of movement may range from inches per year to many feet per second, depending on slope angle, material and water content. Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine what areas are at risk during general time periods. Assessing the geology, vegetation and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for individual landslides. The current standard operating procedure is to monitor situations on a case-by-case basis, and respond after the event has occurred. Generally accepted warning signs for landslide activity include:

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

11.3 SECONDARY HAZARDS

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

11.4 CLIMATE CHANGE IMPACTS

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature could affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

11.5 EXPOSURE

11.5.1 Population

Population could not be examined by landslide hazard area because census block group areas do not coincide with the hazard areas.

11.5.2 Property

A building exposure analysis could not be performed for this assessment due to the lack of available digital parcel data for the planning area. However, to gauge the potential landslide risk exposure solely based on areas with land slide potential, an area analysis was performed for each municipality in the planning area. Table 11-1 shows the percentage of the total area of each municipality with slopes greater than 15 percent and NEHRP Soil Types D or E. This analysis determined that over a quarter of the county's total land mass is potential landslide hazard area.

TABLE 11-1.
LANDSLIDE AREA EXPOSURE

		Slopes Greater than 15%, and Soft Soils (NEHRP Type D and E)	
	Total Area (acres)	Estimated Area Exposed (acres)	Percent of Total Area
Albion	251	25	10.07%
Colfax	2,352	394	16.76%
Colton	388	26	6.78%
Endicott	183	16	8.67%
Farmington	264	3	1.29%
Garfield	577	99	17.14%
LaCrosse	934	8	0.84%
Lamont	186	37	19.83%
Malden	477	16	3.28%
Oakesdale	665	67	10.06%
Palouse	666	85	12.82%
Pullman	6,225	1,529	24.56%
Rosalia	385	1	0.35%
St. John	404	43	10.67%
Tekoa	785	104	13.29%
Uniontown[a]	0	0	0
Unincorporated	1,378,738	406,249	29.47%
Total	**1,393,479**	**408,703**	**29.33%**

a. Uniontown data not available from County Assessor

11.5.3 Critical Facilities and Infrastructure

Table 11-2 summarizes the critical facilities exposed to the landslide hazard.

**TABLE 11-2.
CRITICAL FACILITIES EXPOSED TO LANDSLIDE HAZARDS**

	Number of Exposed Critical Facilities in Risk Area
Medical and Health Services	2
Government Function	0
Protective Function	3
Schools	3
Hazmat	1
Other Critical Function	1
Bridges	35
Water	9
Wastewater	1
Power	0
Communications	1
Total	**56**

A significant amount of infrastructure can be exposed to mass movements:

- **Roads**—Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.
- **Bridges**—Landslides can significantly impact road bridges. Mass movements can knock out abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power Lines**—Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil under a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.

11.5.4 Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Wildlife habitat on hillsides can be lost for prolonged periods due to landslides.

11.6 VULNERABILITY

11.6.1 Population

Due to the nature of census block group data, it is difficult to determine demographics of populations vulnerable to mass movements. In general, all persons exposed to higher risk landslide areas are considered to be vulnerable. Increasing population and the fact that many homes are built on view property atop or below bluffs and on steep slopes subject to mass movement, increases the number of lives endangered by this hazard.

11.6.2 Property

No vulnerability analysis was performed for this assessment due to the lack of available digital data at a parcel level. Currently, there are no nationally accepted damage functions established for the landslide hazard. However, future updates to this assessment could use digital parcel data by intersecting it with the available landslide hazard data and applying an estimate of damage to the value of the assets.

11.6.3 Critical Facilities and Infrastructure

There are 56 critical facilities exposed to the landslide hazard to some degree. No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from mass movements should be done to determine if they could withstand impacts of a mass movement.

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

11.6.4 Environment

The environment vulnerable to landslide hazard is the same as the environment exposed to the hazard.

11.7 FUTURE TRENDS IN DEVELOPMENT

Landslide hazard areas are included in “geologically hazardous areas,” one category of critical areas regulated under the state GMA for Whitman County. They are defined as follows:

> “Landslide hazard areas” means areas potentially subject to mass earth movement based on a combination of geologic, topographic, and hydrologic factors, with a vertical height of 10 feet or more. These include the following:
>
> – Areas of historical landslides as evidenced by landslide deposits, avalanche tracks, and areas susceptible to basal undercutting by streams, rivers or waves
>
> – Areas with slopes steeper than 15 percent that intersect geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock, and which contain springs or groundwater seeps
>
> – Areas located in a canyon or an active alluvial fan, susceptible to inundation by debris flows or catastrophic flooding.

Whitman County and its planning partners are well-equipped to deal with future growth and development within the planning area. The landslide hazard portions of the planning area are regulated by County Code (Title 9) as well as by the International Building Code. Development will occur in landslide hazards within the planning area, but it will be regulated such that the degree of risk will be reduced through building standards and performance measures.

11.8 SCENARIO

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

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

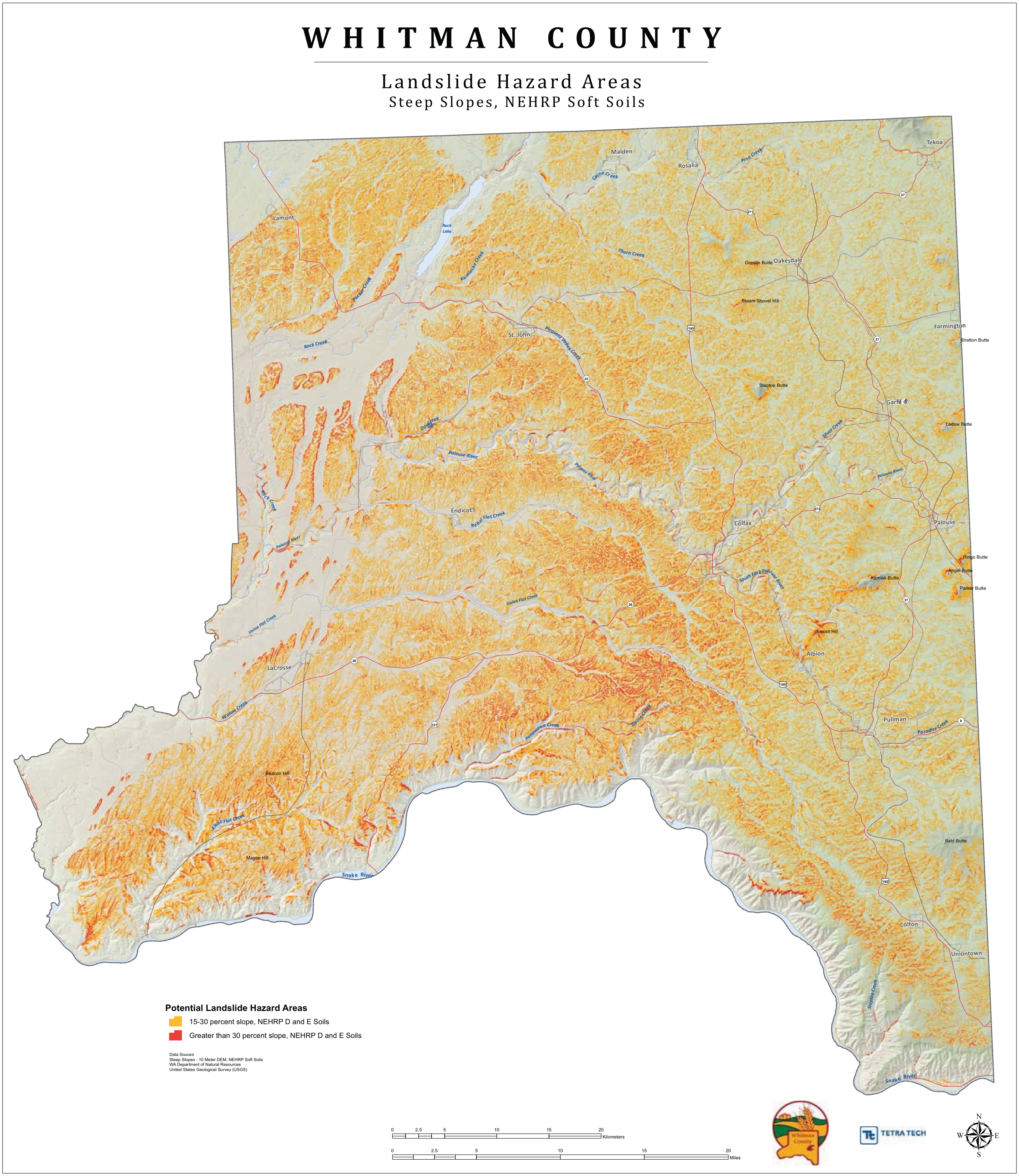
Continued heavy rains and flooding will complicate the problem further. As emergency response resources are applied to flooding problems, it is possible they will be unavailable to assist with landslides.

11.9 ISSUES

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

- There are many unknowns about the potential impact of this hazard due to the lack of available information.
- Future development could lead to more homes in landslide risk areas.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- The impact of climate change on landslides is uncertain. If climate change impacts atmospheric conditions, then exposure to landslide risks is likely to increase.
- Landslides may cause negative environmental consequences, including water quality degradation.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

Map 11-1.



WHITMAN COUNTY
Landslide Hazard Areas
Steep Slopes, NEHRP Soft Soils
Malden
Rosalia
Tekoa
Lamont
Oakesdale
Granite Butte
Steam Shovel Hill
St. John
Farmington
Stratton Butte
Steptoe Butte
Garfield
Ladow Butte
Endicott
Colfax
Palouse
Ringo Butte
Angel Butte
Kamiak Butte
Parker Butte
Smoot Hill
Albion
LaCrosse
Pullman
Beacon Hill
Magee Hill
Bald Butte
Colton
Uniontown
Rock Lake
Rock Creek
Pine Creek
Cache Creek
Thorn Creek
Kamiache Creek
Pleasant Valley Creek
Palouse River
Silver Creek
Rebel Flat Creek
Union Flat Creek
South Fork Palouse River
Willow Creek
Penawawa Creek
Almota Creek
Alkali Flat Creek
Snake River
Paradise Creek
Steptoe Creek
Potential Landslide Hazard Areas
15-30 percent slope, NEHRP D and E Soils
Greater than 30 percent slope, NEHRP D and E Soils
Data Souces
Steep Slopes - 10 Meter DEM, NEHRP Soft Soils
WA Department of Natural Resources
United States Geological Survey (USGS)
0 2.5 5 10 15 20 Kilometers
0 2.5 5 10 15 20 Miles
Whitman County
TETRA TECH
N W E S

CHAPTER 12.
SEVERE WEATHER

12.1 GENERAL BACKGROUND

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, downbursts, tornadoes, waterspouts, snowstorms, ice storms, and dust storms.

Severe weather can be categorized into two groups: those that form over wide geographic areas are classified as general severe weather; those with a more limited geographic area are classified as localized severe weather. Severe weather, technically, is not the same as extreme weather, which refers to unusual weather events are at the extremes of the historical distribution for a given area.

Five types of severe weather events typically impact Whitman County: thunderstorms, damaging winds, hail storms, heavy snowfall associated with winter storms and flash flooding. Flooding issues associated with severe weather are discussed in Chapter 10. The other four types of severe weather common to Whitman County are described in the following sections.

12.1.1 Thunderstorms

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as “severe” when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado.

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

DEFINITIONS

Freezing Rain—The result of rain occurring when the temperature is below the freezing point. The rain freezes on impact, resulting in a layer of glaze ice up to an inch thick. In a severe ice storm, an evergreen tree 60 feet high and 30 feet wide can be burdened with up to six tons of ice, creating a threat to power and telephone lines and transportation routes.

Severe Local Storm—”Microscale” atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms and snowstorms. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area. Typical impacts are on transportation infrastructure and utilities.

Thunderstorm—A storm featuring heavy rains, strong winds, thunder and lightning, typically about 15 miles in diameter and lasting about 30 minutes. Hail and tornadoes are also dangers associated with thunderstorms. Lightning is a serious threat to human life. Heavy rains over a small area in a short time can lead to flash flooding.

Tornado—Funnel clouds that generate winds up to 500 miles per hour. They can affect an area up to three-quarters of a mile wide, with a path of varying length. Tornadoes can come from lines of cumulonimbus clouds or from a single storm cloud. They are measured using the Fujita Scale, ranging from F0 to F5.

Windstorm—A storm featuring violent winds. Southwesterly winds are associated with strong storms moving onto the coast from the Pacific Ocean. Southern winds parallel to the coastal mountains are the strongest and most destructive winds. Windstorms tend to damage ridgelines that face into the winds.

Winter Storm—A storm having significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation.

it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves we hear as thunder. Thunderstorms have three stages (see Figure 12-1):

- The ***developing stage*** of a thunderstorm is marked by a cumulus cloud that is being pushed upward by a rising column of air (updraft). The cumulus cloud soon looks like a tower (called towering cumulus) as the updraft continues to develop. There is little to no rain during this stage but occasional lightning. The developing stage lasts about 10 minutes.
- The thunderstorm enters the ***mature stage*** when the updraft continues to feed the storm, but precipitation begins to fall out of the storm, and a downdraft begins (a column of air pushing downward). When the downdraft and rain-cooled air spread out along the ground, they form a gust front, or a line of gusty winds. The mature stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The storm occasionally has a black or dark green appearance.
- Eventually, a large amount of precipitation is produced and the updraft is overcome by the downdraft beginning the ***dissipating stage***. At the ground, the gust front moves out a long distance from the storm and cuts off the warm moist air that was feeding the thunderstorm. Rainfall decreases in intensity, but lightning remains a danger.

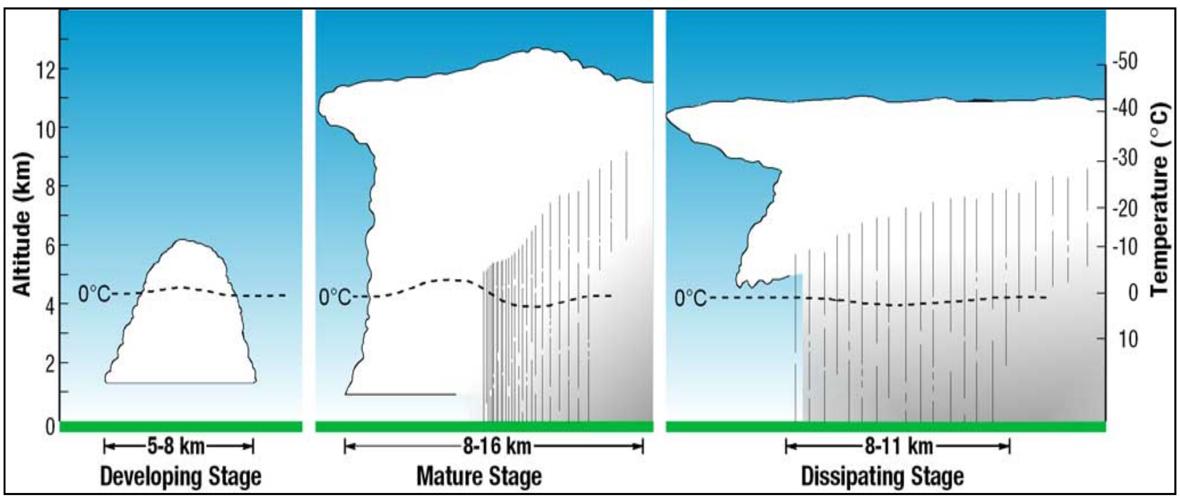


Figure 12-1. The Thunderstorm Life Cycle

There are four types of thunderstorms:

- **Single-Cell Thunderstorms—**Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief severe weather event. When this happens, it is called a pulse severe storm.
- **Multi-Cell Cluster Storm—**A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods and weak tornadoes. Each cell in a multi-cell cluster lasts

only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.

- **Multi-Cell Squall Line—**A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf-ball size, heavy rainfall, and weak tornadoes, but they are best known as the producers of strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line. This produces what is called a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.
- **Super-Cell Storm—**A super-cell is a highly organized thunderstorm that poses a high threat to life and property. It is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 miles per hour. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell (called a mesocyclone when visible on radar) helps the super-cell to produce extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 miles an hour or more, and strong to violent tornadoes.

12.1.2 Damaging Winds

Damaging winds are classified as those exceeding 60 mph. Damage from such winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. There are seven types of damaging winds:

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

typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.

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

12.1.3 Hail Storms

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

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

Hailstones can have layers like an onion if they travel up and down in an updraft, or they can have few or no layers if they are “balanced” in an updraft. One can tell how many times a hailstone traveled to the top of the storm by counting its layers. Hailstones can begin to melt and then re-freeze together, forming large and very irregularly shaped hail.

12.1.4 Winter Storms/Heavy Snow

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

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

The Pacific Ocean provides a virtually unlimited source of moisture for storms. If the air is cold enough, snow falls over Washington and Oregon and sometimes in California. Cold air from the north has to filter through mountain canyons into the basins and valleys to the south. If the cold air is deep enough, it can spill over the mountain ridge. As the air funnels through canyons and over ridges, wind speeds can reach 100 mph, damaging roofs and taking down power and telephone lines. Combining these winds with snow results in a blizzard.

Heavy snow can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse buildings and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches. The cost of snow removal, repairing damage, and loss of business can have large economic impacts on cities and towns.

Areas most vulnerable to winter storms are those affected by convergence of dry, cold air from the interior of the North American continent, and warm, moist air off the Pacific Ocean. Typically, significant winter storms occur during the transition between cold and warm periods.

12.2 HAZARD PROFILE

12.2.1 Past Events

Table 12-1 summarizes severe weather events in Whitman County since 2006, as recorded by the National Oceanic and Atmospheric Administration (NOAA).

12.2.2 Location

Severe weather events have the potential to happen anywhere in the planning area. Communities in low-lying areas next to streams or lakes are more susceptible to flooding. Wind events are most damaging to areas that are heavily wooded. Maps 13-1, 13-2, 13-3 and 13-4 show the distribution of average weather conditions over Whitman County.

12.2.3 Frequency

The severe weather events for Whitman County shown in Table 12-1 are often related to high winds associated with winter storms and thunderstorms. The planning area can expect to experience exposure to some type of severe weather event at least annually. Severe weather in Whitman County tends to be infrequent. The County will experience about one hail event each year, but damage is usually non-significant. Tornadoes are infrequent, as the county may experience one about every 20 years. The 2010 Washington State Hazard Mitigation Plan lists recurrence rates for high-wind and winter storm events in Whitman County as 93 percent and 30 percent, respectively (Washington EMD, 2010).

12.2.4 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but can occur. Roads may become impassable due to flooding, downed trees, ice or snow, or a landslide. Power lines may be downed due to high winds or ice accumulation, and services such as water or phone may not be able to operate without power. Lightning can cause severe damage and injury.

Windstorms can be a frequent problem in the planning area and have been known to cause damage to utilities. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher. Under most conditions the County’s highest winds come from the south or southwest.

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

**TABLE 12-1.
SEVERE WEATHER EVENTS IMPACTING PLANNING AREA SINCE 2006**

Date	Type	Deaths or Injuries	Property Damage
7/16/2012	Hail	0	$7,000 (Crop)
Description: *Public reported quarter to half dollar size hail. Storm total precipitation from 2100 to 0500 was 2.63 inches. Extensive crop damage due to hail. A small debris flow from the rainfall runoff covering the road and railroad track with 6 to 12 inches of debris.*			
4/1/2012	Heavy rain/Snowmelt	0	$5,000
Description: *Hayton Green Park in Palouse was flooded as well as the residence at 415 West Main Street near the park. Flooding was also observed up to the base of the house in the neighboring property. Damage was estimated.*			
10/5/2011	Tornado	0	None reported
Description: *A farmer in northern Whitman County spotted two funnel clouds the afternoon of October 5th approximately thirteen miles northwest of Saint John. One funnel cloud briefly touched down over open wheat fields.*			
1/16/2011	Heavy Rain/snowmelt	0	$25,000
Description: *The Palouse River at Palouse overflowed its banks inundating portions of downtown. The hardest hit were low lying areas, where water surrounded homes and covered nearly all of Hayton Green Park on the west end of town. A basement of a local resident and a former school gymnasium were flooded on Main Street. Additional flooding was reported along the Palouse River upstream in Latah County. The Palouse River at Potlach went above its flood stage of 15 feet at 16:30 PST on the 16th; crested at 16.5 feet at 5:30 PST on the 17th; and then went back below flood stage at 6:15 PST on the 18th.*			
11/16/2010	Thunderstorm Wind	0	$70,000
Description: *A strong cold front brought high winds to portions of Central and Eastern Washington, with thunderstorms in the Spokane area extending south to the Palouse and Blue Mountains. Numerous power outages and downed trees were reported. The trees damaged several cars and homes. In Pullman, shingles were blown off homes. One tree in Pullman landed on a portion of a home, destroying a collectable car, boat, travel trailer, and golf cart. Estimated damage from this report was $40,000. In Albion shingles were blown off the post office roof. Lightning was abundant over the Palouse. Winds prior to the front gusted to 60 miles per hour in Pullman. Wind gusts reported during the storm include 85 miles per hour in Pullman and 63 miles per hour in Uniontown.*			
6/10/2010	Lightning	0	$2,000
Description: *A line of showers and thunderstorms in the Dusty area resulted in local damage. More than a foot of mud washed into a barn and yard after 1.4 inches of rain fell. In addition, lightning damaged a computer and knocked out phone and on-line services for some homes.*			
8/18/2008	Thunderstorm Wind	0	None reported
Description: *Strong outflow winds from a thunderstorm contributed to several downed power lines in Pullman with about 60 customers losing power. Six trees fell on roads, three trees fell on cars, and two power lines were downed.*			
8/8/2008	Hail	0	None Reported
Description: *Nickel to quarter sized hail lasted for 20 minutes and resulted in extensive crop damage. Three hundred acres of wheat were destroyed as well as 30 percent of the Barley crop. Several four inch diameter tree limbs snapped as well. Heavy rain of 1.46 in 30 minutes also trigger a mudslide of three feet deep.*			
8/31/2007	Thunderstorm Wind	0	$10,000
Description: *A strong outflow boundary from a thunderstorm resulted in damage to trees and power lines in Whitman and Asotin counties. Damage was reported in Pullman, Palouse, Albion, and Clarkston.*			
5/8/2007	Thunderstorm Wind	0	$10,000
Description: *A strong thunderstorm moving up from the southwest tracked across Whitman County, knocking out power to 4,000 customers in the west part of the county as well as Colfax. West county areas that lost power included Diamond, Ewan, Ralston, and Marengo. Two power posts were broken dear the Shawnee substation.*			
3/21/2007	Hail	0	None reported
Description: *A sudden hailstorm on Highway 195 at Hume Road intersection near Steptoe contributed to a collision after a vehicle hit a patch of slush and collided with a semi-truck. Three indirect injuries resulted from the collision.*			

According to the National Climactic Data Center, 107 tornados were reported in Washington State between 1950 and 2010, with two recorded events in Whitman County, causing damage of approximately $50,000. Washington has had six fatalities and 303 injuries. Compared with other states, Washington ranks number 43 for frequency of tornadoes, 29 for number of deaths, 27 for injuries and 46 for cost of damage.

