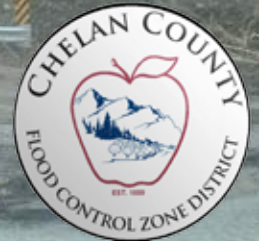




Comprehensive Flood Hazard Management Plan



Chelan County Flood Control Zone District
October 2017



Chelan County Comprehensive Flood Hazard Management Plan

October 2017

PREPARED FOR

Chelan County Flood Control Zone District

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CONTENTS

Executive Summary	xiii
Why Plan for Flooding?	xiii
What is flood hazard mitigation?	xiii
Plan Development Methodology	xiv
Mission statement, Goals and Objectives	xv
Mitigation Actions	xvi
Implementation	xviii
Part 1. PLANNING PROCESS AND PROJECT BACKGROUND.....	1
1. Introduction.....	1-1
1.1 Why Prepare This Plan?	1-1
1.2 Chelan County’s Planning Authority	1-2
1.3 Guidelines for Flood Planning.....	1-2
1.3.1 CRS Steps for Comprehensive Flood Hazard Management Plan	1-2
1.3.2 FCAAP Requirements for Comprehensive Flood Control Management Plan	1-3
1.3.3 Chelan County FCZD Interim Operating Guidelines	1-3
1.4 How to Use This Plan.....	1-3
2. Plan Development Methodology	2-1
2.1 Formation of the Planning Team	2-1
2.2 Defining the Planning Area	2-1
2.3 The Steering Committee.....	2-1
2.4 Coordination with Other Agencies	2-2
2.5 Review of Existing Programs	2-3
2.6 Public Involvement.....	2-3
2.6.1 Strategy	2-4
2.6.2 Public Involvement Results	2-9
2.7 Plan Development Chronology/Milestones.....	2-9
3. Chelan County Profile.....	3-1
3.1 Historical Overview.....	3-1
3.2 Physical Setting	3-3
3.2.1 Watersheds.....	3-3
3.2.2 Geology.....	3-7
3.2.3 Climate.....	3-8
3.3 Development Features	3-9
3.3.1 Land Use	3-9
3.3.2 Critical Facilities and Infrastructure	3-11
3.4 Demographics.....	3-12
3.4.1 Population Characteristics	3-12
3.4.2 Age Distribution.....	3-16
3.4.3 Race, Ethnicity and Language	3-17
3.4.4 Disabled Populations	3-17
3.5 Economy	3-18
3.5.1 Income	3-18
3.5.2 Industry, Businesses and Institutions	3-19
3.5.3 Employment Trends and Occupations	3-20
4. Relevant Programs and Regulations	4-1

4.1 Federal	4-1
4.1.1 Disaster Mitigation Act of 2000	4-1
4.1.2 National Flood Insurance Program	4-1
4.1.3 The Community Rating System.....	4-2
4.1.4 Endangered Species Act	4-3
4.1.5 The Clean Water Act	4-4
4.1.6 National Environmental Policy Act	4-4
4.1.7 National Incident Management System	4-5
4.1.8 Americans with Disabilities Act	4-5
4.1.9 Civil Rights Act of 1964.....	4-5
4.1.10 Rural Development Program	4-5
4.1.11 Community Development Block Grant Disaster Resilience Program	4-6
4.1.12 Emergency Watershed Program.....	4-6
4.1.13 Presidential Executive Orders 11988 and 13690	4-6
4.1.14 Presidential Executive Order 11990	4-7
4.1.15 Emergency Relief for Federally Owned Roads Program.....	4-7
4.1.16 U.S. Army Corps of Engineers Programs	4-7
4.2 State	4-8
4.2.1 Washington State Floodplain Management Law	4-8
4.2.2 Department of Ecology Grants	4-8
4.2.3 Shoreline Management Act.....	4-9
4.2.4 Growth Management Act.....	4-9
4.2.5 Washington State Building Code.....	4-9
4.2.6 Comprehensive Emergency Management Planning	4-10
4.2.7 Watershed Management Act.....	4-10
4.2.8 Washington State Enhanced Mitigation Plan.....	4-11
4.2.9 Washington Silver Jackets	4-11
4.2.10 Land and Water Conservation Fund	4-11
4.2.11 Salmon Recovery Fund.....	4-11
4.2.12 State Environmental Policy Act.....	4-11
4.2.13 State Hydraulic Code	4-12
4.3 Local	4-12
4.3.1 Flood Control Zone District.....	4-12
4.3.2 Comprehensive Plan	4-13
4.3.3 Emergency Management Plan	4-13
4.3.4 Critical Areas Ordinance.....	4-13
4.3.5 Shoreline Master Program	4-14
4.3.6 WRIA Planning.....	4-14
4.3.7 Chelan County Department of Natural Resources	4-14
4.3.8 Voluntary Stewardship Program.....	4-14
4.4 Capability Assessment.....	4-14
5. Regional Consistency.....	5-1
5.1 Local Applicability of County Flood Plans	5-1
5.2 Consistency Review	5-1
5.2.1 Methodology	5-1
5.2.2 Findings	5-2
5.3 Consistency Definition for this Flood Plan	5-2
5.4 Policies to Ensure Consistency.....	5-3

Part 2. RISK ASSESSMENT 1

6. Risk Assessment Methodology	6-1
6.1 Purpose of Risk Assessment.....	6-1
6.2 Risk Assessment Approach	6-2
6.2.1 FEMA’s Hazus-MH Software	6-2
6.2.2 Sources of Data Used in Hazus Modeling	6-3
6.2.3 Flood Depth Grid Generation	6-4
6.2.4 Limitations	6-4
7. Chelan County Flood Hazard Profile.....	7-1
7.1 General Concepts	7-1
7.1.1 Measuring Floods and Floodplains	7-1
7.1.2 Floodplain Ecosystems	7-2
7.1.3 Effects of Human Activities.....	7-2
7.2 Principal Types of Flooding in Chelan County	7-2
7.2.1 Stage Flooding	7-2
7.2.2 Flash Flooding	7-2
7.2.3 Post-Fire Flooding	7-3
7.3 Major Flood Events	7-3
7.3.1 Historical Stage Flooding Events.....	7-4
7.3.2 Historical Flash Flooding Events.....	7-5
7.4 Location.....	7-5
7.5 Frequency	7-7
7.6 Severity	7-7
7.7 Warning Time.....	7-9
7.7.1 Flood Timing With Rainfall Events.....	7-9
7.7.2 Flood Threat Recognition Systems	7-10
7.8 Secondary Hazards	7-11
7.9 Future Trends	7-12
7.10 Scenario	7-12
7.11 challenges, data gaps and Issues.....	7-12
8. Flood Hazard Exposure.....	8-1
8.1 Population.....	8-1
8.2 Property	8-1
8.2.1 Structures in the Floodplain	8-1
8.2.2 Exposed Value	8-2
8.2.3 Land Use in the Floodplain.....	8-3
8.3 Critical Facilities and Infrastructure	8-3
8.3.1 Hazardous Material Facilities	8-3
8.3.2 Utilities and Infrastructure	8-3
8.4 Environment	8-7
9. Flood Hazard Vulnerability	9-1
9.1 Population.....	9-1
9.1.1 Vulnerable Populations.....	9-1
9.1.2 Public Health and Safety.....	9-1
9.1.3 Impacts on People	9-3
9.2 Property	9-3
9.2.1 Loss Estimates	9-3
9.2.2 National Flood Insurance Program	9-3
9.2.3 Repetitive Loss.....	9-5
9.3 Critical Facilities and Infrastructure	9-7

9.4 Environment	9-8
10. Climate Change Considerations for Flood Hazard Management.....	10-1
10.1 What is Climate Change?	10-1
10.2 How Climate Change Affects Flood Hazard Management	10-2
10.3 Current Indications and Observed Changes	10-3
10.3.1 Observed Global Changes.....	10-3
10.3.2 Observed Changes in the Pacific Northwest.....	10-3
10.4 Future Impacts	10-4
10.4.1 Global Projections.....	10-4
10.4.2 Projections and Potential Impacts for the Pacific Northwest.....	10-4
10.5 Impacts on Flood-Related Hazards	10-5
10.5.1 Flood	10-5
10.5.2 Dam Failure	10-5
10.5.3 Wildfire	10-5
10.6 Responses to Climate Change	10-5
Part 3. MITIGATION STRATEGY	1
11. Mission Statement, Goals and Objectives.....	11-1
11.1 Mission Statement	11-1
11.2 Goals.....	11-1
11.3 Objectives.....	11-1
12. Policies.....	12-1
12.1 General Policies.....	12-1
12.1.1 Flood Hazard Management.....	12-1
12.1.2 Policies for Regional Consistency	12-3
12.1.3 National Flood Insurance Program	12-4
12.2 Flood Hazard Area Land Use Policies	12-4
12.2.1 Changes to Flood Hazard Areas Based on Future Conditions.....	12-4
12.2.2 Land Use Regulations	12-5
13. Mitigation Actions	13-1
13.1 Alternatives Analysis.....	13-1
13.1.1 Public Sector Actions.....	13-1
13.1.2 Private Sector Actions.....	13-2
13.1.3 Government Sector Actions.....	13-3
13.2 Selected Mitigation Actions	13-5
13.3 Benefit/Cost review	13-5
13.4 Action Plan Prioritization.....	13-10
13.5 Analysis of Mitigation Actions	13-10
Part 4. PLAN MAINTENANCE	1
14. Plan Adoption	14-1
15. Plan Maintenance Strategy.....	15-1
15.1 Plan Implementation.....	15-1
15.2 Steering Committee	15-1
15.3 Annual Progress Report.....	15-2
15.4 Plan Update	15-2
15.5 Continuing Public Involvement.....	15-3
15.6 Incorporation into Other Planning Mechanisms.....	15-3
References.....	1
Glossary	1

Acronyms1

Definitions2

Appendices

Appendix A. CRS and FCAAP Guidelines

Appendix B. Public Outreach Materials

Appendix C. Example Progress Report

Tables

Table 2-1. Steering Committee Members..... 2-2

Table 2-2. Summary of Public Meetings..... 2-11

Table 2-3. Plan Development Milestones..... 2-11

Table 3-1. Annual Average Chelan County Climate Data 3-8

Table 3-2. Chelan County Critical Facilities 3-15

Table 3-3. Chelan County Critical Infrastructure 3-15

Table 3-4. Recent County Population Growth 3-16

Table 3-5. Projected Future County Population 3-16

Table 4-1. NFIP Participation by Chelan County and Municipalities 4-2

Table 4-2. Legal and Regulatory Capability 4-15

Table 4-3. Administrative and Technical Capability..... 4-16

Table 4-4. Fiscal Capability 4-17

Table 4-5. National Flood Insurance Program Compliance 4-17

Table 5-1. Consistency Review Results 5-2

Table 6-1. Hazus Model Data Documentation 6-3

Table 7-1. History of Chelan County Flood and Fire Events With Presidential Disaster Declarations 7-4

Table 7-2. Summary of Peak Discharges Within the Planning Area 7-7

Table 8-1. Area and Structures Within the 100-Year Floodplain by Municipality 8-1

Table 8-2. Area and Structures Within the 500-Year Floodplain by Municipality 8-2

Table 8-3. Value of Structures in the 100-Year Floodplain by Municipality 8-2

Table 8-4. Value of Structures in the 500-Year Floodplain by Municipality 8-2

Table 8-5. Land Use in the Floodplain 8-3

Table 8-6. Critical Facilities in the Floodplain..... 8-4

Table 8-7. Critical Infrastructure in the Floodplain..... 8-4

Table 8-8. Significant Dams in Chelan County..... 8-6

Table 8-9. Levee Profiles 8-7

Table 9-1. Estimated Flood Impact on Persons 9-3

Table 9-2. Loss Estimates for 100-Year Flood Event 9-4

Table 9-3. Loss Estimates for 500-Year Flood Event 9-4

Table 9-4. Flood Insurance Statistics for Chelan County..... 9-4

Table 9-5. Repetitive Loss Properties in Chelan County 9-7

Table 9-6. Estimated Damage to Critical Facilities from 100-Year Flood..... 9-7

Table 9-7. Estimated Damage to Critical Facilities from 500-Year Event..... 9-8

Table 9-8. Estimated Damage to Critical Infrastructure from Flood Events..... 9-8

Table 9-9. Estimated Flood-Caused Debris.....	9-8
Table 13-1. Flood Mitigation Action Plan Matrix.....	13-6
Table 13-2. Prioritization of Mitigation Actions	13-11
Table 13-3. Analysis of Mitigation Actions	13-12

Figures

Figure 2-1. Sample Page from Comprehensive Flood Hazard Management Plan Web Site	2-5
Figure 2-2. Sample Page from Survey Distributed to the Public	2-6
Figure 2-3. Chelan County Post-Fire, Fall 2015	2-7
Figure 2-4. Planning Team Presentation at Wenatchee Open House	2-8
Figure 2-5. Hazard Modeling Demonstration to Chelan County Public Works Director at Open House.....	2-8
Figure 2-6. Steering Committee Members at Wenatchee Open House	2-8
Figure 2-7. Introduction Slide from Public Open House Presentation	2-8
Figure 2-8. Example Printout from Hazard Modeling Workstation.....	2-10
Figure 3-1. Main Features of Planning Area	3-2
Figure 3-2. Average Daily Temperatures	3-8
Figure 3-3. Monthly Average Precipitation and Snowfall.....	3-9
Figure 3-4. Identified Critical Facilities as Defined within the Planning Area	3-13
Figure 3-5. Identified Critical Infrastructure as Defined within the Planning Area	3-14
Figure 3-6. Washington and Chelan County Population Growth.....	3-15
Figure 3-7. Planning Area Age Distribution	3-17
Figure 3-8. Planning Area Race Distribution	3-18
Figure 3-9. Industry in the Planning Area	3-19
Figure 3-10. U.S., Washington and Chelan County Unemployment Rate	3-20
Figure 3-11. Occupations in the Planning Area	3-21
Figure 4-1. CRS Communities by Class Nationwide as of October 2016.....	4-3
Figure 7-1. Mapped Flood Hazard Areas in Chelan County	7-6
Figure 7-2. Wenatchee River Hydrograph at Peshastin.....	7-9
Figure 7-3. Doppler Radar Gap for East Cascades.....	7-11
Figure 9-1. Repetitive Loss Areas in Chelan County	9-6
Figure 10-1. Global Carbon Dioxide Concentrations Over Time	10-2
Figure 14-1. Resolution Adopting Comprehensive Flood Hazard Management Plan	14-2

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EXECUTIVE SUMMARY

WHY PLAN FOR FLOODING?

Recent floods have shown that Chelan County needs to address the issue of flooding on a countywide basis. Stage, flash and post-fire flooding are three common types of flooding in Chelan County:

- Stage flooding occurs during periods of heavy rains, especially falling on existing snowpack during early winter and late spring. Stage flooding can last several days after a storm.
- Flash floods are most likely during the summer thunderstorm season and are usually associated with cloudburst-type rainstorms. Winter flash flooding events, when they occur, are typically caused by ice or debris dams. Due to the County's topography and climate, stage and flash flooding are a continuing threat in most parts of the county (Chelan County, 2013).
- After a significant wildfire, vegetation is lost and soils can harden to repel rather than absorb water. This can result in mud/silt or debris flows that impact public and private property (county roads, private homes/cabins, etc.). It also reduces flow conveyance, increasing the potential for flood damage.

Because of floods, the Chelan County Board of Commissioners approved the formation of a County-wide flood control zone district in 2013. Once formed, the Chelan County Flood Control Zone District needed a comprehensive plan to guide its operation. The 2017 *Chelan County Comprehensive Flood Hazard Management Plan* (the Flood Plan) will serve as a guidance document for a five-year performance period for the Flood Control Zone District. The Flood Plan recommends regional policies, programs, and projects to reduce the risk to people and property from river flooding, alluvial fans and channel migration in Chelan County. It presents a long-term vision for managing all flood hazards in Chelan County's major river systems and recommends near-term actions to achieve that vision. The Flood Plan recommends actions Chelan County and cities in the county may take to reduce flood risks and to protect, restore or enhance riparian and aquatic ecosystems.

WHAT IS FLOOD HAZARD MITIGATION?

Mitigation is defined as “sustained action taken to reduce or eliminate long-term risk to life and property” It involves strategies such as planning, policy changes, programs, projects, and other activities to address risk from hazards in a planning area. The responsibility for hazard mitigation lies with many, including private property owners, business, industry, and local, state and federal government. Recognizing that there is no one solution for mitigating flood hazards, planning provides a mechanism to identify the best alternatives within the capabilities of a jurisdiction. A flood hazard management plan achieves the following in order to set the course for reducing the risk associated with flooding:

- Ensuring that all possible activities are reviewed and implemented so that local problems are addressed by the most appropriate and efficient solutions.
- Ensuring that activities are coordinated with each other and with other community goals and activities, preventing conflicts and reducing the cost of implementing each individual activity.
- Coordinating local activities with federal, state and regional programs.

- Educating residents on the hazards, loss reduction measures, and natural and beneficial functions of their floodplains.
- Building public and political support for mitigation projects.
- Fulfilling planning requirements for obtaining state or federal assistance.
- Facilitating the implementation of floodplain management and mitigation activities through an action plan that has specific tasks, staff assignments and deadlines.

The *Chelan County Comprehensive Flood Hazard Management Plan* identifies policies and actions chosen through a facilitated process that focused on meeting these objectives.

PLAN DEVELOPMENT METHODOLOGY

Development of the Chelan County Comprehensive Flood Hazard Management Plan included five phases:

- **Phase 1, Organize and review**—A 15-member steering committee was assembled to oversee the development of the plan, consisting of County staff, citizens and other stakeholders in the planning area. A planning team consisting of key County staff as well as a technical consultant was assembled to provide technical support to the Steering Committee. Full coordination with other county, state and federal agencies involved in flood hazard mitigation occurred from the outset of this plan’s development through its completion. A multi-media public involvement strategy centered on a hazard preparedness questionnaire was implemented. A comprehensive review was performed of existing plans and programs that can support flood hazard mitigation. A key function of the Steering Committee was to identify guiding principles, goals and objectives for the Flood Plan.
- **Phase 2, Flood Hazard 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. It focuses on the following parameters:
 - Hazard profiling
 - The impact of hazards on physical, social and economic assets
 - Vulnerability identification
 - Estimates of the cost of damage or cost that can be avoided through mitigation.

The flood hazard risk assessment for this Flood Plan meets the requirements outlined in Chapter 44 of the Code of Federal Regulations as well as the requirements for flood hazard assessment included in the Federal Emergency Management Agency’s (FEMA’s) Community Rating System (CRS).

- **Phase 3, Engage the public**—The Steering Committee developed a public involvement strategy to maximize the capabilities of the County. This strategy was implemented by the planning team and included two public meetings early in the planning process, a public meeting to review the draft plan, a hazard mitigation survey, a County-sponsored website dedicated to the plan, and multiple media releases. This strategy was a key element in the success of the planning effort.
- **Phase 4, Assemble the updated plan**—The Planning Team and Steering Committee assembled key information from Phases 1 and 2 into a document to meet CRS requirements. Under the CRS, a flood hazard management plan must include the following:
 - A description of the planning process
 - A risk assessment
 - A mitigation strategy including goals, a review of alternatives and a prioritized action plan
 - A plan maintenance section
 - Documentation of adoption.

- Phase 5, Plan adoption**—Upon completion of Phase 4, a pre-adoption review draft of the Flood Plan will be sent to the Insurance Services Office (ISO), FEMA’s CRS contractor, for review and comment. Once pre-adoption approval has been granted by ISO, the final adoption phase will begin. The Flood Plan includes a plan implementation and maintenance section that details the formal process for ensuring that the plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the plan’s progress annually and producing a plan revision every five years. This phase includes strategies for continued public involvement and incorporation of the Flood Plan recommendations into other County planning mechanisms, such as the comprehensive plan, capital improvement plan, and the Chelan County Hazard Mitigation Plan.

MISSION STATEMENT, GOALS AND OBJECTIVES

Through a facilitated process, the Steering Committee identified a mission statement, goals and objectives. These planning components all directly support one another. Goals were selected that meet the mission statement; objectives were identified that fulfill multiple goals. The Flood Plan’s mitigation actions were selected to achieve multiple objectives. The planning components are as follows:

- Mission Statement:

Through partnerships and careful planning, identify sustainable, cost-effective actions that will mitigate the impacts from flood hazards, to protect the health, safety, quality of life, environment and economy of the communities within Chelan County.

- Goals:

- Protect life
- Protect property
- Maintain sustainable operation of identified critical facilities
- Increase the awareness of flood risk and ways to mitigate its impacts
- Strive to protect or restore the natural and beneficial functions of floodplains
- Encourage the development and implementation of long-term, cost effective flood mitigation projects and programs.

- Objectives:

- Utilize the best available data, science and local knowledge to consider future conditions in planning for flood and inundation hazards.
- Work cooperatively with public agencies and stakeholders with responsibilities for flood protection; in the planning for and understanding of the impacts from flooding.
- Facilitate the mitigation of structures in high hazard areas, including those known to be repetitively damaged.
- Minimize the new development of high-risk areas; or ensure that if building occurs in these area, it is done in a way to minimize the risk.
- Collect post flood event data that will help gauge the flood hazard management efforts within Chelan County.
- Provide/improve flood protection with flood-risk reduction projects and maintenance plans.
- Improve early warning emergency response systems and plans.
- Provide feasible, cost-effective flood hazard protection that strives to enhance or restore the natural and beneficial riverine floodplain functions.
- Consider flood hazard management policies that promote resiliency and sustainable operations of identified critical facilities.

10. Inform the public on the risk exposure to flood hazards and ways to increase their capability to prepare, respond, recover and mitigate the impacts of these events.
11. Integrate flood hazard management goals and objectives into other plans and programs within the planning area that can support or enhance flood hazard management within Chelan County.

MITIGATION ACTIONS

The flood hazard mitigation action plan is a key element of this plan. It is through the implementation of the action plan that Chelan County can strive to become flood disaster-resilient through sustainable hazard mitigation. The action plan includes an assessment of the capabilities of the County to implement hazard mitigation actions, a review of alternatives, a prioritization schedule, and a mitigation strategy matrix that identifies the following:

- Description of the action
- Objectives addressed
- Lead implementation agency (or agencies)
- Estimated benefits
- Estimated costs
- Timeline for implementation
- Funding sources
- Prioritization

For the purposes of this document, mitigation actions are defined as activities designed to reduce or eliminate losses resulting from the impacts of flooding.

Although one of the driving influences for preparing this plan was CRS, this plan does not focus solely on CRS credits. It was important to the County and the Steering Committee to examine actions that would work through all phases of emergency management. Some of the actions outlined in this plan fall outside CRS credit criteria, and CRS creditability was not the focus of their selection. Rather, the focus was on the actions' effectiveness in achieving the goals of the Flood Plan and whether they are within the County's capabilities. Table ES-1 presents a summary of the identified hazard mitigation actions.

Table ES-1. Summary of Hazard Mitigation actions

Action #	Description	Priority
1	Define regional flood hazard management consistency pursuant to RCW 86.12 for the planning area. This definition will strive to exceed minimum National Flood Insurance Program standards and will be developed thru a facilitated planning effort with all cities within Chelan County.	High
2	Chelan County will continue with the Community Rating System (CRS) application and classification process and will mentor Chelan County cities that show interest in CRS participation.	High
3	Define floodplain mapping criteria that takes into account future flood hazard conditions and/or expected worst case conditions to be applied to all future flood studies within the planning area.	High
4	Identify alternative sources of funding to leverage Flood Control Zone District funding to perform new flood studies in identified areas of need based on risk.	High
5	Inform all future mapping by maintaining a database on known flood risk that tracks historical flood conditions to include, but not limited to: high water marks, recorded damages, photos, observed flood conditions, etc.	Medium
6	Continue to implement the Stormwater Management Program that includes facility identification, design, construction and maintenance within the stormwater utility jurisdictional authority.	High
7	For areas outside of the Stormwater Utility, clearly define the stormwater management program based on existing programs and capabilities.	Medium
8	Develop a facility maintenance operations and maintenance protocol for Flood Control Zone District funded facilities as they are developed	Medium
9	Investigate solutions to issues associated with modification to the landscape that increase runoff, including sediment, to adjacent properties and infrastructure.	Medium

Action #	Description	Priority
10	When requested, the Flood Control Zone District may act as the applicant agent for mitigation grant opportunities for private property requesting to participate in the grant program.	Medium
11	Develop a flood informational website on the Flood Control Zone District web page.	High
12	Deploy public information and outreach program targeting at risk properties within the planning area.	High
13	Coordinate with FEMA Region X on deploying flood insurance workshops for agents, lenders and citizens within the performance period for this plan.	High
14	Investigate feasible, cost-effective solutions to flood issues within No. 1 Canyon.	High
15	Identify a feasible, cost-effective solution to Slide Ridge debris flow issues.	High
16	Investigate feasible, cost-effective solutions to flood issues within No. 2 Canyon.	High
17	Investigate feasible, cost-effective solutions to flood issues within Dry Gulch (south of City of Wenatchee).	High
18	Investigate feasible, cost effective solutions to flood issues within Mission Creek.	High
19	Investigate feasible solutions to flood issues within Ski Hill Basin.	High
20	Coordinate with City of Cashmere on options for the maintenance and management of the levee system within the City and County.	High
21	Maintain database of flood control needs within the planning area as needs become identified for incorporation into future updates and progress reporting to this plan.	High
22	Mitigate flood related risk to publicly owned county bridges.	Medium
23	Maintain the county Critical Areas Ordinance (CAO) pursuant to the requirements of the State Growth Management Act.	High
24	Identify feasible opportunities with like goals for natural resource protection within identified flood risk areas based on available funding.	High
25	Coordinate with watershed planning and program implementation to identify opportunities to leverage available funding for like goals between watershed and Flood Control Zone District plans and programs.	High
26	Utilizing the best available data, science and technology, enhance the existing flood notification program, striving to identify a notification protocol within systems that have real-time flood threat recognition capability.	Medium
27	Update the County emergency response plan to reflect any changes to flood notification protocol within the County.	High
28	Conduct annual exercises of the County Emergency Operations Plan in compliance with National Incident Management System standards, such that flood response actions of the County are reviewed, evaluated, and adapted based on observations from the exercises.	High
29	Draft a prioritized list of road segments and bridges that should be elevated above the 100-year flood hazard area and culverts that will fail under flood flow. Upgrade these structures if funding become available.	Medium
30	Integrate the Chelan County Comprehensive Flood Hazard Management Plan into other appropriate plans and programs that can support or enhance the County's efforts to reduce flood risk as these plans and programs are updated. Examples of such plans/programs would include, but are not limited to: Chelan County Hazard Mitigation Plan, Chelan County Comprehensive Plan, and Chelan County Shorelines Master Plan.	Medium
31	Utilizing the best available data, science and technology, maintain and enhance as data becomes available the Level 2, user-defined HAZUS-MH model that was constructed to support this planning effort.	Medium
32	Establish a sediment management program that includes expanded channel monitoring, establishment of thresholds to trigger actions, and analysis of sediment management action alternatives.	High
33	As Flood Control Zone District projects are constructed, monitor projects using identified performance measures and adaptive management to track the effectiveness of completed projects to inform the design and implementation of future projects.	High

Action #	Description	Priority
34	Respond to inquiries and complaints from citizens and other public and private agencies and tracking per Community Rating System requirements.	High
35	Maximize federal, state, and local funding opportunities through grant application submittals in support of capital improvement projects, technical studies, and other flood hazard management activities.	High
36	Continue to provide flood hazard management technical support to all Chelan County departments and cities proposing activities or projects that affect floodplain functions.	High
37	Continue to maintain good standing under the National Flood Insurance Program by implementing programs that meet or exceed the minimum National Flood Insurance Program requirements. Such programs include enforcing an adopted flood damage prevention ordinance, participating in floodplain mapping updates, and providing public assistance and information on flood hazard requirements and impacts.	High
38	Develop and implement a stand-alone floodplain development permit for all new development and/or substantial improvements within the unincorporated County regulated floodplain.	High

IMPLEMENTATION

Full implementation of the recommendations of this plan will require time and resources. This plan reflects an adaptive management approach in that specific recommendations and plan review protocols are provided to evaluate changes in vulnerability and action plan prioritization after the Flood Plan is adopted. The true measure of the plan's success will be its ability to adapt to the ever-changing climate of hazard mitigation.

Funding resources are always evolving, as are programs based on state or federal mandates. Chelan County has a long-standing tradition of progressive, proactive response to issues that may impact its citizens. This tradition is reflected in the development of this plan. The Chelan County Board of Commissioners will assume responsibility for adopting the recommendations of this plan and committing County resources toward its implementation. The County's track record in floodplain management and its well-established programs and policies have maintained the flood risk at a steady level without increase. The framework established by this plan will help maintain this tradition in that it identifies a strategy to maximize the potential for implementation based on available and potential resources. It commits the County to pursue mitigation projects when the project benefits exceed the project costs. The County developed this plan with extensive public input. These techniques will set the stage for successful implementation of the recommendations in this plan.

Part 1. PLANNING PROCESS AND PROJECT BACKGROUND

1. INTRODUCTION

1.1 WHY PREPARE THIS PLAN?

Flood hazard mitigation is a way to reduce or alleviate the loss of life, personal injury, and property damage that can result from flooding 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 floods. The responsibility for flood hazard mitigation lies with many, including private property owners, business, industry, and local, state and federal government.

Numerous state and federal programs and regulations promote comprehensive flood hazard management planning. Notable among these is the Federal Emergency Management Agency's (FEMA) Community Rating System (CRS) program. This program that is part of the National Flood Insurance program (NFIP), provides benefits in the form of reduced flood insurance costs for communities that meet minimum requirements for flood hazard management.

The *Chelan County Comprehensive Flood Hazard Management Plan* (The Flood Plan) recommends regional policies, programs, and projects to reduce the risk to people and property from river flooding, alluvial fans and channel migration in Chelan County. This plan presents a long-term vision for managing all flood hazards within Chelan County and recommends specific near-term actions to achieve that vision. The Flood Plan recommends actions Chelan County and cities in the county may take to reduce flood risks and to protect, restore or enhance riparian and aquatic ecosystems.

Chelan County and each of its five cities participate in the NFIP. Flooding has been an ongoing hazard in the County. In 2013, floods caused over \$500,000 in public property damage in the County; this figure does not account for extensive additional damage to private property. Data suggests that flood frequency and intensity are increasing (USGS, 2003). In light of this, the County formed a Flood Control Zone District in 2014 to establish a dedicated program and funding source for flood hazard management.

One of the first essential tasks of the Chelan County Flood Control Zone District (FCZD) was to prepare a comprehensive plan. This task has been completed with preparation of the *Chelan County Comprehensive Flood Hazard Management Plan*. The Flood Plan complies with state and federal requirements for flood hazard management and meets the specific near-term planning needs of Chelan County for flood control. It identifies resources, information, and strategies for reducing risk from flood hazards, and will help guide and coordinate mitigation activities. The Flood Plan was developed to meet the following objectives:

- Meet the needs of Chelan County as well as state and federal requirements.
- Coordinate existing plans and programs so that high-priority actions and projects to mitigate possible flood impacts are funded and implemented.
- Create a linkage between the Flood Plan and other established County plans so that they can work together for successful mitigation.