12.2.5 Warning Time

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

12.3 SECONDARY HAZARDS

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

12.4 CLIMATE CHANGE IMPACTS

Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 12-2). The changing hydrograph caused by climate change could have a significant impact on the intensity, duration and frequency of storm events. All of these impacts could have significant economic consequences.

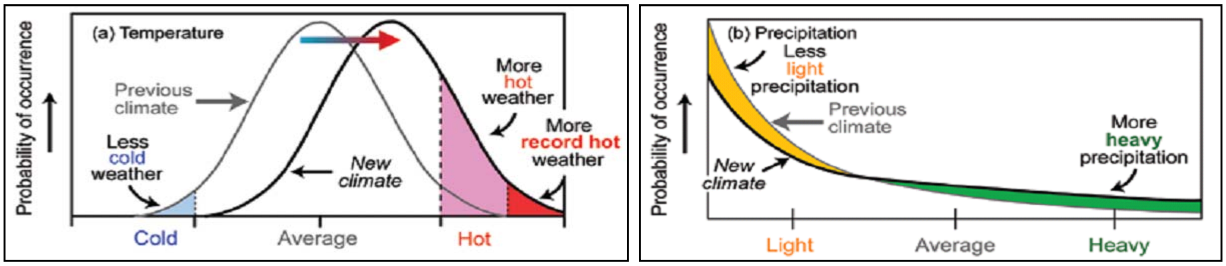


Figure 12-2. Severe Weather Probabilities in Warmer Climates

12.5 EXPOSURE

12.5.1 Population

A lack of data separating severe weather damage from flooding and landslide damage prevented a detailed analysis for exposure and vulnerability. However, it can be assumed that the entire planning area is exposed to some extent to severe weather events. Certain areas are more exposed due to geographic location and local weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out, while populations in low-lying areas are at risk for possible flooding.

12.5.2 Property

According to the 2010 U.S. census, there are 19,354 buildings in the census tracts that define the planning area. Most of these buildings are residential. All of these buildings are considered to be exposed to the severe weather hazard.

12.5.3 Critical Facilities and Infrastructure

All critical facilities exposed to flooding (Chapter 10) are also likely exposed to severe weather. Additional facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with severe weather are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water and sewer systems may not function. Roads may become impassable due to ice or snow or from secondary hazards such as landslides.

12.5.4 Environment

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

12.6 VULNERABILITY

12.6.1 Population

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe weather events and could suffer more secondary effects of the hazard.

12.6.2 Property

All property is vulnerable during severe weather events, but properties in poor condition or in particularly vulnerable locations may risk the most damage. The frequency and degree of damage will depend on specific locations. Those in higher elevations and on ridges may be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse. It is estimated that 30 percent of the residential structures were built without the influence of a structure building code with provisions for wind loads.

Loss estimations for the severe weather hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 12-2 lists the loss estimates to the general building stock.

TABLE 12-2.
LOSS POTENTIAL FOR THE SEVERE WEATHER HAZARD

City	Assessed Value	10% Damage	30% Damage	50% Damage
Albion	$62,087,000	$6,208,700	$1,862,610	$3,104,350
Colfax	$431,637,000	$43,163,700	$12,949,110	$21,581,850
Colton	$39,228,000	$3,922,800	$1,176,840	$1,961,400
Endicott	$57,241,000	$5,724,100	$1,717,230	$2,862,050
Farmington	$13,012,000	$1,301,200	$390,360	$650,600
Garfield	$57,016,000	$5,701,600	$1,710,480	$2,850,800
LaCrosse	$38,358,000	$3,835,800	$1,150,740	$1,917,900
Lamont	$9,749,000	$974,900	$292,470	$487,450
Malden	$20,617,000	$2,061,700	$618,510	$1,030,850
Oakesdale	$45,979,000	$4,597,900	$1,379,370	$2,298,950
Palouse	$88,366,000	$8,836,600	$2,650,980	$4,418,300
Pullman	$2,619,143,000	$261,914,300	$78,574,290	$130,957,150
Rosalia	$57,876,000	$5,787,600	$1,736,280	$2,893,800
St. John	$66,158,000	$6,615,800	$1,984,740	$3,307,900
Tekoa	$80,802,000	$8,080,200	$2,424,060	$4,040,100
Uniontown[a]	0	0	0	0
Unincorporated	$1,080,921,000	$108,092,100	$32,427,630	$54,046,050
Total	**$4,768,190,000**	**$476,819,000**	**$143,045,700**	**$238,409,500**

a. Uniontown data not available from County Assessor

12.6.3 Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures resulting from severe weather, mostly associated with secondary hazards. Landslides caused by heavy prolonged rains can block roads. High winds can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Snowstorms in higher elevations can significantly impact the transportation system and the availability of public safety services. Of particular concern are roads providing access to isolated areas and to the elderly.

Prolonged obstruction of major routes due to landslides, snow, debris or floodwaters can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting electricity and communication. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance.

12.6.4 Environment

The vulnerability of the environment to severe weather is the same as the exposure.

12.7 FUTURE TRENDS IN DEVELOPMENT

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

12.8 SCENARIO

Severe weather could occur during the winter when Chinook winds accompanied by heavy rains drop precipitation over frozen snow and cause heavy runoff and eventually flooding. This scenario could also generate freezing rain that can cause the accumulation of ice on power lines and other ice-related issues. The heavy rain may also knock down ice covered power lines. Also during the winter, Whitman County may experience a blizzard that causes white-out conditions, blocking roads and isolating scattered rural homes and communities. During the summer, an isolated thunderstorm can produce a tornado that occurs near a population center and cause significant damage to property. Lightning strikes during the dry, hot summer can cause wildfires that may spread out of control. Wind events can knock down power and phone lines, cutting off communication and electricity.

12.9 ISSUES

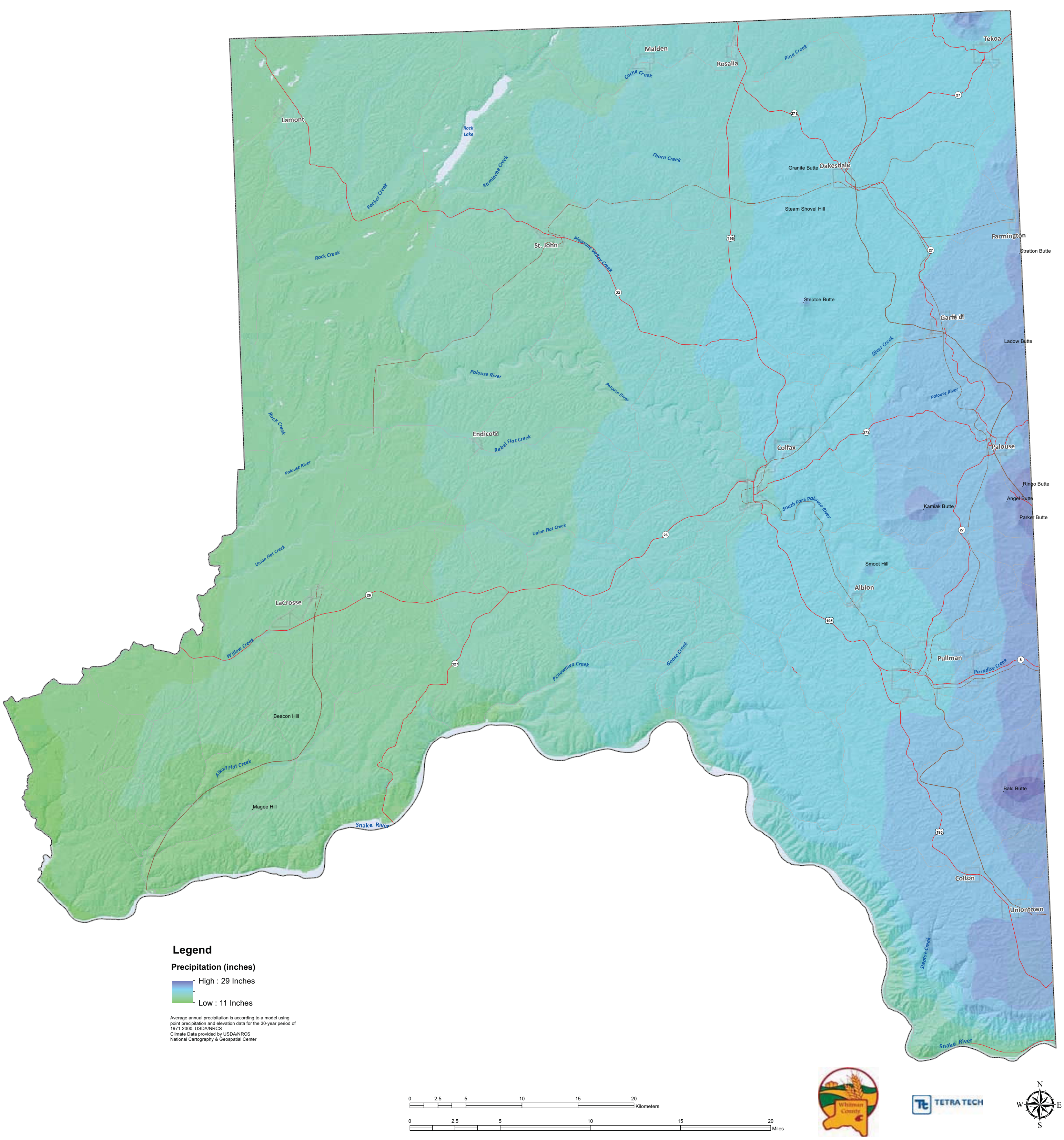
Severe weather cannot be prevented, but measures can be taken to mitigate the effects. Critical infrastructure and utilities can be hardened to prevent damage during an event. The secondary effect of flooding can be addressed through decreasing runoff and water velocity. Important issues associated with a severe weather in the Whitman County planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as windstorms.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- The county has numerous isolated population centers.
- Public education on dealing with the impacts of severe weather needs to be provided.
- Snow removal measures are required.
- Debris management (downed trees, etc.) must be addressed.

Map 12-1.

WHITMAN COUNTY

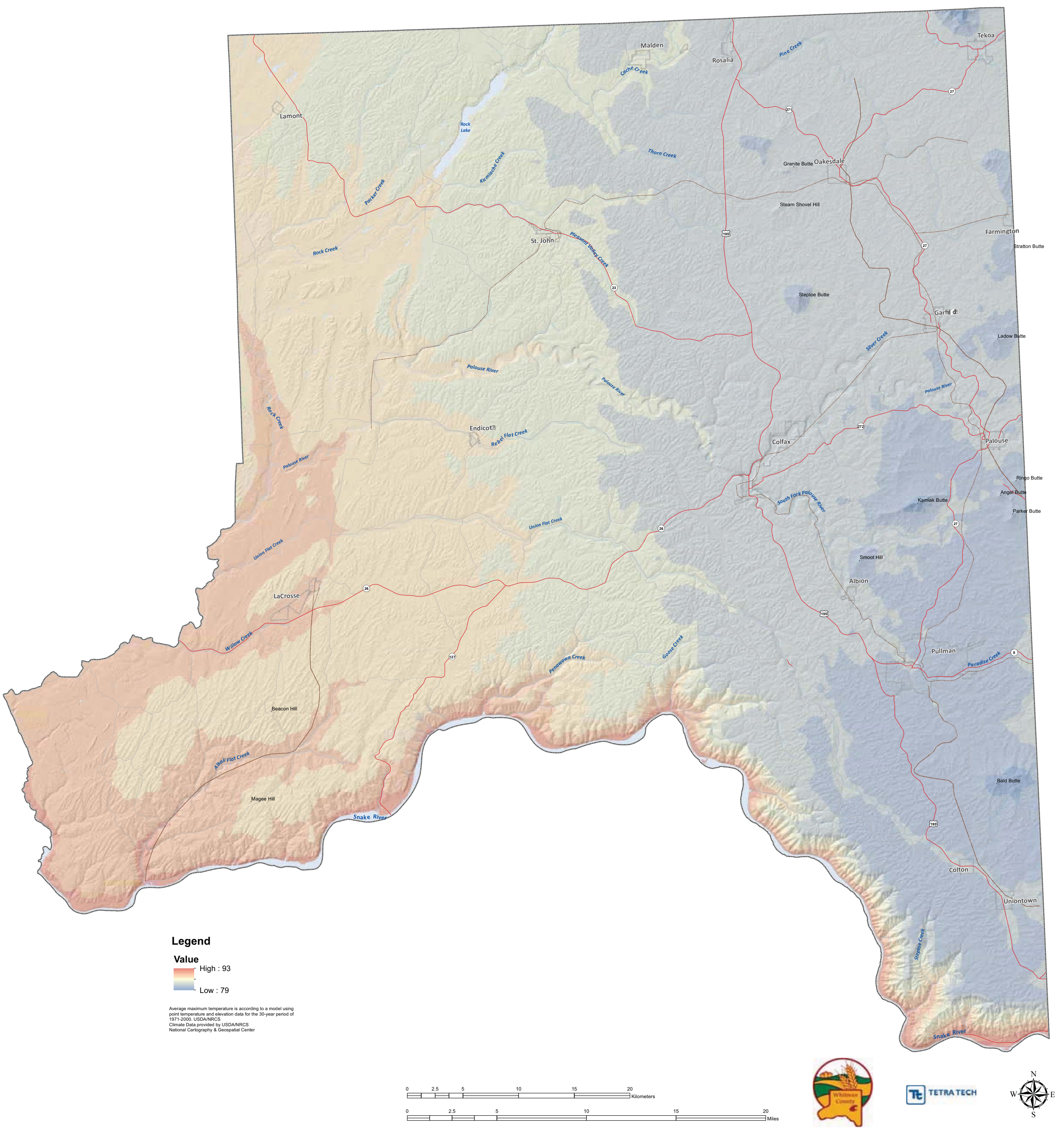
Average Annual Precipitation



Map 12-2.

W H I T M A N   C O U N T Y

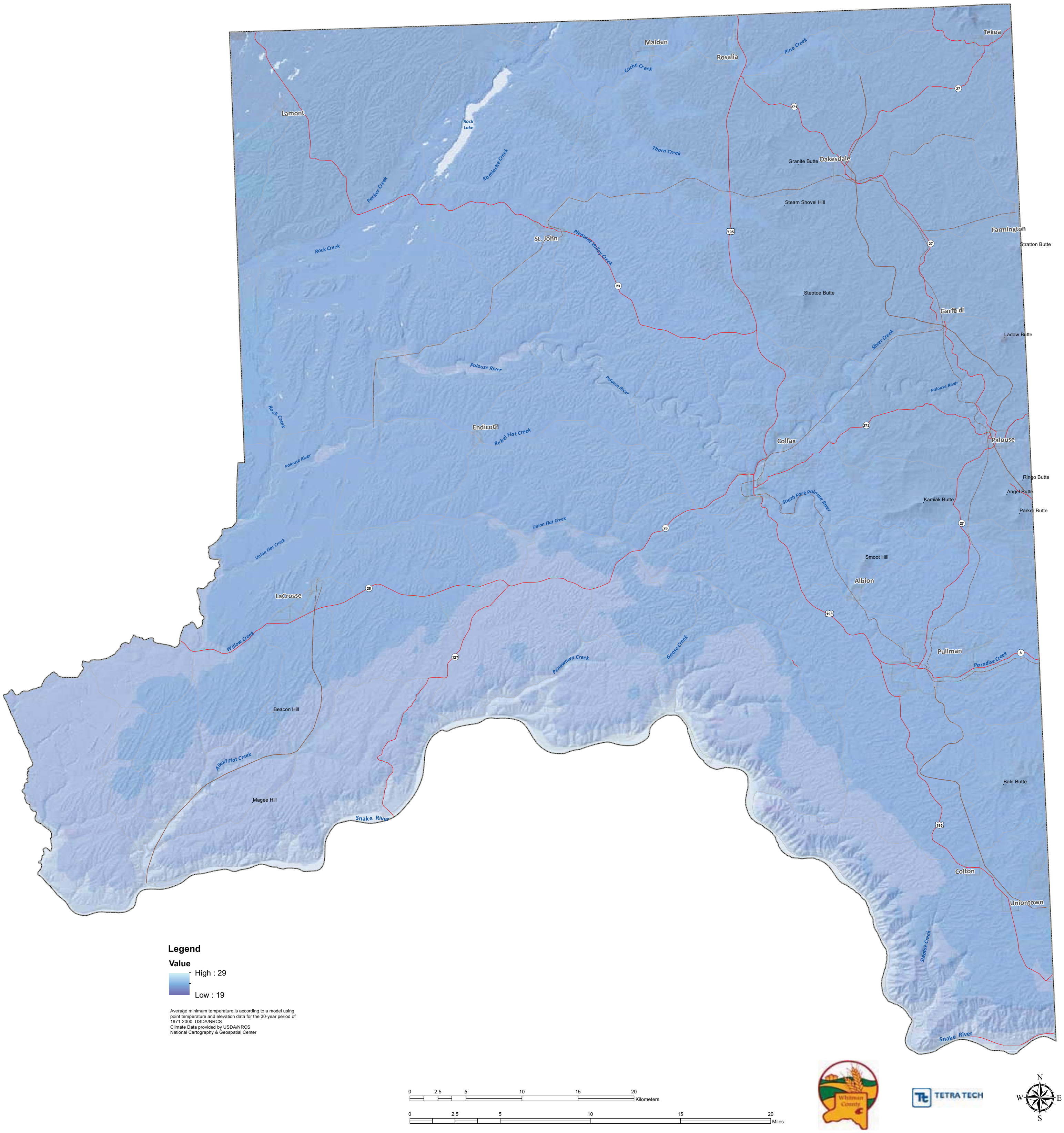
Average Maximum Temperature (F)



Map 12-3.

WHITMAN COUNTY

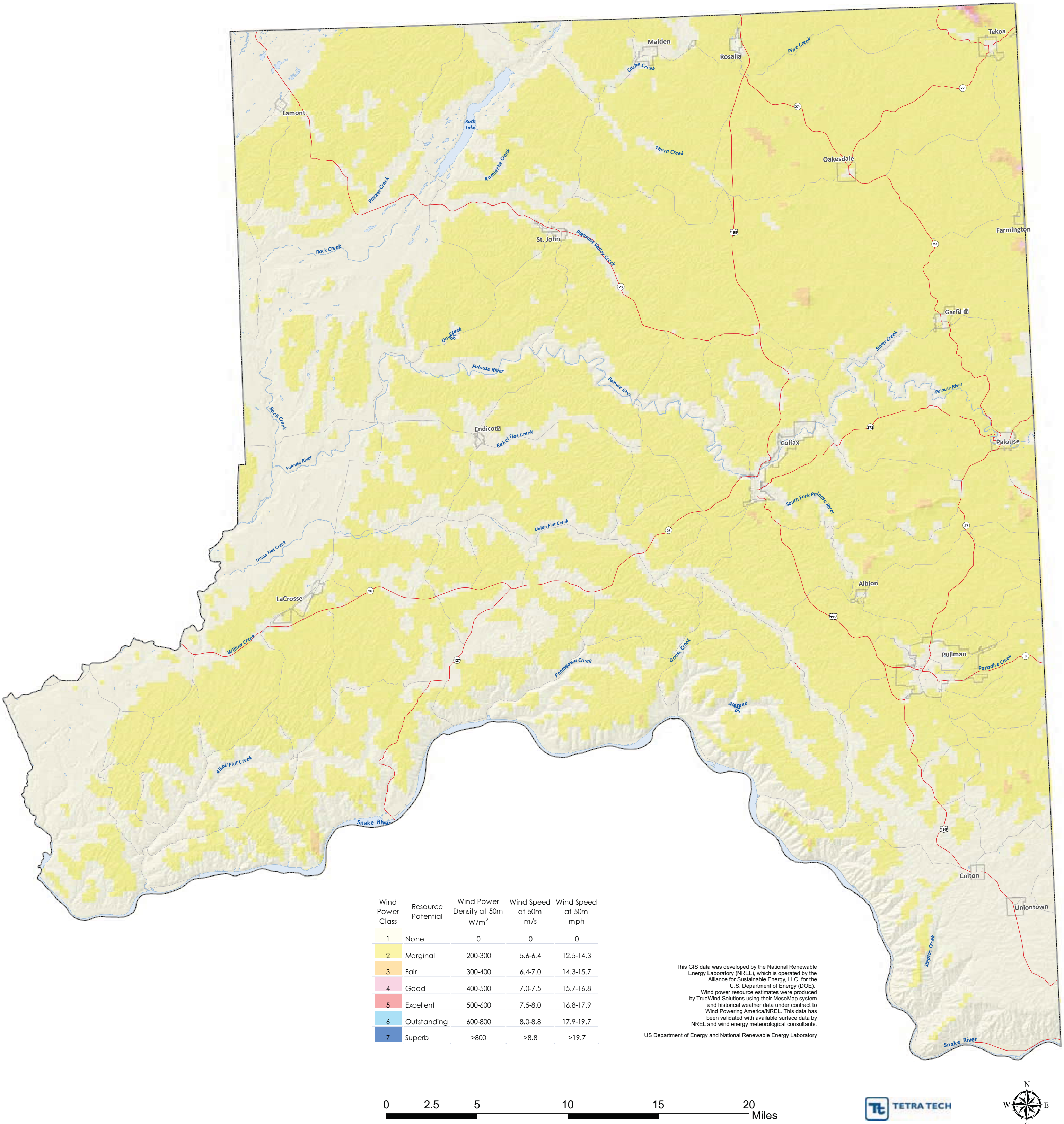
Average Minimum Temperature (F)



Map 12-4.

W H I T M A N   C O U N T Y

Potental W nd



CHAPTER 13.
VOLCANO

13.1 GENERAL BACKGROUND

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

Washington has five major volcanoes in the Cascade Range: Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens and Mount Adams. Mt Hood, in northern Oregon, can also affect the state. These volcanoes can lie dormant for centuries between eruptions, and the risk posed by volcanic activity is not always apparent. When they do erupt, high-speed avalanches of hot ash and rock called pyroclastic flows, lava flows, and landslides can devastate areas up to 10 miles away, while huge mudflows of volcanic ash and debris called lahars can inundate valleys more than 50 miles downstream. Falling ash from explosive eruptions, called tephra, can disrupt human activities hundreds of miles downwind, and drifting clouds of fine ash can cause severe damage to the engines of jet aircraft hundreds or thousands of miles away.

DEFINITIONS

Lahar—A rapidly flowing mixture of water and rock debris that originates from a volcano. While lahars are most commonly associated with eruptions, heavy rains, and debris accumulation, earthquakes may also trigger them.

Lava Flow—The least hazardous threat posed by volcanoes. Cascades volcanoes are normally associated with slow moving andesite or dacite lava.

Stratovolcano—Typically steep-sided, symmetrical cones of large dimension built of alternating layers of lava flows, volcanic ash, cinders, blocks, and bombs, rising as much as 8,000 feet above their bases. The volcanoes in the Cascade Range are all stratovolcanoes.

Tephra—Ash and fragmented rock material ejected by a volcanic explosion

Volcano—A vent in the planetary crust from which magma (molten or hot rock) and gas from the earth's core erupts.

13.2 HAZARD PROFILE

13.2.1 Past Events

Figure 13-1 and Table 13-1 summarize past eruptions in the Cascades. In the 1980 Mount St. Helens eruption, 23 square miles of volcanic material buried the North Fork of the Toutle River and there were 57 human fatalities. Due to its great distance, and location across the crest of the Cascades, the lava and lahar flow from this eruption did not (and could not) affect Whitman County. The County though is almost directly downwind from the volcano, and thus saw about 3/4-inch of tephra (ash) fall. This tephra fall was more of a curiosity than a hazard. Schools and businesses were closed for day or so, but no major disruptions or harm were done to the County, especially after it was cleaned up within a few days.

13.2.2 Location

Figure 13-2 shows the location of Cascade Range volcanoes, most of which have the potential to produce a significant eruption, as well as probabilities of ***tephra*** accumulation from Cascade volcanoes in the Pacific Northwest. Whitman County is outside the area with more than a 0.01-percent annual probability of 10 centimeters or more accumulation of tephra.

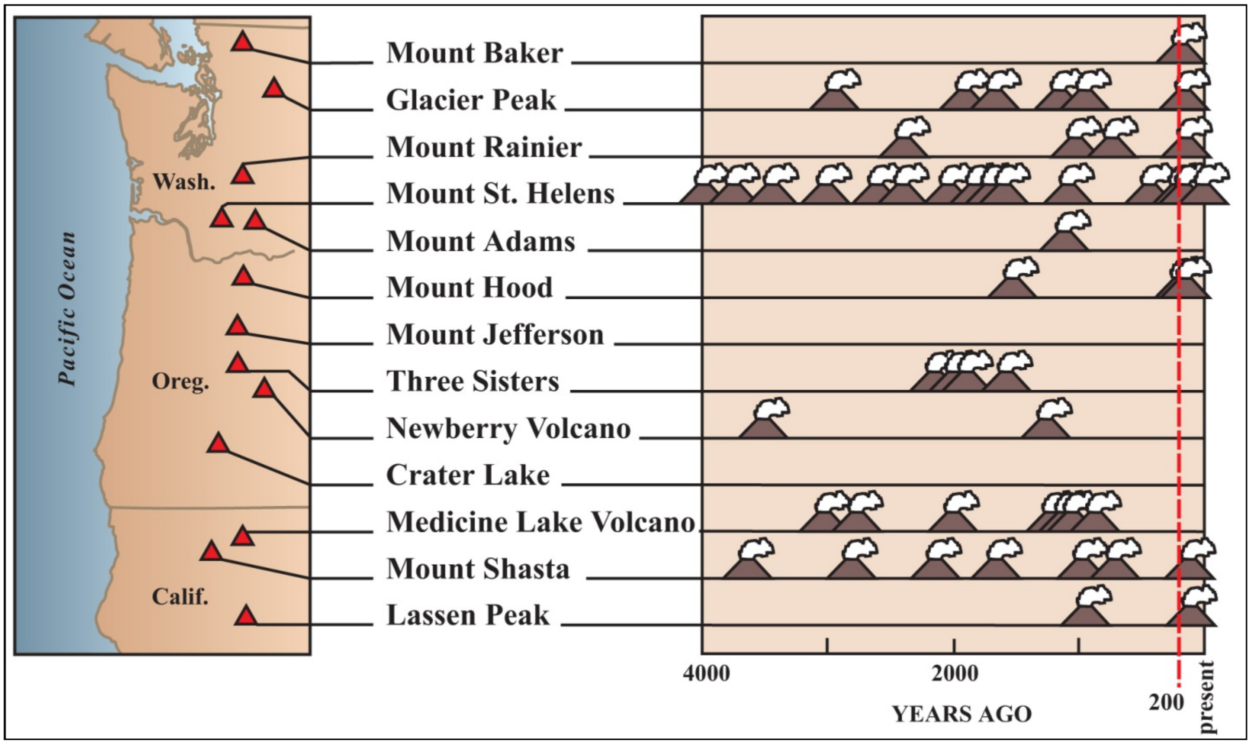


Figure 13-1. Past Eruptions in the Cascade Range

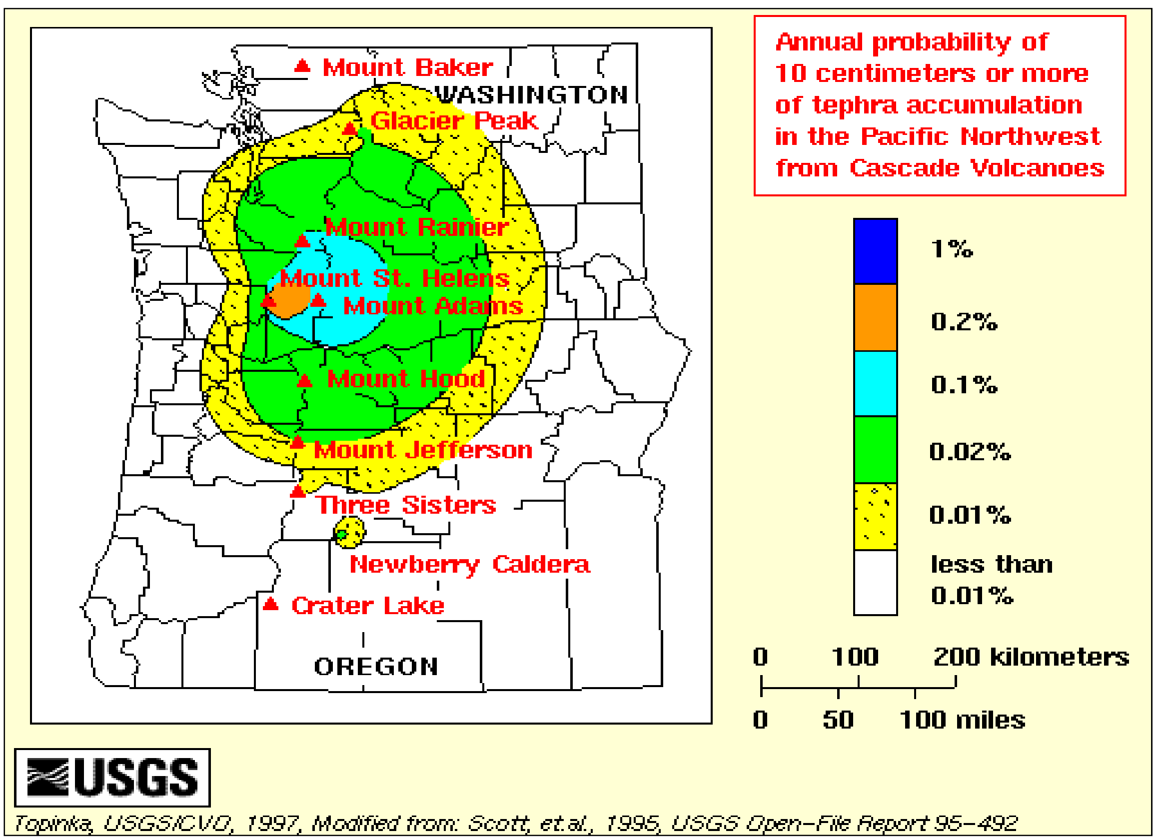


Figure 13-2. Probability of Tephra Accumulation in Pacific Northwest

TABLE 13-1.
PAST ERUPTIONS IN WASHINGTON

Volcano	Number of Eruptions	Type of Eruptions
Mount Adams	3 in the last 10,000 years, most recent between 1,000 and 2,000 years ago	Andesite lava
Mount Baker	5 eruptions in past 10,000 years; mudflows have been more common (8 in same time period)	Pyroclastic flows, mudflows, ash fall in 1843.
Glacier Peak	8 eruptions in last 13,000 years	Pyroclastic flows and lahars
Mount Rainier	14 eruptions in last 9000 years; also 4 large mudflows	Pyroclastic flows and lahars
Mount St Helens	19 eruptions in last 13,000 years	Pyroclastic flows, mudflows, lava, and ash fall

13.2.3 Frequency

Many Cascade volcanoes have erupted in the recent past and will be active again in the foreseeable future. Given an average rate of one or two eruptions per century during the past 12,000 years, these disasters are not part of our everyday experience; however, in the past hundred years, California's Lassen Peak and Washington's Mount St. Helens have erupted with terrifying results. The U.S. Geological Survey classifies Glacier Peak, Mt. Adams, Mt. Baker, Mt. Hood, Mt. St. Helens, and Mt. Rainier as potentially active volcanoes in Washington State. Mt. St. Helens is by far the most active volcano in the Cascades, with four major explosive eruptions in the last 515 years.

13.2.4 Severity

The explosive disintegration of Mount St. Helens' north flank in 1980 vividly demonstrated the power that Cascade volcanoes can unleash. A 1-inch deep layer of ash weighs an average of 10 pounds per square foot, causing danger of structural collapse. Ash is harsh, acidic and gritty, and it has a sulfuric odor. Ash may also carry a high static charge for up to two days after being ejected from a volcano. When an ash cloud combines with rain, sulfur dioxide in the cloud combines with the rain water to form diluted sulfuric acid that may cause minor, but painful burns to the skin, eyes, nose and throat.

13.2.5 Warning Time

Constant monitoring of all active volcanoes means that there will be more than adequate time for evacuation before an event. Since 1980, Mount St. Helens has settled into a pattern of intermittent, moderate and generally non-explosive activity, and the severity of tephra, explosions, and lava flows have diminished. All episodes, except for one very small event in 1984, have been successfully predicted several days to three weeks in advance. However, scientists remain uncertain as to whether the volcano's current cycle of explosive activity ended with the 1980 explosion. The possibility of further large-scale events continues for the foreseeable future.

13.3 SECONDARY HAZARDS

Secondary hazards associated with volcanic eruptions are mud flows and landslides as well as traffic disruptions. The mudflow and landslide hazards are not typical for Whitman County, but there could be traffic disruption caused by tephra accumulation.

13.4 CLIMATE CHANGE IMPACTS

Large-scale volcanic eruptions can reduce the amount of solar radiation reaching the Earth's surface, lowering temperatures in the lower atmosphere and changing atmospheric circulation patterns. The massive outpouring of gases and ash can influence climate patterns for years. Sulfuric gases convert to sub-micron droplets containing about 75 percent sulfuric acid. These particles can linger three to four years in the stratosphere. Volcanic clouds absorb terrestrial radiation and scatter a significant amount of incoming solar radiation, an effect that can last from two to three years following a volcanic eruption.

13.5 EXPOSURE

Whitman County is only moderately exposed to an eruption of a volcano. The County is generally downwind of four volcanoes, and could experience the impacts of a tephra fall from any of these. Using the latest eruption of Mount St. Helens as an indicator, a tephra fall in Whitman County would be anywhere from a half-inch to an inch. Nonetheless, some people, property and elements of the environment are vulnerable to the effects of a tephra fall, as discussed below.

13.5.1 Population

The whole population of Whitman County is exposed to the effects of a tephra fall.

13.5.2 Property

All of the County would be exposed to tephra accumulation in the event of a volcanic eruption.

13.5.3 Critical Facilities

All critical facilities would be exposed to tephra accumulation in the event of a volcanic eruption.

13.5.4 Environment

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

13.6 VULNERABILITY

13.6.1 Population

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

13.6.2 Property

Property vulnerable to the effects of a tephra fall includes equipment and machinery left out in the open, such as combines, whose parts can be clogged by the fine dust. Since Whitman County receives snow every year, and roofs are built to withstand snow loads, most roofs are not vulnerable and would be able to withstand the potential load of ash. Infrastructure such as drainage systems is also potentially vulnerable to the effects of a tephra fall, since the fine ash can clog pipes and culverts. This may be more of a problem if an eruption occurs during winter or early spring when precipitation is highest and floods are most likely.

Loss estimation tools such as HAZUS-MH currently are not able to analyze impacts from volcano hazards. For this study, it was decided to use 0.05 percent as the loss ratio for the volcano hazard. Assessed valuations provided by the Whitman County assessor were the basis for these estimations. The results are summarized by planning partner in Table 13-2.

TABLE 13-2.
ESTIMATED LOSS POTENTIAL FOR VOLCANO HAZARDS IN WHITMAN COUNTY

Jurisdiction	Assessed Valuation	Estimated Losses ($)
Albion	$62,087,000	$31,044
Colfax	$431,637,000	$215,819
Colton	$39,228,000	$19,614
Endicott	$57,241,000	$28,621
Farmington	$13,012,000	$6,506
Garfield	$57,016,000	$28,508
LaCrosse	$38,358,000	$19,179
Lamont	$9,749,000	$4,875
Malden	$20,617,000	$10,309
Oakesdale	$45,979,000	$22,990
Palouse	$88,366,000	$44,183
Pullman	$2,619,143,000	$1,309,572
Rosalia	$57,876,000	$28,938
St. John	$66,158,000	$33,079
Tekoa	$80,802,000	$40,401
Uniontown[a]	0	$0
Unincorporated County	$1,080,921,000	$540,461
Total	**$4,768,190,000**	**$2,384,099**

a. Uniontown data not available from County Assessor

13.6.3 Critical Facilities

Transportation routes in the direction of wind would be vulnerable to tephra accumulations. Water treatment plants and wastewater treatment plants are vulnerable to contamination from ash fall.

13.6.4 Environment

The treeless, rolling landscape of Whitman County leaves the environment, particularly animals, exposed to a tephra fall from a volcanic eruption. Whitman County, however, does not serve as a major habitat for any protected species, so it is unlikely for any animal populations to be adversely affected. Tephra runoff can also potentially damage stream habitats, although this was not observed in Whitman County after the

Mount St. Helens eruption in 1980. The sulfuric acid contained in volcanic ash could be very damaging to area vegetation, waters, wildlife and air quality.

13.7 FUTURE TRENDS IN DEVELOPMENT

All future development has the potential of being impacted by ash fall generated from a volcanic event.

13.8 SCENARIO

The worst case scenario for Whitman County would be a massive eruption from Mount Hood that sent a tephra cloud downwind to Whitman County (although Mount Hood is southwest of Whitman County, the prevailing southwest winds would blow ash directly over the County). No one would be injured or killed from the subsequent ash fall, but businesses and non-essential government would be closed for the period of time until the cloud passes. This could be a few days. People and animals without shelter would also be affected. Structures would be safe, but private property left out in the open, such as farm equipment, might be damaged by the fine ash dust.

13.9 ISSUES

Presently volcanic eruptions are not a major hazard issue in Whitman County. There are proper warning time and awareness mechanisms in place. The major issues that would come about, as with other disaster events, are clean-up costs.

CHAPTER 14.
WILDFIRE

14.1 GENERAL BACKGROUND

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

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

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

14.1.1 Wildfire Types

Wildfires generally can be characterized by their fuels as follows:

- **Ground fires** are fed by subterranean roots, duff and other buried organic matter. This fuel type is especially susceptible to ignition due to spotting. Ground fires typically burn by smoldering, and can burn slowly for days to months.
- **Crawling** or **surface fires** are fueled by low-lying vegetation such as leaf and timber litter, debris, grass, and low-lying shrubbery.

DEFINITIONS

Brush fire—A fast-moving fire that ignites grass, shrubs, bushes, scrub oak, chaparral, marsh grass (cattails), and grain fields. This is the type of wildfire most likely to affect Whitman County.

Conflagration—A fire that grows beyond its original source area to engulf adjoining regions. Wind, extremely dry or hazardous weather conditions, excessive fuel buildup and explosions are usually the elements behind a wildfire conflagration.

Firestorm—A fire that expands to cover a large area, often more than a square mile, when many individual fires grow together. Temperatures may exceed 1000°C. Superheated air and hot gases of combustion rise over the fire zone, drawing surface winds in from all sides, often at velocities approaching 50 miles per hour. Although firestorms seldom spread because of the inward direction of the winds, once started there is no known way of stopping them. Lethal concentrations of carbon monoxide, combined with the intense heat, poses a serious life threat to responding fire forces. In very large events, the rising column of heated air carries enough particulate matter into the upper atmosphere to cause cloud nucleation, creating a thunderstorm and the hazard of lightning strikes.

Interface Area—An area where vegetation susceptible to wildfires and urban or suburban development occur together.

Wildfire—Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and can cause a great deal of destruction.

- **Ladder** fires consume material between low-level vegetation and tree canopies, such as small trees, downed logs and vines. Invasive plants that scale trees may encourage ladder fires.
- **Crown, canopy** or **aerial fires** burn suspended material at the canopy level, such as tall trees, vines and mosses. The ignition of a crown fire, termed *crowning*, is dependent on the density of the suspended material, canopy height, canopy continuity, and sufficient surface and ladder fires to reach the tree crowns.

14.1.2 Factors Affecting Wildfire Risk

Topography

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

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

Fuels

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

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

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

Weather

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

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

14.1.3 Historical Fire Regime and Current Condition Classification

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

- 0- to 35-year frequency and low (surface fires most common) to mixed severity (less than 75 percent of the dominant overstory vegetation replaced)
- 0- to 35-year frequency and high (stand replacement) severity (greater than 75 percent of the dominant overstory vegetation replaced)
- 35- to 100-year frequency and mixed severity (less than 75 percent of the dominant overstory vegetation replaced)
- 35- to 100-year frequency and high (stand replacement) severity (greater than 75 percent of the dominant overstory vegetation replaced)
- >200-year frequency and high (stand replacement) severity.

Understanding ecosystem departures (how ecosystem have changed over time) provides a context for managing sustainable ecosystems. Broad-scale alterations of historical fire regimes and vegetation conditions have occurred in many landscapes in the U.S. through the combined influence of land management practices, fire prevention, livestock grazing, insect and disease outbreaks, climate change, and invasion of non-native plant species. These departures result in changes to one or more of the following ecological components:

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

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

The fire regime condition class (FRCC) is a classification of a given area’s amount of departure from the historical fire regime. FRCCs categorize wildland vegetation and fuel conditions into one of the three condition classes, based on the degree of departure. The three classes indicate low (FRCC 1), moderate (FRCC 2) and high (FRCC 3) departure from the historical fire regime. Low departure is considered to be within the historical range of variability, while moderate and high departures are outside. Determination of the amount of departure is based on comparison of a composite measure of fire regime attributes to the central tendency of the historical fire regime. The amount of departure is then classified to determine the fire regime condition class. Table 14-1 presents a simplified description of the fire regime condition classes and associated potential risks.

TABLE 14-1.
FIRE REGIME CONDITION CLASS DEFINITIONS

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

14.2 HAZARD PROFILE

Whitman County has a low risk of wildfires because 76 percent of the land is cultivated for crops and another 5 percent is urbanized. The County has few trees, and most large concentrations are along the eastern border near Idaho where the County receives more precipitation. The County is somewhat more vulnerable to brush fires.

14.2.1 Past Events

Whitman County does not have a history of wildfires. Every few years minor brush fires break out in some of the canyons along the Snake River or in areas adjacent to railroad tracks or roads. These are most often caused by humans. The County was affected by the Eastern Washington Firestorm of 1991, which caused significant damage and injuries in the Spokane area. Six counties, including Whitman County, were declared federal disaster areas (Federal Disaster #922) and received $12.3 million in Stafford Act assistance. It is not known how much damage the County received, if any, as the 35,000 acres burned were confined primarily to the Spokane area. This fire was caused by high winds that downed power lines, igniting small fires, which in turn were spread and expanded by the high winds.

Due to the limited fire statistics for Whitman County, past-event statistics were evaluated for the Washington Department of Natural Resources’ Southeast Region, which includes Whitman County. Table 14-2 shows the number of fires in this region by type and acres burned for 2003 through 2012.

**TABLE 14-2.
FIRES IN SOUTHEAST REGION, BY CAUSE, 2003-2012**

	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	Total
Arson	2	3	5	4	3	2	0	2	11	9	**41**
Children	2	1	1	4	2	2	5	3	4	2	**26**
Debris Burning	8	16	4	24	18	22	29	27	24	27	**199**
Lightning	57	10	43	26	48	33	38	4	45	22	**326**
Logging	2	4	0	1	2	1	3	1	1	4	**19**
Miscellaneous	25	29	22	36	31	33	38	46	39	35	**334**
Railroad	39	3	0	2	3	2	2	4	2	2	**59**
Recreation	2	3	33	43	40	41	44	45	31	34	**316**
Smoking	3	37	2	2	1	1	**6**	**1**	**3**	**4**	**60**
Total	**138**	**2117**	**110**	**2151**	**2156**	**2144**	**2171**	**2138**	**2164**	**2142**	**1380**
Total Acres Burned	**29,200**	**4,009**	**22,627**	**2,369**	**2,675**	**1,122**	**44,767**	**26,642**	**5,085**	**4,297**	**142,793**

14.2.2 Location

If a wildfire or major brush fire were to occur in Whitman County, it would most likely occur in the western part of the County where there is less precipitation and large areas of cultivated land are fallow because of participation in the Conservation Reserve Program (CRP). The CRP pays farmers to not cultivate lands that are highly erodible, thus extending the usable life of the soil. Wildfires can also occur on lands used as pasture or open range and in steep canyons near the Snake River and the scablands in the northwest part of the County. The Washington State Hazard Mitigation Plan designates the northern part of the County adjacent to the border to Spokane County as a wildfire risk area.

Three types of mapping to identify the location of the wildfire hazard are produced by the U.S. Forest Service and LANDFIRE (a shared program between the wildland fire management programs of the U.S. Forest Service and the U.S. Department of the Interior, under the direction of the Wildland Fire Leadership Council): fire regime mapping, burn probability mapping and flame length mapping.

Fire Regime Mapping

Map 14-1 shows fire regimes in Whitman County based on LANDFIRE models. The LANDFIRE project produces maps of historical fire regimes and vegetation as well as maps of current vegetation and its departure from historical conditions. These maps support fire and landscape management planning outlined in the goals of the National Fire Plan, Federal Wildland Fire Management Policy, and the Healthy Forests Restoration Act. The maps categorize mean fire return intervals and fire severities into five fire regimes as follows (Hann et al. 2004):

- Fire Regime I: 0 to 35 year frequency, low to mixed severity
- Fire Regime II: 0 to 35 year frequency, replacement severity
- Fire Regime III: 35 to 200 year frequency, low to mixed severity
- Fire Regime IV: 35 to 200 year frequency, replacement severity
- Fire Regime V: 200+ year frequency, any severity

Burn Probability and Flame Length Mapping

Burn probability data are generated using the large fire simulator, FSim, which was developed for use in the Fire Program Analysis. FSim uses historical weather data and current land cover data for geographical areas called fire planning units (FPUs) and simulates fires in these FPUs. FSim then defines an overall burn probability and marginal burn probabilities for each 270-square-meter area in the FPU. FSim produces burn probabilities for six fire-intensity (flame length) classes. Summing the product of these burn probabilities and their respective flame length class midpoints yields the conditional flame length. If the defined area burns, it most likely will burn at this intensity (flame length). Map 14-2 shows the burn probabilities for the planning area, and Map 14-3 shows the flame length categories.