All citizens and businesses of Chelan County are the ultimate beneficiaries of this plan. The plan's goals and recommendations lay the groundwork for development and implementation of local mitigation activities and partnerships.

1.2 CHELAN COUNTY'S PLANNING AUTHORITY

The Revised Code of Washington (RCW, Section 86.12.210) authorizes county legislative bodies in Washington to adopt comprehensive flood control management plans for any drainage basin wholly or partially within the county. The Flood Plan must meet NFIP participation requirements (44 CFR Part 60.3) and Washington Department of Ecology flood hazard management requirements (Chapter 86.26 RCW, Chapter 86.16 RCW and Washington Administrative Code (WAC) Chapter 173-145). The *Chelan County Comprehensive Flood Hazard Management Plan* will be adopted by reference in the *Chelan County Comprehensive Plan* for protection of frequently flooded areas, as required by Washington's Growth Management Act. The comprehensive flood hazard management plan also functions as the updated flood hazard portion of the *Chelan County Regional Hazard Mitigation Plan*, which was adopted for compliance with the federal Disaster Mitigation Act.

1.3 GUIDELINES FOR FLOOD PLANNING

The first priority for this plan is to benefit the citizens of Chelan County by providing the greatest possible protection against the hazard posed by flooding. In addition, the Flood Plan has been developed to follow as closely as feasible the guidelines for flood planning presented by FEMA for the Community Rating System (CRS) and by Washington State for the Flood Control Assistance Account Program (FCAAP).

1.3.1 CRS Steps for Comprehensive Flood Hazard Management Plan

Developing a comprehensive flood hazard management plan is among the activities that earn CRS credits toward reduced flood insurance rates. To earn CRS credit for a flood hazard management plan, the community's process for developing the Flood Plan must include at least one item from each of 10 steps (see Appendix A for details):

- Planning process steps:
 - Step 1, Organize
 - Step 2, Involve the public
 - Step 3, Coordinate
- Risk assessment steps:
 - Step 4, Assess the hazard
 - Step 5, Assess the problem
- Mitigation strategy steps:
 - Step 6, Set goals
 - Step 7, Review possible activities
 - Step 8, Draft an action plan
- Plan maintenance steps:
 - Step 9, Adopt the plan
 - Step 10, Implement, evaluate and revise.

1.3.2 FCAAP Requirements for Comprehensive Flood Control Management Plan

Eligibility for Washington’s FCAAP funding for flood projects requires that the requesting jurisdiction complete a comprehensive flood control management plan. The Flood Plan must include six components, as summarized below and described in detail in Appendix A:

- Determination of the need for flood control work.
- Description of alternative flood control work including potential in-stream measures and alternatives to in-stream measures.
- Identification and consideration of potential impacts of in-stream flood control work on the in-stream uses and resources.
- Area of coverage shall include, at a minimum, the area of the 100-year floodplain within a reach of the watershed of sufficient length to ensure that a comprehensive evaluation can be made of the flood problems for a specific reach of the watershed, as well as flood hazard areas not subject to riverine flooding (e.g., coastal flooding, flash flooding, or flooding from inadequate drainage)
- Conclusion and proposed solutions.
- Certification from the Department of Commerce that the local emergency management organization is administering an acceptable comprehensive emergency operations plan.

1.3.3 Chelan County FCZD Interim Operating Guidelines

Interim operating guidelines for the FCZD require the development of a comprehensive plan for the district that achieves the following objectives (Chelan County FCZD, 2014):

- Evaluate the risks to public safety, existing development, and infrastructure in high-priority, flood-prone and channel migration hazard areas of Chelan County.
- Examine potential alternative FCZD actions to reduce risk to life and public property while reducing economic impacts from flash and stage flooding, countywide.
- Specify how future prioritization of flood risks and their associated mitigation measures will be determined and implemented.
- Identify and define the administration of flood control funding and grants between the County and municipal jurisdictions within the county.
- Develop a 5-year FCZD capital facilities plan, which will include the estimated scope and budget for capital projects intended to mitigate flood risks in the following areas:
 - Slide Ridge (S. Lakeshore Road)
 - Number One Canyon
 - Number Two Canyon
 - Dry Gulch (Circle Street)
 - Floodplain reconnection.

Due to smoke from 2015 wildfires, necessary LiDAR data was not able to be collected in a timely manner, so the completion date for this plan has been delayed.

1.4 HOW TO USE THIS PLAN

This Comprehensive Flood Hazard Management Plan is organized into the following primary parts, which follow the organization of the CRS steps for flood hazard management planning:

- Part 1—Planning Process and Project Background
- Part 2—Risk Assessment
- Part 3—Mitigation Strategy
- Part 4—Plan Maintenance

Each part includes elements identified in the CRS's 10 steps. These steps are often cited at the beginning of a subsection to illustrate compliance with the requirement.

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

- Appendix A—Description of CRS and FCAAP planning guidelines
- Appendix B—Public outreach information, including the survey and summary and documentation of public meetings
- Appendix C—A template for progress reports to be completed as this plan is implemented

2. PLAN DEVELOPMENT METHODOLOGY

This chapter describes key parameters, participants and agreements for the following steps followed in developing the Chelan County Comprehensive Flood Hazard Management Plan:

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

2.1 FORMATION OF THE PLANNING TEAM

This planning project was initiated and overseen by Chelan County Public Works. The County hired Tetra Tech, Inc. to assist with plan development and implementation. A planning team was formed to lead the planning effort, made up of the following members:

- Eric Pierson, PE, Director/County Engineer, Chelan County Department of Public Works—FCZD Administrator
- Jason Detamore, Environmental Manager, Chelan County Department of Public Works—County project manager
- Lauren Loeb sack, Public Information Officer /Special Projects Coordinator, Chelan County Department of Public Works
- Rob Flaner, Tetra Tech—Project Manager/Lead Project Planner
- Carol Bauman, Tetra Tech—Risk Assessment lead
- Stephen Veith, Tetra Tech—GIS Analyst
- Patricia Robinson, Tetra Tech—Planner
- Dave Carlton, Dave Carlton & Associates—Flood Management Expert

2.2 DEFINING THE PLANNING AREA

The planning area for this Flood Plan is defined as all of Chelan County, including cities. The Flood Plan assesses the flood risk for all municipalities in the planning area. However, it identifies mitigation actions only for areas under the authority of the Chelan County FCZD.

2.3 THE STEERING COMMITTEE

A steering committee was formed to oversee all phases of the planning effort. The members of this committee included key Chelan County 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 Flood Plan or be impacted by its recommendations. The team confirmed a committee of 15 members, listed in Table 2-1.

Table 2-1. Steering Committee Members

Name	Title	Jurisdiction/Agency
Dan Frazier (Chair)	Director of Public Works	City of Wenatchee
Bob Whitehall (Vice-Chair)	Consultant	City of Entiat
Eric Pierson	FCZD Administrator	Chelan County Public Works
Jason Detamore	Environmental Manager	Chelan County Public Works
Doug Lewin	Floodplain Administrator	Chelan County Community Development
Herb Amick	Director of Public Works	City of Leavenworth
Jason Peterson	Engineering/Minerals Staff Officer	U.S. Forrest Service
Robert Goedde	Mayor	City of Chelan
Mike Cooney	Mayor	City of Chelan
Michael Cushman	Resource Specialist	Cascadia Conservation District
Michelle Gilbert	Floodplain Management Specialist	WA Department of Ecology
David Morgan	Executive Director	Chelan-Douglas Land Trust
Kent Sisson	Sergeant	Chelan County Emergency Management
Katherine Rowden	Service Hydrologist	National Weather Service
David Toften	Hydraulics Engineer	WA Department of Transportation
Tim Larson	Real Estate Manager	Chelan PUD
Mark Botello	Planning Director	City of Cashmere
Aaron Young	Citizen	
Phylisha Olin	Citizen	

Leadership roles and ground rules were established during the Steering Committee’s initial meeting on July 30, 2015. 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 an established work plan. The Steering Committee met 11 times from July 2015 through September 2016. Meeting agendas, notes and attendance logs are available for review upon request. All Steering Committee meetings were open to the public and advertised as such on the FCZD website (see Section 2.6.1). The agendas and meeting notes were posted to the website.

2.4 COORDINATION WITH OTHER AGENCIES

Opportunities for involvement in the planning process were provided to neighboring communities, local and regional agencies involved in flood hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (CRS Step 3). 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 Flood Plan development from the beginning and were kept apprised of plan development milestones:
 - Washington Department of Ecology
 - Washington Department of Fish and Wildlife
 - FEMA Region X
 - U.S. Forest Service
 - Washington Department of Transportation
 - National Weather Service

- Wenatchee Reclamation District
- Chelan Public Utility District
- Cascadia Conservation District
- Chelan-Douglas Land Trust
- City of Cashmere
- City of Chelan
- City of Entiat
- City of Leavenworth
- City of Wenatchee

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 Flood Plan website. Each agency was sent an e-mail message informing them that draft portions of the Flood Plan were available for review. In addition, the complete draft Plan was sent to the Insurance Services Office, FEMA’s CRS contractor, for a pre-adoption review to ensure CRS program compliance.

2.5 REVIEW OF EXISTING PROGRAMS

The planning effort included review and incorporation, if appropriate, of existing plans, studies, reports and technical information. Chapter 4 of this plan provides a review of laws and ordinances in effect within the planning area that can affect mitigation actions, including an assessment of all Chelan County regulatory, technical and financial capabilities to implement flood hazard mitigation actions. In addition, the following programs can affect mitigation within the planning area:

- Chelan County 2000 Comprehensive Plan (scheduled for annual update in 2017)
- Chelan County Hazard Mitigation Plan
- Wenatchee Valley 2016 Stormwater Management Program Plan
- Chelan County 2012 Comprehensive Stormwater Plan
- Wenatchee Watershed Plan
- Wenatchee Watershed Detailed Implementation Plan
- Chelan County Operational Area Emergency Response Plan
- Stormwater Management Manual for Eastern Washington
- Instream Resources Protection Program--Wenatchee River Basin, Water Resource Inventory Area (WRIA) 45
- Chelan County Critical Areas Ordinance
- Chelan County Shoreline Master Program
- Upper Columbia Salmon Recovery Plan.

2.6 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. CRS credits are available for providing opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval, as well as for optional public involvement activities (CRS Step 2).

2.6.1 Strategy

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

- Include members of the public on the Steering Committee.
- Attempt to reach as many citizens as possible using multiple media.
- Use a survey to determine public perception of flood risk and support of mitigation actions.
- Identify and involve stakeholders.
- Conduct public meetings to invite the public's input.
- Press coverage.

Steering Committee Participation

Stakeholders are the individuals, agencies and jurisdictions that have a vested interest in the recommendations of this plan. Gaining stakeholder participation on the Steering Committee was a key element in the public participation strategy. Stakeholders targeted for this process included:

- Community representatives
- Chelan County divisions responsible for activities relevant to flood hazard management
- Environmental advocacy groups
- Local disaster preparedness and response agencies
- Owners and operators of businesses within flood hazard areas
- Repetitive loss area representatives
- State and federal agencies with a role in public lands management within the planning area.

CRS Step 2 awards credit for a planning process conducted through a committee that includes members of the public and/or non-governmental stakeholders. The 15-member Steering Committee includes six non-governmental stakeholders (40 percent).

Multi-Media Outreach

At the beginning of the development of the current plan, a flood hazard management plan section was developed on Chelan County's website to keep the public informed about planning activities and to solicit input (see Figure 2-1). The site's address (<http://www.co.chelan.wa.us/flood-control-zone-district>) was publicized in all press releases, mailings and public meetings. The site provided the public with information on the Flood Plan development process, the Steering Committee, a project survey, and drafts of the plan. Chelan County will keep the website active after the plan's completion to keep the public informed about projects and future plan updates.

Survey

A survey (see Figure 2-2) was developed by the planning team with guidance from the Steering Committee. The survey was used to gauge household preparedness for the flood hazard and the level of knowledge of tools and techniques that assist in reducing risk and loss from flooding. This survey was designed to help identify areas vulnerable to floods. Survey responses helped guide the Steering Committee in selecting goals, objectives and mitigation actions. All attendees at the public open houses were asked to complete a survey. In addition, the survey and the Flood Plan information website were advertised in a "Post-Fire Flood Bulletin" that was distributed County-wide following the fires in the summer of 2015. (see Figure 2-3). Hard copies of the surveys were made available at the public open houses. A web-based version of the survey was made available on the Flood Plan website.

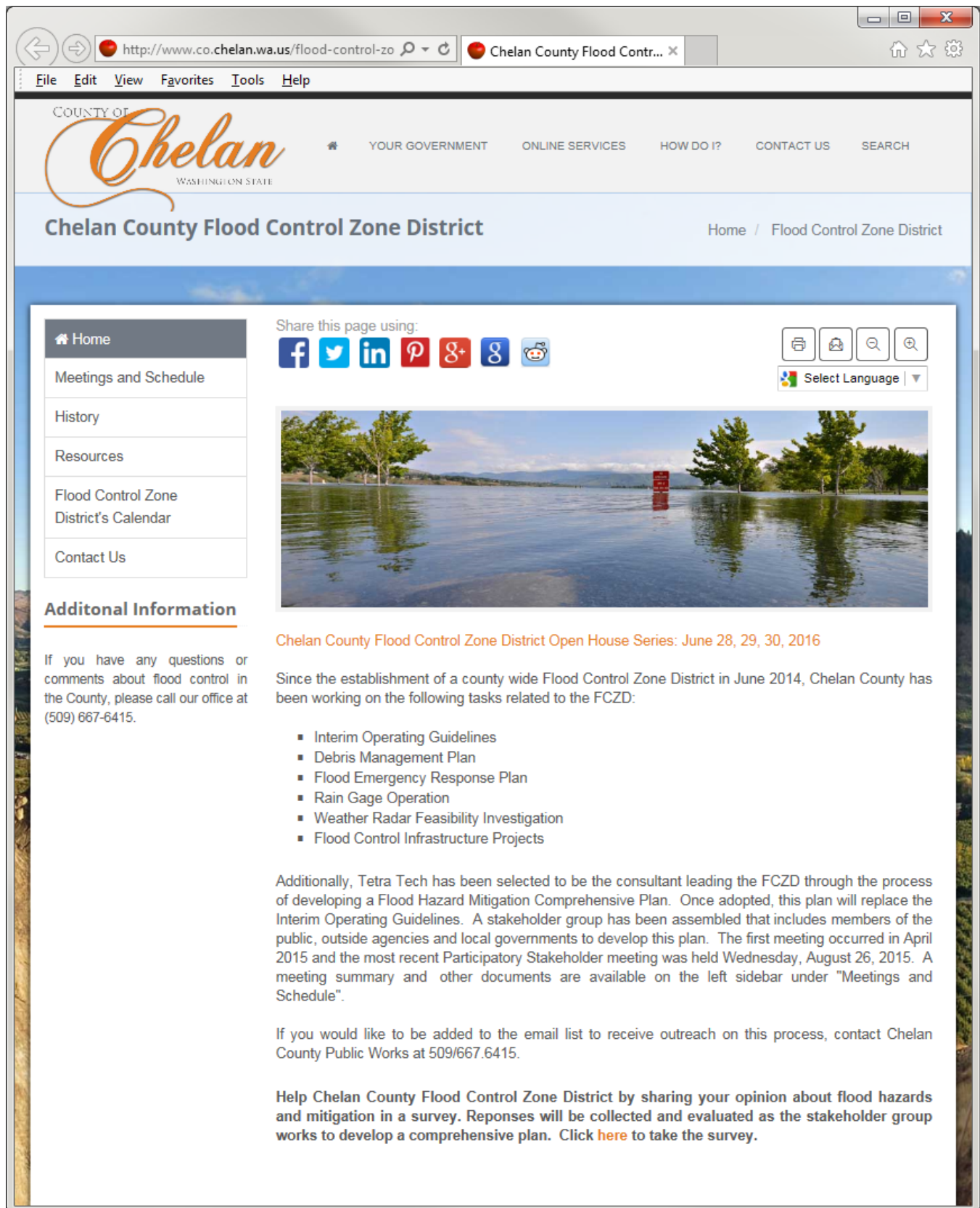


Figure 2-1. Sample Page from Comprehensive Flood Hazard Management Plan Web Site



Chelan County Survey: Flood Preparedness

1. Survey Introduction

CITIZEN PREPAREDNESS QUESTIONNAIRE

Chelan County has embarked on a planning process to reduce the adverse impacts of flood hazards. This effort is being implemented through the Community Rating System (CRS) and will result in an adopted, approved Comprehensive Floodplain Management Plan.

The planning process for this effort is being overseen by a Steering Committee made up of stakeholders from within the planning area. The Steering Committee and planning team are seeking input from the residents of Chelan County on local knowledge of and information on flood related hazards. The information that residents provide will help coordinate activities to help reduce the future flood risk within the County.

This survey contains several questions and a space for additional comments at the end. It will take approximately 5-15 minutes to complete. The Chelan County Floodplain Management Steering Committee and Planning Team thank you for your contribution to this information gathering process.

Please note - A response is required for questions preceded by an asterisk (*).

1. Where in Chelan County do you live?

- ☐ Cashmere
- ☐ Chelan
- ☐ Entiat
- ☐ Leavenworth
- ☐ Wenatchee
- ☐ Unincorporated Chelan County
- ☐ I do not live in Chelan County

Other (please specify)

Figure 2-2. Sample Page from Survey Distributed to the Public



Chelan County Flood Control Zone District Post Fire Resources

October 2015

Having experienced the aftermath of past fires, the impact of rainfall over a burned area can be severe. The burned surface may not be able to absorb even light to normal rainfall, causing the precipitation to travel quickly and take rocks, dirt and other debris with it and overwhelm drainage systems.

There is no way to prevent flooding and steps to mitigate the damage can only reduce the impact to public infrastructure and private property. But there are steps property owners can take to reduce the damage to homes and property. Most of these options are affordable and require only a little preparation.

First and foremost, it is vital to maintain drainways on your property, whether they be natural or developed and to cut back brush, remove rock and yard waste and any structures that might impede conveyance of run off.

If you have a culvert under your driveway, regular inspection and removal of any materials will help the culvert not to be overwhelmed and back up over your driveway and into your yard and the roadway. If you see a clogged culvert in your neighborhood that is the County's responsibility, contact the County to make a service request to address the issue.

Please take time to review the resources available by following the links below:

http://cascadiacd.org/wildfire-recovery-resources_351.html

<http://www.co.chelan.wa.us/public-works/pages/after-the-fire>

Additional questions can be answered by calling the County's Flood Control Zone District at (509) 667-6415.



Flood Control Zone District (FCZD) is a special-purpose government fund authorized under RCW 86.15 to fund flood-reduction projects and programs in the County. The funds collected by the FCZD are protected by state law and can only be used to fund flood control related activities.

Flooding is one of the most common natural hazards that the County has to deal with and is a regular occurrence throughout the year. Because of recent devastating flooding events throughout the county, flood control and hazard mitigation in flood prone areas need to be examined.

A Comprehensive Flood Hazard Plan will determine how the FCZD will prepare and respond to flooding. A stakeholder committee consisting of representatives from the cities, resource agencies and the public are working to develop this plan. This group meets on the 4th Wednesday of each month at the Confluence Technology Center in Wenatchee. These meetings start at 1PM and are open to the public. The committee welcomes input and questions regarding this important process.

Visit our FCZD webpage:
www.co.chelan.wa.us/public-works/pages/flood-control-zone-district

Sign up for future outreach & news:
www.co.chelan.wa.us/public-works/forms/join-newsletter



Figure 2-3. Chelan County Post-Fire, Fall 2015

Over 200 surveys were completed during the course of this planning process. This number is not sufficient to establish trends, but the responses did provide the Steering Committee and planning team with feedback to use throughout the planning process. The Steering Committee used survey results to support the selection of guiding principles, goals and objectives discussed in Chapter 11. The survey results were also used in the review of alternatives and selection of mitigation actions as discussed in Chapter 13. The complete survey and a summary of its findings can be found in Appendix B.

Public Meetings

Following the Chelan Butte Fire, the City of Chelan mayor asked the Chelan County FCZD to provide a presentation at a public City Council meeting. The presentation outlined the roles and responsibilities of the FCZD, including development of its comprehensive plan, public involvement, revenue distribution, emergency response, capital expenditures, and similar topics. FCZD staff gave a 15-minute presentation followed by a question-and-answer session.

Public open-house meetings were held from 4 to 7 p.m. June 28 – 30, 2016 in the Cities of Chelan, Wenatchee and Leavenworth. These interactive meetings were advertised by press release and on the County Commissioners weekly radio broadcast the week prior to the meetings. Example meeting activities are shown in Figure 2-4 through Figure 2-7.



Figure 2-4. Planning Team Presentation at Wenatchee Open House



Figure 2-5. Hazard Modeling Demonstration to Chelan County Public Works Director at Open House



Figure 2-6. Steering Committee Members at Wenatchee Open House

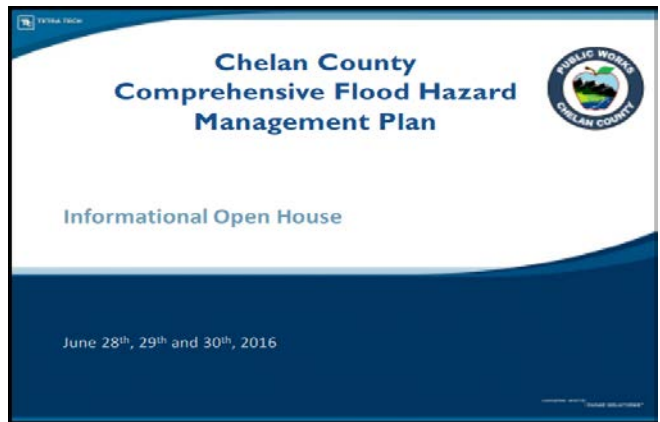


Figure 2-7. Introduction Slide from Public Open House Presentation

The open-house 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 PowerPoint presentation. A computer mapping workstation loaded with output from hazard modeling of the planning area allowed citizens to see information on their property, including exposure and damage estimates for flood hazard events (see Figure 2-8). Participating property owners were provided printouts of this information for their properties. This tool was effective in illustrating risk to the public.

Planning team members were present to answer questions. Each citizen attending the open houses was asked to complete a survey, and each 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 planning team.

On May 10, 2016, Members of the planning team gave a 15-minute presentation to the Chelan County Board of Commissioners on the status of the Flood Plan development, followed by a question-and-answer period. This meeting was open to the public, but no public comment was received.

The draft plan was presented to the Chelan County Board of Commissioners on December 16, 2016. This was an open public meeting with opportunities for public comment. A formal 30-day public comment period was conducted from January 3 to February 3, 2017. During this timeframe, the Flood Plan was available for public comment on the Flood Control District website noted above. A press release advertising the comment period was distributed to all media outlets on January 3, 2017. A State Environmental Policy Act (SEPA) checklist was completed by the County and posted with the draft plan on the website in compliance with state requirements.

Press Coverage

Press releases disseminated during the Flood Plan planning effort generated the following press coverage:

- Cashmere Valley Record. September 30, 2015. “County begins work on flood control plan”
<http://cashmerevalleyrecord.com/main.asp?Search=1&ArticleID=8928&SectionID=5&SubSectionID=5&S=1>
- Wenatchee World. March 13, 2016. “Flood survey could help lower insurance costs”
<https://www.wenatcheeworld.com/news/2016/mar/12/flood-survey-could-help-lower-insurance-costs/>
- Wenatchee World. March 14, 2016. “Flood-control projects coming to Chelan County”
<https://www.wenatcheeworld.com/news/2016/mar/11/flood-control-projects-coming-to-chelan-county/>
- Cashmere Valley Record. July 13, 2016. “Consultants seek flood plan input”
<http://cashmerevalleyrecord.com/main.asp?Search=1&ArticleID=9441&SectionID=5&SubSectionID=5&S=1>
- Cashmere Valley Record. June 28, 2016. “County presents flood zone plan, model”
<http://cashmerevalleyrecord.com/main.asp?SectionID=5&SubSectionID=5&ArticleID=9419>

The Wenatchee Business Journal attended Steering Committee Meetings #3 and #6.

2.6.2 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 components of the plan. Details of attendance and comments received are summarized in Table 2-2.

2.7 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 2-3 summarizes important milestones in the development of the Flood Plan which included 10 stakeholder meetings and other public involvement and outreach activities as well as review opportunities of the draft Plan.

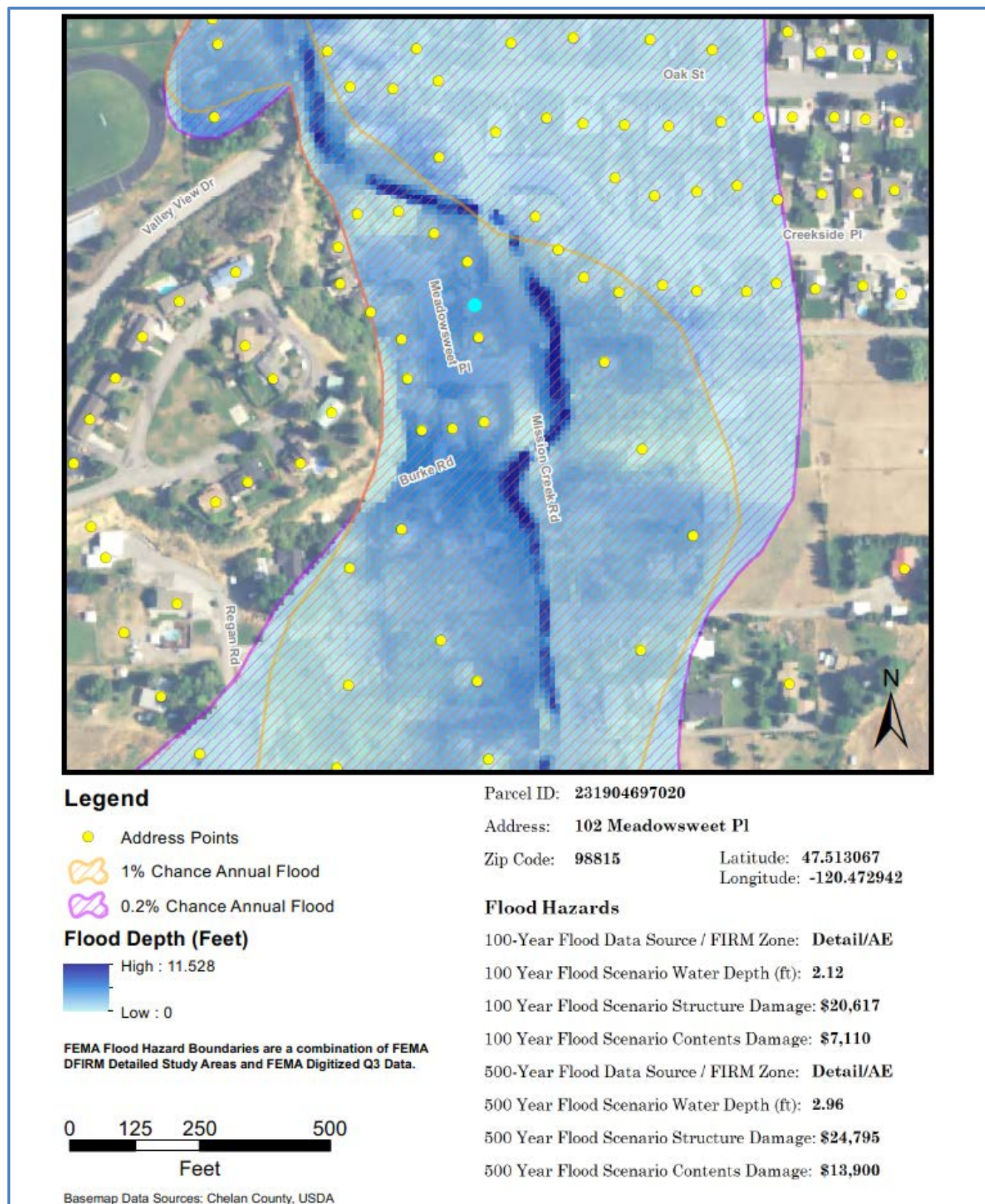


Figure 2-8. Example Printout from Hazard Modeling Workstation

Table 2-2. Summary of Public Meetings

Date	Location	Number of Citizens in Attendance	Number of Comments Received	Number of Surveys Received
6/28/2016	Chelan, WA	6	2	2
6/29/2016	Wenatchee, WA	8	1	3
6/30/2016	Leavenworth, WA	2	0	0
12/16/2016	Wenatchee, WA	2	0	0
Total		18	3	5

Table 2-3. Plan Development Milestones

Date	Event	Description	Attendance
2015			
1/16	Technical Support	County solicits technical support for development of a Comprehensive Flood Hazard Management Plan	N/A
2/25	Technical Support	County selects Tetra Tech, Inc. as technical support contractor for development of Comprehensive Flood Hazard Management Plan	N/A
5/19	Stakeholder Kickoff Meeting	<ul style="list-style-type: none"> • What is mitigation? • What is a flood hazard management plan? • Why develop a flood hazard management plan? • What is the Community Rating System (CRS)? • What is FCAAP? • The Chelan County work plan. • The planning team • The Steering Committee • Stakeholder roles in the process • Identify the Steering Committee 	34
7/30	Steering Committee Meeting #1	<ul style="list-style-type: none"> • Review purposes for the Flood Plan • Organize the Steering Committee • Identify flood hazards of concern • Develop public involvement strategy • Introduce mission statement exercise 	14
8/1	Public Outreach	<ul style="list-style-type: none"> • Informational website launched 	N/A
8/26	Steering Committee Meeting #2	<ul style="list-style-type: none"> • Approve ground rules • Identify flood scenarios • Guiding principle/mission statement • Goal setting • Phase 1 public outreach 	15
9/20	Public Outreach	<ul style="list-style-type: none"> • Flood hazard survey launched via website. 	N/A
9/22	Public Outreach	<ul style="list-style-type: none"> • Initial press release announcing the planning process, website and survey released. 	N/A
9/23	Steering Committee Meeting #3	<ul style="list-style-type: none"> • Risk assessment update • Finalize goals • Introduce objectives exercise • Critical facilities • Phase 1 public outreach 	18
9/30	Press Coverage	<ul style="list-style-type: none"> • Cashmere Valley Record. "County begins work on flood control plan" 	N/A

Date	Event	Description	Attendance
10/28	Steering Committee meeting #4	<ul style="list-style-type: none"> • Risk assessment update • Finalize objectives • Confirm critical facilities definition • Confirm outreach survey • Phase 1 public outreach 	17
12/9	Steering Committee Meeting #5	<ul style="list-style-type: none"> • Risk assessment update • Adopt mission statement, goals and objectives • Phase 1 public involvement strategy • Identify relevant programs that can support/enhance flood hazard management • Introduce strengths, weaknesses, obstacles and opportunities exercise 	19
2016			
1/27	Steering Committee Meeting #6	<ul style="list-style-type: none"> • Risk assessment update • Brainstorm and outline strengths, weaknesses, obstacles and opportunities related to addressing flood issues. 	24
2/24	Steering Committee Meeting #7	<ul style="list-style-type: none"> • Risk assessment update • Review mitigation catalog • Consistency review • County capability assessment • Public outreach status 	17
3/13	Press Coverage	• Wenatchee World. "Flood survey could help lower insurance costs"	N/A
3/14	Press Coverage	• Wenatchee World. "Flood-control projects coming to Chelan County"	N/A
3/23	Steering Committee Meeting #8	<ul style="list-style-type: none"> • Risk assessment update • Public outreach status • Mitigation actions 	22
5/10	Public Outreach	Planning team made presentation on the Flood Plan development status to the Chelan County Board of Commissioners which are open to the public.	10
5/25	Steering Committee Meeting #9	<ul style="list-style-type: none"> • Review preliminary risk assessment results • Review Draft Action Plan • Public Outreach status 	14
6/28	Press Coverage	Cashmere Valley Record. "County presents flood zone plan, model"	N/A
6/28	Public Outreach	Public Open House #1—Chelan	9
6/29	Public Outreach	Public Open House #2—Wenatchee	11
6/30	Public Outreach	Public Open House #3—Leavenworth	5
7/13	Public Outreach	Cashmere Valley Record. "Consultants seek flood plan input"	N/A
7/27	Steering Committee Meeting #10	<ul style="list-style-type: none"> • Review of public meetings • Review critical facilities results • Next steps • Time line 	16
12/6	Public Outreach	Planning team presented the recommended policies of the Flood Plan to the Chelan County Board of Commissioners for their review and comment. This was an open public meeting	8
1/3	Public Outreach	Initiation of a 30-day public comment period and posting of the SEPA checklist	N/A
2/3	Public Outreach	Closing of the 30-day public comment period	N/A
6/6	Public Comment	Meeting with the City of Wenatchee to discuss their comments on the draft plan	8

Date	Event	Description	Attendance
2017			
May	Plan Approval	Submittal to Washington Department of Ecology for review for compliance under RCW Chapter 86.12.210	N/A
TBD	Plan Approval	Final draft plan submitted to Insurance Services Office (ISO) for review and approval	N/A
TBD	Plan Adoption	Plan Adopted by Chelan County Board of Commissioners	N/A
TBD	Plan Approval	Final plan approved by ISO	N/A

3. CHELAN COUNTY PROFILE

Chelan County is located in Central Washington on the east side of the Cascade Mountains, west of the Columbia River (see Figure 3-1). With an area of 2,994 square miles, it is the third largest of Washington's 39 counties. There are five incorporated municipalities in the county: Cashmere, Chelan, Entiat, Leavenworth and Wenatchee. Wenatchee is the largest city in the County and the county seat. Large areas of the county are national forest land.