14.2.3 Frequency

Small, minor brush fires, particularly in the remote canyons along the Snake River, can be expected at least every year, especially during the dry hot summer months. Many of these are caused by human carelessness, such as from fireworks or cigarettes tossed from vehicles. Passing trains are known to cause sparks that can trigger wildfires. There is no record of any major fires, so their frequency in Whitman County is not known.

Natural Fire Rotation (NFR) is defined as the number of years necessary for fires to burn over an area equal to that of the study area. NFR is calculated from the historical record of fires by dividing the length of the record period in years by the percentage of total area burned during that period. It represents the average period between fires under a presumed historical fire regime. Since 2003, the Southeast Region, which includes Whitman County, has seen an average of 138 wildfires per year, totaling 14,279 acres burned each year. This yields an NFR of 97.8 years for the Southeast Region.

14.2.4 Severity

Wildfires in Whitman County tend to be small and usually confined to remote areas. There is no record of property or infrastructure being damaged by wildfires in the County. More than 99 percent of the fires recorded during a 10-year period covered 1 acre or less. Rarely, due to steep terrain, inaccessibility, late notification or a combination of the above, a fire has reached significant size (up to 3,000 acres).

Given the fast response times to fires, the likelihood of injuries and casualties is minimal. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly and those with respiratory and cardiovascular diseases. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds.

14.2.5 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm. If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. Once a fire has started, fire alerting is reasonably rapid in most cases. The spread of cellular and two-way radio communications has contributed to a significant improvement in warning time.

14.3 SECONDARY HAZARDS

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

14.4 CLIMATE CHANGE IMPACTS

Fire in western ecosystems is determined by climate variability, local topography and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Historically, drought patterns in the West are related to large-scale climate patterns in the Pacific and Atlantic oceans. The El Niño–Southern Oscillation in the Pacific varies on a 5- to 7-year cycle, the Pacific Decadal Oscillation varies on a 20- to 30-year cycle, and the Atlantic Multidecadal Oscillation varies on a 65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions in the U.S. shift from region to region. El Niño years bring drier conditions to the Pacific Northwest and more fires.

Climate scenarios project summer temperature increases between 2ºC and 5°C and precipitation decreases of up to 15 percent. Such conditions would exacerbate summer drought and further promote high-elevation wildfires, releasing stores of carbon and further contributing to the buildup of greenhouse gases. Forest response to increased atmospheric carbon dioxide—the so-called “fertilization effect”—could also contribute to more tree growth and thus more fuel for fires, but the effects of carbon dioxide on mature forests are still largely unknown. High carbon dioxide levels should enhance tree recovery after fire and young forest regrowth, as long as sufficient nutrients and soil moisture are available, although the latter is in question for many parts of the western United States because of climate change.

14.5 EXPOSURE

Whitman County’s population, property and infrastructure have minimal exposure to potential wildfires. Scattered homes, ranches and communities in the western part of the County may be at higher risk, especially during the summer. Fallow lands under the CRP may be more vulnerable to wildfire. Most CRP land is also located in the western part of the County. Due to the Firestorm of 1991, the Washington State Hazard Mitigation Plan also maps the northern part of the County as a vulnerable area.

14.5.1 Population

Population could not be examined directly by wildfire regime zones because census blocks do not coincide with the zones. However, population was estimated using the residential building count in each zone and applying the 2010 census value of 2.39 persons per household for Whitman County. The results are shown in Table 14-3.

**TABLE 14-3.
POPULATION ESTIMATES WITHIN FIRE REGIME ZONES**

	0- to 35-Year, Low/Mixed Severity		0- to 35-Year, Stand Replacement		All Other Wildfire Regimes	
	Residential Buildings	Population	Residential Buildings	Population	Residential Buildings	Population
Albion	0	0	0	0	50	120
Colfax	0	0	0	0	13	31
Colton	0	0	7	17	94	225
Endicott	0	0	0	0	0	0
Farmington	0	0	7	17	99	237
Garfield	0	0	70	167	35	84
LaCrosse	0	0	0	0	135	323
Lamont	19	46	0	0	0	0
Malden	0	0	0	0	0	0
Oakesdale	0	0	0	0	48	115
Palouse	0	0	192	459	91	218
Pullman	393	942	34	81	458	1,095
Rosalia	0	0	5	12	0	0
St. John	0	0	0	0	0	0
Tekoa	0	0	237	566	10	34
Uniontown[a]	0	0	0	0	0	0
Unincorporated	21	50	257	614	1250	2,988
Total	**433**	**1038**	**809**	**1933**	**2283**	**5,470**

a. Uniontown data not available from County Assessor

14.5.2 Property

Property damage from wildfires can be severe and can significantly alter entire communities. The number and value of homes in the various fire regime zones within the planning area are summarized in Table 14-4 through Table 14-6.

**TABLE 14-4.
PLANNING AREA STRUCTURES EXPOSED TO 0- TO 35-YEAR, LOW/MIXED SEVERITY FIRE REGIME**

		Assessed Value			
Jurisdiction	Buildings Exposed	Structure	Contents	**Total**	% of AV
Lamont	19	$1,942,000	$1,563,000	$3,505,000	35.95
Pullman	393	$92,510,000	$52,008,000	$144,518,000	5.52
Unincorporated	21	$3,801,000	$1,900,500	**$5,701,500**	0.53
Total	**433**	**$98,253,000**	**$55,471,500**	**$153,724,500**	**3.22**

TABLE 14-5.
PLANNING AREA STRUCTURES EXPOSED TO 0- TO 35-YEAR, STAND REPLACEMENT FIRE REGIME

Jurisdiction	Buildings Exposed	Assessed Value			% of AV
		Structure	Contents	**Total**	
Colton	7	$568,000	$285,000	$853,000	2.17%
Farmington	7	$201,000	$102,000	$303,000	2.33%
Garfield	70	$5,164,000	$3,303,000	$8,467,000	14.85%
Palouse	192	$15,183,000	$9,028,000	$24,211,000	27.40%
Pullman	34	$12,666,000	$6,748,000	$19,414,000	0.74%
Rosalia	5	$510,000	$255,000	$765,000	1.32%
Tekoa	237	$16,019,000	$9,781,000	$25,800,000	31.93%
Unincorporated	257	$90,317,143	$45,158,572	**$135,475,715**	12.53
Total	**809**	**$140,628,143**	**$74,660,572**	**$215,288,715**	**4.52**

TABLE 14-6.
PLANNING AREA STRUCTURES EXPOSED TO ALL OTHER FIRE REGIMES

Jurisdiction	Buildings Exposed	Assessed Value			% of AV
		Structure	Contents	**Total**	
Albion	50	$4,991,000	$2,583,000	$7,574,000	12.20
Colfax	13	$1,465,000	$997,000	$2,462,000	0.57
Colton	94	$9,264,000	$4,806,000	$14,070,000	35.87
Farmington	99	$3,126,000	$1,793,000	$4,919,000	99
Garfield	35	$3,796,000	$2,285,000	$6,081,000	35
LaCrosse	135	$13,344,000	$8,442,000	$21,786,000	56.80
Oakesdale	48	$5,931,000	$4,736,000	$10,667,000	23.20
Palouse	91	$6,533,000	$3,619,000	$10,152,000	11.49
Pullman	458	$120,759,000	$85,396,000	$206,155,000	7.87
Tekoa	10	$736,000	$369,000	$1,105,000	1.37
Unincorporated	1,250	$115,660,000	$57,830,000	**$173,490,000**	16.05
Total	**2,283**	**$285,605,000**	**$172,856,000**	**$458,461,000**	**9.61**

14.5.3 Critical Facilities and Infrastructure

Table 14-7 identifies critical facilities exposed to the wildfire hazard in the county. During a wildfire event, these materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In the event of wildfire, there would likely be little damage to the majority of infrastructure. Most road and railroads would be without damage except in the worst scenarios. Power lines are the most at risk to wildfire because most are made of wood and susceptible to burning. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion.

TABLE 14-7.
CRITICAL FACILITIES EXPOSED TO WILDFIRE REGIMES

	Low Severity (0 – 35 years)	Stand Replacement (0 – 35 years)	All Other Wildfire Regimes
Medical and Health Services	0	0	4
Government Function	0	0	0
Protective Function	0	0	12
Schools	0	2	14
Other Critical Function	0	0	2
Bridges	0	5	64
Water	0	2	18
Wastewater	0	0	2
Power	0	0	0
Communications	0	1	5
Total	**0**	**10**	**121**

14.5.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts:

- Damaged Fisheries—Critical fisheries can suffer from increased water temperatures, sedimentation and changes in water quality.
- Soil Erosion—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- Spread of Invasive Plant Species—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- Disease and Insect Infestations—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- Destroyed Endangered Species Habitat—Catastrophic fires can have devastating consequences for endangered species.
- Soil Sterilization—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

Many ecosystems are adapted to historical patterns of fire occurrence. These patterns, called "fire regimes," include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability.

14.6 VULNERABILITY

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard. There is currently no validated damage function available to support wildfire mitigation planning. Except as discussed in this section, vulnerable populations, property, infrastructure and environment are assumed to be the same as described in the section on exposure.

14.6.1 Population

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

14.6.2 Property

Loss estimations for the wildfire hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 14-8 lists the loss estimates for the general building stock for jurisdictions that have an exposure to wildfire risk areas. These valuations are based on the intersection of the census block and the jurisdictional boundary with the hazard zone. This is purely and estimation an may be overstating the risk by an order of two times.

14.6.3 Critical Facilities and Infrastructure

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

14.7 FUTURE TRENDS IN DEVELOPMENT

The highly urbanized portions of the planning area have little or no wildfire risk exposure. Urbanization tends to alter the natural fire regime, and can create the potential for the expansion of urbanized areas into wildland areas. The expansion of the wildland urban interface can be managed with strong land use and building codes. The planning area is well equipped with these tools, and this planning process has asked each planning partner to assess its capabilities with regards to the tools. As Whitman County experiences future growth, it is anticipated that the exposure to this hazard will remain as assessed or even decrease over time due to these capabilities.

**TABLE 14-8.
POTENTIAL BUILDING LOSSES FROM WILDFIRE HAZARD**

	Buildings in Fire Regime Condition Class Zones		Potential Loss		
	Building Count	Assessed Value	10% Damage	30% Damage	50% Damage
Albion	50	$7,574,000	$757,400	$2,272,200	$3,787,000
Colfax	13	$2,462,000	$246,200	$738,600	$1,231,000
Colton	101	$14,923,000	$1,492,300	$4,476,900	$7,461,500
Endicott	0	0	0	0	0
Farmington	106	$5,222,000	$522,200	$1,566,600	$2,611,000
Garfield	105	$14,548,000	$1,454,800	$4,364,400	$7,274,000
LaCrosse	135	$21,786,000	$2,178,600	$6,535,800	$10,893,000
Lamont	19	$3,505,000	$350,500	$1,051,500	$1,752,500
Malden	0	0	0	0	0
Oakesdale	48	$10,667,000	$1,066,700	$3,200,100	$5,333,500
Palouse	283	$34,363,000	$3,436,300	$10,308,900	$17,181,500
Pullman	885	$370,087,000	$37,008,700	$111,026,100	$185,043,500
Rosalia	5	$765,000	$76,500	$229,500	$382,500
St. John	0	0	0	0	0
Tekoa	247	$26,905,000	$2,690,500	$8,071,500	$13,452,500
Uniontown	0	0	0	0	0
Unincorporated	1,528	$314,667,215	$31,467,215	$94,400,165	$157,333,608
Total	**3,525**	**$827,474,215**	**$82,747,915**	**$248,242,265**	**$413,737,108**

14.8 SCENARIO

A wildfire in Whitman County would most likely occur during an extremely hot, dry summer, perhaps during a period of prolonged drought. There could be numerous causes: people playing with fireworks, sparks from machinery, such as farm equipment or automobiles, or a lightning strike during a summer thunderstorm. Whatever the cause, a small local brush fire, fanned by heavy winds, could disperse embers, triggering more fires that could eventually merge into one or many large fires that don’t burn out on their own. These brush fires could eventually reach scattered homes and farms, or even spread to some of the small communities in the area, such as Hay, LaCrosse or Lamont. These fires could overwhelm emergency responders and resources and could lead to the evacuation of towns and possibly to some structures being destroyed.

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

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

14.9 ISSUES

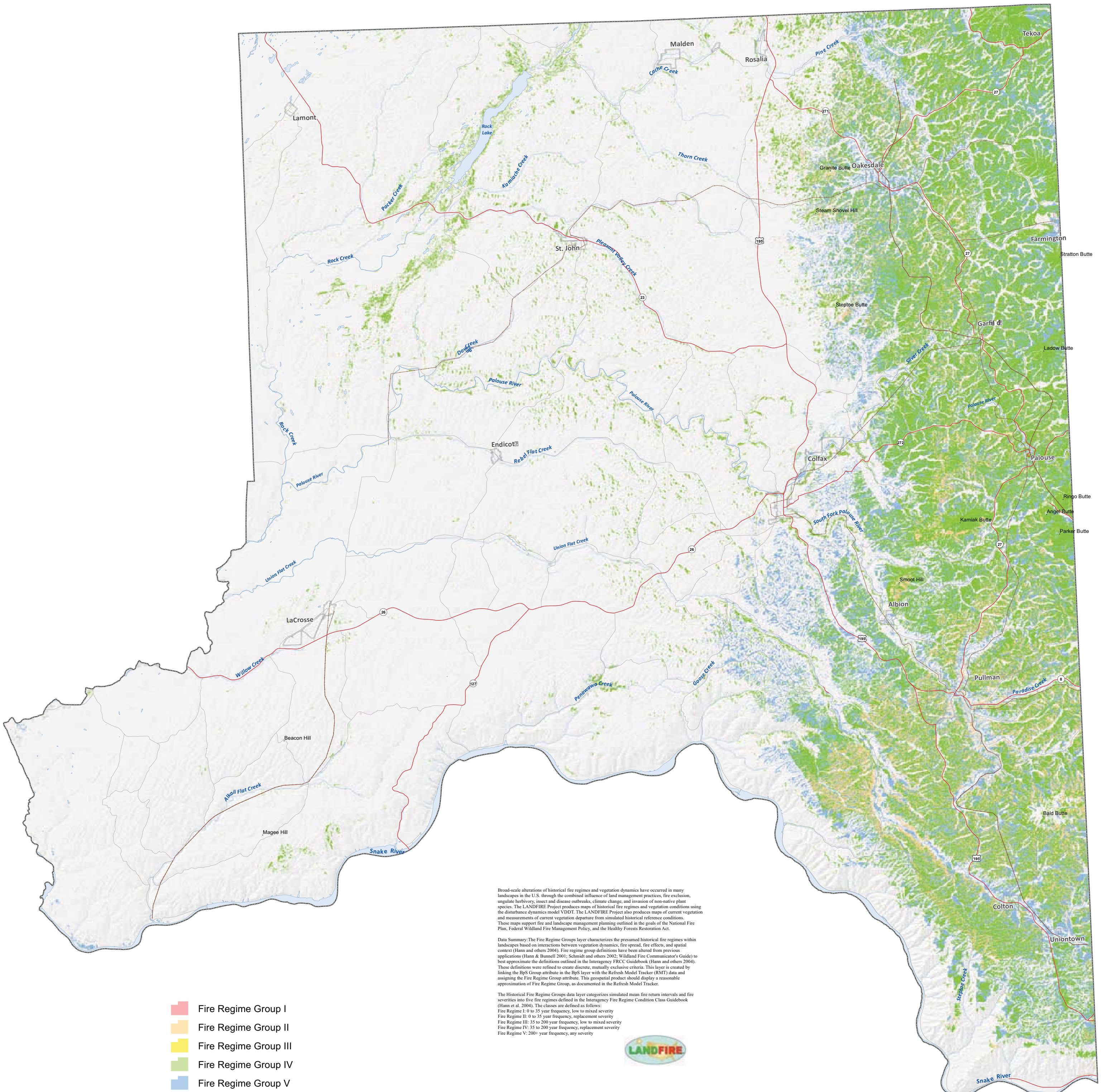
The major issues for wildfire are the following:

- The perceived lack of wildfire activity in the planning area has resulted in a lack of planning for this hazard. Whitman County should consider the development of a Community Wildfire Protection Plan.
- There is a need for better hazard mapping within the planning area. Mapping assessments such as the National Fire Protection Administration 299 risk assessment program would be a significant enhancement to the wildfire risk assessment for the County.
- There is a significant need for digital information on general building stock at the parcel level.
- Public education and outreach to people living in or near fire hazard zones should include information about and assistance with mitigation activities such as defensible space and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Climate change could affect the wildfire hazard.
- Future growth into interface areas should continue to be managed.
- Area fire districts need to continue to train on wildland-urban interface events.
- Vegetation management activities should include enhancement through expansion of the target areas as well as additional resources.
- Regionally consistent higher building code standards are needed, such as residential sprinkler requirements and prohibitive combustible roof standards.
- Fire department water supply must be maintained in high-risk wildfire areas.
- Certifications and qualifications for fire department personnel should be expanded. All firefighters should be trained in basic wildfire behavior and basic fire weather, and all company officers and chief level officers should be trained to the wildland command and strike team leader level.

Map 14-1.

WHITMAN COUNTY

2008 LANDFIRE - FIRE REGIME GROUPS



Broad-scale alterations of historical fire regimes and vegetation dynamics have occurred in many landscapes in the U.S. through the combined influence of land management practices, fire exclusion, ungulate herbivory, insect and disease outbreaks, climate change, and invasion of non-native plant species. The LANDFIRE Project produces maps of historical fire regimes and vegetation conditions using the disturbance dynamics model VDDT. The LANDFIRE Project also produces maps of current vegetation and measurements of current vegetation departure from simulated historical reference conditions. These maps support fire and landscape management planning outlined in the goals of the National Fire Plan, Federal Wildland Fire Management Policy, and the Healthy Forests Restoration Act.

Data Summary:The Fire Regime Groups layer characterizes the presumed historical fire regimes within landscapes based on interactions between vegetation dynamics, fire spread, fire effects, and spatial context (Hann and others 2004). Fire regime group definitions have been altered from previous applications (Hann & Bunnell 2001; Schmidt and others 2002; Wildland Fire Communicator's Guide) to best approximate the definitions outlined in the Interagency FRCC Guidebook (Hann and others 2004). These definitions were refined to create discrete, mutually exclusive criteria. This layer is created by linking the BpS Group attribute in the BpS layer with the Refresh Model Tracker (RMT) data and assigning the Fire Regime Group attribute. This geospatial product should display a reasonable approximation of Fire Regime Group, as documented in the Refresh Model Tracker.

The Historical Fire Regime Groups data layer categorizes simulated mean fire return intervals and fire severities into five fire regimes defined in the Interagency Fire Regime Condition Class Guidebook (Hann et al. 2004). The classes are defined as follows:
Fire Regime I: 0 to 35 year frequency, low to mixed severity
Fire Regime II: 0 to 35 year frequency, replacement severity
Fire Regime III: 35 to 200 year frequency, low to mixed severity
Fire Regime IV: 35 to 200 year frequency, replacement severity
Fire Regime V: 200+ year frequency, any severity

- Fire Regime Group I
- Fire Regime Group II
- Fire Regime Group III
- Fire Regime Group IV
- Fire Regime Group V
- Unclassified

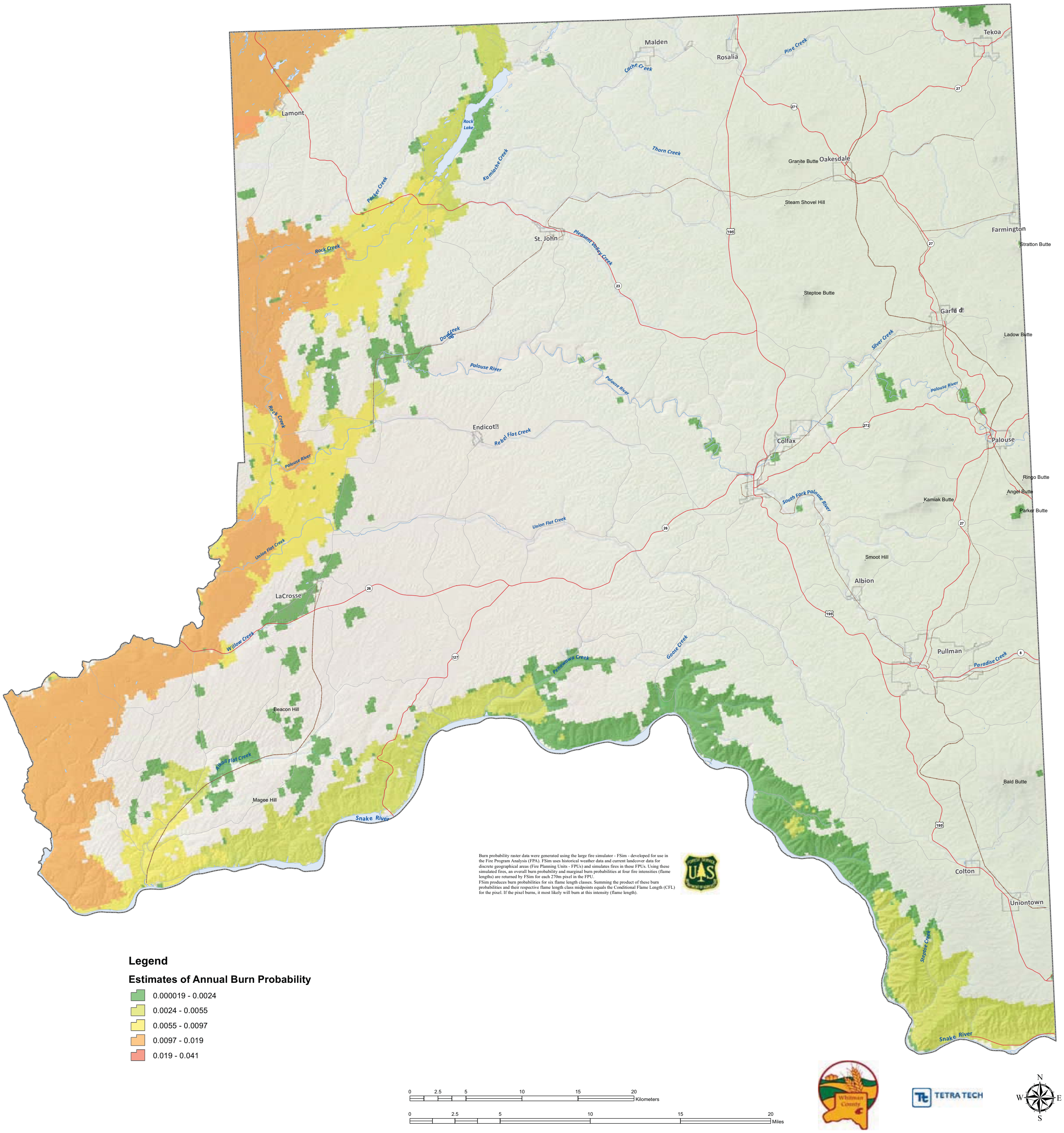
0 2.5 5 10 15 20 Kilometers

0 2.5 5 10 15 20 Miles

Map 14-2.

WHITMAN COUNTY

USFS FSim - Annual Burn Probability

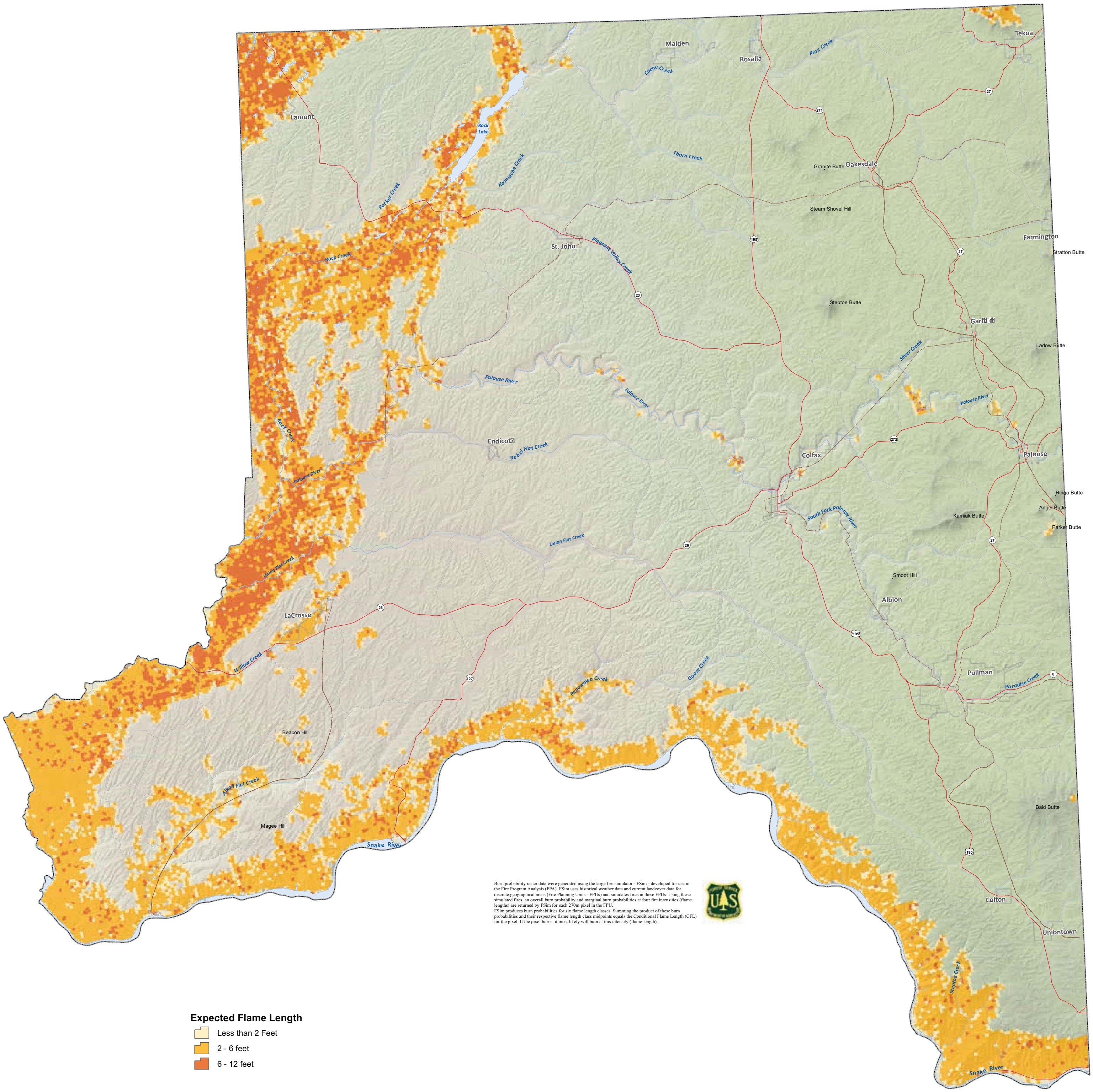


Burn probability raster data were generated using the large fire simulator - FSim - developed for use in the Fire Program Analysis (FPA). FSim uses historical weather data and current landcover data for discrete geographical areas (Fire Planning Units - FPUs) and simulates fires in these FPUs. Using these simulated fires, an overall burn probability and marginal burn probabilities at four fire intensities (flame lengths) are returned by FSim for each 270m pixel in the FPU.
FSim produces burn probabilities for six flame length classes. Summing the product of these burn probabilities and their respective flame length class midpoints equals the Conditional Flame Length (CFL) for the pixel. If the pixel burns, it most likely will burn at this intensity (flame length).

Map 14-3.

WHITMAN COUNTY

USFS FSim - Average Flame Length



Burn probability raster data were generated using the large fire simulator - FSim - developed for use in the Fire Program Analysis (FPA). FSim uses historical weather data and current landcover data for discrete geographical areas (Fire Planning Units - FPUs) and simulates fires in these FPUs. Using these simulated fires, an overall burn probability and marginal burn probabilities at four fire intensities (flame lengths) are returned by FSim for each 270m pixel in the FPU.

FSim produces burn probabilities for six flame length classes. Summing the product of these burn probabilities and their respective flame length class midpoints equals the Conditional Flame Length (CFL) for the pixel. If the pixel burns, it most likely will burn at this intensity (flame length).

Expected Flame Length

- Less than 2 Feet
- 2 - 6 feet
- 6 - 12 feet

0 2.5 5 10 15 20 Kilometers

0 2.5 5 10 15 20 Miles

TETRA TECH

CHAPTER 15.
PLANNING AREA RISK RANKING

A risk ranking was performed for the hazards of concern described in this plan. This risk ranking assesses the probability of each hazard's occurrence as well as its likely impact on the people, property and economy of the planning area. The risk ranking was conducted via facilitated brainstorming sessions with the Steering Committee. Estimates of risk were generated with data from HAZUS-MH using methodologies promoted by FEMA. The results are used in establishing mitigation priorities.

15.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a probability factor based on likelihood of annual occurrence:

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

The assessment of hazard frequency is generally based on past hazard events in the area. Table 15-1 summarizes the probability assessment for each hazard of concern for this plan.

TABLE 15-1.
PROBABILITY OF HAZARDS

Hazard Event	Probability (high, medium, low)	Probability Factor
Dam Failure	Low	1
Drought	High	3
Earthquake	Medium	2
Flood	High	3
Landslide	High	3
Severe Weather	High	3
Volcano	Low	1
Wildfire	High	3

15.2 IMPACT

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

- **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. It should be noted that planners can use an element of subjectivity when assigning values for impacts on people. Impact factors were assigned as follows:

  – High—50 percent or more of the population is exposed to a hazard (Impact Factor = 3)
  – Medium—25 percent to 49 percent of the population is exposed to a hazard (Impact Factor = 2)
  – Low—25 percent or less of the population is exposed to the hazard (Impact Factor = 1)
  – No impact—None of the population is exposed to a hazard (Impact Factor = 0)

- **Property**—Values were assigned based on the percentage of the total ***property value exposed*** to the hazard event:
  – High—30 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
  – Medium—15 percent to 29 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2)
  – Low—14 percent or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
  – No impact—None of the total assessed property value is exposed to a hazard (Impact Factor = 0)
- **Economy**—Values were assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total assessed value of the property exposed to the hazard. For some hazards, such as wildfire, landslide and severe weather, vulnerability was considered to be the same as exposure due to the lack of loss estimation tools specific to those hazards. Loss estimates separate from the exposure estimates were generated for the earthquake and flood hazards using HAZUS-MH.
  – High—Estimated loss from the hazard is 20 percent or more of the total assessed property value (Impact Factor = 3)
  – Medium—Estimated loss from the hazard is 10 percent to 19 percent of the total assessed property value (Impact Factor = 2)
  – Low—Estimated loss from the hazard is 9 percent or less of the total assessed property value (Impact Factor = 1)
  – No impact—No loss is estimated from the hazard (Impact Factor = 0)

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

Table 15-2, Table 15-3 and Table 15-4 summarize the impacts for each hazard.

15.3 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property and operations, as summarized in Table 15-5.

**TABLE 15-2.
IMPACT ON PEOPLE FROM HAZARDS**

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (3)
Dam Failure	Low	1	(3x1)=3
Drought	No Impact	0	(3x0)=0
Earthquake	Medium	2	(3x2)=6
Flood	Medium	2	(3x2)=6
Landslide	Low	1	(3x1)=3
Severe Weather	High	3	(3x3)=9
Volcano	Low	1	(3x1)=3
Wildfire	Medium	2	(3x2)=6

**TABLE 15-3.
IMPACT ON PROPERTY FROM HAZARDS**

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (2)
Dam Failure	Low	1	(2x1)=2
Drought	No Impact	0	(2x0)=0
Earthquake	Low	1	(2x1)=2
Flood	Medium	2	(2x2)=4
Landslide	Low	1	(2x1)=2
Severe Weather	High	3	(2x3)=6
Volcano	Low	1	(2x1)=2
Wildfire	Medium	2	(2x2)=4

**TABLE 15-4.
IMPACT ON ECONOMY FROM HAZARDS**

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (1)
Dam Failure	High	3	(3x1)=3
Drought	High	3	(3x1)=3
Earthquake	Medium	2	(2x1)=2
Flood	Medium	2	(2x1)=2
Landslide	Low	1	(1x1)=1
Severe Weather	High	3	(3x1)=3
Volcano	Low	1	(1x1)=1
Wildfire	Medium	2	(2x1)=2

**TABLE 15-5.
HAZARD RISK RATING**

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Dam Failure	1	(3+2+3)=8	(1x8)=8
Drought	3	(0+0+3)=3	(3x3)=9
Earthquake	2	(6+2+2)=10	(2x10)=20
Flood	3	(6+4+2)=12	(3x12)=36
Landslide	3	(3+2+1)=6	(3x6)=18
Severe Weather	3	(9+6+3)=18	(3x18)=54
Volcano	1	(3+2+1)=6	(1x6)=6
Wildfire	3	(6+4+2)=12	(3x12)=36

Based on these ratings, a priority of high, medium or low was assigned to each hazard. The hazards ranked as being of highest concern are severe weather, flood and wildfire. Hazards ranked as being of medium concern are earthquake and landslide. The hazards ranked as being of lowest concern are drought, dam failure and volcano. Table 15-6 shows the hazard risk ranking.

**TABLE 15-6.
HAZARD RISK RANKING**

Hazard Ranking	Hazard Event	Category
1	Severe Weather	High
2	Flood	High
2	Wildfire	High
4	Earthquake	Medium
5	Landslide	Medium
6	Drought	Low
7	Dam Failure	Low
8	Volcano	Low

PART 3 — MITIGATION STRATEGY

CHAPTER 16.
MITIGATION ALTERNATIVES

Catalogs of hazard mitigation alternatives were developed that present a broad range of alternatives to be considered for use in the planning area, in compliance with 44 CFR (Section 201.6(c)(3)(ii)). One catalog was developed for each hazard of concern evaluated in this plan. The catalogs for each hazard are listed in Table 16-1 through Table 16-8. The catalogs present alternatives that are categorized in two ways:

- By what the alternative would do:
  - Manipulate a hazard
  - Reduce exposure to a hazard
  - Reduce vulnerability to a hazard
  - Increase the ability to respond to or be prepared for a hazard
- By who would have responsibility for implementation:
  - Individuals
  - Businesses
  - Government.

Hazard mitigation initiatives recommended in this plan were selected from among the alternatives presented in the catalogs. The catalogs provide a baseline of mitigation alternatives that are backed by a planning process, are consistent with the planning partners' goals and objectives, and are within the capabilities of the partners to implement. However, not all the alternatives meet all the planning partners' selection criteria.

**TABLE 16-1.
CATALOG OF MITIGATION ALTERNATIVES—DAM FAILURE**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• None	1. Remove dams 2. Remove levees 3. Harden dams	1. Remove dams 2. Remove levees 3. Harden dams
Reduce Exposure		
• Relocate out of dam failure inundation areas.	• Replace earthen dams with hardened structures	1. Replace earthen dams with hardened structures 2. Relocate critical facilities out of dam failure inundation areas. 3. Consider open space land use in designated dam failure inundation areas.
Reduce Vulnerability		
• Elevate home to appropriate levels.	• Flood-proof facilities within dam failure inundation areas	1. Adopt higher regulatory floodplain standards in mapped dam failure inundation areas. 2. Retrofit critical facilities within dam failure inundation areas.
Increase Preparation or Response Capability		
1. Learn about risk reduction for the dam failure hazard. 2. Learn the evacuation routes for a dam failure event. 3. Educate yourself on early warning systems and the dissemination of warnings.	1. Educate employees on the probable impacts of a dam failure. 2. Develop a continuity of operations plan.	1. Map dam failure inundation areas. 2. Enhance emergency operations plan to include a dam failure component. 3. Institute monthly communications checks with dam operators. 4. Inform the public on risk reduction techniques 5. Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas. 6. Consider the probable impacts of climate in assessing the risk associated with the dam failure hazard. 7. Establish early warning capability downstream of listed high hazard dams. 8. Consider the residual risk associated with protection provided by dams in future land use decisions.

TABLE 16-2.
CATALOG OF MITIGATION ALTERNATIVES—DROUGHT

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	Groundwater recharge through stormwater management
Reduce Exposure		
None	None	Identify and create groundwater backup sources
Reduce Vulnerability		
1. Drought-resistant landscapes 2. Reduce water system losses 3. Modify plumbing systems (through water saving kits)	1. Drought-resistant landscapes 2. Reduce private water system losses	1. Water use conflict regulations 2. Reduce water system losses 3. Distribute water saving kits
Increase Preparation or Response Capability		
• Practice active water conservation	• Practice active water conservation	1. Public education on drought resistance 2. Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers 3. Develop drought contingency plan 4. Develop criteria “triggers” for drought-related actions 5. Improve accuracy of water supply forecasts 6. Modify rate structure to influence active water conservation techniques

**TABLE 16-3.
CATALOG OF MITIGATION ALTERNATIVES—EARTHQUAKE**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	None
Reduce Exposure		
• Locate outside of hazard area (off soft soils)	• Locate or relocate mission-critical functions outside hazard area where possible	• Locate critical facilities or functions outside hazard area where possible
Reduce Vulnerability		
1. Retrofit structure (anchor house structure to foundation) 2. Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) 3. Build to higher design	1. Build redundancy for critical functions and facilities 2. Retrofit critical buildings and areas housing mission-critical functions	1. Harden infrastructure 2. Provide redundancy for critical functions 3. Adopt higher regulatory standards
Increase Preparation or Response Capability		
1. Practice “drop, cover, and hold” 2. Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event 3. Keep cash reserves for reconstruction 4. Become informed on the hazard and risk reduction alternatives available. 5. Develop a post-disaster action plan for your household	1. Adopt higher standard for new construction; consider “performance-based design” when building new structures 2. Keep cash reserves for reconstruction 3. Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. 4. Develop a Continuity of Operations Plan	1. Provide better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas (e.g., tax incentives, information) 4. Include retrofitting and replacement of critical system elements in capital improvement plan 5. Develop strategy to take advantage of post-disaster opportunities 6. Warehouse critical infrastructure components such as pipe, power line, and road repair materials 7. Develop and adopt a Continuity of Operations Plan 8. Initiate triggers guiding improvements (such as <50% substantial damage or improvements) 9. Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. 10. Develop a post-disaster action plan that includes grant funding and debris removal components.

TABLE 16-4.
CATALOG OF MITIGATION ALTERNATIVES—FLOOD

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
1. Clear stormwater drains and culverts 2. Institute low-impact development techniques on property	1. Clear stormwater drains and culverts 2. Institute low-impact development techniques on property	1. Maintain drainage system 2. Institute low-impact development techniques on property 3. Dredging, levee construction, and providing regional retention areas 4. Structural flood control, levees, channelization or revetments. 5. Stormwater management regulations and master planning 6. Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff
Reduce Exposure		
1. Locate outside of hazard area 2. Elevate utilities above base flood elevation 3. Institute low impact development techniques on property	1. Locate business critical facilities or functions outside hazard area 2. Institute low impact development techniques on property	1. Locate or relocate critical facilities outside of hazard area 2. Acquire or relocate identified repetitive loss properties 3. Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. 4. Adopt land development criteria such as planned unit developments, density transfers, clustering 5. Institute low impact development techniques on property 6. Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff
Reduce Vulnerability		
1. Retrofit structures (elevate structures above base flood elevation) 2. Elevate items within house above base flood elevation 3. Build new homes above base flood elevation 4. Flood-proof existing structures	1. Build redundancy for critical functions or retrofit critical buildings 2. Provide flood-proofing measures when new critical infrastructure must be located in floodplains	1. Harden infrastructure, bridge replacement program 2. Provide redundancy for critical functions and infrastructure 3 Adopt appropriate regulatory standards, such as: increased freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions. 4. Stormwater management regulations and master planning. 5. Adopt “no-adverse impact” floodplain management policies that strive to not increase the flood risk on downstream communities.

**TABLE 16-4.
CATALOG OF MITIGATION ALTERNATIVES—FLOOD**

Personal Scale	Corporate Scale	Government Scale
Increase Preparation or Response Capability		
1. Buy flood insurance 2. Develop household mitigation plan, such as retrofit savings, communication capability with outside, 72-hour self-sufficiency during and after an event	1. Keep cash reserves for reconstruction 2. Support and implement hazard disclosure for the sale/re-sale of property in identified risk zones. 3. Solicit cost-sharing through partnerships with other stakeholders on projects with multiple benefits.	1. Produce better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) 4. Incorporate retrofitting or replacement of critical system elements in capital improvement plan 5. Develop strategy to take advantage of post-disaster opportunities 6. Warehouse critical infrastructure components 7. Develop and adopt a Continuity of Operations Plan 8. Consider participation in the Community Rating System 9. Maintain existing data and gather new data needed to define risks and vulnerability 10. Train emergency responders 11. Create a building and elevation inventory of structures in the floodplain 12. Develop and implement a public information strategy 13. Charge a hazard mitigation fee 14. Integrate floodplain management policies into other planning mechanisms within the planning area. 15. Consider the probable impacts of climate change on the risk associated with the flood hazard 16. Consider the residual risk associated with structural flood control in future land use decisions 17. Enforce National Flood Insurance Program 18. Adopt a Stormwater Management Master Plan

TABLE 16-5.
CATALOG OF MITIGATION ALTERNATIVES—LANDSLIDE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope 3. Minimize vegetation removal and the addition of impervious surfaces.	1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope	1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope
Reduce Exposure		
• Locate structures outside of hazard area (off unstable land and away from slide-run out area)	• Locate structures outside of hazard area (off unstable land and away from slide-run out area)	1. Acquire properties in high-risk landslide areas. 2. Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas.
Reduce Vulnerability		
• Retrofit home.	• Retrofit at-risk facilities.	1. Adopt higher regulatory standards for new development within unstable slope areas. 2. Armor/retrofit critical infrastructure against the impact of landslides.
Increase Preparation or Response Capability		
1. Institute warning system, and develop evacuation plan 2. Keep cash reserves for reconstruction 3. Educate yourself on risk reduction techniques for landslide hazards.	1. Institute warning system, and develop evacuation plan 2. Keep cash reserves for reconstruction 3. Develop a Continuity of Operations Plan 4. Educate employees on the potential exposure to landslide hazards and emergency response protocol.	1. Produce better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas: better land controls, tax incentives, information 4. Develop strategy to take advantage of post-disaster opportunities 5. Warehouse critical infrastructure components 6. Develop and adopt a Continuity of Operations Plan 7. Educate the public on the landslide hazard and appropriate risk reduction alternatives.

**TABLE 16-6.
CATALOG OF MITIGATION ALTERNATIVES—SEVERE WEATHER**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	None
Reduce Exposure		
None	None	None
Reduce Vulnerability		
1. Insulate house 2. Provide redundant heat and power 3. Insulate structure 4. Plant appropriate trees near home and power lines (“Right tree, right place” National Arbor Day Foundation Program)	1. Relocate critical infrastructure (such as power lines) underground 2. Reinforce or relocate critical infrastructure such as power lines to meet performance expectations 3. Install tree wire	1. Harden infrastructure such as locating utilities underground 2. Trim trees back from power lines 3. Designate snow routes and strengthen critical road sections and bridges
Increase Preparation or Response Capability		
1. Trim or remove trees that could affect power lines 2. Promote 72-hour self-sufficiency 3. Obtain a NOAA weather radio. 4. Obtain an emergency generator.	1. Trim or remove trees that could affect power lines 2. Create redundancy 3. Equip facilities with a NOAA weather radio 4. Equip vital facilities with emergency power sources.	1. Support programs such as “Tree Watch” that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. 2. Establish and enforce building codes that require all roofs to withstand snow loads 3. Increase communication alternatives 4. Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. 5. Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines 6. Provide NOAA weather radios to the public

TABLE 16-7.
CATALOG OF RISK REDUCTION MEASURES—VOLCANO

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	Limited success has been experienced with lava flow diversion structures
Reduce Exposure		
Relocate outside of hazard area, such as lahar zones	• Locate mission critical functions outside of hazard area, such as lahar zones whenever possible.	Locate critical facilities and functions outside of hazard area, such as lahar zones, whenever possible.
Reduce Vulnerability		
None	• Protect corporate critical facilities and infrastructure from potential impacts of severe ash fall (air filtration capability)	• Protect critical facilities from potential problems associated with ash fall. • Build redundancy for critical facilities and functions.
Increase Preparation or Response Capability		
• Develop and practice a household evacuation plan.	1. Develop and practice a corporate evacuation plan 2. Inform employees through corporate sponsored outreach 3. Develop a cooperative	1. Public outreach, awareness. 2. Tap into state volcano warning system to provide early warning to Whitman County residents of potential ash fall problems

TABLE 16-8.
CATALOG OF MITIGATION ALTERNATIVES—WILDFIRE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• Clear potential fuels on property such as dry overgrown underbrush and diseased trees	• Clear potential fuels on property such as dry underbrush and diseased trees	1. Clear potential fuels on property such as dry underbrush and diseased trees 2. Implement best management practices on public lands.
Reduce Exposure		
1. Create and maintain defensible space around structures 2. Locate outside of hazard area 3. Mow regularly	1. Create and maintain defensible space around structures and infrastructure 2. Locate outside of hazard area	1. Create and maintain defensible space around structures and infrastructure 2. Locate outside of hazard area 3. Enhance building code to include use of fire resistant materials in high hazard area.
Reduce Vulnerability		
1. Create and maintain defensible space around structures and provide water on site 2. Use fire-retardant building materials 3. Create defensible spaces around home	1. Create and maintain defensible space around structures and infrastructure and provide water on site 2. Use fire-retardant building materials 3. Use fire-resistant plantings in buffer areas of high wildfire threat.	1. Create and maintain defensible space around structures and infrastructure 2. Use fire-retardant building materials 3. Use fire-resistant plantings in buffer areas of high wildfire threat. 4. Consider higher regulatory standards (such as Class A roofing) 5. Establish biomass reclamation initiatives
Increase Preparation or Response Capability		
1. Employ techniques from the National Fire Protection Association's Firewise Communities program to safeguard home 2. Identify alternative water supplies for fire fighting 3. Install/replace roofing material with non-combustible roofing materials.	1. Support Firewise community initiatives. 2. Create /establish stored water supplies to be used for firefighting.	1. More public outreach and education efforts, including an active Firewise program 2. Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas 3. Identify fire response and alternative evacuation routes 4. Seek alternative water supplies 5. Become a Firewise community 6. Use academia to study impacts/solutions to wildfire risk 7. Establish/maintain mutual aid agreements between fire service agencies. 8. Create/implement fire plans 9. Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions

CHAPTER 17.
AREA-WIDE MITIGATION INITIATIVES AND IMPLEMENTATION STRATEGY

17.1 SELECTED COUNTY-WIDE MITIGATION INITIATIVES

The planning partners and the Steering Committee determined that some initiatives from the mitigation catalogs could be implemented to provide hazard mitigation benefits countywide. Table 17-1 lists the recommended countywide initiatives, the lead agency for each and the proposed timeline. The parameters for the timeline are as follows:

- Short Term = to be completed in 1 to 5 years
- Long Term = to be completed in greater than 5 years
- Ongoing = currently being funded and implemented under existing programs.