3.1 HISTORICAL OVERVIEW

Prior to European settlement of what is now Chelan County, the Wenatchee tribe lived along the Wenatchee River and the Chelan tribe lived along the south end of Lake Chelan. The culture and economy of the tribes centered on fishing, but members also gathered roots and berries and hunted game. In 1855, the Wenatchee and 13 other Native American tribes signed the Yakama Treaty, forfeiting title to 10.8 million acres of north central Washington in exchange for a smaller reservation, cash, and other incentives. Soon afterward, many tribes repudiated the agreements and war broke out. Eventually, only a few small allotments near Lake Chelan remained in Native American hands (Wilma, 2006).

Trappers visited the Chelan and Wenatchee valleys from the 1810s through the 1840s in search of beaver pelts. Placer miners came from California in the 1860s and established a village on the Columbia opposite the mouth of the Chelan. Two traders set up a commercial operation in 1872 at the future site of Wenatchee. That same year, a missionary built a small log church, and the town that was established nearby eventually became Cashmere. For a short time in 1880, the U.S. Army maintained Camp Chelan at the south end of Lake Chelan. The town of Wenatchee was founded in 1888. In July 1889, the town of Chelan was laid out where the Chelan River left the lake. The Wenatchee Development Company platted a town site a mile south of the original town in May 1892, and residents of the original town moved to the new community. The residents of Wenatchee voted for incorporation in December 1892 (Wilma, 2006).

After 1888, the Chelan Valley was part of Okanogan County to the north and the Wenatchee Valley was part of Kittitas County to the south. In 1899, the State Legislature created Chelan County out of the two other counties with Wenatchee as the county seat (Wilma, 2006).

Starting in 1901, businessmen and landowners raised money for the Wenatchee Canal Company and the Highline Canal, running 14 miles from Dryden to Wenatchee. This later became the Wenatchee Reclamation District. The federal Reclamation Act of 1902 provided for the organization and funding of irrigation districts that had the authority of government in acquiring land and issuing bonds. This made possible the construction of reservoirs and canals and the dramatic growth of the fruit industry. In the 1930s, the U.S. government began constructing irrigation and flood control dams on the Columbia (Wilma, 2006).

The Wenatchee Canal Company used the flow from the Highline Canal for power. A number of small power companies later sprung up using the hydraulic potential of the area's rivers. These firms eventually combined under the Puget Sound Power & Light Co. Congress created the Bonneville Power Administration in 1937 to distribute the electricity from Columbia River dams to publicly owned utilities.



Voters approved the Chelan County Public Utility District in 1937, which acquired the properties of Puget Sound Power & Light in 1948, the assets of the Washington Water Power Co. in 1955, and Rock Island Dam on the Columbia in 1956. The Aluminum Company of America (Alcoa) built its plant at Malaga in 1952 to take advantage of the cheap and plentiful power (Wilma, 2006).

Today, Chelan County's Board of County Commissioners is responsible for overall administration of Chelan County government. The Board consists of three officials elected from designated Commissioner districts. Its duties include adopting and enacting ordinances and resolutions, levying taxes, establishing County policies, and conducting general County administration. The Board is responsible for adoption of the annual budget, provision and maintenance of public facilities, construction and maintenance of County roads, development and implementation of planning and zoning policies, and appointments to advisory committees and boards.

3.2 PHYSICAL SETTING

3.2.1 Watersheds

A watershed is an area draining into a river, lake, or other water body. The Washington Department of Ecology has divided Washington into Water Resource Inventory Areas to delineate the state's major watersheds. The following sections describe the WRIAs that make up Chelan County.

WRIA 45, Wenatchee River Watershed

Surface Waters

The Wenatchee Watershed (WRIA 45) is approximately 1,370 square miles, including some areas that drain directly into the Columbia River. This area includes 230 miles of major streams and rivers and associated aquatic habitat. The headwaters of WRIA 45 are the Little Wenatchee and White Rivers in the Cascade Mountain range. These rivers flow into Lake Wenatchee, the source of the Wenatchee River. The Wenatchee River discharges into the Columbia River in the City of Wenatchee. The following tributaries enter the Wenatchee River downstream of the lake, adding significant volume to the river.

- Nason Creek—Confluence at Wenatchee River Mile (RM) 53.6
- Chiwawa River—Confluence at RM 48.6
- Chiwaukum Creek—Confluence at RM 35.6
- Icicle Creek—Confluence at RM 25.6
- Chumstick Creek—Confluence at RM 23.5
- Peshastin Creek—Confluence at RM 17.9
- Mission Creek—Confluence at RM 10.4.

The Chiwawa, White and Little Wenatchee Rivers, and Nason and Icicle Creeks are the source of over 90 percent of the surface water in the watershed (Wenatchee River Watershed Steering Committee, 1996).

Climate and Stream Flows

The Wenatchee Watershed extends from snowfields, glaciers and steep, forested Cascade Mountains in the northwest, through orchards in the Wenatchee River Valley, to the shrub-steppe of the eastern watershed at the confluence of the Wenatchee and Columbia Rivers. Average annual precipitation over this drainage area varies from over 150 inches at the Cascade Crest to 8 inches in Wenatchee. The climate in the watershed is hot and dry in the summer, especially in the lower elevations. The higher elevations receive, on average, between 10 and 20 feet of snow in the winter (Wenatchee River Watershed Steering Committee, 1998). Snowmelt is a primary source of late summer and fall stream flow. Variability in winter precipitation results in highly variable stream

flow, especially in the more arid lower watershed. The different climatic zones within the watershed are important because the largest irrigation and domestic water demands occur in the drier, lower valley near Wenatchee, where stream flow can be limited some years.

Topography and Soils

The main topographic features of the Wenatchee River watershed are as follows (Chelan County, 2011):

- All or part of the Wenatchee River, Chumstick Creek, Peshastin Creek and Icicle Creek Valleys
- Ollala, Hay, Nahahum, Warner, Warm Springs, Brender, Brisky, Tripp, Yaksum and Fairview Canyons

The topography of the west and north is a direct result of large mountain glaciers that formed in the Icicle, Tumwater, and Chumstick Canyons. Glacial action was responsible for deepening and smoothing the valley floors. These glaciers probably terminated along the Mountain Home Road, to the southeast of Leavenworth, where there is evidence of a terminal moraine (Chelan County, 2011).

Throughout much of the area, the soil is underlain with alluvial deposits and glacial drift. Volcanic pumice and ash from the Glacier Peak region have added substantially to the depth and character of the soil in many areas. The mountainous terrain, with characteristically steep slopes and high elevations, consists largely of rock outcroppings and shallow soils (Chelan County, 2011).

Fish

The Wenatchee River and its tributaries have some of the healthiest anadromous fish runs in the Columbia River drainage and contain salmonid habitat that is important to the entire Columbia River region. However, spring Chinook in the Wenatchee Watershed have been federally listed as endangered and bull trout and steelhead have been listed as threatened under the Endangered Species Act (ESA) (listings occurred in 1998, 1999 and 2006, respectively). Core populations of sockeye salmon, steelhead, bull trout, and spring and summer Chinook salmon in the upper Wenatchee are relatively strong compared to other populations in the Columbia River basin. Anadromous salmonid populations in the Wenatchee watershed must negotiate a 468-mile journey from the mouth of the Wenatchee River to the Pacific Ocean, once as smolts and again as adults. Within the watershed, human alterations are reducing habitat quality and quantity (Andonaegui, 2001).

WRIA 46, Entiat River Watershed

Surface Waters

The Entiat River is the major surface water source in this 418-square-mile watershed. Dozens of small creeks and streams are tributary to the river. The higher elevations in the northwest portion of the watershed receive about 100 inches of precipitation annually, most of which occurs as snow. The lowest elevations, near the town of Entiat, receive about 10 inches of precipitation. Meltwater from the snowpack supplies most of the stream flow in spring and early summer. Nearly all of the precipitation runoff and snowmelt occurs from April through July (Washington Department of Ecology, 1995b).

The watershed is shaped like a triangle with the Columbia River at the base and the valley rising between the Chelan and Entiat Mountains. The Entiat River begins at the terminus of the Entiat Glacier on Mt. Maude and flows approximately 50 miles into the Columbia River at the south end of the City of Entiat. The drainage is generally long and narrow, with numerous small tributaries flowing into the main river. The north fork of the Entiat River and the Mad River are the largest tributaries. These bodies of water and their tributaries provide the main source of drinking water for the area and are also important for irrigation and recreation (Chelan County, 2011).

There are no reservoirs in the Entiat watershed, although the lowest 0.5 miles of the Entiat River and floodplain is influenced by backwater effects from Lake Entiat, which is the pool for the Rocky Reach Dam Hydroelectric Facility on the Columbia River. No artificial ponds have been identified (Andonaegui 1999).

Climate and Stream Flow

Mean annual precipitation varies from 90 inches in the headwater areas near the Cascade crest to less than 10 inches along the Columbia River. Approximately 75 percent of the mean annual precipitation falls from October March. Most winter precipitation falls as snow; however, rain is not unusual at some mid- and lower elevations. Cumulative snow depths range from less than 24 inches in lower elevations to nearly 400 inches in the mountains. Precipitation in July and August, the two driest months, is 5 to 10 percent of the annual mean. Local climate station records from 1949 to 1992 show no definitive increasing or decreasing trend in annual precipitation (Kirk et al. 1995). High flows in the Entiat watershed commonly result from rapid spring snowmelt, large storms (including warm rain-on-snow events), or high-intensity convective storms. High-intensity, short-duration thunderstorms in summer can result in brief but heavy downpours that occasionally produce flash floods.

Topography and Soils

Elevations in the Entiat River watershed range from just over 700 feet above sea level along the Columbia River to 9,249 feet at the summit of Mt. Fernow. Many of the soils in the area become unstable or erosive as slopes increase. Throughout much of the area, the soil is underlain with alluvial deposits and glacial drift. The geology of the Entiat area is igneous bedrock with granite and diorite predominating (Chelan County, 2011).

Most of the large-scale topographic features are the result of alpine glaciation, which significantly affected the upper half of the watershed. During the neo-glaciation period, a valley glacier nearly 25 miles long extended from its source at the headwall of the Entiat watershed to just below Potato Creek, which is marked by a terminal moraine indicating the furthest downstream influence of the glacier on channel geomorphology and bed material. Above the terminal moraine, the Entiat valley has a characteristic U-shaped appearance and is covered with glacial till. Glaciation resulted in hanging valleys and a moderately broad floodplain in the mid Entiat River that contains water-stratified silt, sand, gravel and cobbles. (Chelan County Conservation District, 2004).

WRIA 47, Lake Chelan Watershed

Surface Waters

The main surface water feature of this 1,047-square-mile watershed is Lake Chelan, the largest and deepest lake in Washington. The lake consists of two basins: the Wapato basin at the lower end of the lake is about 12 miles long and has a maximum depth of about 400 feet; the upper Lucerne basin is 38 miles long and has a maximum depth of nearly 1,500 feet. A shallow sill, about 130 feet deep, separates the two basins at a restriction of the lake known as The Narrows. The lake's average width is about 1.5 miles (Kendra and Singleton, 1987). Lake Chelan and the Columbia River provide the main source of drinking water for the area. They are also important for irrigation and recreation (Washington Department of Ecology, 1995c; Chelan County, 2011).

Roughly 75 percent of the inflow to Lake Chelan comes from the Stehekin River and Railroad Creek. Smaller tributaries to the lake include Fish, Prince, Gold, First, Safety Harbor, and Twenty-Five Mile Creeks. The lake discharges to the Chelan River, which in turn discharges to the Columbia River. The outfall is controlled through a hydroelectric dam and a penstock system to the Columbia River.

There are two reservoirs in WRIA 47 with volumes of 10 acre-feet or greater. Wapato Lake, at 2,000 acre-feet, and Antilon Lake, at 1,920 acre-feet, were constructed in natural, in-channel basins enlarged to enhance irrigation storage. These reservoirs cover 338 acres.

About 10 percent of WRIA 47 consists of sub-basins that drain directly to the Columbia River; less than 5 percent of total WRIA 47 stream flow discharges from these sub-basins. Approximately 2 percent of WRIA 47 lies within Okanogan County,

Average annual precipitation in the Chelan watershed ranges from 150 inches per year at the crest of the Cascade Mountains to 11 inches per year in the city of Chelan. Most of the annual precipitation falls in winter as snow. As the snowpack melts in spring and early summer, it supplies most of the stream flow. In addition, some melting snow infiltrates into the soil to become groundwater, which then slowly discharges to rivers and tributary streams, providing a relatively low but constant flow the rest of the year. Precipitation that is not lost to evapotranspiration runs off steep slopes into stream channels and minor tributaries of the Stehekin River and Railroad Creek, and into minor tributaries of Lake Chelan, where they ultimately discharge out of Lake Chelan into Chelan River and finally the Columbia River.

Topography and Soils

Elevations in the Lake Chelan Watershed range from just over 700 feet above sea level along the Columbia River to 9,511 feet at the summit of Bonanza Peak, the highest point in Chelan County. Approximately 70 percent of WRIA 47 is above an elevation of 3,000 feet, and 47 percent is above 5,000 feet. The mountainous terrain, with characteristically steep slopes and high elevations, consists largely of rock outcroppings and shallow soils. The geology is characterized by underlying rock formations covered by a shallow mantle of soils in the valleys (Chelan County, 2011).

The Soil Conservation Service has classified 84 percent of the Lake Chelan watershed ground cover as forest. Lands below the forest level consist of grasses, sagebrush and shrubs, with the more level areas developed as crop land (Chelan County, 2011).

Many of the soils in the area become unstable or erosive as slopes increase. Throughout much of the area, the soil is underlain with alluvial deposits and glacial drift. Volcanic pumice and ash from the Glacier Peak region have added substantially to the depth and character of the soil in many areas (Chelan County, 2011).

Landforms consist of the classic U-shaped glacially-carved valleys of Lake Chelan, the Stehekin River and smaller tributaries in the higher elevation sub-basins, which are surrounded by high ridges and steep cliffs. The Stehekin Valley is a U-shaped, glacially-carved canyon above Lake Chelan that is nearly 6,000 feet deep, and a mile or less wide as it extends 25 miles from Lake Chelan to the Cascade Crest. Lower elevation sub-basins are narrower incised valleys that are tributaries to Lake Chelan and the Columbia River, bounded by rolling hills near the lake's terminus at the City of Chelan, and gravel terraces along the Columbia River.

WRIA 40, Alkali-Squilchuck (Malaga-Stemilt-Squilchuck Area)

Surface Waters

In addition to the three primary watersheds making up Chelan County, a small portion of WRIA 40 (Alkali-Squilchuck) extends into the southeastern corner of the county around Malaga. The portion of WRIA 40 in Chelan County includes the Squilchuck Creek, Stemilt Creek and Cummings Canyon Creek watersheds. The rest of the watershed extends into Kittitas, Yakima and Benton Counties, and includes other small creeks primarily draining directly to the Columbia River.

Squilchuck and Stemilt Creeks are tributaries to the Columbia River. The Squilchuck/Stemilt Watershed (WRIA 40A) covers 76.6 square miles, bounded by the Columbia River to the north, sub-basins of the Wenatchee and Columbia Rivers to the west, Naneum Ridge to the south, and Jump-off Ridge to the east. Approximately 8 percent of WRIA 40A is in Kittitas County and the remainder is in Chelan County. This area consists of four sub-

basins: Stemilt (21,430 acres); Squilchuck (17,600 acres); Malaga (8,490 acres); and Wenatchee Heights (2,200 acres).

Squilchuck Creek is 10.6 miles long with three perennial tributaries: Miners Run Creek, Lake Creek and Upper Squilchuck Creek. Numerous intermittent tributaries flow during periods of snowmelt and during high-intensity thunderstorms (USFS, 1998). About 27 percent of the Squilchuck Creek watershed is in public ownership (RH2, 2007).

Stemilt Creek is 12.4 miles long with four perennial tributaries: Orr Creek (also called Westerly Northwest Branch); Middle Creek (also called Easterly Northwest Branch); Little Stemilt Creek (also called Southeast Branch); and Big Stemilt Creek (also called Easterly Southeast Branch). A few springs discharge into lower Stemilt Creek. About 58 percent of the Stemilt Creek watershed is in public ownership (RH2, 2007).

There are approximately 35 reservoirs in WRIA 40A with volumes of 10 acre-feet or greater. They cover 195 acres and provide storage of approximately 3,500 acre-feet. Eight are inactive, and all but one were constructed in natural, off-channel basins enlarged to enhance irrigation storage. Water levels in these reservoirs are largely sustained by diversions from Squilchuck and Stemilt Creeks.

Climate and Stream Flow

Average annual precipitation in WRIA 40A—ranging from 8 inches in the lower elevations to 32 inches in the highest elevations—promotes shrub-steppe and sub-alpine forest vegetation, respectively. Winters are moderately cold, with snow at all elevations. Most precipitation above 3,000 feet is from snow (USFS, 1998). Summers are hot and dry. Approximately 65 percent of annual water flow in Squilchuck and Stemilt Creeks derives from snowmelt during April to July. Springs in the upper reaches support base flow in the creeks (RH2, 2007).

Topography and Soils

The southeast corner of Chelan County includes Pitcher Canyon, Halverson Canyon, Mission Peak, Wenatchee Heights, Jumpoff Ridge, the Malaga and Three Lakes Communities, Rock Island Dam and vicinity, and the drainage basins of Squilchuck Creek, Stemilt Creek, and Colockum Creek. The area is bordered by the Columbia River to the north and east, and by the Kittitas County boundary to the south (Chelan County, 2011).

Elevation in WRIA 40A ranges from 605 feet at the Columbia River to 6,887 feet at Mission Peak. Dominant landforms consist of high ridges and steep slopes that surround large basins, knobs and depressions, deeply incised channels, gravel terraces and the Wenatchee Heights mesa.

3.2.2 Geology

Chelan County sits between the Cascade Mountains to the west and the Columbia Plateau to the east; a significant portion of the County is within the Cascade Mountain Range. The topography of the county ranges from mountainous, with cirques, moraines, spurs and other glacial features, to lower, milder terrain consisting of soils formed of alluvial deposits and glacial drift. The Cascade Mountains are primarily metamorphosed sedimentary, volcanic and granite rock in large outcropping with shallow soils. The Columbia Plateau is mainly thick layers of basaltic bedrock, with outwash deposits of silty sands to sandy gravel at tributary mouths. Elevations range from 700 feet above sea level at the Columbia River to more than 9,000 feet at the highest point of the Cascades.

The Chelan Mountains stretch south to the Columbia River between the Entiat River and the Chelan River. The northern end the Chelan Range merges with the northern end of the Entiat Mountains. Most of the range is within Wenatchee National Forest. The northern end is part of the Glacier Peak Wilderness.

Lake Chelan was formed by the confluence of two glaciers 18,000 years ago: the Chelan Glacier, which originated in the Cascades and advanced down toward the Columbia; and the Cordilleran ice sheet, advancing south from Canada across the Columbia Plateau. The Chelan Glacier extended to somewhere near The Narrows, carving the deep steep walled valley of Lake Chelan's upper Lucerne basin. The continental glacier extended or overrode the basin to at least Wapato Point, creating a small lake between the 2 ice masses. As the glaciers retreated, the outlet of the valley remained filled by the vast quantities of the material deposited by the glaciers, impounding the present day Lake Chelan. As a result of this history, the lake above The Narrows is quite deep.

3.2.3 Climate

The climate of Chelan County possesses both continental and marine characteristics, with the Cascades serving as a topographic and climatic barrier. Air warms and dries as it descends the eastern slopes of the Cascades, resulting in shrub-steppe conditions in the lower elevations of Chelan County. Rainfall occurs about 70 days each year in the lowland and about 120 days in the higher elevations. In July and August, four to eight weeks can pass with only a few scattered showers (Chelan County, 2011). Table 3-1 summarizes annual temperature and precipitation data for three weather stations around Chelan County: Wenatchee, Plain and Stehekin. Monthly averages are shown on Figure 3-2 and Figure 3-3.

Table 3-1. Annual Average Chelan County Climate Data

	Wenatchee	Plain	Stehekin
Annual Average Daily High Temperature (°F)	62.5	57.2	58.2
Annual Average Daily Low Temperature (°F)	42.1	34.0	38.7
Annual Average Total Precipitation (inches)	9.08	27.39	36.12
Annual Average Total Snowfall (inches)	15.7	119.8	124.3

Source: NOAA, 2015

Source: NOAA, 2015

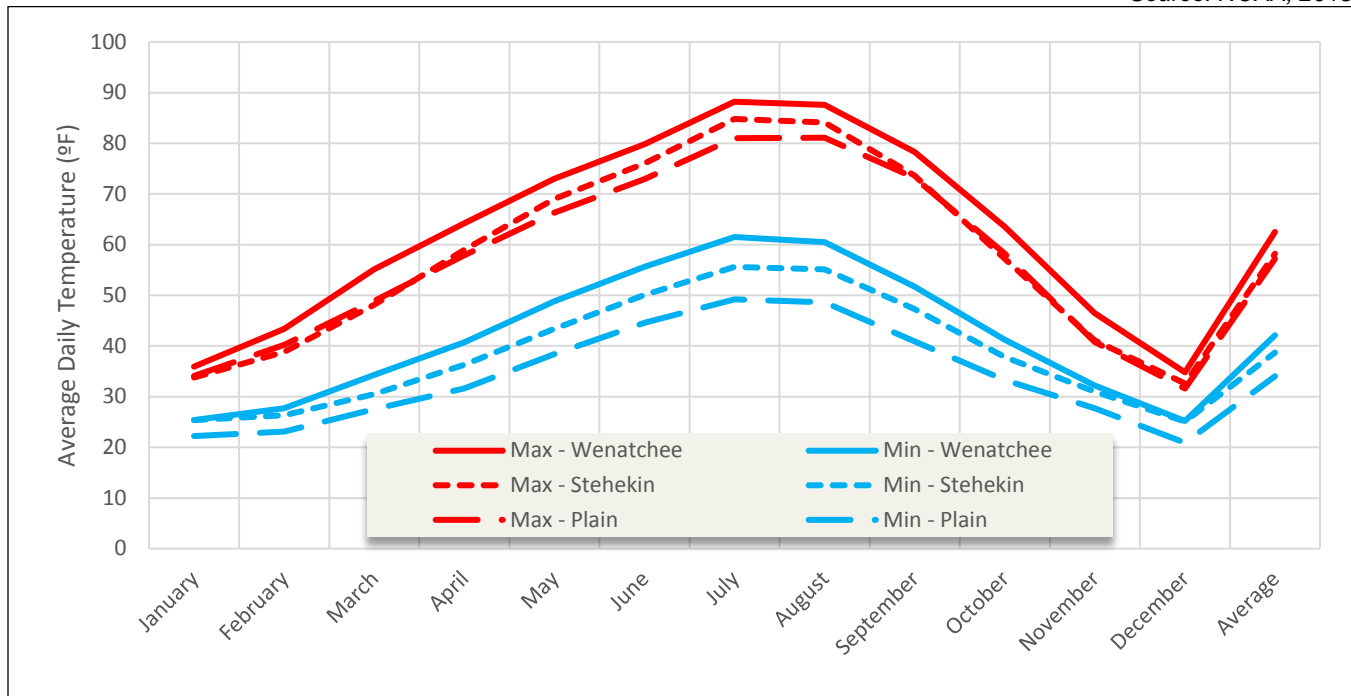


Figure 3-2. Average Daily Temperatures

Source: NOAA, 2015

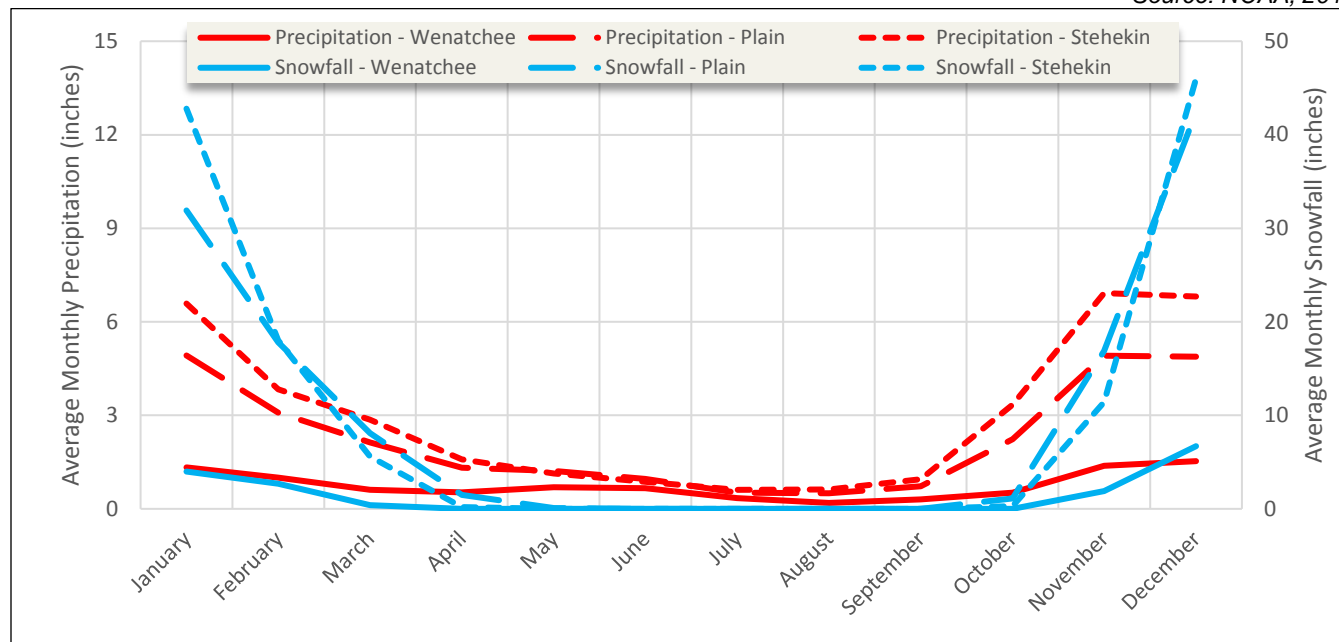


Figure 3-3. Monthly Average Precipitation and Snowfall

The primary flood seasons in Chelan County are during the spring snowmelt (March to June) and from November to February when rain-on-snow events occur. These flood seasons can be exacerbated by denatured slopes due to post-fire conditions. Severe local storms occur when the interior of British Columbia is under the influence of high barometric pressure and a deep low pressure center from over the Pacific approaches the Washington coast. Severe storms normally approach Chelan County from the south or southeast. Thunderstorms occur on one to three days each month from April through September. A few damaging hailstorms are reported each summer (Chelan County, 2011).

During most of the year, the prevailing wind is from the southwest or west. The frequency of northeasterly winds is greatest in fall and winter. Wind velocities ranging from 4 to 12 mph can be expected 60 to 70 percent of the time; 13 to 24 mph, 15 to 24 percent of the time; and 25 mph or higher, 1 to 2 percent of the time. The highest wind velocities are from the southwest or west and are frequently associated with rapidly moving weather systems. Extreme wind velocities can be expected to reach 50 mph at least once in two years; 60 to 70 mph once in 50 years; and 80 mph once in 100 years (Chelan County, 2011).

3.3 DEVELOPMENT FEATURES

3.3.1 Land Use

Wenatchee River Watershed

The Wenatchee River watershed includes the cities of Wenatchee, Cashmere and Leavenworth and communities of Monitor, Sunnyslope, Plain, Peshastin and Dryden. The primary land uses are forestry, wilderness areas, agriculture, range, residential, and recreation. Much of the area is mountainous forest land designated as National Forest. The largest landowner is the U.S. Forest Service, with approximately 395,000 acres of forest land covering about 45 percent of the total watershed area. Most of the private land in the area is concentrated along the major water bodies and transportation routes. Irrigated farmland acreage within the Wenatchee River valley and its tributaries is estimated to be about 12,500 acres. In the upper watershed, much of the area is not suitable for

development due to steep unstable slopes, floodways, wetlands and other critical areas. Development is also constrained by designated resource lands. Current development has occurred on limited areas around the river edges, Lake Wenatchee and Fish Lake. (Washington Department of Ecology, 1995a; Chelan County, 2011).

The rural environment of the lower watershed is characterized by orchards in the valley and on the lower elevations of the rolling hills. Orchards are located throughout much of the valley between Dryden and Sunnyslope. Major crops include apples, pears and cherries. Service industries are found primarily in the incorporated City of Cashmere and the unincorporated community of Sunnyslope. In 2008, a portion of Sunnyslope was included in the City of Wenatchee Urban Growth Area. Several communities along the Wenatchee River and the highway provide small town residential and work opportunities. These areas also contain agricultural processing facilities (Chelan County, 2011).