17.2 BENEFIT/COST REVIEW

The action plan must be prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium and low) to the costs and benefits of these projects.

Cost ratings were defined as follows:

- **High**—Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants and fee increases).
- **Medium**—The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- **Low**—The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High—**Project will provide an immediate reduction of risk exposure for life and property.
- **Medium—**Project will have a long-term impact on the reduction of risk exposure for life and property, or project will provide an immediate reduction in the risk exposure for property.
- **Low—**Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

TABLE 17-1.
ACTION PLAN—COUNTYWIDE MITIGATION INITIATIVES

Hazards Addressed	Lead Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-1— Enhance the Whitman County Emergency Response Plan so that it can be implemented uniformly in a coordinated effort throughout the planning area. This should include a post-disaster action plan that defines responsibilities and actions, leveraging all resources in the planning area.				
All Hazards	Whitman County Emergency Management	Department funding, DHS grants	Short-term	3, 4, 6
CW-2— Integrate the Hazard Mitigation Plan Steering Committee with the Local Emergency Planning Committee to ensure implementation of the plan maintenance strategy.				
All Hazards	Whitman County Emergency Management	Department funding	Short-term, Ongoing	2, 3, 4, 6
CW-3— Enhance the County Assessor data to a full digital format to better support a parcel-based risk assessment for future updates to this plan.				
All Hazards	Whitman County Assessor	General Fund	Long-term	1, 2, 6, 7
CW-4— Continue to maintain a countywide hazard mitigation plan website to present the plan and plan updates, in order to provide the public an opportunity to monitor plan implementation and progress. Each planning partner may support the initiative by including an initiative in its action plan and creating a web link to the website.				
All Hazards	Whitman County Emergency Management	Department funding	Short-term, Ongoing	2, 6, 7
CW-5— Leverage public outreach partnering capabilities to inform and educate the public about hazard mitigation and preparedness.				
All Hazards	Whitman County Emergency Management, All Planning Partners	General Fund, Planning Partner contributions, FEMA Grant funding	Short-term-Ongoing	2, 6, 7
CW-6—Coordinate all mitigation planning and project efforts, including grant application support, to maximize all resources available to the planning partnership.				
All Hazards	Whitman County Emergency Management	FEMA Grant Funding	Long-term	3, 5, 6, 7
CW-7— Consider the development of a Community Wildfire Protection Plan for Whitman County				
Wildfire	Whitman County Emergency Management	FEMA Grant Funding, general Fund	Long term	1, 2, 4, 6, 7
CW-8— Support the collection of improved data (hydrologic, geologic, topographic, volcanic, historical, etc.) to better assess risks and vulnerabilities.				
All Hazards	Whitman County Department of Public Works	General Fund, FEMA mitigation grants	Short term/ ongoing	1, 2, 4, 6, 7
CW-9—Where appropriate, support retrofitting, purchase, or relocation of structures or infrastructure located in hazard-prone areas to protect structures and infrastructure from future damage, with repetitive loss and severe repetitive loss properties as priorities when applicable.				
All Hazards	Al Planning Partners	FEMA mitigation grants	Long term	2, 3, 5, 6

For many of the strategies identified in this action plan, the partners may seek financial assistance under the HMGP or PDM programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, the partners reserve the right to define "benefits" according to parameters that meet the goals and objectives of this plan.

17.3 COUNTY-WIDE ACTION PLAN PRIORITIZATION

Table 17-2 lists the priority of each countywide initiative, using the same parameters used by each of the planning partners in selecting their initiatives. A qualitative benefit-cost review was performed for each of these initiatives. The priorities are defined as follows:

- **High Priority**—A project that meets multiple objectives (i.e., multiple hazards), has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for the HMGP or PDM grant program. High priority projects can be completed in the short term (1 to 5 years).
- **Medium Priority**—A project that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that is grant eligible under HMGP, PDM or other grant programs. Project can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured.
- **Low Priority**—A project that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for HMGP or PDM grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority projects may be eligible for other sources of grant funding from other programs.

TABLE 17-2. PRIORITIZATION OF COUNTYWIDE MITIGATION INITIATIVES

Initiative #	# of Objectives Met	Benefits	Costs	Do benefits equal or exceed Costs?	Is project grant eligible?	Can project be funded under existing programs/ budgets?	Priority (High, Med., Low)
CW-1	3	High	Medium	Yes	Yes	Yes	High
CW-2	4	Medium	Low	Yes	No	Yes	High
CW-3	4	High	High	Yes	No	No	Medium
CW-4	3	Low	Low	Yes	No	Yes	High
CW-5	3	Low	Low	Yes	Yes	Yes	High
CW-6	4	Low	Low	Yes	Yes	Yes	High
CW-7	5	High	High	Yes	Yes	No	Medium
CW-8	5	Medium	Medium	Yes	No	Yes	High
CW-9	4	High	High	Yes	Yes	No	Medium

17.4 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. This plan will be submitted for a pre-adoption review to FEMA and the Washington Emergency Management Division (EMD) prior to adoption. Once pre-adoption approval has been provided, all planning partners will formally adopt the plan. All partners understand that DMA compliance and its benefits cannot be achieved until the plan is adopted. Copies of the resolutions adopting this plan for all planning partners can be found in Appendix E of this volume.

17.5 PLAN MAINTENANCE STRATEGY

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a 5-year cycle
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate
- A discussion on how the community will continue public participation in the plan maintenance process.

This chapter details the formal process that will ensure that the Whitman County Hazard Mitigation Plan remains an active and relevant document and that the planning partners maintain their eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. This chapter also describes how public participation will be integrated throughout the plan maintenance and implementation process. It also explains how the mitigation strategies outlined in this Plan will be incorporated into existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation. The Plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

17.5.1 Plan Implementation

The effectiveness of the hazard mitigation plan depends on its implementation and incorporation of its action items into partner jurisdictions' existing plans, policies and programs. Together, the action items in the Plan provide a framework for activities that the Partnership can implement over the next 5 years. The planning team and the Steering Committee have established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies and programs.

Whitman County Department of Emergency Management will have lead responsibility for overseeing the Plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all planning partnership members and agencies identified as lead agencies in the mitigation action plans (see planning partner annexes in Volume 2 of this plan).

17.5.2 Steering Committee

The Steering Committee is a total volunteer body that oversaw the development of the Plan and made recommendations on key elements of the plan, including the maintenance strategy. It was the Steering

Committee's position that an oversight committee with representation similar to the initial Steering Committee should have an active role in the Plan maintenance strategy. Therefore, it is recommended that a steering committee remain a viable body involved in key elements of the Plan maintenance strategy. The new steering committee should strive to include representation from the planning partners, as well as other stakeholders in the planning area.

The principal role of the new steering committee in this plan maintenance strategy will be to review the annual progress report and provide input to Emergency Management on possible enhancements to be considered at the next update. Future plan updates will be overseen by a steering committee similar to the one that participated in this plan development process, so keeping an interim steering committee intact will provide a head start on future updates. Completion of the progress report is the responsibility of each planning partner, not the responsibility of the steering committee. It will simply be the steering committee's role to review the progress report in an effort to identify issues needing to be addressed by future plan updates.

17.5.3 Annual Progress Report

The minimum task of each planning partner will be the evaluation of the progress of its individual action plan during a 12-month performance period. This review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the planning area
- Review of mitigation success stories
- Review of continuing public involvement
- Brief discussion about why targeted strategies were not completed
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding)
- Recommendations for new projects
- Changes in or potential for new funding options (grant opportunities)
- Impact of any other planning programs or initiatives that involve hazard mitigation.

The planning team has created a template to guide the planning partners in preparing a progress report (see Appendix D). The plan maintenance steering committee will provide feedback to the planning team on items included in the template. The planning team will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- Posted on the Emergency Management website page dedicated to the hazard mitigation plan
- Provided to the local media through a press release
- Presented to planning partner governing bodies to inform them of the progress of actions implemented during the reporting period
- For those planning partners that participate in the Community Rating System, the report can be provided as part of the CRS annual re-certification package. The CRS requires an annual recertification to be submitted by October 1 of every calendar year for which the community has not received a formal audit. To meet this recertification timeline, the planning team will strive to complete progress reports between June and September each year.

Uses of the progress report will be at the discretion of each planning partner. Annual progress reporting is not a requirement specified under 44 CFR. However, it may enhance the planning partnership's opportunities for funding. While failure to implement this component of the plan maintenance strategy will not jeopardize a planning partner's compliance under the DMA, it may jeopardize its opportunity to partner and leverage funding opportunities with the other partners. Each planning partner was informed of these protocols at the beginning of this planning process (in the "Planning Partner Expectations" package provided at the start of the process), and each partner acknowledged these expectations when with submittal of a letter of intent to participate in this process.

17.5.4 Plan Update

Local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (44 CFR, Section 201.6(d)(3)). The Whitman County partnership intends to update the hazard mitigation plan on a 5-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than 5 years based on the following triggers:

- A Presidential Disaster Declaration that impacts the planning area
- A hazard event that causes loss of life
- A comprehensive update of the County or participating city's comprehensive plan

It will not be the intent of future updates to develop a complete new hazard mitigation plan for the planning area. The update will, at a minimum, include the following elements:

- The update process will be convened through a steering committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plans will be reviewed and revised to account for any initiatives completed, dropped, or changed and to account for changes in the risk assessment or new partnership policies identified under other planning mechanisms (such as the comprehensive plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The partnership governing bodies will adopt their respective portions of the updated plan.

17.5.5 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the Emergency Management website and by copies of annual progress reports provided to the media. Each planning partner has agreed to provide links to the County hazard mitigation plan website on their individual jurisdictional websites to increase avenues of public access to the plan. Whitman County Emergency Management has agreed to maintain the hazard mitigation plan website. This site will not only house the final plan, it will become the one-stop shop for information regarding the plan, the partnership and plan implementation. Copies of the plan will be distributed to the Whitman County Library system. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from a new steering committee. This strategy will be based on the needs and capabilities of the planning partnership at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area.

17.5.6 Incorporation into Other Planning Mechanisms

The information on hazard, risk, vulnerability and mitigation contained in this plan is based on the best science and technology available at the time this plan was prepared. The Whitman County Comprehensive Plan and the comprehensive plans of the partner cities are considered to be integral parts of this plan. The County and partner cities, through adoption of comprehensive plans and zoning ordinances, have planned for the impact of natural hazards. The plan development process provided the County and the cities with the opportunity to review and expand on policies contained within these planning mechanisms. The planning partners used their comprehensive plans and the hazard mitigation plan as complementary documents that work together to achieve the goal of reducing risk exposure to the citizens of the Whitman County. An update to a comprehensive plan may trigger an update to the hazard mitigation plan.

All municipal planning partners are committed to creating a linkage between the hazard mitigation plan and their individual comprehensive plans by identifying a mitigation initiative as such and giving that initiative a high priority. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Partners’ emergency response plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Master fire protection plans.

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be incorporated via the update process.

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APPENDIX A. ACRONYMS AND DEFINITIONS

APPENDIX A.
ACRONYMS AND DEFINITIONS

ACRONYMS

CFR—Code of Federal Regulations

cfs—cubic feet per second

CRS—Community Rating System

DMA —Disaster Mitigation Act of 2000

EMD—Emergency Management Division (a division of the Washington State Military Department)

ESA—Endangered Species Act

FCAAP —Flood Control Account Assistance Program

FEMA—Federal Emergency Management Agency

FIRM—Flood Insurance Rate Map

FPU—Fire planning unit

GMA—Growth Management Act

GIS—Geographic Information System

HAZUS-MH—Hazards, United States-Multi Hazard

HMGP—Hazard Mitigation Grant Program

IBC —International Building Code

MM—Modified Mercalli Scale

NEHRP—National Earthquake Hazards Reduction Program

NFR —Natural Fire Rotation

NFIP—National Flood Insurance Program

NOAA—National Oceanic and Atmospheric Administration

OFM —Office of Financial Management (WA State)

PDM—Pre-Disaster Mitigation Grant Program

PDI—Palmer Drought Index

PGA—Peak Ground Acceleration

PHDI—Palmer Hydrological Drought Index

RCW—Revised Code of Washington

SFHA—Special Flood Hazard Area

SHELDUS—Special Hazard Events and Losses Database for the U.S.

SPI—Standardized Precipitation Index

UBC—Uniform Building Code

USGS—U.S. Geological Survey

WAC —Washington Administrative Code

DEFINITIONS

100-Year Flood: The term "100-year flood" can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1 percent chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1 percent annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any man-made or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1% chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Basins are also referred to as "watersheds" and "drainage basins."

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic and/or water reactive materials;
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events, and
- Public and private utilities, infrastructure and transportation systems that are vital to maintaining or restoring normal services to areas damaged by hazard events
- Public gathering places that could be used as evacuation centers during large scale disasters.
- Government and educational facilities central to governance and quality of life along with response and recovery actions taken as a result of a hazard event

Cubic Feet per Second (cfs): Discharge or river flow is commonly measured in cfs. One cubic foot is about 7.5 gallons of liquid.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Avalanche: Volcanoes are prone to debris and mountain rock avalanches that can approach speeds of 100 mph.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Debris Slide: Debris slides consist of unconsolidated rock or soil that has moved rapidly down slope. They occur on slopes greater than 65 percent.

Disaster Mitigation Act of 2000 (DMA); The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Drainage Basin: A basin is the area within which all surface water- whether from rainfall, snowmelt, springs or other sources- flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well-being and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's Flood Insurance rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A flood insurance rate map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area (SFHA).

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Fog: Fog refers to a cloud (or condensed water droplets) near the ground. Fog forms when air close to the ground can no longer hold all the moisture it contains. Fog occurs either when air is cooled to its dew point or the amount of moisture in the air increases. Heavy fog is particularly hazardous because it can restrict surface visibility. Severe fog incidents can close roads, cause vehicle accidents, cause airport delays, and impair the effectiveness of emergency response. Financial losses associated with transportation delays caused by fog have not been calculated in the United States but are known to be substantial.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour (mph)) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people and/or cause property damage.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazards U.S. Multi-Hazard (HAZUS-MH) Loss Estimation Program: HAZUS-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The HAZUS-MH software program assesses risk in a quantitative manner to estimate damage and losses associated with natural hazards. HAZUS-MH is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods and wind hazards. HAZUS-MH has also been used to assess vulnerability (exposure) for other hazards.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation and other valued community resources.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, mudflows, debris flows, sinkholes and lahars.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation actions are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property and the economy. Risk estimates for the City are based on the methodology that the City used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Sinkhole: A collapse depression in the ground with no visible outlet. Its drainage is subterranean. It is commonly vertical-sided or funnel-shaped.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations and zone V in coastal situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Stream Bank Erosion: Stream bank erosion is common along rivers, streams and drains where banks have been eroded, sloughed or undercut. However, it is important to remember that a stream is a dynamic and constantly changing system. It is natural for a stream to want to meander, so not all eroding banks are "bad" and in need of repair. Generally, stream bank erosion becomes a problem where development has limited the meandering nature of streams, where streams have been channelized, or where stream bank structures (like bridges, culverts, etc.) are located in places where they can actually cause damage to downstream areas. Stabilizing these areas can help protect watercourses from continued sedimentation, damage to adjacent land uses, control unwanted meander, and improvement of habitat for fish and wildlife.

Steep Slope: Different communities and agencies define it differently, depending on what it is being applied to, but generally a steep slope is a slope in which the percent slope equals or exceeds 25%. For this study, steep slope is defined as slopes greater than 33%.

Sustainable Hazard Mitigation: This concept includes the sound management of natural resources, local economic and social resiliency, and the recognition that hazards and mitigation must be understood in the largest possible social and economic context.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: A tornado is a violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, its contents, and the economic value of its functions. Like indirect damage, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: These terms refer to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

APPENDIX B.
PUBLIC OUTREACH

Whitman County Survey: Natural Hazards & Mitigation Planning

1. Where in Whitman County do you live?

	Response Percent	Response Count
Albion	2.6%	8
Colfax	16.2%	50
Colton	1.9%	6
Endicott	1.6%	5
Farmington	12.9%	40
Garfield	2.6%	8
LaCrosse	2.9%	9
Lamont	0.0%	0
Malden	0.3%	1
Oakesdale	2.6%	8
Palouse	3.6%	11
Pullman	**30.4%**	**94**
Rosalia	1.9%	6
St. John	1.6%	5

Tekoa	1.0%	3
Uniontown	1.9%	6
Unincorporated County	4.9%	15
Other (please specify)	11.0%	34
	answered question	**309**
	skipped question	**0**

2. Do you work in Whitman County?

	Response Percent	Response Count
Yes	**88.2%**	**261**
No	11.8%	35
	answered question	**296**
	skipped question	**13**

3. Which of the following natural hazard events have you or has anyone in your household experienced in the past 20 years within Whitman County? (Check all that apply)

	Response Percent	Response Count
Avalanche	0.3%	1
Dam/Levee Failure	0.0%	0
Drought	7.0%	21
Earthquake	4.7%	14
Flood	33.9%	102
Hazardous Materials	10.3%	31
Household Fire	6.3%	19
Landslide	3.3%	10
Severe Weather (wind, lightning, winter storm, etc.)	**65.8%**	**198**
Volcanic Eruption (lahar, ash fall)	6.3%	19
Wildland Fire	15.9%	48
None	23.3%	70
Other (please specify)	3.7%	11
	answered question	**301**
	skipped question	**8**

4. How prepared is your household is to deal with a natural hazard event?

	Not at all prepared	Somewhat prepared	Adequately prepared	Well prepared	Very well prepared	Rating Average	Response Count
Check one:	6.0% (17)	**52.5% (149)**	25.7% (73)	11.6% (33)	4.2% (12)	2.56	284
						answered question	**284**
						skipped question	**25**

5. Which of the following have provided you with useful information to help you be prepared for a natural hazard event? (Check all that apply)

	Response Percent	Response Count
Emergency preparedness information from a government source (e.g., federal, state, or local emergency management)	37.6%	106
Personal experience with one or more natural hazards/disasters	**50.0%**	**141**
Locally provided news or other media information	40.8%	115
Schools and other academic institutions	12.8%	36
Attended meetings that have dealt with disaster preparedness	19.5%	55
Community Emergency Response Training (CERT)	8.9%	25
Church	7.1%	20
None	9.9%	28
Other (please specify)	11.0%	31
	answered question	**282**
	skipped question	**27**

6. Which of the following steps has your household taken to prepare for a natural hazard event? (Check all that apply)

	Response Percent	Response Count
Received first aid/CPR training	76.8%	218
Made a fire escape plan	44.7%	127
Designated a meeting place	37.0%	105
Identified utility shutoffs	44.7%	127
Sand bags	1.8%	5
Prepared a disaster supply kit	24.6%	70
Installed smoke detectors on each level of the house	**80.6%**	**229**
Stored food and water	50.4%	143
Stored flashlights and batteries	75.7%	215
Stored a battery-powered radio	38.0%	108
Stored a fire extinguisher	68.0%	193
Stored medical supplies (first aid kit, medications)	65.5%	186
Natural hazard insurance (Flood, Earthquake, Wildfire)	14.8%	42
None	0.7%	2

Other (please specify)		2.5%	7
		answered question	**284**
		skipped question	**25**

7. How concerned are you about the following natural hazards in Whitman County? (Check one response for each hazard)

	Not Concerned	Somewhat Concerned	Concerned	Very Concerned	Extremely Concerned	Rating Average	Response Count
Climate Change	**49.3% (138)**	32.5% (91)	8.2% (23)	6.1% (17)	3.9% (11)	1.83	280
Dam/Levee Failure	**80.4% (221)**	13.8% (38)	4.7% (13)	0.4% (1)	0.7% (2)	1.27	275
Drought	34.8% (95)	**39.9% (109)**	20.5% (56)	2.6% (7)	2.2% (6)	1.97	273
Earthquake	**59.6% (164)**	32.0% (88)	6.5% (18)	1.1% (3)	0.7% (2)	1.51	275
Flood	**35.1% (98)**	34.1% (95)	24.4% (68)	3.9% (11)	2.5% (7)	2.05	279
Hazardous Materials	31.1% (85)	**37.7% (103)**	21.2% (58)	7.0% (19)	2.9% (8)	2.13	273
Household Fire	12.1% (34)	**38.2% (107)**	33.6% (94)	11.8% (33)	4.3% (12)	2.58	280
Landslide	**60.4% (166)**	27.3% (75)	10.9% (30)	1.5% (4)	0.0% (0)	1.53	275
Severe Weather	11.0% (31)	31.0% (87)	**36.3% (102)**	16.4% (46)	5.3% (15)	2.74	281
Volcanic Eruption	**60.4% (165)**	24.9% (68)	9.5% (26)	4.0% (11)	1.1% (3)	1.60	273
Wildland Fire	26.6% (73)	**28.8% (79)**	26.6% (73)	10.6% (29)	7.3% (20)	2.43	274
Other	**72.3% (34)**	4.3% (2)	10.6% (5)	4.3% (2)	8.5% (4)	1.72	47

(Please specify other natural hazard)		15
answered question		**284**
skipped question		**25**

8. Which of the following methods do you think are most effective for providing hazard and disaster information? (Check all that apply)

	Response Percent	Response Count
Newspaper	46.8%	133
Telephone Book	4.9%	14
Informational Brochures	27.1%	77
City Newsletters	26.1%	74
Public Meetings	25.7%	73
Workshops	20.1%	57
Schools	24.6%	70
TV News	58.5%	166
TV Ads	23.6%	67
Radio News	**66.9%**	**190**
Radio Ads	27.8%	79
Internet	56.0%	159

Outdoor Advertisements	9.2%	26
Fire Department/Rescue	37.7%	107
Law Enforcement	30.3%	86
Church (faith-based institutions)	16.9%	48
CERT Classes	9.2%	26
Public Awareness Campaign (e.g., Flood Awareness Week, Winter Storm Preparedness Month)	35.2%	100
Books	9.2%	26
Chamber of Commerce	9.5%	27
Academic Institutions	9.9%	28
Public Library	26.4%	75
Red Cross Information	26.1%	74
Community Safety Events	27.5%	78
Fair Booths	29.2%	83
Word of Mouth	30.3%	86
Social Media (Twitter, facebook, Linkdin)	29.9%	85
Other (please specify)	2.1%	6
	answered question	**284**

	skipped question	**25**

9. Is your property located in or near a FEMA designated floodplain?

	Response Percent	Response Count
Yes	10.2%	29
No	**64.1%**	**182**
Not Sure	25.7%	73
	answered question	**284**
	skipped question	**25**

10. Do you have flood insurance?

	Response Percent	Response Count
Yes	10.2%	29
No	**79.2%**	**225**
Not Sure	10.6%	30
	answered question	**284**
	skipped question	**25**

11. Is your property located near an earthquake fault?

	Response Percent	Response Count
Yes	1.1%	3
No	**67.3%**	**191**
Not Sure	31.7%	90
	answered question	**284**
	skipped question	**25**

12. Do you have earthquake insurance?

	Response Percent	Response Count
Yes	3.5%	10
No	**81.7%**	**232**
Not Sure	14.8%	42
	answered question	**284**
	skipped question	**25**

13. Is your property located in an area at risk for wild fires?

	Response Percent	Response Count
Yes	32.0%	91
No	**54.6%**	**155**
Not Sure	13.4%	38
answered question		**284**
skipped question		**25**

14. Have you ever had problems getting homeowners or renters insurance due to risks from natural hazards?

	Response Percent	Response Count
Yes	2.1%	6
No	**92.5%**	**260**
Not Sure	5.3%	15
If "yes," which natural hazard was involved?		6
answered question		**281**
skipped question		**28**

15. Do you have any special access or functional needs within your household that would require early warning or specialized response during disasters?