Most of the Upper Wenatchee River Valley contains evergreen mountains with residential development along the rivers and lakes. The development areas are pockets of higher densities surrounded by natural lands. Land to the west of Leavenworth is extremely limited by mountains and steep slopes. Small parcel sizes are common due to the building area and ownership patterns (Chelan County, 2011).

Most of the Plain-Lake Wenatchee area contains residential homes among the evergreen mountains, with denser populations along the lakes and rivers. This is consistent with the rural recreation opportunities of the area. Plain provides a community area with commercial services and a public post office and school. Development is limited by ownership and parks (Chelan County, 2011).

Entiat River Watershed

The Entiat watershed is 87 percent forested, and timber is the largest land use. Agricultural uses, both irrigated and non-irrigated, are the second biggest land uses. Most of the irrigated agricultural use is along the Entiat River and downstream from the town of Ardenvoir. There are also 9,000 acres of range land, mostly in the lower part of the watershed near the City of Entiat. Residences and businesses are mostly found in the southeastern portion of the watershed near the towns of Ardenvoir and Entiat. Development is limited by single public access up the valley. The City of Entiat and associated urban growth area are located at the base of the Entiat River along the Columbia. The area provides for pockets of residential development and rural businesses. Virtually all existing structural and orchard development has occurred on lands below 2,000 feet in elevation and on less than a 20-percent slope (Washington Department of Ecology, 1995b; Chelan County, 2011).

Lake Chelan Watershed

Over 3 percent of the Chelan watershed is in agricultural use, primarily orchards, and less than 1 percent is developed into roads, houses, and commercial areas. Approximately 6 percent of the watershed consists of Lake Chelan and other water bodies, and about 90 percent of the watershed is forest land managed by the U.S. Forest Service, the National Park Service, and private owners. Virtually all existing structural and orchard development has occurred on lands below 2,000 feet in elevation and on less than a 20-percent slope. Most development is concentrated around the lower end of Lake Chelan, where private land dominates. The upper portion of the basin lies within the North Cascades National Park and the Lake Chelan National Recreation Area, while the area between is in the Wenatchee National Forest, a portion of which is in the Glacier Peak Wilderness Area (Washington Department of Ecology, 1995c; Chelan County, 2011).

The Chelan and Manson communities provide urban services within defined boundaries. The remaining portion of the region is characterized by a variety of parcel sizes containing a mix of orchards and vineyards, wineries, large estate homes, golf courses, ranchettes, open space, pasture land. To the west, access roads become primitive, private or forest service, which greatly reduces the number and types of land uses. Higher levels of development, primarily residential uses, are common along the lakes.

Most of the Stehekin area is undeveloped federal land. The area is influenced by the National Park Service 1995 General Management Plan for the Lake Chelan National Recreation Area. The Park Service manages the majority of federal property in the area. There are about 820 acres of private land, classified as single-family, intermingled with federal land administered by the National Park Service and commercial forest lands. A small community along the northern shore of Lake Chelan continues to develop and grow as a recreation tourist service center. The area is spotted with remote cabins and is not expected to develop (Chelan County, 2011).

Malaga-Stemilt-Squilchuck Area

The town site of Malaga was platted in 1903. Chelan County's first irrigation ditch was built in Malaga to serve the orchards and vineyards planted by early settlers. Development of the Alcoa plant in the early 1950s stimulated residential development in the area. Most of the recent development has occurred southwest of the original town site, especially around Cortez Lake, which is part of the Three Lakes residential area. The Wenatchee Heights area is a large plateau overlooking the Wenatchee Valley that contains several large orchard tracts. Residences are scattered throughout the area. The Stemilt Hill is another large agricultural area, with residential development scattered throughout the orchards. South of Malaga, the rural character is defined by industrial uses, primarily the Alcoa plant. Colockum Creek, Jumpoff Ridge, Stemilt Basin, Mission Ridge are mainly undeveloped open spaces varying from grassland to forest. Primary land uses in those areas include rangeland, timber production and recreation. Recreation, industrial development, and agriculture are the most significant contributors to the economic base (Chelan County, 2011).

3.3.2 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 facilities that hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event. Through a facilitated process, the Steering Committee established a definition of critical facilities for this Comprehensive Flood Hazard Management Plan that includes but is not limited to the following:

A critical facility is defined as a local (not state or federal) facility or infrastructure in either the public or private sector that provides essential products and services to the general public, such as preserving the quality of life in Chelan County and fulfilling important public safety, emergency response, and disaster recovery functions. Loss of a critical facility would result in a severe economic or catastrophic impact and would affect the County's ability to provide essential services that protect life and property. The critical facilities profiled in this plan include but are not limited the following:

- Government facilities, such as departments, agencies, and administrative offices
- Emergency response facilities, including police, fire, and emergency operations centers
- Educational facilities, including K-12 and community college
- Medical and care facilities, such as hospitals, nursing homes, continuing care retirement facilities and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event
- Community gathering places, such as parks, museums, libraries, and senior centers
- Public and private utilities and infrastructure vital to maintaining or restoring normal services to areas damaged by hazard events
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials.

An inventory of facilities that meet this definition was created and input to the computer model used to assess risk for this Flood Plan (FEMA’s Hazus model). Two principle sources of information were used for this inventory:

- The Hazus default entries contained in the Comprehensive Data Management System (Hazus version 3.1)
- The inventory of critical facilities and infrastructure maintained by Chelan County Emergency Management to support the Critical Infrastructure/Key Resource initiative.

Figure 3-4 shows the location of critical facilities in the planning area and Figure 3-5 shows the location of critical infrastructure. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with Chelan County. Table 3-2 and Table 3-3 provide summaries of the general types of critical facilities and infrastructure in the planning area. All critical facilities and infrastructure were analyzed to help identify the flood risk and mitigation actions. Chapter 7 assesses facilities that are exposed and vulnerable to the flood hazard.

3.4 DEMOGRAPHICS

Some populations are at greater risk from hazard events such as floods because of decreased resources or physical abilities. Elderly people, for example, may be more likely to require additional assistance. 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 (Rufat et al., 2015). 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 help to extend focused public outreach and education to these most vulnerable citizens.

3.4.1 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. The Washington State Office of Financial Management estimated Chelan County’s population at 74,300 as of 2014, making it the 17th largest county by population in the state (OFM, 2014).

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Figure 3-6 shows the Chelan County population change from 1990 to 2014 compared to that of the State of Washington (Washington ESD, 2014). The County grew faster than the statewide average through the early 1990s but has since had a growth rate somewhat below that of the state. Table 3-4 shows the county population from 2000 to 2014.

The Washington Office of Financial Management has developed forecasts of future population as shown in Table 3-5. The projections estimate a population of 89,113 in Chelan County by 2040, a 20-percent increase from 2014.

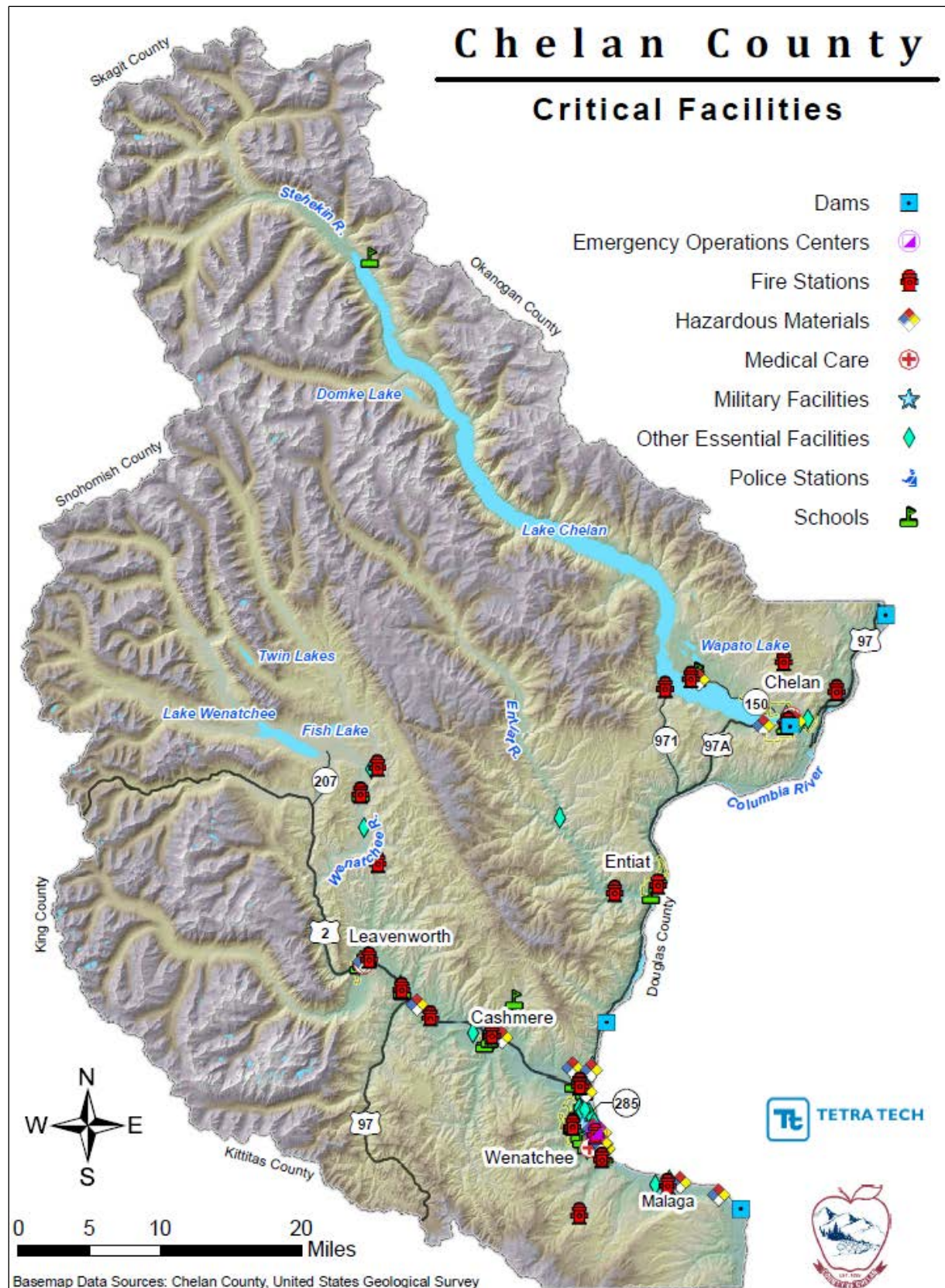


Figure 3-4. Identified Critical Facilities as Defined within the Planning Area

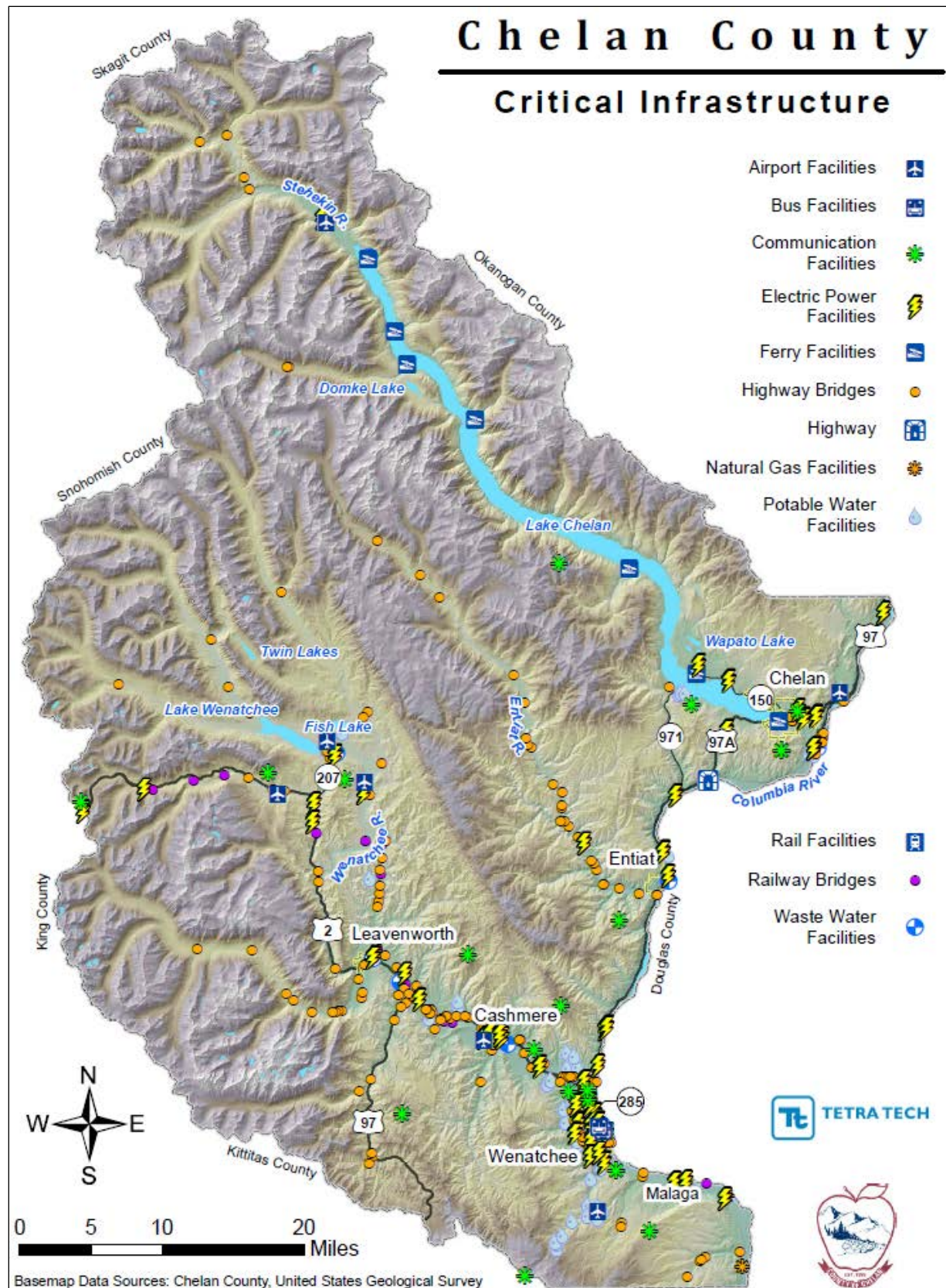


Figure 3-5. Identified Critical Infrastructure as Defined within the Planning Area

Table 3-2. Chelan County Critical Facilities

City	Police & Fire Stations	Emergency Operations Centers	Medical Care	Schools & Educational Facilities	Hazardous Materials Facilities	Dams	Other Essential Facilities	Total
Cashmere	2	0	1	3	1	0	7	14
Chelan	2	0	1	7	5	1	7	23
Entiat	1	0	0	1	0	0	1	3
Leavenworth	1	0	1	5	1	0	4	12
Wenatchee	4	1	2	19	5	0	18	49
Unincorporated	14	0	0	10	7	3	20	54
Total	24	1	5	45	19	4	57	155

Table 3-3. Chelan County Critical Infrastructure

City	Transportation Systems	Communications Facilities	Natural Gas Facilities	Electric Facilities	Potable Water Facilities	Wastewater Facilities	Total
Cashmere	5	0	0	4	1	1	11
Chelan	3	1	0	2	0	0	6
Entiat	0	0	0	1	0	1	2
Leavenworth	4	0	0	2	0	1	7
Wenatchee	20	0	0	11	10	1	42
Unincorporated	208	19	4	31	46	5	313
Total	240	20	4	51	57	9	381

Source: Washington ESD, 2014

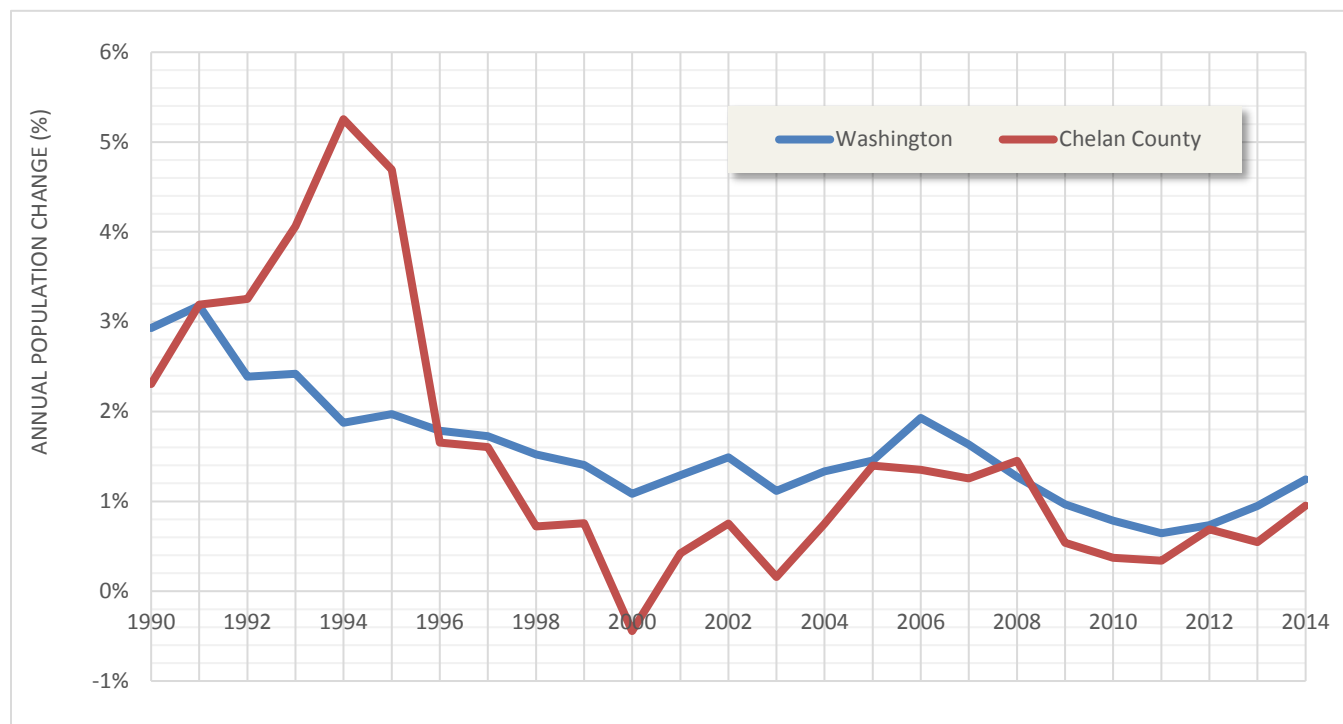
**Figure 3-6. Washington and Chelan County Population Growth**

Table 3-4. Recent County Population Growth

Year	Chelan County Population	Year	Chelan County Population	Year	Chelan County Population
2000	66,616	2005	68,963	2010	72,453
2001	66,896	2006	69,895	2011	72,700
2002	67,400	2007	70,773	2012	73,200
2003	67,507	2008	71,799	2013	73,600
2004	68,013	2009	72,185	2014	74,300

Source: Washington ESD, 2014

Table 3-5. Projected Future County Population

	Chelan County Population
2015	75,068
2020	78,469
2025	81,763
2030	84,652
2035	87,038
2040	89,113

Source: Washington ESD, 2014

3.4.2 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary 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. 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 the flood hazard.

The overall age distribution for the planning area is illustrated in Figure 3-7. Based on the most recent 3-year estimates (2011 – 2013) from the U.S. Census Bureau’s American Community Survey, 15.9 percent of the planning area’s population is 65 or older, compared to the state average of 13.2 percent. According to U.S. Census data, 30.0 percent of the over-65 population has disabilities of some kind and 9.6 percent have incomes below the poverty line. The Census estimates that 22.5 percent of children under 18 live below the poverty line. The county’s population includes 20.1 percent who are 14 or younger, compared to the state percentage of 19.2 percent (U.S. Census, 2013).

Source: U.S. Census, 2013

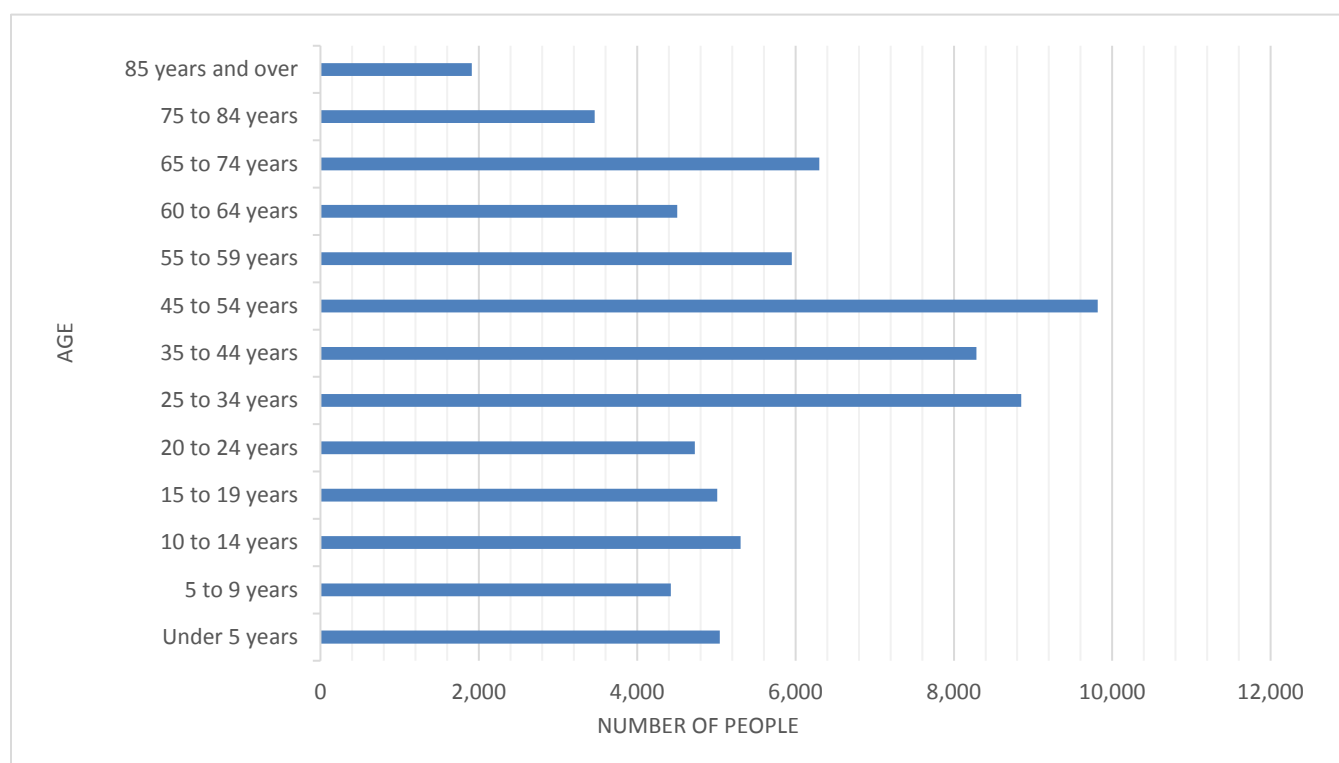


Figure 3-7. Planning Area Age Distribution

3.4.3 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 (Gibbs and Montagnino, 2006). 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.

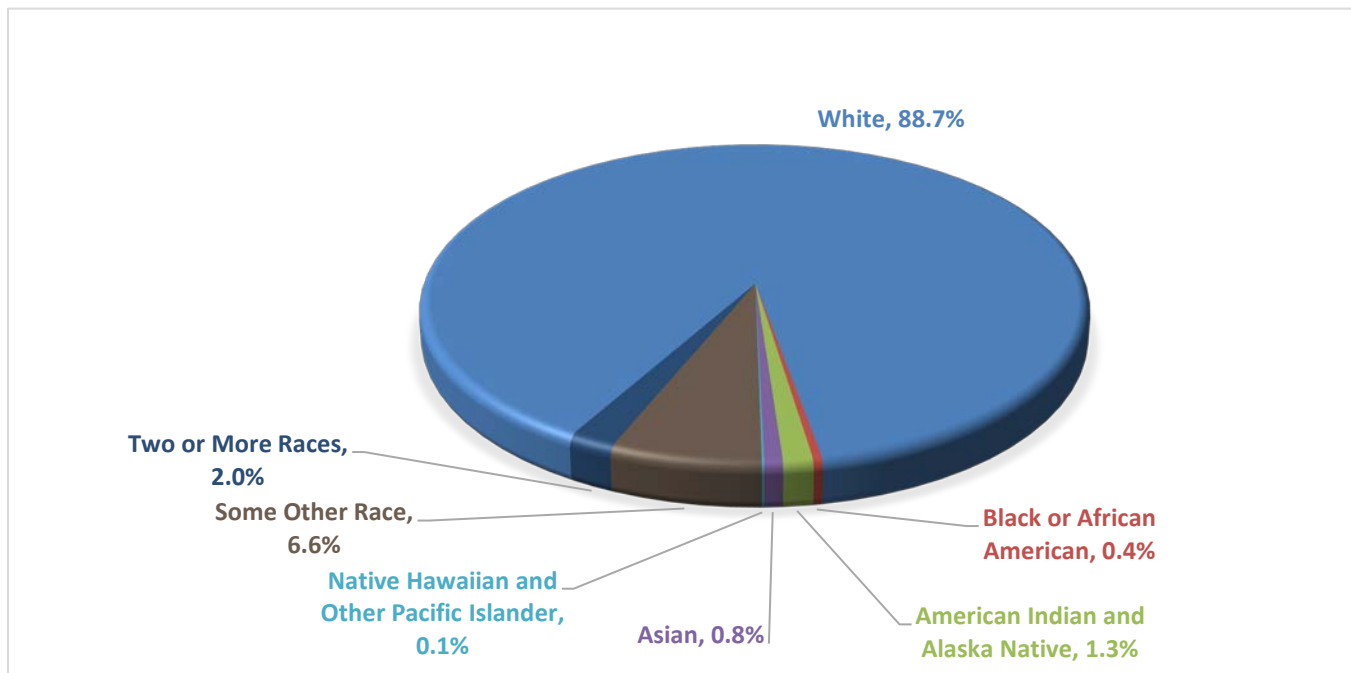
According to the most recent 3-year estimates (2011 – 2013) from the U.S. Census Bureau’s American Community Survey, the racial composition of the planning area is predominantly white, at 88.7 percent. The largest non-white populations are those identifying as “some other race” at 6.6 percent and those identifying as two or more races at 2.0 percent. Figure 3-8 shows the racial distribution in the planning area (U.S. Census, 2012). Those identifying as Hispanic or Latino, of any race, make up 26.9 percent of the population.

The planning area has a 12.9-percent foreign-born population. Other than English, the most commonly spoken language in the planning area is Spanish, with 23.3 percent of the population speaking Spanish at home. The census estimates that 10.3 percent of the residents speak English “less than very well.” (U.S. Census, 2012).

3.4.4 Disabled Populations

The 2010 U.S. Census estimates that 54 million non-institutionalized Americans with disabilities live in the U.S. This equates to about one-in-five persons. People with disabilities are more likely to have difficulty responding to a hazard event than the general population. Local government is the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts.

Source: U.S. Census, 2013

**Figure 3-8. Planning Area Race Distribution**

It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability will allow emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs.

According to the 2008-2010 3-year Census estimates, there are more than 8,000 individuals with some form of disability in the county, representing 11 percent of the total population (U.S. Census, 2013)

3.5 ECONOMY

3.5.1 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 disadvantaged when confronting hazards such as flooding. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in floods than other types of housing. 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 the most recent 3-year estimates (2011 – 2013) from the U.S. Census Bureau's American Community Survey, per capita income in Chelan County was \$25,056 and the median household income was \$51,518. It is estimated that about 11.3 percent of households receive an income between \$100,000 and \$149,999 per year and 6.5 percent of household incomes are above \$150,000 annually. The Census Bureau estimates that 15.4 percent of the population in the planning area lives below the poverty level (U.S. Census, 2013).

3.5.2 Industry, Businesses and Institutions

The planning area's economy is strongly based in the education/health care/social service industry (20 percent of employment), followed by agriculture/forestry/fishing/hunting/mining (13 percent) and retail trade (12 percent). Information (2 percent), public administration (3 percent) and other service industries (3 percent) make up the smallest source of the local economy. Figure 3-9 shows the breakdown of industry types in the planning area. (U.S. Census, 2013)

Source: U.S. Census, 2013

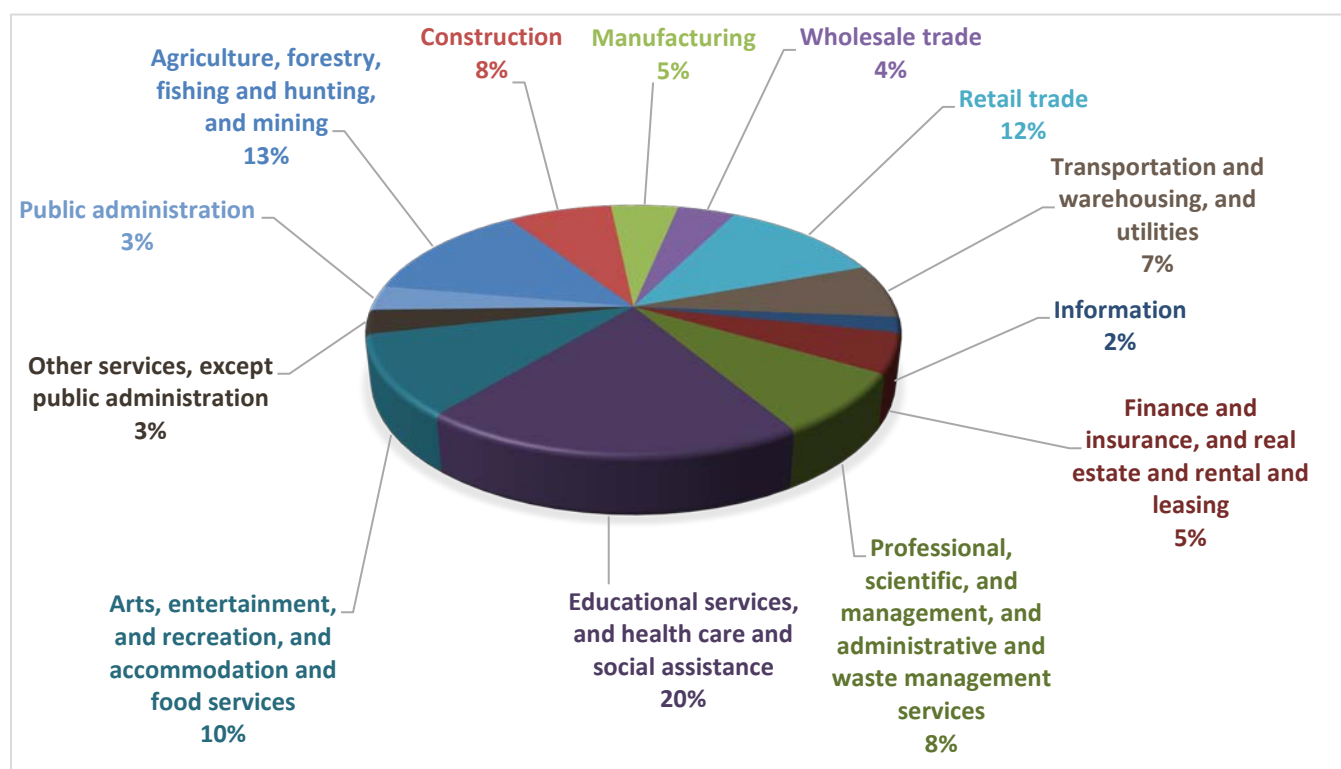


Figure 3-9. Industry in the Planning Area

The Port of Chelan County is responsible for updating demographics for the Chelan-Douglas County area, including a list of large employers, showing the number of employees for each employer (Port of Chelan County, 2015):

- Confluence Health, with 3,527 full-time employees, is the largest full-time employer in the two-county area.
- Stemilt Growers, LLC, with 2,000 full-time employees and 4,000 seasonal employees, has the greatest total number of employees in the two-county area.
- The third greatest number of full-time employees in the two-county area is at apple-slicing company Crunch Pak, which has 900 full-time employees, as well as 99 part-time employees.
- The Wenatchee School District employs 581 people full-time and 446 part-time.
- Other companies in the area with 500 or more total employees are as follows:
 - Agricultural company McDougall & Sons, Inc., with 604 full-time and 296 part-time
 - Chelan County PUD No. 1, with 641 full-time, 21 part-time and 72 seasonal
 - Eastmont School District #206, with 651 full-time and 41 part-time
 - Chelan County, with 443 full-time and 68 part-time

3.5.3 Employment Trends and Occupations

According to the 2011-2013 3-year American Community Survey, 62.6 percent of the planning area's population 16 years old or older is in the labor force, including 55 percent of women in that age range and 70 percent of men (U.S. Census, 2013).

Figure 3-10 compares unemployment trends from 1990 through 2014 for the United States, Washington and Chelan County, based on data from the state Employment Security Department (Washington ESD, 2012). Chelan County's unemployment rate was lowest in 2008 at 5.8 percent. The rate peaked at 8.4 percent in 2011, but has declined steadily since then.

Source: Washington Employment Security Department

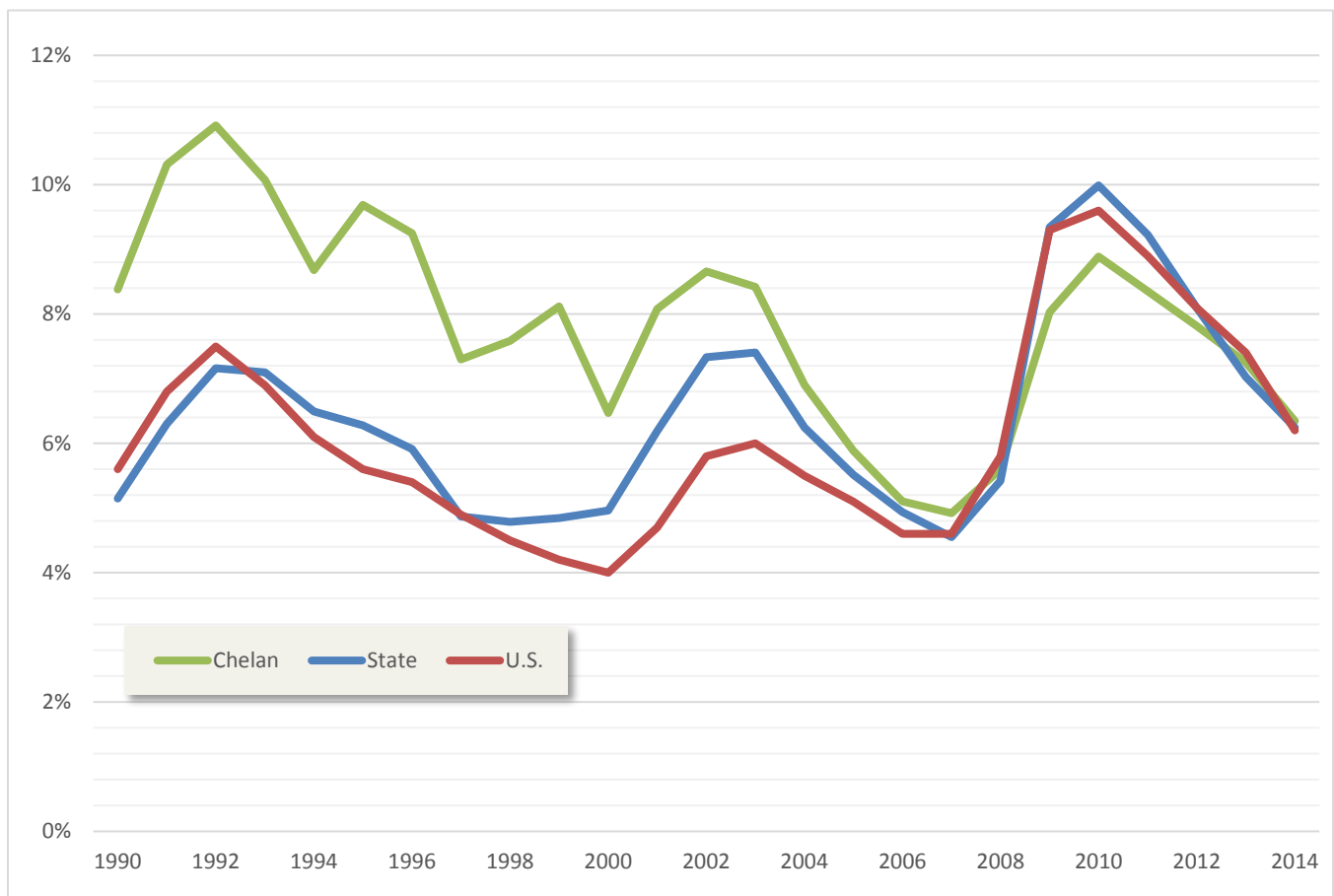
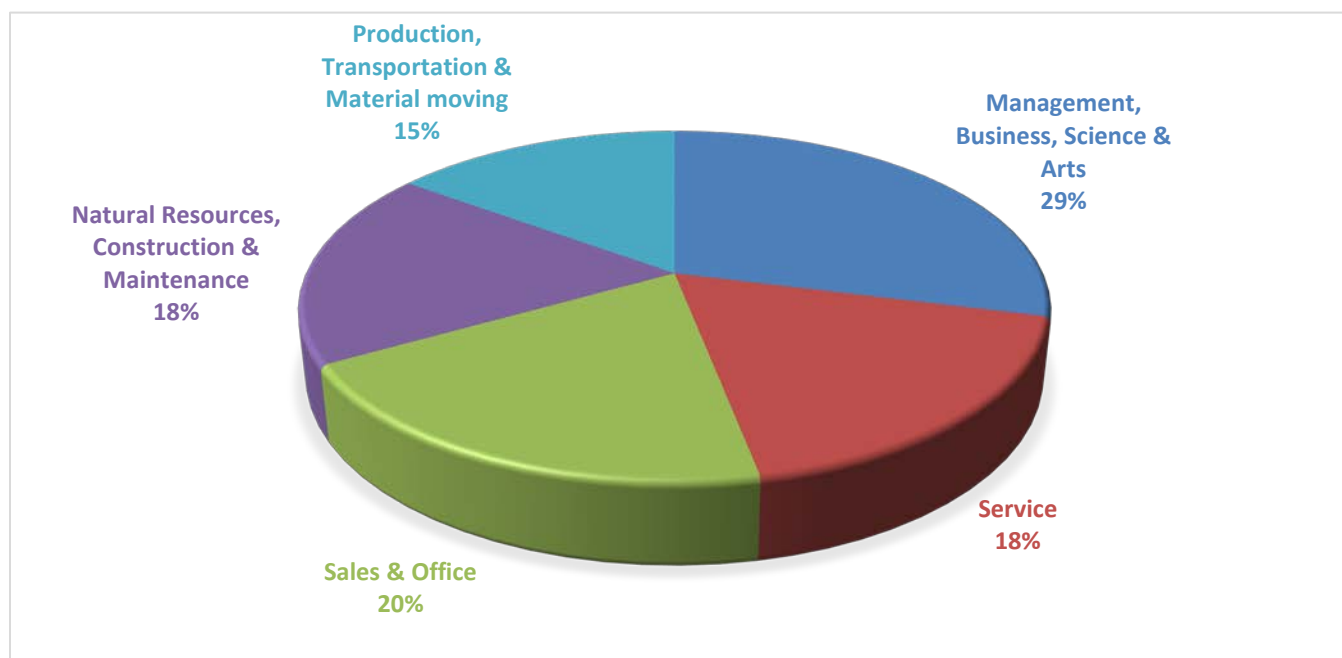


Figure 3-10. U.S., Washington and Chelan County Unemployment Rate

Figure 3-11 shows U.S. Census estimates of employment distribution by occupation category (U.S. Census, 2013). Management, business, science and arts occupations make up 29 percent of the jobs in the planning area. Sales and office occupations make up 20 percent.

The U.S. Census estimates that 77 percent of workers in the planning area commute alone (by car, truck or van) to work (U.S. Census, 2013).

2013 U.S. Census

**Figure 3-11.** Occupations in the Planning Area

4. RELEVANT PROGRAMS AND REGULATIONS

Existing laws, ordinances and plans at the federal, state and local level can support or impact flood hazard mitigation actions identified in this plan. Flood hazard mitigation planning typically includes review and incorporation as appropriate of existing plans, studies, and technical information. This section provides a review of laws and ordinances that can affect flood hazard mitigation in the planning area. Some laws and programs have emergency protocols that go into effect during emergency situations to waive or expedite requirements or procedures. These modifications are limited in scope and duration, and all mitigation and recovery projects should be planned for and implemented in ways that they meet all federal, state and local laws. All of the following federal, state and local programs have been identified as being related to the goals and objectives to this plan.

4.1 FEDERAL

4.1.1 Disaster Mitigation Act of 2000

The federal Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390) provides the legal basis for FEMA mitigation planning requirements for state, local and Indian tribal governments as a condition of mitigation grant assistance. The DMA amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act by replacing previous mitigation planning provisions with new requirements that emphasize the need for planning entities to coordinate mitigation planning and implementation efforts. The law added incentives for increased coordination and integration of mitigation activities at the state level by establishing two levels of state plans. The DMA also established a new requirement for local mitigation plans and authorized up to 7 percent of Hazard Mitigation Grant Program funds to be available for development of state, local, and Indian tribal mitigation plans.

4.1.2 National Flood Insurance Program

The NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities that enact flood hazard management regulations. 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 (100-year 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 flood hazard management program.

NFIP participants must, at a minimum, regulate development in floodplains in accordance with NFIP criteria. Before issuing a permit to build in a mapped flood area, participants 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.

Chelan County participates in the NFIP, as do the cities of Cashmere, Chelan, Leavenworth and Wenatchee and the City of Entiat. All have adopted regulations that meet the NFIP requirements. Table 4-1 summarizes participation dates for these communities.

Table 4-1. NFIP Participation by Chelan County and Municipalities

ID	Community Name	Initial Flood Hazard Boundary Map	Initial Flood Insurance Rate Map	Current Effective Map Date	Program Entry Date
530016	City of Cashmere	04/05/74	12/1/77	09/30/04	12/1/77
530015	Chelan County	01/12/73	02/04/81	09/30/04	02/04/81
530017	City of Chelan	06/25/76	01/05/78	01/05/78	01/05/78
530019	City of Leavenworth	05/24/74	01/05/78	07/02/02	01/05/78
530020	City of Wenatchee	02/01/74	11/2/77	01/06/94	02/04/81
530018	City of Entiat	11/01/74		NSFHA ^a	08/03/84

- a. NSFHA = Non-Special Flood Hazard Area. This indicates an area that is in a moderate- to low-risk flood zone. An NSFHA is not in any immediate danger from flooding caused by overflowing rivers or hard rains, although structures are still at risk. In fact, more than 20 percent of all flood insurance claims come from outside mapped high-risk flood areas.

Source: FEMA, 2015a

Structures permitted or built in participating communities before the first FIRM was adopted 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 effective date for the current FIRM is September 30, 2004. At the time of this planning process, FEMA was in the process of updating Chelan County’s maps under its RiskMAP initiative. Chelan County is currently in good standing with the provisions of the NFIP.

4.1.3 The Community Rating System

The CRS is a voluntary program within the NFIP that encourages flood hazard management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted in participating communities to reflect the reduced flood risk resulting from community actions to meet the CRS goals of reduce and avoid flood damage to insurable property, strengthen and support the insurance aspects of the NFIP and foster comprehensive floodplain management.

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 19 creditable activities in the following categories:

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

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 67 percent of the NFIP’s policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including riverine, shallow and flash flood risks.

As of October 2016, out of 1,391 communities in the U.S. participating in the CRS program, only 116 were rated Class 5 and only 11 were rated higher (see Figure 4-1). Chelan County and its incorporated cities do not currently participate in the CRS.

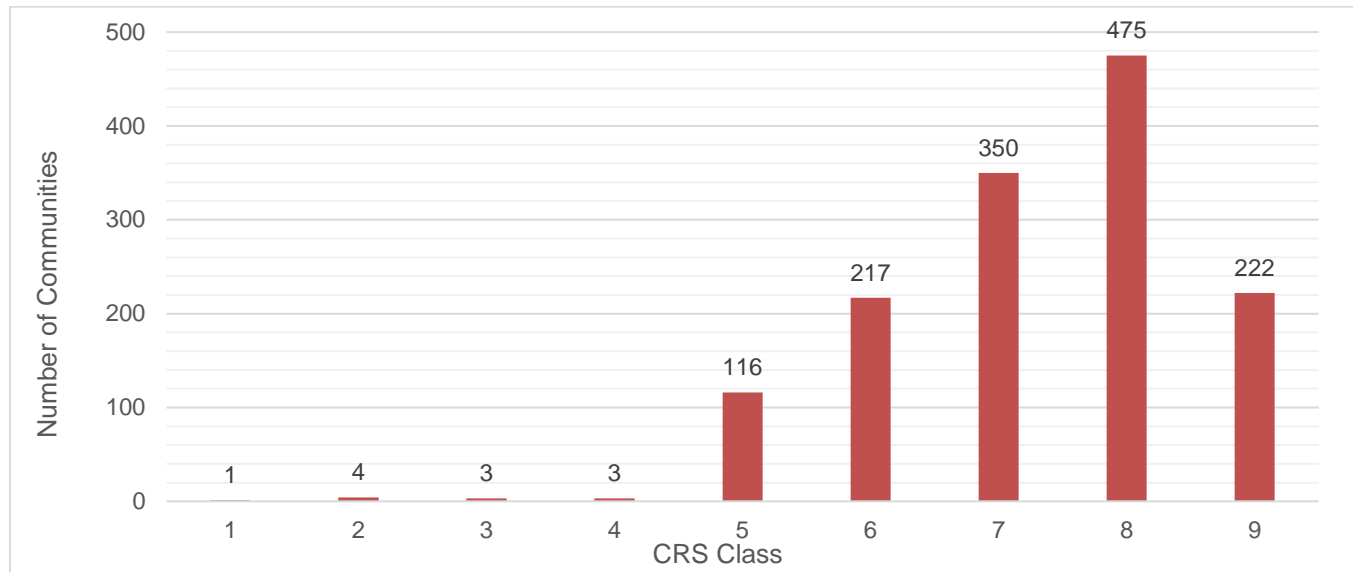


Figure 4-1. CRS Communities by Class Nationwide as of October 2016

4.1.4 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.

4.1.5 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.

4.1.6 National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to consider the environmental impacts of proposed actions and reasonable alternatives to those actions, alongside technical and economic considerations. NEPA established the Council on Environmental Quality, whose regulations (40 CFR Parts 1500-1508) set the standard for NEPA compliance. Consideration of environmental impacts and decision-making process is documented in an environmental impact statement or environmental assessment. Environmental impact

assessment requires the evaluation of reasonable alternatives to a proposed action, solicitation of input from organizations and individuals that could be affected, and the unbiased presentation of direct, indirect, and cumulative environmental impacts.

4.1.7 National Incident Management System

The National Incident Management System (NIMS) is a systematic approach for government, nongovernmental organizations, and the private sector to work together to manage incidents involving floods and other hazards. The NIMS provides a flexible but standardized set of incident management practices. Incidents typically begin and end locally, and they are managed at the lowest possible geographical, organizational, and jurisdictional level. In some cases, success depends on the involvement of multiple jurisdictions, levels of government, functional agencies, and emergency-responder disciplines. These cases necessitate coordination across this spectrum of organizations. Communities using NIMS follow a comprehensive national approach that improves the effectiveness of emergency management and response personnel across the full spectrum of potential hazards (including natural hazards, terrorist activities, and other human-caused disasters) regardless of size or complexity.

4.1.8 Americans with Disabilities Act

The Americans with Disabilities Act (ADA) seeks to prevent discrimination against people with disabilities in employment, transportation, public accommodation, communications, and government activities. Title II of the ADA deals with compliance with the Act in emergency management and disaster-related programs, services, and activities. It applies to state and local governments as well as third parties, including religious entities and private nonprofit organizations.

The ADA has implications for sheltering requirements and public notifications. During an emergency, officials must use a combination of warning methods to ensure that all residents have any necessary information. Those with hearing impairments may not hear radio, television, sirens, or other audible alerts, while those with visual impairments may not see flashing lights or visual alerts. Two technical documents issued for shelter operators address physical accessibility needs of people with disabilities as well as medical needs and service animals.

The ADA intersects with disaster preparedness programs in regards to transportation, social services, temporary housing, and rebuilding. Persons with disabilities may require additional assistance in evacuation and transit (e.g., vehicles with wheelchair lifts or paratransit buses). Evacuation and other response plans should address the unique needs of residents. Local governments may be interested in implementing a special-needs registry to identify the home addresses, contact information, and needs for residents who may require more assistance.

4.1.9 Civil Rights Act of 1964

The Civil Rights Act of 1964 prohibits discrimination based on race, color, religion, sex or national origin and requires equal access to public places and employment. The Act is relevant to emergency management and hazard mitigation in that it prohibits local governments from favoring the needs of one population group over another. Local government and emergency response must ensure the continued safety and well-being of all residents equally, to the extent possible.

4.1.10 Rural Development Program

The mission of the U.S. Department of Agriculture (USDA) Rural Development Program is to help improve the economy and quality of life in rural America. The program provides project financing and technical assistance to help rural communities provide the infrastructure needed by rural businesses, community facilities, and households. The program addresses rural America's need for basic services, such as clean running water, sewage and waste disposal, electricity, and modern telecommunications and broadband. Loans and competitive grants are

offered for various community and economic development projects and programs, such as the development of essential community facilities including fire stations.

4.1.11 Community Development Block Grant Disaster Resilience Program

In response to disasters, Congress may appropriate additional funding for the U.S. Department of Housing and Urban Development Community Development Block Grant programs to be distributed as Disaster Recovery grants (CDBG-DR). These grants can be used to rebuild affected areas and provide seed money to start the recovery process. CDBG-DR assistance may fund a broad range of recovery activities, helping communities and neighborhoods that otherwise might not recover due to limited resources. CDBG-DR grants often supplement disaster programs of the Federal Emergency Management Agency, the Small Business Administration, and the U.S. Army Corps of Engineers. Housing and Urban Development generally awards noncompetitive, nonrecurring CDBG-DR grants by a formula that considers disaster recovery needs unmet by other federal disaster assistance programs. To be eligible for CDBG-DR funds, projects must meet the following criteria:

- Address a disaster-related impact (direct or indirect) in a federally declared county
- Be a CDBG-eligible activity (according to regulations and waivers)
- Meet a national objective.

Incorporating preparedness and mitigation into these actions is encouraged, as the goal is to rebuild in ways that are safer and stronger.

4.1.12 Emergency Watershed Program

The USDA Natural Resources Conservation Service (NRCS) administers the Emergency Watershed Protection (EWP) Program, which responds to emergencies created by natural disasters. Eligibility for assistance is not dependent on a national emergency declaration. The program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, wind-storms, and other natural occurrences. EWP is an emergency recovery program. Financial and technical assistance are available for the following activities:

- Remove debris from stream channels, road culverts, and bridges
- Reshape and protect eroded banks
- Correct damaged drainage facilities
- Establish cover on critically eroding lands
- Repair levees and structures
- Repair conservation practices (National Resources Conservation Service, 2016).

4.1.13 Presidential Executive Orders 11988 and 13690

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. It requires federal agencies to provide leadership and take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of floodplains. The requirements apply to the following activities (FEMA, 2015d):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

Executive Order 13690 expands Executive Order 11988 and acknowledges that the impacts of flooding are anticipated to increase over time due to the effects of climate change and other threats. It mandates a federal flood risk management standard to increase resilience against flooding and help preserve the natural values of floodplains. This standard expands management of flood issues from the current base flood level to a higher vertical elevation and corresponding horizontal floodplain when federal dollars are involved in a project. The goal is to address current and future flood risk and ensure that projects funded with taxpayer dollars last as long as intended (Office of the Press Secretary, 2015).

4.1.14 Presidential Executive Order 11990

Executive Order 11990 requires federal agencies to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The requirements apply to the following activities (National Archives, 2016):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

4.1.15 Emergency Relief for Federally Owned Roads Program

The U.S. Forest Service's Emergency Relief for Federally Owned Roads Program was established to assist federal agencies with repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel and have suffered serious damage by a natural disaster over a wide area or by a catastrophic failure. The program funds both emergency and permanent repairs (Office of Federal Lands Highway, 2016).

4.1.16 U.S. Army Corps of Engineers Programs

The U.S. Army Corps of Engineers has several civil works authorities and programs related to flood risk and flood hazard management:

- Floodplain Management Services are 100-percent federally funded technical services such as development and interpretation of site-specific data related to the extent, duration and frequency of flooding. Special studies may be conducted to help a community understand and respond to flood risk. These may include flood hazard evaluation, flood warning and preparedness, or flood modeling.
- For more extensive studies, the Corps of Engineers offers a cost-shared program called Planning Assistance to States and Tribes. Studies under this program generally range from \$25,000 to \$100,000 with the local jurisdiction providing 50 percent of the cost.
- The Corps of Engineers has several cost-shared programs (typically 65 percent federal and 35 percent non-federal) aimed at developing, evaluating and implementing structural and non-structural capital projects to address flood risks at specific locations or within a specific watershed:
 - The Continuing Authorities Program for smaller-scale projects includes Section 205 for Flood Control, with a \$7 million federal limit and Section 14 for Emergency Streambank Protection with a \$1.5 million federal limit. These can be implemented without specific authorization from Congress.
 - Larger scale studies, referred to as General Investigations, and projects for flood risk management, for ecosystem restoration or to address other water resource issues, can be pursued through a specific authorization from Congress and are cost-shared, typically at 65 percent federal and 35 percent non-federal.

- Watershed Management planning studies can be specifically authorized and are cost-shared at 50 percent federal and 50 percent non-federal.
- The Corps of Engineers provides emergency response assistance during and following natural disasters. Public Law 84-99 enables the Corps to assist state and local authorities in flood fight activities and cost share in the repair of flood protective structures. Assistance afforded under PL 84-99 is broken down in to the following 3 categories:
 - **Preparedness**—The Flood Control and Coastal Emergency Act establishes an emergency fund for preparedness for emergency response to natural disasters; for flood fighting and rescue operations; for rehabilitation of flood control and hurricane protection structures. Funding for Corps of Engineers emergency response under this authority is provided by Congress through the annual Energy and Water Development Appropriation Act. Disaster preparedness activities include coordination, planning, training and conduct of response exercises with local, state and federal agencies.
 - **Response Activities**—PL 84-99 allows the Corps of Engineers to supplement State and local entities in flood fighting urban and other non-agricultural areas under certain conditions (Engineering Regulation 500-1-1 provides specific details). All flood fight efforts require a Project Cooperation Agreement signed by the public sponsor and a requirement for the sponsor to remove all flood fight material after the flood has receded. PL 84-99 also authorizes emergency water support and drought assistance in certain situations and allows for “advance measures” assistance to prevent or reduce flood damage conditions of imminent threat of unusual flooding.
 - **Rehabilitation**—Under PL 84-99, an eligible flood protection system can be rehabilitated if damaged by a flood event. The flood system would be restored to its pre-disaster status at no cost to the Federal system owner, and at 20% cost to the eligible non-Federal system owner. All systems considered eligible for PL 84-99 rehabilitation assistance have to be in the Rehabilitation and Inspection Program (RIP) prior to the flood event. Acceptable operation and maintenance by the public levee sponsor are verified by levee inspections conducted by the Corps on a regular basis. The Corps has the responsibility to coordinate levee repair issues with interested Federal, State, and local agencies following natural disaster events where flood control works are damaged.

4.2 STATE

4.2.1 Washington State Floodplain Management Law

Washington’s floodplain management law (Revised Code of Washington (RCW) 86.16, implemented through Washington Administrative Code (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 1978 major challenge to the law—Maple Leaf Investors Inc. v. Department of Ecology—is cited in legal references to flood hazard management issues. The court upheld the law, declaring that denial of a permit to build residential structures in the 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.

4.2.2 Department of Ecology Grants

Washington’s first flood control maintenance program, passed in 1951, was called the Flood Control Maintenance Program. In 1984, the state Legislature established the Flood Control Assistance Account Program (FCAAP) to assist local jurisdictions in comprehensive planning and flood control maintenance (RCW 86.26; WAC 173-145). This is one of the few state programs in the country that provides grant funding to local governments for flood

hazard management planning and implementation. The account is funded at \$4 million per state biennium, unless modified by the Legislature. Projects include comprehensive flood hazard management planning, maintenance projects, feasibility studies, purchase of flood-prone properties, matches for federal projects, and emergency projects. FCAAP grants for non-emergency projects may not exceed \$500,000 per county. Due to funding cuts, applications to this program are currently being accepted only for emergency projects.

In 2013, the Legislature authorized \$44 million in new funding for integrated projects consistent with Floodplains by Design, an emerging partnership of local, state, federal and private organizations focused on coordinating investment in and strengthening the integrated management of floodplain areas. A similar level of funding was authorized for the 2015-17 biennium. The Department of Ecology's Floods and Floodplain Management Division administers the Floodplains by Design grant program. Ecology awards grants on a competitive basis to eligible entities for collaborative and innovative projects in Washington that support the integration of flood hazard reduction with ecological preservation and restoration. Proposed projects may also address other community needs, such as preservation of agriculture, improvements in water quality, or increased recreational opportunities, provided they are part of a larger strategy to restore ecological functions and reduce flood hazards.

4.2.3 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 all water areas of the state, including reservoirs, and their associated shorelands, together with the lands underlying them, except: shorelines of statewide significance; streams upstream of where the mean annual flow is 20 cubic feet per second or less; and lakes smaller than 20 acres.

4.2.4 Growth Management Act

The 1990 Washington State Growth Management Act (RCW Chapter 36.70A) mandates that local jurisdictions adopt land use ordinances to protect the following critical areas:

- Wetlands
- Critical aquifer recharge areas
- Fish and wildlife habitat conservation areas
- Frequently flooded areas
- Geologically hazardous areas.

The Growth Management Act regulates development in these areas, and therefore has the potential to affect hazard vulnerability and exposure at the local level.

4.2.5 Washington State Building Code

The Washington State Building Code Council adopted the 2015 editions of national model codes, with some amendments (RCW 19.27.074). The Council also adopted changes to the Washington State Energy 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 (as amended) 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 2015 International Building Code went into effect as the Washington model code on July 1, 2016.

4.2.6 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 upon 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 manpower, resources, and facilities for dealing with disasters.

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 that can threaten human life as the result of three main factors:
 - Natural conditions, such as weather and seismic activity
 - Human interference with natural processes, such as a levee that displaces the natural flow of floodwaters
 - Human activity and its products, such as homes in a flood hazard area.
- The definitions for hazard, hazard event, hazard identification, and flood hazard include related concepts:
 - A hazard may be connected to human activity.
 - Hazards are extreme events.

Hazards generally pose a risk of damage, loss, or harm to people and/or their property

4.2.7 Watershed Management Act

Washington's Watershed Management Act of 1998 encourages local communities to develop plans for protecting local water resources and habitat. Lawmakers wanted local governments and citizens to develop plans since they know their own regions best. WRIA is an acronym for "Water Resource Inventory Area." WRIs are watershed planning areas established by the Department of Ecology. Washington State is divided into 62 WRIs, each loosely drawn around a natural watershed or group of watersheds. A watershed is an area of land that drains into a common river, lake or the ocean.

4.2.8 Washington State Enhanced Mitigation Plan

The 2013 Washington State Enhanced Hazard Mitigation Plan provides guidance for hazard mitigation throughout Washington (Washington Emergency Management Division, 2013). The plan identifies hazard mitigation goals, objectives and actions 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).

4.2.9 Washington Silver Jackets

The Washington Silver Jackets team was formed in 2010 and is a mix of federal and state agencies that work together to address flood risk priorities in the state. Federal agencies include the Corps of Engineers, which facilitates coordination within the group, FEMA, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Geological Survey (USGS). Participating state agencies include the Department of Ecology, the Emergency Management Division, and the Department of Transportation. The team's projects are intended to address state needs and improve flood risk management throughout the full flood life cycle (Silver Jackets, 2016).

4.2.10 Land and Water Conservation Fund

Congress established the Land and Water Conservation Fund in 1965 and authorized the Secretary of the Interior to provide financial assistance to the states for the acquisition and development of public outdoor recreation areas. The Washington State Recreation and Conservation Office administers the program in Washington. Funding comes from a portion of federal revenue from selling and leasing off-shore oil and gas resources. Eligible projects include land acquisition and development or renovation projects, such as natural areas and open space. The Washington State Recreation and Conservation Office administers the program (Washington State Recreation and Conservation Office, 2016a).

4.2.11 Salmon Recovery Fund

In 1999, the Washington State Legislature created the Salmon Recovery Funding Board. The board provides grants to protect or restore salmon habitat. Funded projects may include activities that protect existing, high quality habitat for salmon or that restore degraded habitat to increase overall habitat health and biological productivity. Funding also is available for feasibility assessments to determine future projects and for other salmon related activities. Projects may include the actual habitat used by salmon and the land and water that support ecosystem functions and processes important to salmon (Washington State Recreation and Conservation Office, 2016b).

4.2.12 State Environmental Policy Act

The State Environmental Policy Act (SEPA) provides a way to identify possible environmental impacts of governmental decisions. These decisions may be related to issuing permits for private projects, constructing public facilities, or adopting regulations, policies, or plans. Information provided during the SEPA review process helps agency decision-makers, applicants, and the public understand how a proposal will affect the environment. This information can be used to change a proposal to reduce likely impacts, or to condition or deny a proposal when adverse environmental impacts are identified. Actions identified in hazard mitigation plans are frequently subject to SEPA review requirements before implementation (Washington Department of Ecology, 2016).

Non-project actions are governmental actions involving decisions on policies, plans, or programs that contain standards controlling use or modification of the environment, or that will govern a series of connected actions. This includes, but is not limited to, the adoption or amendment of comprehensive plans (WAC 197-11-704(2)(b)).