	Response Percent	Response Count
Yes	5.4%	15
No	**94.6%**	**263**
	answered question	**278**
	skipped question	**31**

16. If the answer to question # 15 was yes, would you like County Emergency Management personnel to contact you regarding your access and functional needs? If yes, please enter your contact information in the following text box.

	Response Percent	Response Count
Yes	4.1%	7
No	25.7%	44
Not Applicable	**70.2%**	**120**
	Contact Information	7
	answered question	**171**
	skipped question	**138**

17. When you moved into your home, did you consider the impact a natural disaster could have on your home?

	Response Percent	Response Count
Yes	37.3%	103
No	**60.1%**	**166**
Not Sure	2.5%	7
	answered question	**276**
	skipped question	**33**

18. Was the presence of a natural hazard risk zone (e.g., dam failure zone, flood zone, landslide hazard area, high fire risk area) disclosed to you by a real estate agent, seller, or landlord before you purchased or moved into your home?

	Response Percent	Response Count
Yes	12.3%	34
No	**74.6%**	**206**
Not Sure	13.0%	36
	answered question	**276**
	skipped question	**33**

19. Would the disclosure of this type of natural hazard risk information influence your decision to buy or rent a home?

	Response Percent	Response Count
Yes	**58.3%**	**161**
No	25.0%	69
Not Sure	16.7%	46
	answered question	**276**
	skipped question	**33**

20. How much money would you be willing to spend to retrofit your home to reduce risks associated with natural disasters? (for example, by elevating a home above the flood level, performing seismic upgrades, or replacing a combustible roof with non-combustible roofing)

	Response Percent	Response Count
$10,000 or above	6.9%	19
$5,000 to $9,999	10.5%	29
$1,000 to $4,999	14.1%	39
Less than $1,000	8.7%	24
Nothing	21.0%	58
Not Sure	**38.8%**	**107**
	answered question	**276**
	skipped question	**33**

21. Which of the following incentives would encourage you to spend money to retrofit your home to protect against natural disasters? (Check all that apply)

	Response Percent	Response Count
Insurance premium discount	**57.6%**	**159**
Mortgage discount	39.1%	108
Low interest rate loan	35.9%	99
Grant funding	52.5%	145
None	18.1%	50
Other (please specify)	4.7%	13
	answered question	**276**
	skipped question	**33**

22. If your property were located in a designated “high hazard” area or had received repetitive damages from a natural hazard event, would you consider a ”buyout” offered by a public agency?

	Response Percent	Response Count
Yes	**51.3%**	**140**
No	16.5%	45
Not Sure	32.2%	88
	answered question	**273**
	skipped question	**36**

23. Would you support the regulation (restriction) of land uses within known high hazard areas?

	Response Percent	Response Count
Would support	**64.6%**	**166**
Would not support	35.4%	91
	answered question	**257**
	skipped question	**52**

24. Please indicate how you feel about the following statement: It is the responsibility of government (local, state and federal) to provide education and programs that promote citizen actions that will reduce exposure to the risks associated with natural hazards.

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Rating Average	Response Count
Choose one:	9.6% (26)	15.1% (41)	18.0% (49)	**42.6% (116)**	14.7% (40)	3.38	272
						answered question	**272**
						skipped question	**37**

25. Please indicate how you feel about the following statement: It is my responsibility to educate myself and take actions that will reduce my exposure to the risks associated with natural hazards.

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Rating Average	Response Count
Choose one:	1.8% (5)	2.2% (6)	6.6% (18)	31.6% (86)	**57.7% (157)**	4.41	272
						answered question	**272**
						skipped question	**37**

26. Please indicate how you feel about the following statement: Information about the risks associated with natural hazards is readily available and easy to locate.

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Rating Average	Response Count
Choose one:	3.7% (10)	16.0% (43)	26.9% (72)	**39.2% (105)**	14.2% (38)	3.44	268
						answered question	**268**
						skipped question	**41**

27. Please indicate your age range:

	Response Percent	Response Count
Under 18	0.7%	2
18 to 30	10.3%	28
31 to 40	16.9%	46
41 to 50	**29.0%**	**79**
51 to 60	27.9%	76
61 or older	15.1%	41
	answered question	**272**
	skipped question	**37**

28. Please indicate the primary language spoken in your household.

	Response Percent	Response Count
English	**100.0%**	**270**
Spanish	0.0%	0
Other Indo-European Languages	0.0%	0
Asian and Pacific Island Languages	0.0%	0
Other (please specify)	0.0%	0
	answered question	**270**
	skipped question	**39**

29. Please indicate your gender:

	Response Percent	Response Count
Male	44.9%	120
Female	**55.1%**	**147**
	answered question	**267**
	skipped question	**42**

30. Please indicate your highest level of education.

	Response Percent	Response Count
Grade school/No schooling	0.0%	0
Some high school	0.7%	2
High school graduate/GED	8.8%	24
Some college/Trade school	29.4%	80
College degree	**44.9%**	**122**
Graduate degree	15.8%	43
Other (please specify)	0.4%	1
	answered question	**272**
	skipped question	**37**

31. How long have you lived in Whitman County?

	Response Percent	Response Count
Less than 1 year	6.0%	15
1 to 5 years	12.0%	30
6 to 10 years	17.2%	43
11 to 20 years	18.0%	45
More than 20 years	**46.8%**	**117**
	answered question	**250**
	skipped question	**59**

32. Do you own or rent your place of residence?

	Response Percent	Response Count
Own	**83.7%**	**220**
Rent	16.3%	43
	answered question	**263**
	skipped question	**46**

33. How much is your gross household income?

	Response Percent	Response Count
$20,000 or less	2.9%	7
$20,001 to $49,999	26.3%	64
$50,000 to $74,999	**28.4%**	**69**
$75,000 to $99,999	23.9%	58
$100,000 or more	18.5%	45
	answered question	**243**
	skipped question	**66**

34. Do you have regular access to the Internet?

	Response Percent	Response Count
Yes	**93.6%**	**248**
No	6.4%	17
Not Sure	0.0%	0
	answered question	**265**
	skipped question	**44**

35. Comments

	Response Count
	25
answered question	**25**
skipped question	**284**

APPENDIX C.
5-YEAR PROGRESS REPORT
ON INITIAL WHITMAN COUNTY HAZARD MITIGATION PLAN

APPENDIX C.
5-YEAR PROGRESS REPORT ON INITIAL WHITMAN COUNTY HAZARD MITIGATION PLAN

Reporting Period

May 2006 to December 2012

Background

Whitman County and its planning partners developed a Hazard Mitigation Plan to provide a vision for reducing risk from all natural hazards by identifying resources, information, and strategies for risk reduction. Responding to programmatic requirements defined under the Disaster Mitigation act of 2000. This act required state and local governments to develop hazard mitigation plans as a condition for federal grant assistance. Over a 20 month period from May of 2004 to January of 2006, the partnership organized resources, assessed the risks to natural hazards within the planning area, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address the probable impacts from natural hazards within Snoqualmie. By completing this process, the Partnership has maintained its compliance with the parameters of the Disaster Mitigation Act, and thus leveraged hazard mitigation grant funding opportunities afforded under the Robert T. Stafford Act. Copies of the plan are available to the public throughout the Whitman County Public Library system and it can be viewed on-line at:

http://www.whitmancounty.org/page.aspx?pn=Emergency+Management

Summary Overview of the Plan's Progress

The performance period for the Hazard Mitigation Plan became effective on May 6, 2006, with the final approval of the plan by FEMA region X. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur sometime in 2011. This progress report will cover the full 5-year performance period. The Hazard Mitigation Plan identified hazard mitigation initiatives to be pursued by the Planning Partnership during the initial performance period of this plan. As of the reporting period, the following overall progress can be reported:

- 40 out of 107 initiatives (37.4%) reported ongoing action towards completion.
- 8 out of 107 initiatives (7.5%) were reported as being complete as of this reporting period.
- 59 out of 107 initiatives (55.1%) reported no action taken as of this reporting period

Purpose

The purpose of this report is to provide the governing bodies of the planning partnership, Stakeholders and the citizens of Whitman County an update on the implementation of the action plan identified in the Whitman County Hazards Mitigation Plan. This report has been prepared by the planning team and was reviewed and confirmed by the Steering Committee in accordance with section 7.1 of the plan. The Steering Committee reviewed and approved this progress report at their meeting held June 21, 2012. The objective of this evaluation is to ensure that there is a continuing and responsive planning process that will keep the Hazard Mitigation Plan dynamic and responsive to the needs and capabilities of the planning partnership. This report will discuss the following:

- Natural Hazard Events that have occurred within the last year

- Changes in risk exposure within the planning area
- Mitigation Success Stories
- Review of the action plan(s)
- Changes in capability within the planning Area that could impact plan implementation
- Recommendations for changes/enhancement

The Steering Committee

Development of the plan was overseen by a 15-member steering committee made up of planning partners and stakeholders within the planning area. This oversight committee operated under a set of ground rules that they helped to establish and that that supported the primary objectives of the planning process. It was determined through the plan's development process that a Steering committee will remain as a viable body to oversee the maintenance aspects of the plan as established in Chapter 7. This body will remain as organized in the established ground rules, but will be dynamic in its membership. It is anticipated that there will be turn-over in this membership annually that will be monitored via the progress reporting mechanism. It is also anticipated the Steering Committees role in overall plan implementation will be dynamic, based on the hazard mitigation needs of the city. At a minimum, the Steering Committee will provide technical review and oversight on the development of the annual progress report. For this reporting period, the Steering Committee Membership is as indicated in Table C-1.

TABLE C-1.
STEERING COMMITTEE MEMBERS

Name	Title	Jurisdiction/Agency
Bill Tensfeld *a*	Fire Chief	Whitman County Fire Protection District #7
Fran Martin *b*	Emergency Manager	Whitman County Emergency Management
Mark Workman	Director of Public Works	City of Pullman
Rick Wekenman		City of Palouse
Annie Pillars		City of Garfield
Bill Whitman		Pullman Regional Hospital
Sue Bafus		Town of Endicott
Barbara Dial-Flomer		Town of Farmington
Linda Hayes		Town of St. John
Daryl Ruby	Regional Coordinator	WA State Homeland Security Region 9
Mary Gegon		Town of Oakesdale
Larry Burgess		Town of Lacrosse
Brian Keller		Town of Colton
Gary Burns		Whitman County Hospital
Aaron Lee		Whitman County Citizen
Ted Olsen		WA Department of Ecology

a. Steering Committee Chairperson b. Steering Committee Vice Chairperson

Natural Hazard Events within the Planning Area

During the reporting period, there were no natural hazard events with in the planning area that had a measurable impact on people or property.

Changes in Risk exposure within the Planning Area

The Hazard Mitigation Plan addressed the probable impacts of the following hazards:

- Drought
- Earthquake
- Flood
- Severe Weather
- Volcano
- Wildfire

During the reporting period, there was no occurrence of any natural hazard event within the planning area that would alter or change the probability of occurrence, or ranking of risk for the natural hazards addressed by the Hazard Mitigation Plan. It should be noted that the concurring update to the Hazard Mitigation Plan is assessing 2 additional hazards of concern (Dam failure and landslide) based on direction from the most current version of the WA State Enhanced Hazard Mitigation Plan.

Mitigation Success Stories

Little mitigation activity was accomplished during the initial performance period for the plan. This can be attributed to the lack of disaster activity within the planning area as well as the harsh economic times that hit not only the County, but the entire country during this time frame. The continued implementation of the "ongoing" actions identified in the actions plans of the planning partners is considered to be a major success story, in light of the harsh economic times.

Review of the Action Plan

This section will review the action plan of each planning partner and determine the status of each initiative. The action plan matrix in Table C-2 provides the following information:

- Brief summary of the initiative
- Time Line
- Priority
- Status

Reviewers of this report should refer to Part 4 of the plan for more detailed descriptions of each initiative and the prioritization process. Under the "status" section of the following section the following comments with regards to each initiative:

- Was any element of the initiative carried out during the reporting period?
- If no action was completed, why?
- Is the timeline for implementation for the initiative still appropriate?
- If the initiative was completed, does it need to be changes or removed from the action plan?

TABLE C-2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
WHITMAN COUNTY				
WC-1.) Retrofit critical infrastructure such vulnerable roads, bridges and large culverts from the impacts of flood and earthquake hazards.				
Yes	Short	High	This is an ongoing activity by Whitman County Department of Public Works.. There is a systematic replacement of short to medium length bridges and culverts annually.	**O**
WC-2.) Mitigate vulnerable roadways with historical erosion problems with slope armoring techniques, drainage improvements or roadway relocation depending on which techniques is the most cost beneficial alternative.				
Yes	Short	High	This is an ongoing activity by Whitman County Department of Public Works, with 1 to 2 projects completed annually	**O**
WC-3.) Restore the roadside drainage capacity of vulnerable facilities by removing the erosion sediment via standard drainage facility maintenance protocol.				
Yes	Short	Medium	This is an ongoing maintenance function for Whitman County Department of Public Works. There is annual sediment removal at strategic locations.	**O**
WC-4.) Strategically locate stormwater management facilities to control the sediment load in critical portions of pre-identified stream locations to mitigate the future loss of stream channel capacity.				
No	Long	Medium	Preliminary actions to identify budget have been taken. But no action as of this reporting period.	**X**
WC-5.) Consider the adoption of regulatory provisions that require “buffers” or “setbacks” to attenuate the impacts of flooding and erosion on development within the county.				
Yes	Short	High	Currently working with federal Legislator to consider buffer protections. There is some level of buffer protection in local ordinances	**O**
WC-6.) Use the risk assessment data of this plan to consider higher regulatory standards that will mitigate the impacts of natural hazards through the County’s annual review of its codes and ordinances.				
No	Short	High	County is currently in the drafting stages of a re-write of the wetlands, floodplain and critical areas ordinances	**X**
WC-7.) Relocate the Public Works Critical Facilities and the Department of Emergency Management to a feasible location that is not vulnerable to impacts from any natural hazard. This relocation would include the development of an alternate location for the Emergency Operations Center to be used as a back-up.				
No	Long	Medium	No action taken on this initiative due to lack of funding	**X**
WC-8.) Create remote emergency response capability by developing a “mobile command unit” that can be used as an Emergency Operations Center in the isolated portions of the County during hazard events				
Yes	Long	Low	County has acquired and emergency communications truck	✓

TABLE C-2. ACTION PLAN MATRIX				
Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
WC-9.) Enhance the Whitman County Emergency response plan to include: a.) identification of critical transportation routes vulnerable to impacts of natural hazards and that identifies alternative routes to be used during evacuation. b.) critical facility notification procedures c.) a post-disaster action plan. d.) coordination with County planning partners to establish a regional emergency response protocol				
No	Short	High	No action taken on this initiative during the reporting period	**X**
WC-10.) Use risk assessment data from this plan to identify (map) a list of flood susceptible structures within the entire County (including planning partners Cities) to target public education and outreach on property protection and flood preparedness				
No	Short	High	No action taken on this initiative during the reporting period	**X**
WC-11.) Consider voluntary participation in programs such as the Community Rating System and Firewise programs that will provide benefits/incentives to the Citizens of Whitman County for hazard mitigation.				
No	Short	Low	No action taken on this initiative during the reporting period	**X**
WC-12.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of the county and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership.				
Yes	Short	High	County continued to maintain the hazard mitigation plan website. Coordination of information between partners was accomplished via an Local Emergency Planning Committee, which was established during the reporting period.	✓
13.) Seek opportunities to develop GIS capability within the County to enhance all facets of planning capability for the County.				
Now	Short	medium	No action taken on this initiative during the reporting period	**X**
CITY OF PALOUSE				
#Pa-1.) Implement the action items identified in the City of Palouse Flood Mitigation Plan				
Yes	Long	High	This is an ongoing action	**O**
#Pa-2.) Implement appropriate and feasible bank stabilization projects, using best engineering practices and techniques.				
Yes	Long	Medium	This is an ongoing action	**O**
#Pa-3.) Develop and adopt an emergency response plan for the City of Palouse that will identify response actions for all hazards that the City has exposure and develop a post disaster action plan.				
Yes	Short	Medium	2006- Annexed into Whitman County Plan	✓

TABLE C-2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
#Pa-4.) Acquire and remove vulnerable properties adjacent to the Palouse River along SR 27. Implementation of this action is dependent upon willing sellers. The land use of these property acquisitions would be converted to an open space use that would provide increased flood storage and habitat enhancement.				
Yes	Short	High	Completed/Ongoing	✓
#Pa-5.) Seek to acquire and remove vulnerable floodplain properties that are eligible under multiple funding programs and can provide multiple program benefits				
Yes	Short	High	Brownfield cleanup on E. Main is an ongoing action.	**O**
#Pa-6.) Retrofit the City-owned footbridge across the Palouse River to provide increased conveyance and eliminate blockage of stream flow in high water events. Project would also provide seismic protection to the bridge which was not constructed according to any seismic standards				
No	Long	Medium	No action on this initiative during the reporting period.	**X**
#Pa-7.) Consider the adoption of higher regulatory standards appropriate for the hazards for which Palouse has vulnerability and within the City's capabilities				
Yes	Short	High	This is an ongoing action. Permitting requirements have been enhanced during the reporting period.	**O**
#Pa-8.) Due to the age and type of construction of City-owned buildings such as City Hall, the Police Station and Fire Station, the City will consider a seismic analysis of these properties to determine their vulnerability to seismic events and possible mitigation measures.				
No	Long	Low	No action on this initiative during the reporting period.	**X**
#Pa-9.) Seek flood control alternatives that will provide the highest degree of flood protection to the City of Palouse that enhance/attenuate the natural and beneficial functions of the floodplain.				
Yes	Long	Low	Subscription to USGS flood gauge	**O**
#Pa-10.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of Palouse and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership				
Yes	Short	High	Palouse is a committed planning partner in the Whitman County Hazard Mitigation planning effort.	**O**
#PA-11.) Consider voluntary participation in programs such as the Community Rating System, Firewise and Storm Ready programs that will provide benefits/incentives to the Citizens of Palouse for hazard mitigation.				
No	Long	Medium	No action on this initiative during the reporting period.	**X**
#Pa-12.) Continue to coordinate and work with Whitman County Emergency Management in disaster response and preparedness. This level of coordination should include: updates to the Emergency response plan, development of a post disaster action plan, training and support.				
Yes	Short	high	Ongoing- Whitman County meetings	**O**

TABLE C-2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
CITY OF PULLMAN				
#Pu-1.) Implement the flood mitigation strategies and emergency action plans for flood events identified in the City of Pullman Comprehensive Flood Hazard Management Plan.				
Yes	Short	High	Many strategies have been implemented. An crisis team has been identified through an SOP for the first major impact due to flooding, the Pine Street Bridge; a process for flood detection evaluation, and classification has been developed using the gauging station on the South Fork of the Palouse River at State Street and generated hydrograph. Stream maintenance has been pursued, but has proven to not be feasible due to permitting and mitigation requirements – we can't even put riprap in front of a scoured bridge pier or remove trees growing in the middle of a stream channel.	**O**
#PU-2.) Missouri Flat Creek Channel improvements and property acquisition. This project would acquire and remove the carwash property located at Stadium Way, channel improvements that include 700 feet of channel clearing, and removal of an abandoned railroad trestle.				
Yes	Short	High	The railroad trestle has been removed and the channel improvements have mostly been completed except for near the car wash. Purchasing of the car wash was pursued, but the owner wanted an exorbitant amount of money ($750,000) that far exceeded any benefit/cost analysis. The plan is to wait until the current ownership changes or the owner wants to develop the property and revisit this at that time.	**O**
#Pu-3.) Acquire railroad right-of-way adjacent to Missouri Flat Creek and convert to an open space use that will provide increased flood storage, conveyance and habitat.				
Yes	Long	Medium	This was done to the extent practical, given the proximity of the railroad mainline track. More could be done near the carwash if that could be purchased	**O**
#Pu-4.) Acquire University Trailer Park located along the south Fork of the Palouse River and convert to open space area which is contiguous with a parcel currently in an open space use. This project would remove habitable structures from a high risk area that includes mapped floodway. Open space are would be used for flood storage and habitat enhancement.				
Yes	Short	High	This was pursued, but the owner wanted an exorbitant amount of money. He currently nets about $2,500 per month and wanted a buyout amount that would yield that in interest income. This buyout amount far exceeded any benefit/cost analysis. The plan is to wait for the owner to change his mind.	**O**