Adoption of the Comprehensive Flood Hazard Management Plan will have no probable significant adverse impact on the environment, therefore an environmental impact statement will not be required under RCW 43.21C.030(2)(c).

4.2.13 State Hydraulic Code

Washington's Hydraulic Code states that any person or government agency intending to undertake a hydraulic project shall, before commencing work, secure a Hydraulic Project Approval from the Washington Department of Fish and Wildlife verifying the adequacy of the proposed means for protecting fish (RCW 77.55.021 (1)). The code defines a hydraulic project as work that will use, divert, obstruct, or change the natural flow or bed of any salt or freshwaters of the state. Approval is required for projects at or waterward of the ordinary high water line and for projects landward of the ordinary high water line that are immediately adjacent to waters of the state.

4.3 LOCAL

4.3.1 Flood Control Zone District

The Chelan County Flood Control Zone District (FCZD) was initiated by the Board of Chelan County Commissioners in June 2014 (Resolution 2014-59). RCW 86.15 enables the creation of such districts for the purpose of undertaking, operating or maintaining flood control projects. Activities of the Chelan County FCZD may include the following:

- Flood warning and emergency response
- Flood-proofing and elevation of structures
- Property acquisition
- Implementation of consistent development regulations that recognize the impacts of flooding
- Basin-wide flood planning
- Flood facility maintenance
- Public education and outreach
- Mapping and technical studies
- Mechanisms for citizen inquiry and public assistance
- Identification, engineering and construction of capital projects to mitigate flood problems.

The Chelan County FCZD was established in response to the growing frequency and severity of flash and stage flooding in greater Chelan County. The Interim Operating Guidelines for the FCZD identified the following primary purposes of the District, the spirit of which will continue to be implemented throughout the life of this Plan (Chelan County Flood Control Zone District, 2014):

- To safeguard human life, health, and safety by protecting public infrastructure from flooding and channel migration
- To identify and implement flood hazard management activities in a cost-effective and environmentally sensitive manner
- To identify flood-prone and repetitive loss areas involving public infrastructure within Chelan County and identify solutions for flood control mitigation in those areas
- To prioritize capital projects to mitigate damage from flash and stage flooding in flood-prone and repetitive loss areas
- To lead and coordinate recovery efforts for significant flooding events within Chelan County with local, state, and federal agencies
- To increase awareness and provide education to the public and other local agencies on flood hazards and effective mitigation measures

- To update, manage, and administer flood zone mapping, local flood zone regulations, and flood hazard assessments within greater Chelan County for consistency with the NFIP.

The Chelan County FCZD is funded by an annual property tax of \$0.07 per \$1,000 assessed value. Twenty counties in Washington have some type of flood control district, including seven with county-wide flood control zone districts. Examples of 2016 levy rates in these districts include \$0.12980 per \$1,000 in King County, \$0.1344 per \$1,000 in Whatcom County, \$0.070054 per \$1,000 in Kittitas County, \$0.10 per \$1,000 in Pierce County and \$0.08975 per \$1,000 in Yakima County.

Completion of this Flood Plan is one of the principle goals identified under the interim operating guidelines. The adopted Flood Plan will supplant the Interim Operating Guidelines and direct future operations of the Chelan County FCZD.

4.3.2 Comprehensive Plan

Chelan County's first Comprehensive Plan, adopted in 1958, provided guidance about what residents hoped to see in their community. Washington's 1990 Growth Management Act established specific goals and requirements for local comprehensive plans and development regulations. Chelan County adopted a Comprehensive Plan in 2000 to comply with the Washington Growth Management Act (GMA). The last mandated review and update to the Comprehensive Plan was completed in 2007 (Resolution 2007-52), with additional updates occurring annually. The County's Comprehensive Plan is currently being updated, with a targeted completion date of June 30, 2017. This provides an opportunity to integrate the findings and recommendation of this Flood Plan into the updated Comprehensive Plan.

4.3.3 Emergency Management Plan

The 2010 Comprehensive Emergency Management Plan is Chelan County's framework for response to a disaster or emergency. Several emergency support function documents provided as functional annexes to the basic plan outline general guidelines by which County organizations will carry out the responsibilities assigned in the plan. These emergency support function documents are consistent with FEMA's 2008 *National Response Framework*.

The Comprehensive Emergency Management Plan details the authorities, functions, and responsibilities of local, state, and federal agencies in the event of emergency. It describes the processes of crisis and consequence management and how the integrated actions of local, state, and federal agencies establish a mutually cooperative environment for preparedness, prevention, response, and recovery activities.

4.3.4 Critical Areas Ordinance

Washington's GMA requires cities and counties to adopt policies and development regulations based on the best available science to protect critical areas. Chelan County updated its Critical Areas Ordinance to comply with the GMA in 2007. Title 11 of the Zoning Code describes, and defines setback requirements for, the following critical areas:

- Fish and wildlife habitat conservation areas
- Wetland areas
- Aquifer recharge areas
- Frequently flooded areas
- Geologically hazardous areas.

4.3.5 Shoreline Master Program

Chelan County's Shoreline Master Program is a planning and regulatory document that contains policies, goals and land-use regulations for shorelines. The current Shoreline Master Program was adopted by the Chelan County Regional Planning Council and the Washington Department of Ecology in 1975 and was revised in 1979. Primary responsibility for administering this regulatory program is assigned to the County's Community Development Department, which has jurisdiction for permitting development on the state's shoreline within the County.

Currently, the Chelan County Community Development Department is working through the public process to update the Shoreline Master Program. The Cities of Cashmere, Chelan, Entiat, Leavenworth and Wenatchee also either have begun or have recently adopted an updated Shoreline Master Program. Each city and the county adopted Shoreline Master Programs in the mid-1970s to comply with the state's Shoreline Management Act.

4.3.6 WRIA Planning

Although Washington's Watershed Management Act does not require planning, Chelan County and local governments have undertaken WRIA-related planning activities. The Washington Department of Ecology is providing technical and financial support for the effort. Chelan County has participated in watershed planning for four WRIs (see descriptions in Section 3.2.1):

- Wenatchee Watershed (WRIA 45)
- Entiat Watershed (WRIA 46)
- Chelan Watershed (WRIA 47)
- Alkali-Squilchuck Watershed (WRIA 40).

4.3.7 Chelan County Department of Natural Resources

The County's Natural Resource Department addresses federal, state, and local natural resource mandates and issues. Areas of focus include water resources and timber, fish, wildlife, and agricultural activities within Chelan County and north-central Washington. The Department addresses the impacts of local, state, federal, tribal, and other initiatives, both regulatory and non-regulatory, on natural resource and the economic base of Chelan County. It responds to the general policy direction of the Board of County Commissioners and integrates other County departments' activities into its work products.

4.3.8 Voluntary Stewardship Program

The Voluntary Stewardship Program is an optional, incentive-based approach to protecting critical areas while promoting agriculture. The program is allowed under the Growth Management Act as an alternative to traditional approaches to critical areas protection, such as "no touch" buffers. Chelan County is one of 28 counties that has opted in to the Voluntary Stewardship Program and has received funding to develop a work plan for the program.

4.4 CAPABILITY ASSESSMENT

The planning team performed an inventory and analysis of existing authorities and capabilities called a "capability assessment." A capability assessment creates an inventory of an agency's mission, programs and policies, and evaluates its capacity to carry them out. Table 4-2 summarizes the legal and regulatory capability of Chelan County. Table 4-3 summarizes the administrative and technical capability. Table 4-4 summarizes fiscal capability.

Table 4-5 summarizes the County's participation in national flood-related programs. These programs rank the County's capabilities to implement flood hazard reduction programs such as building code enforcement and flood warning and response activities.

Table 4-2. Legal and Regulatory Capability

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Y	N	N	Y	Title 3, Chapter 3.04 adopts the WA State Building Code that consists of the current versions of the International Building Code, International Residential Code, International Mechanical Code and International Fire Code, 2016
Zoning Code	Y	N	N	Y	Title 11, 2007
Subdivisions	Y	N	N	N	Title 12, Chapter 12.12, 2010
Post-Disaster Recovery	N	N	N	N	
Real Estate Disclosure	Y	N	Y	Y	Revised Code of Washington 42.56 Public Records Act. Updated 2012.
Growth Management	Y	N	N	Y	County Comprehensive Plan , 2015
Site Plan Review	Y	N	N	N	Title 12, Chapter 12.04, 2010
Special Purpose (flood management, critical areas)	Y	N	N	Y	<i>Critical Areas:</i> Title 11, Chapters 11.78, 11.80, 11.82, 11.84 and 11.86; 2007 <i>Flood Damage Prevention:</i> Title 3, chapter 3.20; 2016 <i>Stormwater:</i> Title 13, Chapters 13.16 and 13.18; 2010 <i>Watershed Management Plans:</i> Title 13, Chapter 13.08; 2013
Planning Documents					
Comprehensive Plan	Y	N	N	Y	County Comprehensive Plan, 2015
Capital Improvement Plan	Y	N	N	N	The County has a 6-year Transportation Program for 2015 to 2021 that is reviewed and updated annually.
Economic Development Plan	Y	N	N	N	Countywide Policy # 7 of the 2015 Comprehensive plan addresses policies for county-wide economic development and employment.
Floodplain or Basin Plan	Y	N	N	N	This plan will become the flood hazard management plan of record for the County
Stormwater Manual	Y	N	N	Y	Washington Department of Ecology, Stormwater Management Manual for Eastern Washington, 2004
Comprehensive Stormwater Plan	Y	N	N	N	Chelan County Surface and Stormwater Management Utility, 2012
Habitat Conservation Plan	Y	N	N	N	Chelan County Natural Resources Department
Shoreline Management Plan	Y	N	N	N	1980 Shoreline Master Program, anticipated adoption 2017
Emergency Response Plan	Y	N	N	N	2008 Comprehensive Emergency Management Plan
Community Wildfire Protection Plan	Y	N	N	N	Chelan County Community Fire Plan, November 2008, and 11 individual Community Wildfire Protection Plans that are correlated with the nine fire district boundaries
Continuity of Operations Plan	N	N	N	N	
Post Disaster Recovery Plan	N	N	N	N	

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Other Relevant Plans	Y	N	N	N	Channel Migration Plans: http://www.co.chelan.wa.us/natural-resources/pages/habitat-projects?parent=Habitat%20Projects Salmon Recovery Planning: http://www.co.chelan.wa.us/natural-resources/pages/salmon-recovery-planning?parent=Planning The Upper Wenatchee Community Lands Plan: http://www.co.chelan.wa.us/natural-resources/uwclp-minutes?parent=planning

Definitions:

Local Authority—This capability is based on local adopted regulations and/or plans.

State or Federal Prohibitions—This capability is in response to a prohibition contained in a state or federal mandate. For example, the Clean Water Act includes prohibitions at the local level to ensure water quality.

Other Jurisdictional Authority—This capability based on another authority within the planning area. This is sometimes referred to as "extraterritorial jurisdiction."

State Mandate—This capability is based on a mandate by state statutes. For example, growth management or building codes are mandated by the State of Washington.

Table 4-3. Administrative and Technical Capability

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Community Development, Natural Resources and Public Works
Engineers or professionals trained in building or infrastructure construction practices	Yes	Community Development and Public Works
Planners or engineers with an understanding of flooding hazards	Yes	Community Development, Natural Resources and Public Works
Staff with training in benefit/cost analysis	Yes	Public Works or, if needed, can contract for service
Floodplain manager	Yes	Community Development
Surveyors	Yes	Public Works. Staff surveyors can be augmented by contract support during busy periods
Personnel skilled or trained in GIS applications	Yes	Community Development, Public Works
Scientist familiar with flooding hazards in local area	Yes	Natural Resources and Public Works
Emergency manager	Yes	Emergency Management
Grant writers	Yes	Chelan County

Table 4-4. Fiscal Capability

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	No
Withhold Public Expenditures in Hazard-Prone Areas	No
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes

Table 4-5. National Flood Insurance Program Compliance

What department is responsible for floodplain management in your community?	Community Development
Who is your community's floodplain administrator?	The Director of Community Development
Do you have any certified floodplain managers on staff in your community?	No
What is the date of adoption of your flood damage prevention ordinance?	Last updated 3/1/2016
When was the most recent Community Assistance Visit or Community Assistance Contact?	November 18, 2015 performed by Washington Department of Ecology.
To the best of your knowledge, does your community have outstanding NFIP compliance violations that need to be addressed? If so, please describe.	Yes. These were minor issues being addressed by the County.
Do your flood hazard maps adequately address the flood risk within your community?	No. County still has old FEMA flood data (Q3 data) on its effective FIRM and feels the floodplains are not adequately mapped up the three canyons outside Wenatchee. County is slated for re-mapping under FEMA's RiskMAP program.
Does your floodplain management staff need any assistance or training to support its floodplain management program? If so, what type of assistance/training is needed?	The County is always looking to expand the knowledge base of its floodplain administration staff.
Does your community participate in the Community Rating System (CRS)? If so, is your community seeking to improve its CRS Classification? If not, is your community interested in joining the CRS program?	Not currently. County will use this planning effort as the initiative to apply to CRS upon the plans completion.

5. REGIONAL CONSISTENCY

5.1 LOCAL APPLICABILITY OF COUNTY FLOOD PLANS

A provision of Washington state law regarding flood control by counties authorizes county governments to levy taxes, condemn properties and undertake flood control activities for public purposes. This provision was the basis for the formation of the Chelan County FCZD. It also addresses the development of comprehensive flood control management plans and notes that such plans, when adopted, “shall be binding on each jurisdiction and special district that is located within an area included in the plan” (RCW Chapter 86.12.210). Cities in the planning area of a county flood plan have 120 days to formally adopt the Flood Plan after the county’s adoption date. The statute includes provisions for arbitration of disputes between a city and county over disagreement on scope and applicability of policies in a flood hazard management plan.

This provision of state law seeks to establish regional consistency in flood hazard management. It recognizes the shortcomings of flood hazard management policy recommendations if they are not applied uniformly within a planning area. Flood risk cuts across municipal boundaries, and the actions of one jurisdiction can impact the flood risk of jurisdictions downstream. Flood hazard planning efforts must define what constitutes consistency in the implementation of flood hazard management actions or policies.

5.2 CONSISTENCY REVIEW

The Chelan County Flood Plan Steering Committee opted to perform a review of all municipalities within the planning area to assess the degree of consistency in their flood hazard management administration practices. The review assessed the floodplain administration capabilities of the County as well as the cities. The results were used in developing a definition of regional consistency for the Chelan County Flood Plan.

5.2.1 Methodology

The CRS provides a quantifiable rating system to create an incentive for more effective flood hazard management. The Baseline Assessment Tool (BATool™) is a proprietary tool developed by Tetra Tech, Inc. that helps communities gauge their ability to participate in the CRS. It provides feedback on the community’s ability to succeed under the CRS program and whether a community’s flood hazard management program is ready for a community assistance visit by CRS personnel. The BATool™ asks 57 quantifiable questions that pertain to floodplain management in the following categories:

- Flood Risk (looking at the degree of flood risk exposure versus all assets within the Community)
- Programmatic—Regulations (looks at regulatory capability)
- Programmatic—Planning (Looks at planning capability)
- Programmatic—Administration. (programmatic administration and enforcement)

Answers are weighted based on the importance of the component to overall, programmatic flood hazard management. These weights were calibrated by looking at a sample of communities across the country.

The BATool™ classifies communities as green, yellow, or red:

- **Green**—Community is ready to move forward with a CRS community assistance visit.
- **Yellow**—Community is close, but might want to consider some resilience recommendations.
- **Red**—Significant issues must be addressed before applying to the CRS.

This tool was used for the Chelan County consistency review because it scores each program, allowing for a comparison of scores to identify which jurisdictions have the capability to administer policies considered for the flood hazard management plan and which do not. Based on that information, a policy being considered for inclusion in the Flood Plan can be amended for uniform application or dropped from consideration because it could not be implemented uniformly across the planning area.

5.2.2 Findings

The planning team performed BATool™ evaluations on the County and the five municipalities within the planning area. The results of these evaluations are shown in Table 5-1.

Table 5-1. Consistency Review Results

Municipality	Category Results				
	Flood Risk (%)	Programmatic-Regulation (%)	Programmatic Planning (%)	Programmatic Administration (%)	Overall Score (%)
Cashmere	65.00	53.04	57.63	57.14	58.38
Chelan	58.33	46.09	42.37	56.04	53.44
Entiat	50.00	13.91	49.15	38.46	37.39
Leavenworth	61.67	15.65	30.51	26.01	32.28
Wenatchee	71.67	62.61	57.63	62.4	64.73
Unincorporated County	48.33	56.52	66.10	48.72	53.79
Average	59.16	41.30	50.57	48.13	50.00

80% or Higher = **Green**; 50% to 79% = **Yellow**; 49% or Lower = **Red**

No municipality scored in the green level (80th percentile or higher) in any of the categories. The average overall score was 50 percent (yellow). The highest score was 71.6 percent and the lowest was 13.9 percent. The results indicate little area-wise programmatic consistency. The following were consistent issues among jurisdictions:

- Local flood hazard mapping does not accurately reflect the true flood risk for the area. This impacts a community's abilities to implement a program that is applied to a mapped and defined hazard area.
- With the exception of freeboard, the flood damage prevention ordinances in effect are minimum-requirement NFIP ordinances.
- Record keeping and formal administrative procedure are lacking across the board.
- Local permitting authority is generally limited to building permits, which makes it difficult to regulate development that does not include the placement of a structure.

All jurisdictions evaluated currently participate in the NFIP and are in full compliance and good standing under that program. None of the jurisdictions currently participate in the CRS program.

5.3 CONSISTENCY DEFINITION FOR THIS FLOOD PLAN

Based on the consistency review findings, flood hazard management program consistency for the *Chelan County Comprehensive Flood Hazard Management Plan* will be defined as maintaining compliance and good standing

under the program requirements of the NFIP. Maintaining compliance is contingent upon each jurisdiction's strict enforcement of its own adopted codes and policies that govern development in the regulated floodplain. If a jurisdiction adopts a higher standard, strict application of that standard with no variance is expected under this definition of consistency. Compliance status is to be monitored by state or federal NFIP coordinating offices. The consistency definition does not establish what codes and policies each jurisdiction should adopt to support floodplain management, but it calls on all jurisdictions to enforce whatever codes and policies they have adopted.

5.4 POLICIES TO ENSURE CONSISTENCY

In the interest of supporting the objectives of RCW 86.16, Chelan County has identified policies that strive to achieve regional consistency in flood hazard management within Chelan County. These policies can be found under the "general policy" section of chapter 12 of this plan.

Part 2. RISK ASSESSMENT

6. RISK ASSESSMENT METHODOLOGY

6.1 PURPOSE OF RISK ASSESSMENT

This part of the Flood Plan evaluates the risk of the flood hazard in the planning area (CRS Step 5). Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards such as flooding. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- Exposure identification—Determine the extent of people, property, environment and economy exposed to the effects of the natural hazard.
- Vulnerability evaluation—Estimate potential damage from the natural hazard and associated costs.

The risk assessment describes the flooding hazard, the planning area's vulnerabilities, and probable event scenarios. The following steps were used to define the risk:

- Identify and profile the flooding hazard (CRS Step 4); the following information is given:
 - Principal sources of flooding in the planning area
 - Major past flood events
 - Geographic areas most affected by floods
 - Estimated flood event frequency
 - Estimates of flood severity
 - Warning time likely to be available for response
 - Existing flood protection programs and projects
 - Secondary hazards associated with the flood hazard
 - Potential impacts of climate change on flooding
 - Expected future trends that could affect the flood hazard
 - Scenario of potential worst-case flood event
 - Key issues related to flood hazard management in the planning area.
- Determine exposure to the flood hazard—Exposure was determined by overlaying flood maps with an inventory of structures, facilities, and systems to determine which of them would be exposed to flood events.
- Assess the vulnerability of exposed facilities—Vulnerability of exposed structures and infrastructure was determined by interpreting the probability of occurrence of each flood event and assessing structures, facilities, and systems that are exposed. In addition the repetitive loss areas in the County were reviewed, mapped and evaluated.

6.2 RISK ASSESSMENT APPROACH

6.2.1 FEMA's Hazus-MH Software

In 1997, FEMA developed the standardized Hazards U.S. (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. The use of Hazus for hazard mitigation planning offers numerous advantages:

- 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 FEMA 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 flood hazard management plan throughout its implementation.

Hazus is a GIS-based software program that includes extensive inventory data, such as demographics, building stock, critical facilities, transportation facilities and utilities. It uses multiple models to estimate potential losses from natural disasters. The program maps hazard areas and estimates damage and economic losses for buildings and infrastructure.

To estimate damage that would result from a flood, Hazus uses pre-defined relationships between flood depth at a structure and resulting damage, with damage given as a percent of total replacement cost. These are referred to as depth-damage curves and are based on data from the Federal Insurance Administration and the Corps of Engineers. Curves defining these relationships have been developed for damage to structures and for damage to typical contents for a variety of residential, commercial and public structures. By inputting flood depth data and known property replacement cost values, users can generate dollar-value estimates of damage that will result from any given flood event.

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

- 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 modeled area.
- Level 2—More accurate estimates of losses require more detailed information about the modeled 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 modeled area. Level 3 involves establishing new damage curves, which is not necessary for flood hazard analyses, because those damage functions are well established.

To assess the flood hazard for this Flood Plan, a Level 2, user-defined analysis was performed for both general building stock and critical facilities. Findings from this analysis are covered in Chapter 8.

6.2.2 Sources of Data Used in Hazus Modeling

Data loaded into Hazus included property replacement cost values and detailed structure information derived from address, parcel, and tax assessor data provided by Chelan County. When available, an updated inventory was used in place of the Hazus defaults for critical facilities and infrastructure.

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

Flood hazard areas for the 100- and 500-year floods were delineated using new FEMA digital flood data where available (from Digital Flood Insurance Rate Maps) and older FEMA digital flood data (Q3 data) where digital mapping has not yet been developed.

Table 6-1 summarizes the sources of data used in the Hazus model for this Flood Plan.

Table 6-1. Hazus Model Data Documentation

Data	Source	Date	Format
Property parcel data	Chelan County	2015	Digital (GIS) format
Address data	Chelan County	2015	Digital (GIS) format
Building information (square footage, use description, year built, number of stories, garage type, and construction class)	Chelan County	2015	Digital (text) format
Building replacement cost	RS Means	2015	Paper format.
Population data	U.S. Census Bureau	2010	Digital (GIS and tabular) format
FEMA Effective Digital Flood Insurance Rate Map data	FEMA	09/2004	Digital (GIS) format
FEMA Q3 digital data	Washington State Department of Ecology	1996	Digital (GIS) format
Number 1 Canyon flood event data	City of Wenatchee	8/5/2013	Digital (GIS) format
Digital elevation model, 1-meter horizontal resolution	Oregon Lidar Consortium	2015	Digital (raster) format
Digital elevation model, 10-meter horizontal resolution	U.S. Geological Survey	2000 – present	Digital (raster) format
Landmark data (emergency operation centers, fire stations, medical care facilities, schools, military facilities, hazardous material facilities, airports, rail facilities, communications facilities, wastewater facilities, public facilities)	Chelan County	2015	Digital (GIS) format
Default critical facilities and infrastructure data (medical care facilities, police stations, schools, bus facilities, ferry facilities, highway tunnels, rail facilities, communications facilities)	Hazus-MH v. 3.1	2015	Digital (GIS) format
Utility facilities (dams, communications facilities, electric power facilities, potable water facilities, waste water facilities)	Chelan County Public Utility District	Unknown	Digital (GIS) format
Hazardous material facilities	U.S. Environmental Protection Agency website Toxic Release Inventory data	2016	Digital (GIS) format
Road and railway bridge data	Chelan County	Unknown	Digital (GIS) format

6.2.3 Flood Depth Grid Generation

An important input to Hazus for modeling flood damage is a flood depth grid, which defines the depth of floodwater at points covering the flooded area for any given flood event. For this Flood Plan, depth grids were prepared for the 100- and 500-year flood events where mapping and detailed flood studies were available. The following methods were used to create the flood depth grid, depending on the mapping data available:

- **Water Surface Elevation Reconstruction**—This technique used datasets that include base (100-year) flood water surface elevations for a floodway or floodplain. These were primarily the FEMA detailed study flood zones along the Wenatchee River, Mission Creek and Icicle Creek. GIS tools were used to create a water surface based on the water surface value given for the base flood. The Corps of Engineering software package CORPSCON6 was used to convert 100-year water surface elevations from the original 1929 National Geodetic Vertical Datum to the 1988 North American Vertical Datum. Water surface elevations for the 500-year flood were derived from cross sectional values in the most recent FEMA *Flood Insurance Study* (Number 530015V000B, September 2004). The water surface elevation grids were intersected with the existing ground surface to create flood depth grids.
- **Flood Zone Direct Calculation**—This technique was used for flood zone datasets that provided only a water depth or water surface elevation. This includes AO, AH, and similar FEMA zones. If a depth was given for one of these zones, a depth grid was created directly out of that zone boundary. If a static water surface elevation was given, a water surface grid was created out of that zone and intersected with the ground surface to create flood depth grids.
- **Flood zone interpolation**—This technique was used for designated approximate A zones, and 500-year X zone floodplain boundaries from FEMA Q3 data. The floodplain boundaries were intersected with the ground surface, with the assumption that the elevation along that boundary marked the water surface elevation edge. The boundary was interpolated to 3D and converted to a water surface grid. This grid was then intersected with the ground surface within the boundary to create flood depth grids.
- **Hazus Hydrology and Hydraulics (H&H) Flood Modeling**—This technique was used for areas for which no effective FEMA floodplains have been designated, including No. 1 Canyon, No. 2 Canyon and Dry Gulch outside Wenatchee. The Oregon LiDAR Consortium 1-meter digital elevation model was input into the Hazus software H&H model to produce 100- and 500-year floodplain depth grids in those canyons. Both depth grids were generated using discharge numbers for each canyon as outlined in the 2012 *Chelan County Comprehensive Stormwater Plan*. Using GIS tools, the Hazus H&H output depth grids were enhanced with additional connecting depth grids to join the canyon stream channels to the effective FEMA flood zone boundaries at the mouth of the canyons.

6.2.4 Limitations

Loss estimates, exposure assessments and vulnerability evaluations rely on the best available data and methodologies. However, results are subject to uncertainties associated with the following factors:

- Incomplete scientific knowledge about flood hazards and their effects on the built environment
- 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 the flood hazard
- Mitigation actions already employed
- The amount of advance notice residents have to prepare for a flood event
- FEMA adheres to a protocol for map revision. Understanding that flood hazard areas are dynamic and constantly changing, FEMA attempts to keep its maps current by adhering to this protocol. It should be understood that at any point in time a current map may not reflect current conditions.

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.

Results are particularly imprecise for modeling that used the flood zone interpolation technique. That technique assumed that FEMA Q3 flood boundaries for the affected zones are accurate, but subsequent assessments found that floodwater surface elevations at some boundaries are unrealistically high. The flood damage estimated using those elevations is therefore likely much greater than would actually occur.

7. CHELAN COUNTY FLOOD HAZARD PROFILE

7.1 GENERAL CONCEPTS

A floodplain is the area adjacent to a flood source such as a river, creek, alluvial fan 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 altered or significantly reduced.

DEFINITIONS

Flood—The inundation of normally dry land resulting from the overland flow of water from any source.

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

100-Year Floodplain—The area flooded by a flood event 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.

7.1.1 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for 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.

7.1.2 Floodplain Ecosystems

Floodplains can support ecosystems that are rich in plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. 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.

7.1.3 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.

7.2 PRINCIPAL TYPES OF FLOODING IN CHELAN COUNTY

Stage, flash and post-fire flooding are three types of flooding common in Chelan County. Stage flooding occurs during periods of heavy rains, especially falling on existing snowpack during early winter and late spring. Stage flooding can last several days after the storm. Flash floods are most likely to occur during the summer thunderstorm season and are usually associated with cloudburst-type rainstorms. Winter flash flooding events, when they occur, are typically caused by ice or debris dams. Due to the County's topography and climate, stage and flash flooding are a continuing threat in most parts of the county (Chelan County, 2013). After a significant wildfire, vegetation is lost and soils can harden to repel rather than absorb water. This can result in mud/silt or debris flows that impact public and private property (county roads, private homes/cabins, etc.). It also reduces flow conveyance, increasing the potential for flood damage.

7.2.1 Stage Flooding

Stage floods occur because of prolonged heavy rainfall, a rapidly melting snow pack or a combination of these. Stage flooding problem areas can occur countywide; some of the most susceptible areas are the area where Icicle Creek and the Wenatchee River meet in Leavenworth, the Wenatchee River between Cashmere and Wenatchee, the headwaters of the Wenatchee River, and the confluence area of the Wenatchee and Columbia Rivers. The following sections describe the watersheds in the planning area that are sources of stage flooding

7.2.2 Flash Flooding

Flash flooding is flooding characterized by a quick rise and fall of water level. Flash floods generally result from intense storms dropping large amounts of rain within a short period of time onto watersheds that cannot absorb or slow the flow.

Historically, Chelan County has had regular occurrences of flash flooding. Present problem areas for flash flooding include Slide Ridge in the Chelan area and No. 1 and No. 2 Canyons and Dry Gulch in the Wenatchee area. The primary cause of flash flooding, which can occur in any county drainage area, is high-intensity rainfall.

Depending upon the characteristics of a particular watershed, peak flows may be reached from less than one hour to several hours after rain begins. The debris dams and mudslides accompanying rapid runoff conditions make narrow canyons and alluvial fans at the mouth of the canyons extremely hazardous areas (Chelan County, 2011).

7.2.3 Post-Fire Flooding

Wildfires dramatically change landscape and ground conditions, which can lead to increased risk of flooding due to heavy rains, flash flooding, and mudflows. The threat of flash flooding is increased in an area that has suffered from a major wildland fire. Not only is there a greater amount of loose debris, but most of the ground cover also has been burnt away. Without ground cover, more soil and debris can flow, increasing the chance of debris dams. When rain falls on unprotected earth, as in a burn area, soils on moderate to steep slopes can become unstable. The heavily saturated earth can liquefy and flow down a hillside into populated areas. This can cause devastating floods and mudflows.

Post-fire flooding is a concern in Chelan County. Since 2010, over 600 square miles in the county have been burned by wildfires. Much of this area has been in steep canyons or areas that contribute to drainage area that feed the floodplains of Chelan County. Post-fire flooding can be the worst type of flooding in that there is usually large sediment loads associated with these types events. This sediment transport can lead to channel deposition and migration, which can lead to public safety issues, lack of early warning, and costly cleanup for public agencies and private residents.

The 1972 flood was an area-wide event resulting from a large frontal storm combined with the late melt of a record snow pack. The Preston Creek debris torrent that occurred during this event originated from lands burned in 1970. The Crum/Ringsted/Byrd Canyon floods of 1977, the Dinkelman/Mills/Roaring flood of 1989, and the Potato Creek and Oklahoma Gulch floods of 1997 were all post-fire responses triggered by short duration, high intensity convective storms (Chelan County Conservation District, 2004).