TABLE C-2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
#Pu-5.) Raise Park Street to an elevation that will not be inundated during flooding events. The importance of this roadway is that it is a vital link to the City’s Operation and Maintenance facility and Wastewater treatment Plant.				
No	Long	Medium	Work has not yet been undertaken on this project. However, the alternate solution of constructing a permanent flood wall or a structural rail system that can be converted to a flood wall during events is being investigated. This solution would minimize the impact to adjacent properties.	**O**
#Pu-6.) Retrofit Spring Street and Kamiaken Street Bridges to provide increased channel conveyance in the Palouse River and provide seismic protection to these critical infrastructure elements.				
No	Long	Medium	Spring Street bridge is to be replaced in the medium term. Kamiaken Street bridge has some deck problems and if these can be addressed, the bridge will be retained. If not, the bridge will be replaced in the medium term	**O**
#Pu-7.) Create a stormwater utility and adopt stormwater manual to seek compliance with NPDES Phase 2 requirements and to control a future increase in flooding problems within the City.				
Yes	Short	High	Stormwater utility created and stormwater manual adopted in a stormwater ordinance. Pullman is in compliance with its NPDES Phase 2 Municipal Stormwater Permit	✓
#Pu-8.) Consider the adoption of higher regulatory standards appropriate for the hazards for which Pullman has vulnerability and within the City’s capabilities				
Yes	Short	High	Some consideration given, but nothing implemented	**O**
#Pu-9.) Create and maintain a hazard mitigation informational web page on the City of Pullman’s website.				
Yes	Short	High	A link to the Whitman County Hazard Mitigation Plan that covers the entire County, including Pullman is provided on the City of Pullman website.	**O**
#Pu-10.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of Pullman and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership.				
Yes	Short	High	Ongoing	**O**
#Pu-11.) Consider voluntary participation in programs such as the Community Rating System, Firewise and Storm Ready programs that will provide benefits/incentives to the Citizens of Pullman for hazard mitigation.				
Yes	Short	High	Participation in the Community Rating System was pursued but not implemented due to the lack of staff time to devote to the issue. We may look at it again sometime in the future.	**O**

TABLE C-2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
#Pu-12.) Continue to coordinate and work with Whitman County Emergency Management in disaster response and preparedness. This level of coordination should include: updates to the Emergency response plan, development of a post disaster action plan, training and support.				
Yes	Short	High	Ongoing	**O**
TOWN OF COLTON				
#C-1.) Develop a comprehensive flood hazard management plan that will update the flood risk assessment for Colton, and identify alternatives within the capabilities of Colton to mitigate the impacts of flooding.				
No	Short	High	No action reported during the reporting period	**X**
#C-2.) Work with local utility providers to initiate/promote underground utilities when opportunities arise via repair or replacement of utilities.				
No	Short	High	No action reported during the reporting period	**X**
#C-3.) Adopt the International Building Code by adopting the Revised Washington State Building Code.				
No	Short	High	No action reported during the reporting period	**X**
#C-4.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of Colton and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership.				
No	Short	High	No action reported during the reporting period	**X**
#C-5.) Consider voluntary participation in programs such as the Firewise and Storm Ready programs that will provide benefits/incentives to the Citizens of Colton for hazard mitigation.				
No	Short	High	No action reported during the reporting period	**X**
#C-6.) Use information provided in the Whitman County HIVA to consider regulatory provisions that will reduce the vulnerability, and promote wise land use with regards to hazards that impact the City of Colton.				
No	Short	High	No action reported during the reporting period	**X**
#C-7.) Continue to coordinate and work with Whitman County Emergency Management in disaster response and preparedness. This level of coordination should include: updates to the Emergency response plan, development of a post disaster action plan, training and support.				
No	Short	High	No action reported during the reporting period	**X**
TOWN OF ENDICOTT				
#E-1) Promote private property owner water conservation through public outreach programs implemented by the Town of Endicott				
No	Short	High	No action reported during the reporting period	**X**

TABLE C-2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
#E-2.) Retrofit the town municipal water system by increasing stored water capacity, hardening water storage facilities and distribution mains such that they can withstand seismic grand shaking, and increase fire hydrant spacing where current spacing is deficient.				
No	Long	Medium	No action reported during the reporting period	**X**
#E-3.) Enhance stream channel capacity on Rebel Flat Creek to mitigate the impacts of flooding that have benefits that exceeds costs, enhances the natural and beneficial functions of the floodplain, while providing flood protection to the people and property within Endicott.				
No	Long	Medium	No action reported during the reporting period	**X**
#E-4.) Consider regulatory standards appropriate for the risk to mitigate future impacts to new development within Endicott for which the Town has susceptibility.				
No	Shot	High	No action reported during the reporting period	**X**
#E-5.) Update building code by formally adopting the revised Washington State Building Code which now included the International Building Code (IBC).				
No	Short	High	No action reported during the reporting period	**X**
#E-6.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of Endicott and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership.				
No	Short	High	No action reported during the reporting period	**X**
#E-7.) Consider voluntary participation in programs such as the Community Rating System, Firewise, and Storm Ready programs that will provide benefits/incentives to the Citizens of Endicott for hazard mitigation.				
No	Long	High	No action reported during the reporting period	**X**
#E-8.) Use information provided in the Whitman County HIVA to consider regulatory provisions that will reduce the vulnerability, and promote wise land use with regards to hazards that impact the Town of Endicott.				
No	Long	High	No action reported during the reporting period	**X**
#E-9.) Continue to coordinate and work with Whitman County Emergency Management in disaster response and preparedness. This level of coordination should include: updates to the Emergency response plan, development of a post disaster action plan, training and support.				
No	Short	High	No action reported during the reporting period	**X**
TOWN OF FARMINGTON				
#F-1.) Water Conservation – install sprinkler system (Town of Farmington uses excess water for landscape and parks via manual watering)				
No	Short	High	No longer financially feasible.	**X**

TABLE C-2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
#F-2.) Meter for town-used water (public water system not metered; private water system is metered)				
Yes	Short	High	In progress. Expected completion date 2017.	**O**
#F-3.) Modify water well electrical system to connect existing 20 kW generator for emergency water supply/fire flow.				
Yes	Short	High	In progress. Completion contingent upon available funding in current Community Development Block Grant, this project could potentially be completed by September 2012.	**O**
#F-4.) Seismic retrofit/upgrade of that portion of the Town's domestic water supply system that is vulnerable to sever grand shaking due to its age and construction.				
No	Long	Medium	No longer financially feasible.	**O**
#F-5.) Coordinate with Whitman County to update the Flood Insurance Study for the Town of Farmington.				
No	Long	Low	Pending. Awaiting FEMA RiskMAP process	**O**
#F-6.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of Farmington and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership.				
Yes	Short	High	The Town of Farmington remains a fully committed planning partner under the Whitman County Hazard Mitigation Plan, and fully supports all county-wide initiatives identified in the plan.	**O**
#F-7.) Consider voluntary participation in programs such as the Community Rating System, Firewise and Storm Ready programs that will provide benefits/incentives to the Citizens of Farmington for hazard mitigation.				
No	Short	Medium	No action taken on this initiative at this time. Awaiting new mapping before looking at the feasibility of the CRS program.	**X**
#F-8.) Use information provided in the Whitman County HIVA to consider regulatory provisions that will reduce the vulnerability, and promote wise land use with regards to hazards that impact the Town of Farmington				
Yes	Short	High	Ongoing	**O**
#F-9.) Continue to coordinate and work with Whitman County Emergency Management in disaster response and preparedness. This level of coordination should include: updates to the Emergency response plan, development of a post disaster action plan, training and support.				
Yes	Short	High	We have an updated emergency response plan with our elected officials who continually participating in training and support.	**O**

**TABLE C-2.
ACTION PLAN MATRIX**

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
TOWN OF GARFIELD				
#G-1.) Create redundancy to electrical power supply to critical infrastructure such as the water supply system with purchase of backup generator.				
Yes	Short	Medium	As part of the town's 2009 Water System Plan a backup power supply system was identified and given a priority ranking of No. 6 with options such as a diesel generator, propane generator and a natural gas generator. An estimated cost of $65,000 was determined for this backup system. Funding sources outside of town resources are necessary for this project. Identifying and seeking such funding opportunities is ongoing.	**O**
#G-2.) Retrofit vulnerable water distribution mains from the impacts of severe ground shaking caused from earthquakes				
Yes	Long	Medium	In 2009 the town received a $118,000 ARRA grant for the replacement of a 2,100 lineal foot steel leaded joint flexible pipe with a new 8" main with C900 plastic rubber boots that flexes every 4 feet. This retrofit project was completed June 2010.	**O**
#G-3.) Implement structural measures that will mitigate the causes of flooding on Silver Creek, which include: decrease channel capacity due to sediment deposition, stream channel maintenance and ice jams at the railroad trestle crossing. Phase 1 of this project will include feasibility analysis to identify most appropriate action within the city's capabilities.				
No	Long	Medium	Since the original hazard mitigation plan was adopted, the town has a new engineering firm that has become familiar with issues facing the town. Phase I options can now be explored.	**O**
#G-4.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of Garfield and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership.				
Yes	Short	High	February 2010 the town had a digital 2' interval mapping of town completed. The town provides information on and copies of its Floodplain Map and Critical Areas Protection Zoning Ordinance. With the assistance of Washington State Department of Ecology, the town updated its floodplain management ordinance in August of 2011. In February 2012 the town renewed its partnership with Whitman County Natural Hazards Mitigation Planning and is actively participating in the 2012 county-wide plan update.	**O**

**TABLE C-2.
ACTION PLAN MATRIX**

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
#G-5.) Consider voluntary participation in programs such as the Community Rating System, Firewise and Storm Ready programs that will provide benefits/incentives to the Citizens of Garfield for hazard mitigation.				
No	Short	High	This goal will be re-addressed as part of the town's 2012 Hazard Mitigation Plan update.	O
#G-6.) Use information provided in the Whitman County HIVA to consider regulatory provisions that will reduce the vulnerability, and promote wise land use with regards to hazards that impact the City of Garfield.				
Yes	Long	High	May 2007 the town adopted a Critical Areas Protection Ordinance. February 2010 the town had a digital 2' interval mapping of town completed.	✓
#g-7.) Continue to coordinate and work with Whitman County Emergency Management in disaster response and preparedness. This level of coordination should include: updates to the Emergency response plan, development of a post disaster action plan, training and support				
Yes	Short	High	All town employees have taken National Incident Management Systems (NIMS) training. The new Public Works Superintendent specifically completed NIMS 100 training for public works in April 2011.	O
TOWN OF LACROSSE				
#L-1.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of LaCrosse and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership.				
No	Short	High	No action reported during the reporting period	X
#L-2.) Continue to coordinate and work with Whitman County Emergency Management in disaster response and preparedness. This level of coordination should include: updates to the Emergency response plan, development of a post disaster action plan, training and support.				
No	Short	High	No action reported during the reporting period	X
#L-3.) Adopt International Building Code pursuant to State mandate.				
No	Short	High	No action reported during the reporting period	X
#L-4.) Consider Voluntary participation in the National Flood insurance program				
No	Short	High	No action reported during the reporting period	X
#L-5.) Work with local utility providers to initiate/promote underground utilities when opportunities arise via repair or replacement of utilities.				
No	Short	Medium	No action reported during the reporting period	X

TABLE C-2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
TOWN OF MALDEN				
#M-1.) Additional water well to improve capacity and reliability for fire protection				
No	Long	Medium	No action reported during the reporting period	**X**
#M-2.) Perform floodplain study to evaluate potential flood hazards and mitigation recommendations				
No	Long	Low	No action reported during the reporting period	**X**
#M-3.) Enhance and revise Malden's floodplain management program such that NFIP sanctions could be lifted and Malden would achieve full program eligibility afforded under the Robert T Stafford Act.				
No	Short	High	No action reported during the reporting period	**X**
#M-4.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of Malden and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership.				
No	Short	High	No action reported during the reporting period	**X**
#M-5.) Consider voluntary participation in programs such as the Firewise and Storm Ready programs that will provide benefits/incentives to the Citizens of Malden for hazard mitigation.				
No	Short	High	No action reported during the reporting period	**X**
#M-6.) Adopt the revised WA. State Building Code that includes the International Building Code				
No	Short	High	No action reported during the reporting period	**X**
#M-7.) Use information provided in the Whitman County HIVA to consider regulatory provisions that will reduce the vulnerability, and promote wise land use with regards to hazards that impact the City of Malden.				
No	Short	High	No action reported during the reporting period	**X**
#M-8.) Continue to coordinate and work with Whitman County Emergency Management in disaster response and preparedness. This level of coordination should include: updates to the Emergency response plan, development of a post disaster action plan, training and support.				
No	Short	High	No action reported during the reporting period	**X**
TOWN OF OAKESDALE				
#O-1.) Develop a Comprehensive Flood Hazard Management plan that will update the flood risk assessment for Oakesdale, and identify alternatives within the capabilities of Oakesdale to mitigate the impacts of flooding.				
No	Short	High	No action reported during the reporting period	**X**
#O-2.) Initiate damage/feasibility study to determine seismic vulnerability and identify mitigation alternatives for city owned critical facilities and infrastructure.				
No	Short	High	No action reported during the reporting period	**X**

TABLE C-2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
#O-3.) Work with local utility providers to initiate/promote underground utilities when opportunities arise via repair or replacement of utilities.				
No	Short	High	No action reported during the reporting period	**X**
#O-4.) Initiate outreach program to educate home owners on floodproofing their basements				
No	Short	High	No action reported during the reporting period	**X**
#O-5.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of Oakesdale and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership.				
No	Short	High	No action reported during the reporting period	**X**
#O-6.) Consider voluntary participation in programs such as the Community Rating System, Firewise and Storm Ready programs that will provide benefits/incentives to the Citizens of Oakesdale for hazard mitigation.				
No	Short	High	No action reported during the reporting period	**X**
#O-7.) Use information provided in the Whitman County HIVA to consider regulatory provisions that will reduce the vulnerability, and promote wise land use with regards to hazards that impact the Town of Oakesdale.				
No	Long	High	No action reported during the reporting period	**X**
#O-8.) Continue to coordinate and work with Whitman County Emergency Management in disaster response and preparedness. This level of coordination should include: updates to the Emergency response plan, development of a post disaster action plan, training and support.				
No	Short	High	No action reported during the reporting period	**X**
TOWN OF ST. JOHN				
#SJ-1.) Pleasant Valley Creek- Stream Maintenance/Enhancement. Enhance steam channel capacity through ongoing maintenance and channel improvements that will increase conveyance while enhancing the natural and beneficial functions of the stream system				
Yes	Short	High	City continues to perform stream maintenance	**O**
#SJ-2.) Relocate sewage treatment plant from its current location which has vulnerability to both flood and earthquake hazards.				
Yes	Long	Medium	Land has been purchased	**O**
#SJ-3.) Purchase an emergency generator for water supply/sewage treatment plant, which continuous operation is critical to vital City services.				
Yes	Long	High	Generator purchased	✓

**TABLE C-2.
ACTION PLAN MATRIX**

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
#SJ-4.) Seismic retrofit/upgrade of that portion of the City's domestic water supply system that is vulnerable to severe ground shaking due to its age and construction. This project will also include enhancement to the City's fire hydrant spacing/distribution as mitigation for the wild land fire hazard exposure				
No	Long	Medium	No action reported during the reporting period	X
#SJ-5.) Retrofit water supply well #3 for exposure to the flood and earthquake hazards.				
Y	Long	Low	Well has been decommissioned	✓
#SJ-6.) Work with providers of electric utility services to the City of St. John to place electric utilities underground when being repaired, replaced or enhanced as mitigation for the impacts of the severe weather hazard.				
Yes	Short	High	Most utilities are now underground	O
#SJ-7.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of St. John and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership.				
Yes	Short	High	Continued to support this initiative during the reporting period	O
#SJ-8.) Continue to coordinate and work with Whitman County Emergency Management in disaster response and preparedness. This level of coordination should include: updates to the Emergency response plan, development of a post disaster action plan, training and support.				
Yes	Short	High	Continued to support this initiative during the reporting period.	O
WHITMAN COUNTY FIRE PROTECTION DISTRICT #7				
#FD7-1.) Coordinate with Rosalia to purchase an emergency generator for water supply/sewage treatment plant, which continuous operation is critical to vital City services.				
No	Short	High	No action reported during the reporting period	X
#FD7-2.) Coordinate with Rosalia to continue promotion/implementation of water conservation program that includes: reducing leaks, replacement of infrastructure to reduce consumption of water. Implemented water conservation program via rate study, timed park automatic sprinkler systems, public information - To implement water conservation programs, reduce water use in City Parks, and inform public of conservation issues.				
No	Long	High	No action reported during the reporting period	X
#FD-3.) Acquire property in Thorton & Pine City: drill well and construct 25, 000 gallon reservoir				
No	Long	Low	No action reported during the reporting period	X
#FD-4.) Non-structural seismic retrofits: tie down equipment, computers, etc. at District owned facilities				
No	Short	High	No action reported during the reporting period	X

TABLE C-2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O, ✓)
#FD-5.) Public information program: create/distribute brochures on property protection from the impacts of natural hazards				
No	Short	High	No action reported during the reporting period	X
#FD-6.) Construct Fire District website				
No	Short	High	No action reported during the reporting period	X
#FD-7.) Support countywide initiatives that promote the education of the public on the impacts of natural hazards within Whitman County, and the preparedness for and the mitigation of those impacts. This support will be in the form of dissemination of appropriate information to the residents of Whitman County Fire District #7 service area and continuing support/participation in the Whitman County Natural Hazards Mitigation Planning Partnership.				
No	Short	High	No action reported during the reporting period	X
#FD-8.) Consider voluntary participation in the Firewise program that will provide benefits/incentives to the Citizens of Whitman County Fire District #7 service area for hazard mitigation.				
No	Short	High	No action reported during the reporting period	X
#FD-9.) Continue to coordinate and work with Whitman County Emergency Management in disaster response and preparedness. This level of coordination should include: updates to the Emergency response plan, development of a post disaster action plan, training and support.				
No	Short	High	No action reported during the reporting period	X

Completion status legend:
- ✓= Project Completed
- O = Action ongoing towards completion
- X = No progress at this time

Changes in the Planning Area That May Impact Implementation of the Plan

During the reporting period, there were no significant changes within the planning area that would have a profound impact on the implementation of the plan. All technical, regulatory and financial capabilities identified by the Planning Partnership during the plan's development remain consistently in place throughout the planning area.

Recommendations for Changes or Enhancements

Based on the review of this report by the Hazard Mitigation Plan Steering Committee, the following recommendations will be noted for future updates or revisions to the plan.

See January 2013 Update to the Hazard Mitigation Plan.

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the governing bodies of all planning partners, the local media outlets, and posted on the Whitman County Emergency Management-Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Fran Martin, Director
Whitman County Emergency Management
North 310, Main St..
Colfax, WA 99111
(509) 397-6280
Franm@co.whitman.wa.us.

APPENDIX D. ANNUAL PROGRESS REPORT TEMPLATE

APPENDIX D.
ANNUAL PROGRESS REPORT TEMPLATE

Whitman County
Hazard Mitigation Plan Update
Annual Progress Report

Reporting Period: *(Insert reporting period)*

Background: Whitman County and participating cities and special purpose districts in the county developed a hazard mitigation plan to reduce risk from all hazards by identifying resources, information and strategies for risk reduction. The federal Disaster Mitigation Act of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the participating partners organized resources, assessed risks from natural hazards within the county, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, these jurisdictions maintained compliance with the Disaster Mitigation Act, achieving eligibility for mitigation grant funding opportunities afforded under the Robert T. Stafford Act. The plan can be viewed on-line at:

http://www.whitmancounty.org/page.aspx?pn=Emergency+Management

Summary Overview of the Plan's Progress: The performance period for the Hazard Mitigation Plan became effective on ____, 2011, with the final approval of the plan by FEMA. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur before ______, 2016. As of this reporting period, the performance period for this plan is considered to be __% complete. The Hazard Mitigation Plan has targeted __ hazard mitigation initiatives to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ out of __ initiatives (__%) reported ongoing action toward completion.
- __ out of __ initiatives (__%) were reported as being complete.
- __ out of __ initiatives (___%) reported no action taken.

Purpose: The purpose of this report is to provide an annual update on the implementation of the action plan identified in the Whitman County Hazard Mitigation Plan Update. The objective is to ensure that there is a continuing and responsive planning process that will keep the Hazard Mitigation Plan dynamic and responsive to the needs and capabilities of the partner jurisdictions. This report discusses the following:

- Natural hazard events that have occurred within the last year
- Changes in risk exposure within the planning area (all of Whitman County)
- Mitigation success stories
- Review of the action plan
- Changes in capabilities that could impact plan implementation
- Recommendations for changes/enhancement.

The Hazard Mitigation Plan Steering Committee: The Hazard Mitigation Plan Steering Committee, made up of planning partners and stakeholders within the planning area, reviewed and approved this progress report at its annual meeting held on _____, 201_. It was determined through the plan's development process that a steering committee would remain in service to oversee maintenance of the plan. At a minimum, the Steering Committee will provide technical review and oversight on the development of the annual progress report. It is anticipated that there will be turnover in the membership annually, which will be documented in the progress reports. For this reporting period, the Steering Committee membership is as indicated in Table 1.

TABLE 1.
STEERING COMMITTEE MEMBERS

Name	Title	Jurisdiction/Agency

Natural Hazard Events within the Planning Area: During the reporting period, there were __ natural hazard events in the planning area that had a measurable impact on people or property. A summary of these events is as follows:

- ____________________________
- ____________________________

Changes in Risk Exposure in the Planning Area: *(Insert brief overview of any natural hazard event in the planning area that changed the probability of occurrence or ranking of risk for the hazards addressed in the hazard mitigation plan)*

Mitigation Success Stories: *(Insert brief overview of mitigation accomplishments during the reporting period)*

Review of the Action Plan: Table 2 reviews the action plan, reporting the status of each initiative. Reviewers of this report should refer to the Hazard Mitigation Plan for more detailed descriptions of each initiative and the prioritization process.

Address the following in the "status" column of the following table:

- *Was any element of the initiative carried out during the reporting period?*
- *If no action was completed, why?*
- *Is the timeline for implementation for the initiative still appropriate?*
- *If the initiative was completed, does it need to be changed or removed from the action plan?*

TABLE 2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				
Initiative #__ —____________________[description]				

TABLE 2.
ACTION PLAN MATRIX

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				
Initiative #__—____________________[description]				

Completion status legend:
✓= Project Completed
O = Action ongoing toward completion
X = No progress at this time

Changes That May Impact Implementation of the Plan: *(Insert brief overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the Hazard Mitigation Plan Steering Committee, the following recommendations will be noted for future updates or revisions to the plan:

- ____________________________
- ____________________________
- ____________________________
- ____________________________
- ____________________________
- ____________________________

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the governing boards of all planning partners and to local media outlets and the report is posted on the Whitman County Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Insert Contact Info Here

APPENDIX E.
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

APPENDIX E.
PLAN ADOPTION RESOLUTIONS FROM PLANNING PARTNERS

To Be Provided With Final Release