7.3 MAJOR FLOOD 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. Chelan County has experienced 7 flood events and 22 fire events since 1972 for which presidential disaster declarations were issued, as summarized in Table 7-1. The fire events are relevant to flood history in relation to post-fire flooding, as described in Section 7.2.3.

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale future events. Still, many flood events do not trigger federal disaster declarations, but have significant impacts on the communities impacted. These events are also important to consider in establishing recurrence intervals for flooding. The following sections provide an overview of some of the more significant floods in the county.

Table 7-1. History of Chelan County Flood and Fire Events With Presidential Disaster Declarations

Disaster Number	Event Dates	Declaration Date	Description
FM-5087	6/28/2015	6/29/2015	Sleepy Hollow Fire
FM-5100	8/13/2015 – 9/10/2015	8/14/2015	Chelan Fire Complex
DR4243	8/13/2015 – 9/10/2015	10/20/2015	Washington Wildfires and Mudslides
FM-5048	8/20/2013 – 8/28/2013	8/21/2013	Eagle Fire (\$2.23 million in public assistance grants)
FM-5042	8/10/2013-8/14/2013	8/10/2013	Milepost 10 Fire (\$908,893 in public assistance grants)
FM-5038	7/27/2013 -8/14/2013	7/30/2013	Colockum Tarps Fire (\$6.8 million in public assistance grants)
FM-5020	9/19/2012	9/20/2012	Table Mountain Fire (\$3.03 million in public assistance grants)
FM-5018	9/12/2012	9/13/2012	Peavine Fire (\$285,252 in public assistance grants)
FM-5017	9/12/2012-10/31/2012	9/12/2012	Poison Fire (\$684,418 in public assistance grants)
FM-5015	9/10/2012-9/19/2012	9/10/2012	Byrd Canyon Fire (\$219,571 in public assistance grants)
FM-5012	9/9/2012 – 9/19/2012	9/9/2012	1st Canyon Fire (\$528,668 in public assistance grants)
FM-2823	7/28/2009 – 8/2/2009	7/29/2009	Union Valley Fire (\$640,028 in public assistance grants)
DR-1817	1/6/2009 – 1/16/2009	1/30/2009	Severe winter storm, landslides, mudslides, and flooding
FM-2711	7/8/2007 – 7/10/2007	7/8/2007	Easy Street Fire (\$1.104 million in public assistance grants)
DR-1671	11/2/2006 – 11/11/2006	12/12/2006	Severe storms, flooding, landslides, and mudslides
FM-2674	9/9/2006 -9/16/2016	9/11/2006	Flick Creek Fire (\$80,510 in public assistance grants)
FM-2572	7/31/2005 – 8/18/2005	8/1/2005	Dirty Face Fire (\$1.061 million in public assistance grants)
FM-2543	8/11/2004 – 8/26/2004	8/11/2004	Fischer Fire (\$3.033 million in public assistance grants)
FM-2537	7/30/2004 – 8/5/2004	7/30/2004	Deep Harbor Fire (\$47,180 in public assistance grants)
DR-1499	10/15/2003 – 10/23/2003	11/7/2003	Severe storms and flooding
FM-2449	7/20/2002 – 7/27/2002	7/20/2002	Deer Point Fire (\$2.573 in public assistance grants)
FM-2379	8/13/2001 – 8/31/2001	8/17/2001	Rex Creek Fire Complex (\$1.008 million in PA grants)
DR-1159	12/26/1996 – 2/10/1997	1/17/1997	Severe winter storms, land & muds slides, flooding
DR-1079	11/7/1995 – 12/18/1995	1/3/1996	Severe storms, high wind, and flooding
DR-883	11/9/1990 – 12/20/1990	11/26/1990	Severe storms & flooding
DR-334	6/10/1972	6/10/1972	Severe storms & flooding

Source: FEMA, 2015b

7.3.1 Historical Stage Flooding Events

Stage flooding events have been the most common type of recorded flood events to occur within the County in the past 25 years. Episodes in 1990 and 1995 far exceeded the predicted 100-year flood events. These floods have caused extensive damage along the Wenatchee River and Icicle Creek drainages; however, no fatalities have been recorded as a result of stage flooding in Chelan County. In October 2003, substantial flooding occurred in the Stehekin River, destroying public and private property and infrastructure.

The following are notable stage flooding events in Chelan County (Chelan County, 2011):

- May/June 1948—Snowmelt flooding broke lake and river records countywide.
- May/June 1972—Snowmelt flooding combined with heavy rains affected rivers countywide, particularly the Entiat River.
- November 1990—Severe storms and flooding occurred during Veteran’s Day and Thanksgiving weekend countywide, particularly along the Wenatchee River.

- November/December 1995—Extensive rains caused record-setting flood stages countywide, particularly in the Wenatchee River.
- December 1996/January 1997—Saturated ground combined with snow, freezing rain, rain, rapid warming and high winds within a five-day period combined to cause flooding.
- October 2003—A rain-on-snow event in the upper Cascades caused a flood-of-record in the Stehekin River.
- May 2006—Rapid spring thaw caused flooding in the Entiat River, Chatter Creek and Icicle Creek.
- November 2006—A rain-on-snow event caused extensive flooding in the Stehekin River and limited flooding in Icicle Creek.
- January 2009—A rain-on-snow event caused limited flooding in the Mad River, Mill Creek and Icicle Creek, particularly in the Leavenworth area.

7.3.2 Historical Flash Flooding Events

The following flash flood events in Chelan County have resulted in fatalities:

- 1925, Squilchuck Creek—14 fatalities
- 1942, Tenas Gorge—8 fatalities
- 1972, Preston Creek/Entiat River—4 fatalities.

7.4 LOCATION

Chelan County has significant floodplains along the Columbia, Wenatchee, White, Entiat, Chiwawa, and Stehekin Rivers, and Nason, Chumstick, Icicle, Peshastin, Mission and Squilchuck Creeks. There are other unmapped flood hazard areas throughout the County. The hazard areas range from urban settings around the cities of Wenatchee, Cashmere and Leavenworth to rural areas along the White River and smaller streams (Chelan County, 2013).

No. 1 Canyon, No. 2 Canyon and Dry Gulch are each located on the western edge of the City of Wenatchee. The upper basins of these drainages are largely undeveloped and remain vegetated with native plant species. Development has occurred along the eastern fringes where the canyons discharge runoff into the City. These interface zones have experienced flash flooding problems in recent years due to a variety of issues, such as lack of appropriately sized drainage channels, the alteration of drainage channels, development adjacent to the channels, and wildfires. As drainage flows from the county through the city and ultimately is discharged into the Columbia River, new channels can be cut by the flows when current conveyance capacities are exceeded. Outside of those areas immediately adjacent to the city, conveyance systems within the county predominantly consist of open ditches and culverts (Chelan County, 2011).

Flooding in portions of the planning area has been extensively documented by gage records, high water marks, damage surveys and personal accounts. This documentation was the basis for the September 30, 2004 FIRMs generated by FEMA for the planning area. To map the extent and location of the flood hazard for this plan, two sources of data were used (see Figure 7-1):

- The 2004 Flood Insurance Study (special flood hazard areas)
- Hazus-MH version 3.1 (No. 1 Canyon, No. 2 Canyon and Dry Gulch)

See Section 6.2.2 for more information on data sources and Section 6.2.3 for information on data generation.

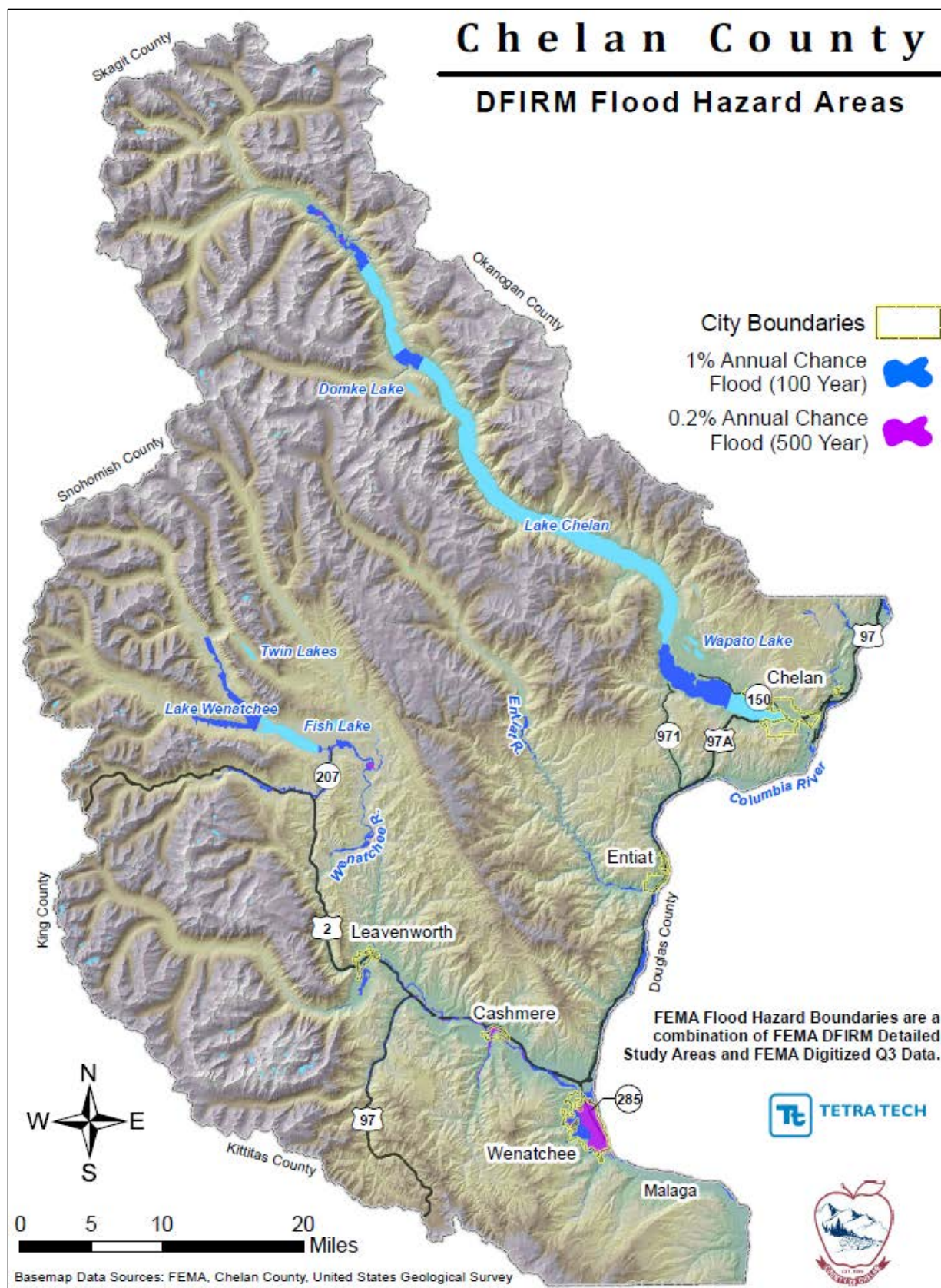


Figure 7-1. Mapped Flood Hazard Areas in Chelan County

7.5 FREQUENCY

Floods are commonly described as having a 10-, 50-, 100-, and 500-year recurrence interval, meaning that floods of these magnitudes have (respectively) a 10-, 2-, 1-, or 0.2-percent chance of occurring in any given year. These measurements reflect statistical averages only; it is possible for two or more rare floods (with a 100-year or higher recurrence interval) to occur within a short time period. Assigning recurrence intervals to historical floods on different rivers can help indicate the intensity of an event over a large area.

The Columbia River, Wenatchee River, Entiat River, Stehekin River and other perennial streams in Chelan County follow an annual cycle, with peak flow in April and May and low flow in August and September. Normally, flow in many of the smaller drainages is seasonally intermittent, with drainages in lower elevations often dry. Primary flood seasons in Chelan County are during the spring snowmelt (March to June) and from November to February, when rain-on-snow events have produced historic floods (Chelan County, 2011). Flash flooding can also occur in summer following severe thunder storms.

Recent history has shown that Chelan County can expect an average of one episode of minor river flooding each winter. Large, damaging floods typically occur every two to five years. Urban portions of the county annually experience nuisance flooding related to drainage issues.

7.6 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 7-2 lists peak flows used by FEMA to map the floodplains of the planning area.

Flash flooding has caused deaths in the area and is a threat to populated areas. For example, the City of Wenatchee, with a population nearing 30,000, is located on an alluvial fan below the mouths of three canyons (No. 1 Canyon, No. 2 Canyon and Dry Gulch). A severe thunderstorm or rapid snowmelt can quickly lead to extensive damage and possible fatalities.

Table 7-2. Summary of Peak Discharges Within the Planning Area

Source/Location	Drainage area (sq. mi.)	Discharge (cubic feet/second)			
		10-Year	50-Year	100-Year	500-Year
Wenatchee River					
At Monitor Gage	1,301	26,500	38,500	48,700	82,000
At Dryden Gage	1,155	25,700	36,863	46,372	78,289
At Peshastin Gage	1,000	24,300	34,000	42,300	71,800
At South Line S34, T26N, R17E	606	17,600	21,500	23,000	26,000
At Plain Gage	591	17,500	26,500	34,100	62,800
At lake Gage	273	10,000	12,100	13,000	14,800
Mission Creek					
At southern city limits of Cashmere	82	660	1,780	2,600	5,700
Peshastin Creek					
At Mouth	143	1,980	3,210	3,790	5,130

Source/Location	Drainage area (sq. mi.)	Discharge (cubic feet/second)			
		10-Year	50-Year	100-Year	500-Year
Icicle Creek					
At mouth	213	7,930	11,000	12,360	15,650
Chumstick Creek					
At mouth	82	900	1,430	1,720	2,810
At Eagle Creek Road	50	560	900	1,200	1,820
At Cross Section AP	41	470	760	930	1,520
At Sunistich Canyon Rd.	30	400	640	770	1,250
Chiwawa River					
At mouth	190	4,900	6,500	7,200	8,800
Nason Creek					
At Kahler Creek Bridge	98.6	4,270	5,860	6,590	8,250
Above Kahler Creek confluence	91.2	3,990	5,490	6,170	7,720
Below Butcher Creek confluence	87.5	3,850	5,290	5,960	7,460
Below Roaring Creek confluence	76.3	3,430	4,720	5,320	6,670
Above Gill Creek confluence	70.8	3,220	4,440	5,000	6,260
At Merritt	67.5	3,090	4,270	4,810	6,020
At Burlington Northern Railroad bridge	64.2	2,960	4,090	4,610	5,780
Entiat River					
At mouth	419	6,000	8,000	8,900	11,000
At Fish Hatcher Road	343	5,600	7,500	8,300	10,500
At Mad River Road	251	5,100	6,700	7,400	9,200
At cross section CJ	203	4,700	6,200	6,900	8,400
Mad River					
At mouth	92	1,200	1,750	2,000	2,500
Stehekin River					
At mouth	344	14,400	17,900	19,200	22,100
At Cross section J	308	13,200	16,500	17,700	20,300
At Cross Section U	277	12,200	15,200	16,300	18,800
Squilchuck Creek					
At Mouth	28	400	950	1,300	2,500
At Cross Section Y	15	300	750	1,000	1,900
No. 1 Canyon					
At Mouth	8	254	942	1,490	3,810
No. 2 Canyon					
At Mouth	10	300	1,100	1,700	4,300
Dry Gulch					
At Mouth	1.3	76	270	428	1,090

Data Source: FEMA Flood Insurance Study for Chelan County, WA; September 30, 2004

7.7 WARNING TIME

7.7.1 Flood Timing With Rainfall Events

Due to the sequential pattern of meteorological conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding.

A hydrograph, which is a graph or chart illustrating stream flow in relation to time (see Figure 7-2), is a useful tool for examining a stream's response to rainfall. Once rain starts falling over a watershed, runoff begins and the stream begins to rise. Water depth in the stream (stage of flow) will continue to rise in response to runoff even after rainfall ends. Eventually, the runoff will reach a peak and the stage of flow will crest. The stream stage will remain the most stable at this point, exhibiting little change over time until it begins to fall and eventually subsides to a level below flooding stage.

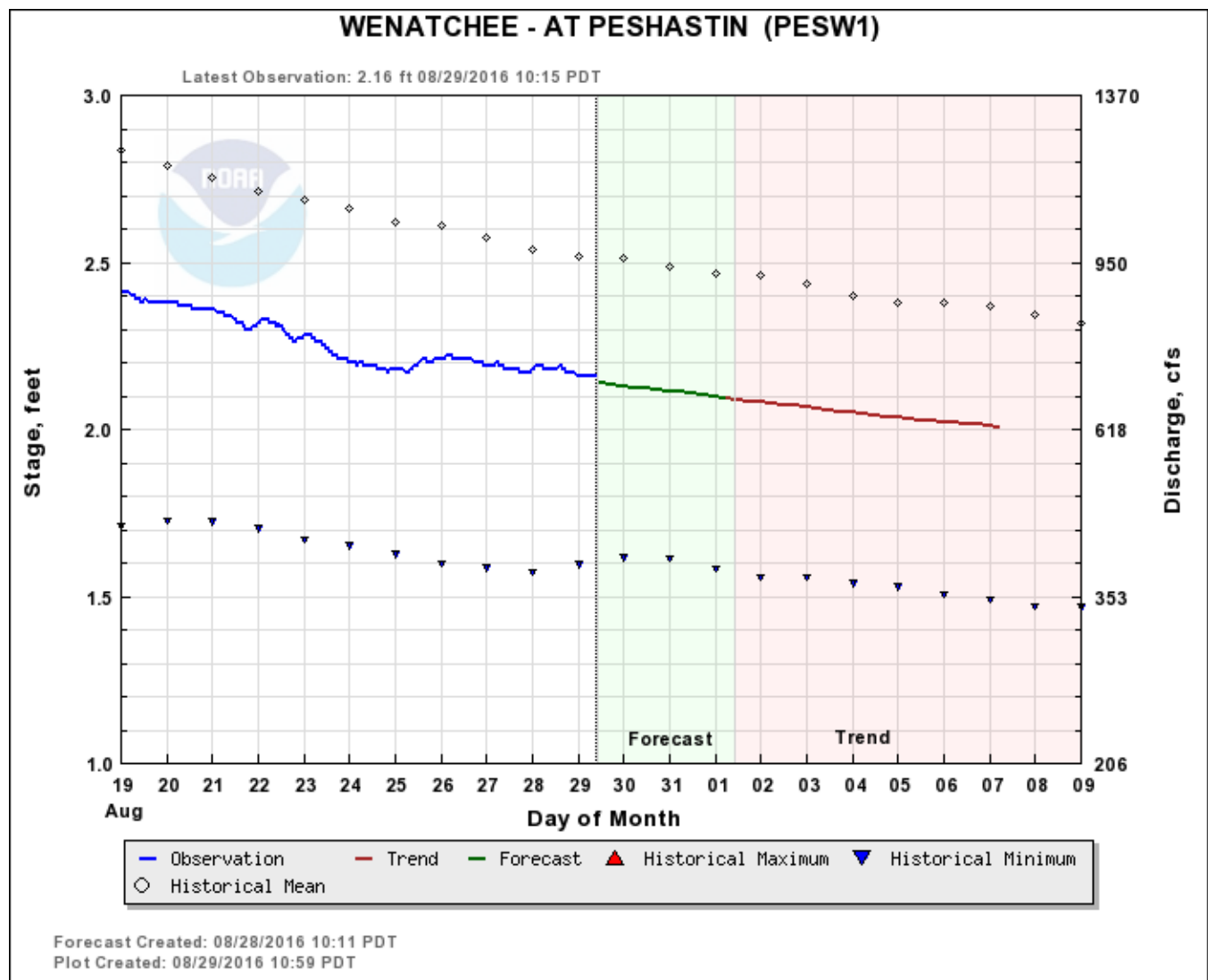


Figure 7-2. Wenatchee River Hydrograph at Peshastin

The potential warning time a community has to respond to a flooding threat is a function of the time between the first measurable rainfall and the first occurrence of flooding. The time it takes to recognize a flooding threat reduces the potential warning time to the time that a community has to take actions to protect lives and property. Another element that characterizes a community's flood threat is the length of time floodwaters remain above flood stage.

7.7.2 Flood Threat Recognition Systems

The Chelan County flood threat recognition system consists, in part, of precipitation and U.S. Geological Survey stream gages at strategic locations in the county that constantly monitor and report rainfall and stream levels. To assess the flood threat along the major rivers in the county, the stream gage information is fed into a National Weather Service (NWS) river forecasting program. This program creates a forecast of the amount of flow expected in the stream for the next 10 days (measured in cubic feet per second), which can then be compared to the flood stages at those locations. For locations that do not have stream gages or river forecasts, the NWS also provides Doppler radar data and weather/flood forecast information that can determine other types of flood risk across the county, such as flash flooding, small stream flooding, etc. All of this information is analyzed to evaluate the flood threat and possible evacuation needs.

Flood Watches and Warnings

The NWS issues flood watches and warnings when forecasts indicate rivers may approach bank-full levels or when other types of localized flooding are possible. When a flood watch is issued, the public should prepare for the possibility of a flood. When a flood warning is issued, the public is advised to stay tuned to a local radio station for further information and be prepared to take quick action if needed. A flood warning means a flood is imminent, generally within 12 hours, or is occurring. Local media typically broadcast NWS watches and warnings; they can also be found online. If a flash flood warning is issued, which indicates that sudden or violent flooding is imminent or occurring, the Emergency Alert Service will alarm on NOAA weather radios and cut into local media broadcasts. Flash flood warnings will also trigger wireless emergency alerts on smart phones. Official thresholds for flood warnings have been established on the major rivers within Chelan County as follows:

- Wenatchee River—Action phase at 12 feet, flood stage at 13 feet at Peshastin.
- Entiat River—Action phase at 6 feet, flood Stage at 7.5 feet at Ardenvoir.
- Stehekin River— Action Phase at 22 feet, flood stage at 23 feet at Stehekin.

There are several more stream gages across the county for areas that do not currently have river forecasts or predetermined flood stages. These gages are monitored for situational awareness during flood events.

Rain Gages

Chelan County Public Works Department has purchased and installed a series of rain gages, in cooperation with the county's Natural Resource Department, the U.S. Forest Service, the U.S. Geologic Service, the Natural Resource Conservation Service and the Cascadia Conservation District. These rain gages collect and measure precipitation to provide an early alert system to the community when a potentially high-intensity storm is in the area. Selection of rain gage locations was based upon factors such as historical flooding, high-burn-severity areas and population centers. Seven rain gages are located along ridgelines throughout Chelan County in order to transmit precipitation data to the NWS between from April through November. When a gage receives heavy rainfall over a 10-minute period, the NWS begins to monitor the gage. If warranted, the NWS will issue a watch or warning based on the precipitation information received.

Doppler Radar Gap

The NWS uses five active Doppler radars (Spokane, Pendleton, Langley Hill (Grays Harbor), Camano Island (Seattle), and Portland) to monitor real-time weather conditions in Washington, identify hazardous weather conditions, and predict weather. None of the five radars have coverage of weather conditions below 10,000 feet on the northeastern slopes of the Cascades, leaving a gap in coverage along the eastern slopes of the Cascades and part of the Columbia Basin from the Canadian border in Okanogan County to around Yakima (see Figure 7-3). This gap in coverage creates a less reliable weather prediction system for the area, thus creating a vulnerability or uncertainty for local residents, businesses, and industries.

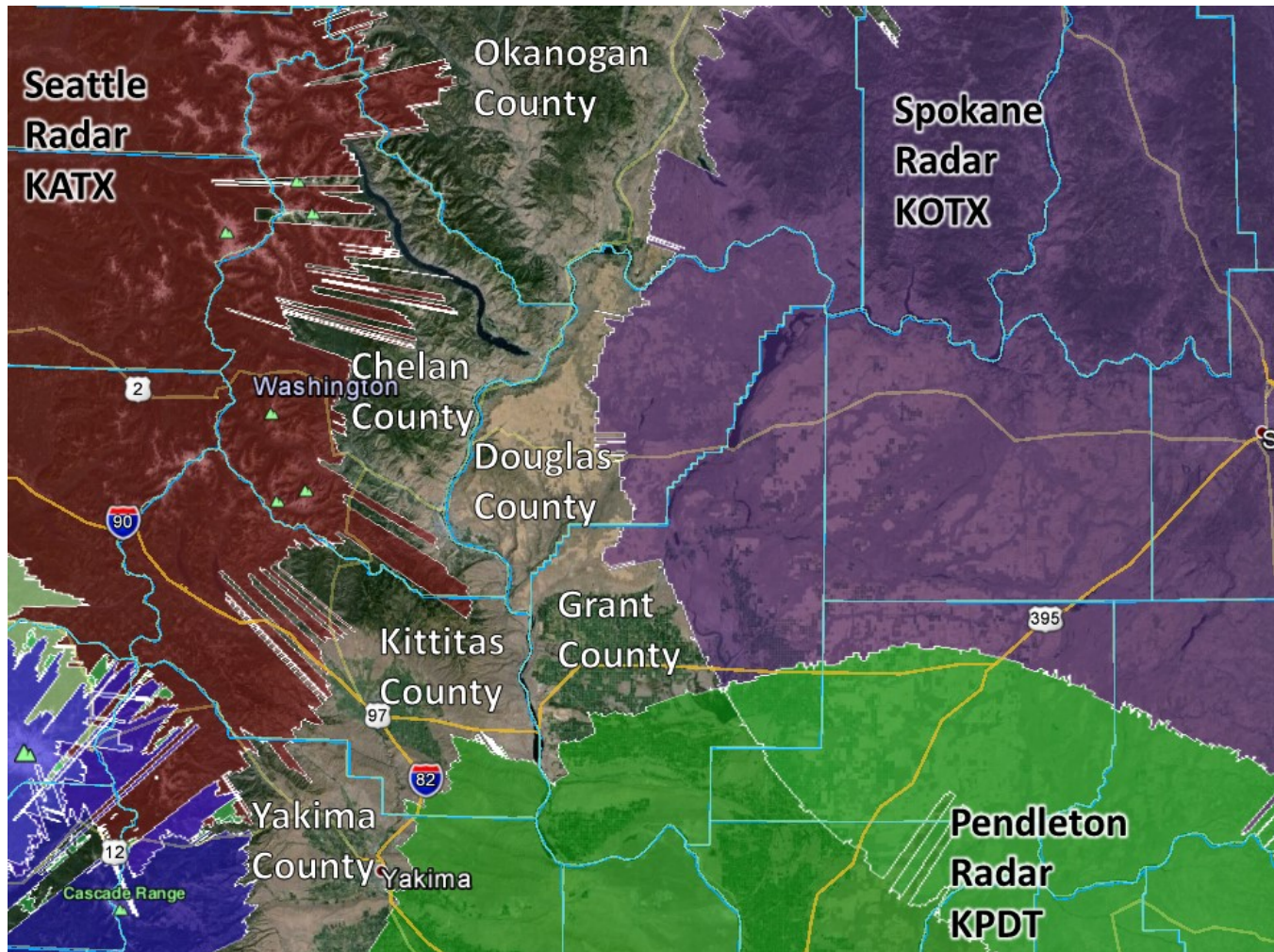


Figure 7-3. Doppler Radar Gap for East Cascades

7.8 SECONDARY HAZARDS

The most problematic secondary hazard for stage 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 flood hazard areas 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.

Within the planning area, the potential for erosion is most concerning following wildfires. Runoff from steep slopes that have been baked and denatured by wildfires increases velocities in channels. This accelerates erosion rates and results in large volumes of sediment being carried downstream. As stream velocities deaccelerate, the sediments fall out and decrease the carrying capacities of the channel, which causes overbank flows and can lead to channel migration. Channel migration is especially a concern for the numerous, developed alluvial fans within the planning area. Additionally, this sediment can be conveyed over land and deposited on developed lands such as roads and public/private property.

7.9 FUTURE TRENDS

Chelan County has experienced a 3.87-percent average annual growth rate since 1990, making it one of the faster growing counties in the State of Washington. Since 2006, the population of the County has increased by 10.5 percent. In 1990, Washington State adopted the Growth Management Act, which among other things required Chelan County to establish urban growth boundaries, rural areas and natural resource lands. The County and all of the cities have adopted plans and development regulations that are currently in compliance with the Growth Management Act.

Several comprehensive plans guide development in unincorporated parts of Chelan County, as described in Section 4.3.2. The County's Comprehensive Plan has adopted goals, objectives, policies and actions with regards to frequently flooded areas. These plan components strive to steer future trends in development away from increasing flood risks in Chelan County. Chelan County's critical areas regulations regulate how development and redevelopment can safely occur on lands that contain critical areas, as described in Section 4.3.4. Additionally, Chelan County and its cities participate in the NFIP and have adopted flood damage prevention ordinances in response to its requirements. Chelan County has committed to maintaining its good standing under the NFIP through actions identified in this plan.

7.10 SCENARIO

The primary water courses in the planning area have the potential to flood at regular intervals (two to five years on the average), generally in response to a succession of intense winter rainstorms. Storm patterns of warm, moist air usually occur between early November and late March. The worst-case scenario is a series of storms in a short time that flood numerous drainage basins that have been burned over by wildfire. This could overwhelm response and flood hazard management capabilities within the planning area. Major roads could be blocked, preventing critical access for many residents and responders. High in-channel flows could cause water courses to scour, possibly washing out roads and creating additional isolation issues. In a multi-basin flood event, resources would be stretched thin resulting in delays in repairing and restoring critical facilities and infrastructure. The mapped and identified floodplains in the County are where most impacts from flooding would be concentrated; however, groundwater flooding issues typical for the planning area would be significantly enhanced as the ground reaches saturation.

7.11 CHALLENGES, DATA GAPS AND ISSUES

The planning team has identified challenges, data gaps and issues associated with full identification and understanding of flood hazards in the planning area. These are, include but not limited to the following:

- The currently available flood hazard mapping for the County does not accurately reflect the true flood risk.
- 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 potential mitigation projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.

- Existing floodplain-compatible uses such as agricultural and open space need to be maintained. During times of moderate to high growth there is pressure to convert these areas to more intensive uses.
- There needs to be a coordinated flood hazard mitigation effort among county jurisdictions affected by flood hazards.
- Education for residents in flood hazard areas about flood preparedness and the resources available during and after floods should continue.
- There is a lack of consistency in regional flood hazard management policy in the planning area.
- As the planning area continues to grow, there will be increased pressures for development in areas subject to flood risk.
- The potential impact of climate change on flood conditions in the planning area is unknown and needs to be monitored.
- Wildfires will likely continue to impact the planning area. Post-fire best management practices will need to be maintained to limit the impacts of these fires on flooding. The County should continue to coordinate with the U.S. Forest Service.
- The capability for prediction forecast modeling needs to be enhanced.
- There are significant gaps in the flood threat recognition capabilities within the planning area (i.e.: the Doppler radar gap)
- Flood warning capability should be tied to flood phases.
- Enhanced modeling is needed to better understand the true flood risk.
- Floodplain restoration/reconnection opportunities should be identified as a means to reduce flood risk.
- Post-flood disaster response and recovery actions need to be clearly identified.
- Current or greater staff capacity is required to maintain the existing level of flood hazard management within the planning area.
- Flood hazard management actions require interagency coordination.
- Predetermined flood stages and corresponding actions are need for those stream gages within the County that currently do not have flood forecasting capabilities.

8. FLOOD HAZARD EXPOSURE

The Level 2 (user-defined) Hazus protocol was used to assess exposure to flooding in the planning area. The model used census data at the block level, FEMA floodplain data and H&H data developed for this assessment, which has a level of accuracy acceptable for planning purposes. It should be noted that the 100-year and 500-year floodplain areas discussed in the exposure and vulnerability sections of this plan have been expanded to include both FEMA mapped floodplains and the floodplains developed in No. 1 and No. 2 Canyons and Dry Gulch. The Hazus default data was enhanced using local GIS data from local, state and federal sources (see Chapter 6 for more information on data sources and methodology).

8.1 POPULATION

Population counts of those living in the 100- and 500-year floodplains were generated by analyzing structures in the floodplain. The total planning area population from the 2010 Census was multiplied by the ratio of the number of residential structures in each floodplain to the total number of residential structures. Using this approach, the populations in each floodplain were estimated as follows:

- 100-year floodplain—11,068 (14.8 percent of the planning area population)
- 500-year floodplain—31,162 (41.5 percent of the planning area population).

8.2 PROPERTY

8.2.1 Structures in the Floodplain

The Hazus model determined that there are 3,637 structures within the mapped 100-year floodplain; 98 percent are residential and 2 percent are commercial, industrial or agricultural. In the 500-year floodplain, Hazus determined that there are 10,202 structures in the floodplain. More than 91 percent of these structures are residential. This amounts to more than 30 percent of the total structures within the County. More than 80 percent of the structures located within the 500-year floodplain are in the City of Wenatchee. Table 8-1 and Table 8-2 summarize the total area and number of structures in the 100-year and 500-year floodplains by municipality.

Table 8-1. Area and Structures Within the 100-Year Floodplain by Municipality

	Area (acres)	Number of Structures							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Cashmere	75	75	0	2	0	1	0	0	78
Chelan	53	75	0	0	0	0	0	0	75
Entiat	27	0	0	0	0	0	0	0	0
Leavenworth	104	5	0	0	0	0	0	0	5
Wenatchee	1,073	2,446	12	1	0	6	2	1	2,468
Unincorporated County	24,492	980	6	1	7	2	15	0	1,011
Total	25,824	3,581	18	4	7	9	17	1	3,637

Table 8-2. Area and Structures Within the 500-Year Floodplain by Municipality

	Area (acres)	Number of Structures							Total
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	
Cashmere	277	524	55	10	1	12	1	0	603
Chelan	53	75	0	0	0	0	0	0	75
Entiat	27	0	0	0	0	0	0	0	0
Leavenworth	113	5	0	0	0	0	0	0	5
Wenatchee	3,772	7,418	633	68	7	43	10	4	8,183
Unincorporated County	25,438	1,294	11	2	9	4	16	0	1,336
Total	29,680	9,316	699	80	17	59	27	4	10,202

8.2.2 Exposed Value

Table 8-3 and Table 8-4 summarize the estimated replacement cost of exposed buildings in the 100-year and 500-year floodplains by municipality. The analysis estimated \$1.12 billion of building-and-contents exposure to the 100-year flood, representing 6.4 percent of the total replacement cost of the planning area and \$6.66 billion of building-and-contents exposure to the 500-year flood, representing 37.9 percent of the total.

Table 8-3. Value of Structures in the 100-Year Floodplain by Municipality

	Value Exposed ^a			% of Total Replacement Cost
	Structure	Contents	Total	
Cashmere	\$13,748,297	\$7,985,766	\$21,734,063	2.9%
Chelan	\$9,769,030	\$4,884,515	\$14,653,545	0.9%
Entiat	\$0	\$0	\$0	0.0%
Leavenworth	\$1,062,934	\$531,467	\$1,594,401	0.2%
Wenatchee	\$540,458,616	\$303,876,379	\$844,334,995	12.5%
Unincorporated County	\$156,872,035	\$84,111,183	\$240,983,219	3.3%
Total	\$721,910,912	\$401,389,310	\$1,123,300,223	6.4%

a. Exposure estimated derived from Hazus analysis.

Table 8-4. Value of Structures in the 500-Year Floodplain by Municipality

	Value Exposed ^a			% of Total Structure
	Structure	Contents	Total	
Cashmere	\$267,613,862	\$239,942,708	\$507,556,570	67.9%
Chelan	\$9,769,030	\$4,884,515	\$14,653,545	0.9%
Entiat	\$0	\$0	\$0	0.0%
Leavenworth	\$1,062,934	\$531,467	\$1,594,401	0.2%
Wenatchee	\$3,235,383,204	\$2,560,537,691	\$5,795,920,895	85.8%
Unincorporated County	\$218,649,840	\$126,562,481	\$345,212,321	4.7%
Total	\$3,732,478,870.00	\$2,932,458,862.00	\$6,664,937,732.00	37.9%

a. Exposure estimated derived from Hazus analysis.

8.2.3 Land Use in the 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. Table 8-5 shows the existing land use of all parcels in the 100-year and 500-year floodplains, including vacant parcels and parcels in public/open space uses. Approximately 58.7 percent of the parcels in the 100-year floodplain are classified as either undeveloped or uncategorized. Uncategorized categories are predominantly comprised of state and/or federally owned land within the planning area.

Table 8-5. Land Use in the Floodplain

Land Use Category ^a	100-Year Floodplain		500-year Floodplain	
	Area (acres)	% of total	Area (acres)	% of total
Agriculture	444.96	1.7%	576.80	1.9%
Commercial	825.25	3.2%	1,321.75	4.5%
Education	101.85	0.4%	236.26	0.8%
Forest	1,043.63	4.0%	1,059.74	3.6%
Government	3,685.98	14.3%	4,033.48	13.6%
Industrial	37.22	0.1%	104.60	0.4%
Open Space	605.67	2.4%	674.76	2.3%
Other (right-of-way, easements)	48.47	0.2%	60.34	0.2%
Religion	26.24	0.1%	65.26	0.2%
Residential	3,851.66	14.9%	5,559.62	18.7%
Undeveloped Land	429.19	1.7%	473.91	1.6%
Uncategorized	14,722.84	57.0%	15,513.53	52.3%
Total	25,822.96	100%	29,680.05	100%

a. Land use designations were derived from County Assessor data.

8.3 CRITICAL FACILITIES AND INFRASTRUCTURE

Table 8-6 and Table 8-7 summarize the planning area critical facilities and infrastructure in the 100-year and 500-year floodplains. Additional details are provided in the following sections.

8.3.1 Hazardous Material Facilities

Hazardous material facilities are those that use or store materials that can harm the environment if damaged by a flood. For this assessment, such facilities were identified through the EPA's Toxic Release Inventory (TRI) and other facilities identified by the planning team. Five businesses in the 500-year floodplain have been identified as TRI reporting facilities or other known hazardous material containing facilities. During a flood event, containers holding these materials can rupture and leak into the surrounding area, having a disastrous effect on the environment as well as residents.

8.3.2 Utilities and Infrastructure

It is important to determine who may be at risk if infrastructure is damaged by flooding. Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the planning area. Preserving access is particularly important for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Dikes and levees can fail or be overtopped, inundating the land that they protect. The following sections provide more information on specific types of critical infrastructure.

Table 8-6. Critical Facilities in the Floodplain

	Number of Facilities in the 100-Year Floodplain	Number of Facilities in the 500-Year Floodplain
Medical and Health Services	0	5
Government Function	0	15
Protective	2	6
Hazardous Materials	0	5
Schools	7	19
Other	5	13
Total	14	63

Table 8-7. Critical Infrastructure in the Floodplain

	Number of Facilities in the 100-Year Floodplain	Number of Facilities in the 500-Year Floodplain
Bridges ^a	73	90
Water Supply	0	0
Wastewater	0	2
Power	6	15
Communications	1	1
Other	0	5
Total	80	113

a. County, state and federally owned. Does not include privately owned bridges.

Roads

The following major roads in the planning area pass through the 100-year and/or 500-year floodplain and thus are exposed to flooding. Some of these roads are built above the flood level, and others function as levees to prevent flooding. Still, in severe flood events these roads can be blocked or damaged, preventing access to some areas:

- U.S. Highway 2
- U.S. Highway 97
- U.S. Highway 97 Alternate
- State Route 150
- State Route 207
- State Route 285
- State Route 971

Bridges

Flooding events can significantly impact bridges, which provide the only ingress and egress to some neighborhoods. There are 73 bridges that are in or cross over the 100-year floodplain and 90 bridges that are in or cross over the 500-year floodplain in the planning area.

Water and Sewer Infrastructure

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

Dams

According to the Washington Department of Ecology’s inventory of dams, there are 42 dams in or adjacent to Chelan County. Many of them serve more than one purpose, such as hydroelectric power generation, irrigation and recreation. Dam failures can be caused by natural events, such as flooding or an earthquake, but they are predominantly caused by human error such as poor construction, operation, maintenance or repair. The effects of a dam failure are highly variable, depending on the dam, the amount of water stored behind the dam, the current stream flow, and the size and proximity of the downstream population. There are many effects of a major dam failure: loss of life, destruction of homes and property, damage to roads, bridges, power lines and other infrastructure, loss of power generation and flood control capabilities, disruption of fish stock and spawning beds, and the erosion of stream and river banks. Many dam failures have occurred in Washington State over the last 40 years, but none have been in or affected Chelan County.

Washington State’s Downstream Hazard Classification system for dams assigns a hazard rating of “Low,” “Significant” or “High” for areas at risk of economic loss and environmental damage should a dam fail. Of the 42 state inventoried dams within Chelan County, 25 are rated high (see Table 8-8). Failure of any of these dams could affect a population of 300 or more, inundate major transportation routes and industries, and have long-term effects on water quality and wildlife.

The failure of a high hazard dam would threaten important segments of Chelan County, suggesting high vulnerability. Due to their status as high hazard dams, inundation mapping is included in their emergency action plans. However, this data is not readily available to local governments for public access in a format that can support planning due to security concerns. Emergency management agencies typically have this data to support emergency response functions, however there can be limitations on the use and distribution of this data due to security concerns.

Levees

Levees are a basic means of providing flood protection along waterways in regions where development exists or is planned, and in agricultural areas. Levees typically confine floodwaters to the main river channel. Failure of a levee can lead to inundation of surrounding areas.

The causes of levee failures are structural failures, foundation failures of underlying soils, and overtopping by flood flows and waves. Contributing factors include poor construction materials, erosion by current and wave action, seepage through or under the levee, burrowing rodents, and improper repairs. Lack of adequate and regular maintenance to correct these problems also contributes to levee failure, including vegetation. Most failures are composites of several of these factors.

FEMA accredits levees as providing adequate risk reduction if levee certification and an adopted operation and maintenance plan are adequate. The criteria for which a levee can be accredited are specified in 44 CFR Section 65. Section 65.10 provides the minimum design, operation and maintenance standards levee systems must meet in order to be recognized as providing protection from the base flood on a Flood Insurance Rate Map. In order for a levee to be accredited, the owner must provide data and documentation to demonstrate that the levee complies with these requirements.

An area impacted by an accredited levee is shown as a moderate-risk area and labeled Zone X on a FIRM. This accreditation affects insurance and building requirements. The NFIP does not require flood insurance for areas protected by accredited levees, although FEMA recommends the purchase of flood insurance in these areas due to the residual risk of flooding from levee failure or overtopping. If a levee is not accredited, the area it protects will still be mapped as a high-risk area (a SFHA), and the federal mandatory purchase of flood insurance will apply (FEMA, 2012).

Table 8-8. Significant Dams in Chelan County

Name ^a	Water Course	Owner	Year Built	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Drainage area (sq. mi.)
3 Amigos Reservoir	Stemilt Creek, off stream	Kyle Mathison Orchards, Inc.	2003	2300	23	124	0.00
Antilon Lake Dam	Tributary, Johnson Creek	Lake Chelan Reclamation District	1913	300	65	2900	2.54
Asamaera-Cannon Mine Tailings Dam	Dry Gulch	ConocoPhillips	1986	1050	350	3300	45
Beehive Dam	Tributary, Squilchuck Creek	Beehive Irrigation District	1953	380	10	130	0.11
Chelan Dam ^b	Chelan River	Chelan Co. PUD. #1	1928	490	30 ^c	677,400	95.2
Clear Lake dam	Tributary, Stemilt Creek to Columbia River	Stemilt Irrigation District	1888	240	8	60	17
Clear Lake Saddle Dam	Tributary, Stemilt Creek to Columbia River	Stemilt Irrigation District	1888	300	13	48	0.03
Great Depression Dam	Squilchuck Creek, off stream	Camp David Enterprises LLC	1997	210	22	37	0.06
Lilly Lake Dam	Tributary, Stemilt Creek to Columbia River	Stemilt Irrigation District	1892	500	14	420	0.43
Meadow Lake Dam	Tributary, Columbia River	Galler Ditch Co.	1920	350	18	600	5.00
Nada Lake Dam	Snow Creek, off stream	USFS	1940	23	9	150	0.00
Rock Island Dam ^b	Columbia River	Chelan Co. PUD #1	1933	3580	80 ^d	113,700	94,900
Rocky Reach ^b	Columbia River	Chelan Co. PUD #1	1962	3820	135 ^e	390,000	94,100
Spring Hill Dam	Tributary, Stemilt Creek, off stream	Wenatchee Heights Reclamation District	1918	800	30	520	0.43
Spring Hill Saddle Dam	Tributary, Stemilt Creek, off stream	Wenatchee Heights Reclamation District	1918	250	12	340	0.43
Stemilt Equalizing Reservoir	Tributary, Stemilt Creek, off stream	Stemilt Irrigation District	1985	440	24	43	0.04
Stemilt Main Dam	Orr Creek, off stream	Stemilt Project Inc.	1962	1000	65	580	0.28
Stemilt Saddle Dam	Orr Creek, off stream	Stemilt Project Inc.	1962	200	9	200	0.28
Tumwater Canyon Dam ^b	Wenatchee River	Chelan Co. PUD # 1	1909	400	20	10	686
Upper Loop Reservoir	Tributary, Stemilt Creek, off stream	Kyle Mathison Orchards	--	--	--	115	--
Upper Wheeler Dam	Orr Creek	Wenatchee Heights Reclamation District	1922	900	65	795	2.3
Upper Wheeler Saddle Dam	Orr Creek	Wenatchee Heights Reclamation District	1992	920	15	495	2.24
Wapato Lake Dam	Tributary, Lake Chelan	Lake Chelan Reclamation District	1912	540	40	3500	15.3
Wells Dam	Columbia River	Douglas County T & LS	1967	4105	196	500,000	85,300

- a. Dams listed are those with downstream Hazard Class 1 (> 300 lives at risk). This refers to the potential effect in the case of a dam failure. It does not indicate a high probability of such failure.
- b. According to Chelan County PUD dam break studies, in an event of a dam-break at these dams, the water surface/flood wave will be maintained within the PUD's project boundaries, so the potential loss of life is near zero.
- c. Height measured from deck (1,109) to riverbed (apron at 1,079)
- d. Height measured from deck (616) to foundation of north abutment wall (536)
- e. Height measured from parapet wall (720) to foundation (585)
- Source: Ecology, 2016.

Even with levee certification and FEMA accreditation, there is a flood risk associated with levees. While levees are designed to reduce risk, even properly maintained levees can fail or be overtopped by large flood events. Levees reduce risk, they do not eliminate it.

In Chelan County, there are 3 levee segments that provide protection against floods of 25-year or more frequent recurrence intervals. These levee segments are all located within the City of Cashmere along the Wenatchee River. Information on these levee segments has been provided in Table 8-9. None of these levee segments are accredited by FEMA or have been accepted under the U.S. Army Corps of Engineers Program (PL 84-99) as discussed in Section 4.1.16.

Table 8-9. Levee Profiles

Levee Segment Name	Length (feet)	Top Width (feet)	Level of Protection (% chance of exceedance)	PL 84-99 Rating
Cashmere Segment 1 (partially in unincorporated county)	675	12-50	20	Minimally Acceptable
Cashmere Segment 2	1,450	10-20	10	Minimally Acceptable
Cashmere Segment Sewage Treatment Plant	3,400	10	10	Unacceptable

8.4 ENVIRONMENT

Flooding is a natural event and floodplains provide many natural and beneficial functions. Nonetheless, flooding can impact the environment in negative ways, especially when compounded with impacts from human development. Migrating fish can wash into roads or over levees into flooded fields. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods these pollutants can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees, and logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

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

- Mammals depend upon a supply of water for their existence. Riparian communities have a greater diversity and structure of vegetation than other upland areas. Beavers and muskrats are now recolonizing streams, wetlands and fallow farm fields, which are converted wetlands. As residences are built in rural areas, there is an increasing concern of beaver dams causing flooding of low-lying areas and abandoned farm ditches being filled leading to localized flooding.
- A great number of birds are associated with riparian areas. They swim, dive, feed along the shoreline, or snatch food from above. Chelan County rivers, lakes and wetlands are important feeding and resting areas for migratory and resident waterfowl. Other threatened or endangered species (such as the bald eagle or the peregrine falcon) eat prey from these riparian areas.
- Fish habitat throughout the county varies widely based on natural conditions and human influence. Many ditches were dug throughout the county to make low, wet ground better for farming. As the water drained away and the wetlands were converted to farm fields, natural stream conditions were altered throughout

the county. Agriculture along many rivers extends to the water's edge and smaller side channels have been tilled to drain better. Within developing areas, small streams were placed in pipes and wetland filled in to support urban development.

Protection of these biological resources within the floodplains of the planning area is very important to Chelan County. Equipped with planning tools such as WRIA planning, comprehensive planning, critical areas ordinances, and open space planning, Chelan County has been able to establish a diverse inventory of preserve areas that maintain the natural and beneficial functions of the floodplain. This has resulted in flood hazard areas that are developed as shown in Table 8-5. Habitat complexity project areas that promote the natural and beneficial functions of floodplains include the following:

- The Peshastin Fishway (<http://www.co.chelan.wa.us/natural-resources/pages/peshastin-fishway?parent=Water%20Resources>)
- Cashmere Pond (<http://hwsconnect.ekosystem.us/project.aspx?sid=290&id=7102&stat=on>)
- The Nason Creek Oxbow (<http://hwsconnect.ekosystem.us/project.aspx?sid=290&id=1888&stat=on>)
- The Wenatchee River Irwin property (<http://hwsconnect.ekosystem.us/project.aspx?sid=290&id=1688&stat=on>)
- The Entiat National Fish hatchery
- Icicle Creek (<http://hwsconnect.ekosystem.us/project.aspx?sid=290&id=1764&stat=on>)

9. FLOOD HAZARD VULNERABILITY

Many areas exposed to flooding may not experience serious flooding or flood damage. Vulnerability can be defined as: the extent of harm, which can be expected under certain conditions of exposure, susceptibility and resilience (UNESCO-IHE, 2016). Defining vulnerability can help flood hazard managers understand the best ways to reduce it. The main objective in assessing vulnerability is to inform decision-makers or specific stakeholders about options for adapting to the impact of flooding hazards. This section describes vulnerabilities in terms of population, property, critical facilities infrastructure and environment.

9.1 POPULATION

9.1.1 Vulnerable Populations

An analysis using Hazus model demographic data (based on 2010 U.S. Census data) identified populations vulnerable to the flood hazard as follows:

- **Economically Disadvantaged Populations**—An estimated 16.3 percent of the people within the households in the census blocks that intersect the 100-year floodplain are economically disadvantaged, defined as having annual household incomes of \$20,000 or less.
- **Population over 65 Years of Age**—An estimated 20.5 percent of the population in the census blocks that intersect the 100-year floodplain are over 65 years of age. Approximately 28 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 of Age**—An estimated 23.1 percent of the population within census blocks that intersect the 100-year floodplain are under 16 years of age.

In addition, persons with disabilities or others with access and functional needs are more likely to have difficulty responding to a flood or other hazard event than the general population. Local government is the first level of response to assist these individuals. Coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability allows emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs. According to the U.S. Census Bureau 2015 American Community Survey estimates, there are 10,164 individuals in Chelan County with some form of disability, representing 13.6 percent of the county population. Approximately 62 percent (6,290 individuals) are under the age of 65 (U.S. Census, 2015).

9.1.2 Public Health and Safety

Floods present threats to public health and safety. Floodwater is frequently contaminated by pollutants such as sewage, human and animal feces, pesticides and insecticides, fertilizers, oil, asbestos, and rusting building materials. The following health and safety risks are commonly associated with flood events:

- **Unsafe food**—Floodwaters contain disease-causing bacteria, dirt, oil, human and animal wastes, and farm and industrial chemicals. They carry away whatever lies on the ground and upstream. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat and hazardous to human health. Power failures caused by floods damage stored food. Refrigerated and frozen foods are affected during the outage periods, and must be carefully monitored and examined prior to consumption. Foods kept inside cardboard, plastic bags, jars, bottles, and paper packaging are subject to disposal if contaminated by floodwaters. Even though the packages may not appear to be wet, they may be unhygienic with mold contamination and deteriorate rapidly.
- **Contaminated drinking and washing water and poor sanitation**—Flooding impairs clean water sources with pollutants and affects sanitary toilets. Direct and indirect contact with the contaminants—whether through direct food intake, vector insects such as flies, unclean hands, or dirty plates and utensils—can result in waterborne infectious disease. Wastewater treatment plants, if flooded and caused to malfunction, can be overloaded with polluted runoff waters and sewage beyond their disposal capacity, resulting in backflows of raw sewage to homes and low-lying grounds. Private wells can be contaminated or damaged severely by floodwaters, while private sewage disposal systems can become a cause of infection and illnesses if they are broken or overflow. Unclean drinking and washing water and sanitation, coupled with lack of adequate sewage treatment, can lead to disease outbreaks, including life-threatening cholera, typhoid, dysentery and some forms of hepatitis.
- **Mosquitoes and animals**—Prolonged rainfall and floods provide new breeding grounds for mosquitoes—wet areas and stagnant pools—and can lead to an increase in the number of mosquito-borne diseases such as West Nile. Rats and other rodents and wild animals also can carry viruses and diseases. The public should avoid such animals and should dispose of dead animals in accordance with guidelines issued by local animal control authorities.
- **Molds and mildews**—Excessive exposure to molds and mildews can cause flood victims—especially those with allergies and asthma—to contract upper respiratory diseases and to trigger cold-like symptoms such as sore throat, watery eyes, wheezing and dizziness. Molds grow in as short a period as 24 to 48 hours in wet and damp areas of buildings and homes that have not been cleaned after flooding, such as water-infiltrated walls, floors, carpets, toilets and bathrooms. Very small mold spores can be easily inhaled and, in large enough quantities, cause allergic reactions, asthma episodes, and other respiratory problems. Infants, children, elderly people and pregnant women are considered most vulnerable to mold-induced health problems.
- **Carbon monoxide poisoning**—Carbon monoxide poisoning is as a potential hazard after major floods. Carbon monoxide can be found in combustion fumes, such as those generated by small gasoline engines, stoves, generators, lanterns and gas ranges, or by burning charcoal or wood. In the event of power outages following floods, flood victims tend to use alternative sources of fuels for heating, cooling, or cooking inside enclosed or partly enclosed houses, garages or buildings without an adequate level of air ventilation. Carbon monoxide builds up from these sources and poisons the people and animals inside.
- **Hazards when reentering and cleaning flooded homes and buildings**—Flooded buildings can pose health hazards after floodwaters recede. Electrical power systems can become hazardous. People should avoid turning on or off the main power while standing in floodwater. Gas leaks from pipelines or propane tanks can trigger explosion when entering and cleaning damaged buildings or working to restore utility service. Flood debris—such as broken bottles, wood, stones and walls—may cause wounds and injuries when cleaning damaged buildings. Containers of hazardous chemicals, including pesticides, insecticides, fertilizers, car batteries, propane tanks and other industrial chemicals, may be hidden or buried under flood debris. A health hazard can also occur when hazardous dust and mold in ducts, fans and ventilators of air-conditioning and heating equipment are circulated through a building and inhaled by those engaged in cleanup.
- **Mental stress and fatigue**—Exposure to extreme disaster events can cause psychological distress. Having experienced a devastating flood, seen loved ones lost or injured, and homes damaged or

destroyed, flood victims can experience long-term psychological impact. The expense and effort required to repair flood-damaged homes places severe financial and psychological burdens on the people affected, in particular the unprepared and uninsured. Post-flood recovery—especially when prolonged—can cause anxiety, anger, depression, lethargy, hyperactivity, sleeplessness, and, in an extreme case, suicide. Behavior changes may also occur in children. There is also a long-term concern among the affected that their homes can be flooded again in the future.

Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

9.1.3 Impacts on People

Table 9-1 summarizes Hazus-estimated impacts on the planning area population for each flood scenario.

Table 9-1. Estimated Flood Impact on Persons				
	100-Year Flood ^a		500-Year Flood ^a	
	Displaced Persons	Persons Requiring Short-Term Shelter ^b	Displaced Persons	Persons Requiring Short-Term Shelter ^b
Cashmere	42	25	1,214	1,077
Chelan	6	1	7	1
Entiat	0	0	0	0
Leavenworth	2	2	2	2
Wenatchee	6,156	5,769	25,261	24,295
Unincorporated	306	149	565	331
Total	6,512	5,946	27,049	25,706

a. Results shown are not precise, but are estimates of needs that may occur as the result of the modeled flood.

b. The number of persons requiring publicly provided shelter is less than the number of displaced persons because not all households will require public assistance to find short-term shelter.

Note: Sources of data used in Hazus modeling are described in 6.2.2

9.2 PROPERTY

9.2.1 Loss Estimates

Hazus calculates flood losses to structures based on flooding depth and structure type. Using historical flood insurance claim data, Hazus 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. The results of the analyses for the scenario flood events are summarized in Table 9-2 and Table 9-3.

9.2.2 National Flood Insurance Program

Table 9-4 lists flood insurance statistics that help identify vulnerability in the planning area. Six planning area communities participate in the NFIP, with 838 flood insurance policies providing \$205.6 million in coverage. According to FEMA statistics, 143 flood insurance claims were paid between January 1, 1978 and May 31, 2015, for a total of \$1.1 million, an average of \$7,717 per claim. Not all structures within the special flood hazard area are covered by flood insurance; according to FEMA, fewer than 25 percent of structures at risk nationally are covered by flood insurance.

Table 9-2. Loss Estimates for 100-Year Flood Event

	Structures Impacted ^a	Estimated Loss Associated with Flood			% of Total Replacement Cost
		Structure	Contents	Total	
Cashmere	49	\$1,160,285	\$598,309	\$1,758,595	0.2%
Chelan	20	\$778,346	\$354,526	\$1,132,872	0.1%
Entiat	0	\$0	\$0	\$0	0.0%
Leavenworth	2	\$78,325	\$44,907	\$123,232	Less than 0.1%
Wenatchee	1,255	\$56,001,910	\$25,614,855	\$81,616,765	1.2%
Unincorporated County	712	\$26,560,267	\$17,308,072	\$43,868,299	0.6%
Total	2,038	\$84,579,133	\$43,920,669	\$128,499,763	0.7%

a. Impacted structures are those structures with finished floor elevations below the Hazus-estimated 100-year water surface elevation. These structures are the most likely to receive damage in a 100-year flood event

Notes: Values in this table are only for purposes of comparison among results. See Section 6.2.4 for a discussion of data limitations.

Sources of data used in Hazus modeling are described in Section 6.2.2.

Table 9-3. Loss Estimates for 500-Year Flood Event

	Structures Impacted ^a	Estimated Loss Associated with Flood			% of Total Replacement Cost
		Structure	Contents	Total	
Cashmere	167	\$5,848,969	\$3,813,835	\$9,662,804	1.3%
Chelan	22	\$739,176	\$356,850	\$1,096,026	0.1%
Entiat	0	\$0	\$0	\$0	0.0%
Leavenworth	3	\$179,846	\$107,253	\$287,099	Less than 0.1%
Wenatchee	2,825	\$355,636,665	\$486,122,571	\$841,759,236	12.5%
Unincorporated County	860	\$35,505,093	\$24,569,765	\$60,074,858	0.8%
Total	3,877	\$397,909,749	\$514,970,274	\$912,880,023	5.2%

a. Impacted structures are those structures with finished floor elevations below the Hazus-estimated 500-year water surface elevation. These structures are the most likely to receive damage in a 500-year flood event

Notes: Values in this table are only for purposes of comparison among results. See Section 6.2.4 for a discussion of data limitations.

Sources of data used in Hazus modeling are described in Section 6.2.2.

Table 9-4. Flood Insurance Statistics for Chelan County

Jurisdiction	Date of Entry Initial FIRM Effective Date	# of Flood Insurance Policies as of 8/31/2012	Insurance In Force	Total Annual Premium	Claims, 11/1978 to 8/31/2012	Value of Claims paid, 11/1978 to 5/31/2015 ^a
Cashmere	12/1/1977	39	\$8,271,200	\$32,988	7	\$7,976
City of Chelan	01/05/1978	10	\$2,223,300	\$13,903	0	0
Chelan County	02/04/1981	428	\$107,315,400	\$283,943	102	\$980,211
Entiat	08/03/1984	1	\$350,000	\$414	0	0
Leavenworth	01/05/1978	14	\$3,373,200	\$9,457	4	\$87,000
Wenatchee	11/2/1977	346	\$84,065,600	\$244,036	30	\$28,358
Total		838	\$205,598,700	\$584,741	143	\$1,103,545

a. Values reflected have not been converted to current dollar values. Amounts reflect damages covered under the standard flood insurance policy and do not reflect exclusions such as basement flooding or non-structural damages.

Source: FEMA, 2015c

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding because they were constructed after regulations and codes were adopted to decrease vulnerability. Structures built before a FIRM is adopted are more vulnerable to flooding because they do not meet current codes or are located in hazardous areas. The first FIRMs in the planning area were available in 1977.

The following information related to flood insurance statistics is relevant for understanding and reducing flood risk in the planning area:

- The uptake of flood insurance in the planning area is below the national average. Only 23 percent of insurable buildings in the planning area 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 (Congressional Record, V. 152, Pt. 9, June 16, 2006 to June 27 2006)
- The amount of insurance coverage in force represents approximately 18.3 percent of the total value of the assets exposed within the SFHA.
- The average claim paid in the planning area represents about 2.5 percent of the 2012 average assessed value of structures in the floodplain. This correlates to a flood depth of less than one foot for a one story structure with no basement using the U.S. Army Corps of Engineers generic flood-depth/damage curves.
- 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, 82 percent of policies in the planning area are on structures within an identified SFHA, and 18 percent are for structures outside such areas. It may be that a high number of these policies are in the 500-year floodplain (Shaded X zones), which are not impacted by the mandatory purchase requirement of the NFIP.

9.2.3 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 had 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 report on repetitive losses by the National Wildlife Federation (1998) found that 20 percent of these properties are located outside of the 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. Figure 9-1 shows the repetitive loss areas in the planning area. FEMA's list of repetitive loss properties identifies 6 such properties in the planning area as of December 31, 2015. The breakdown of the properties by jurisdiction is shown in Table 9-5.

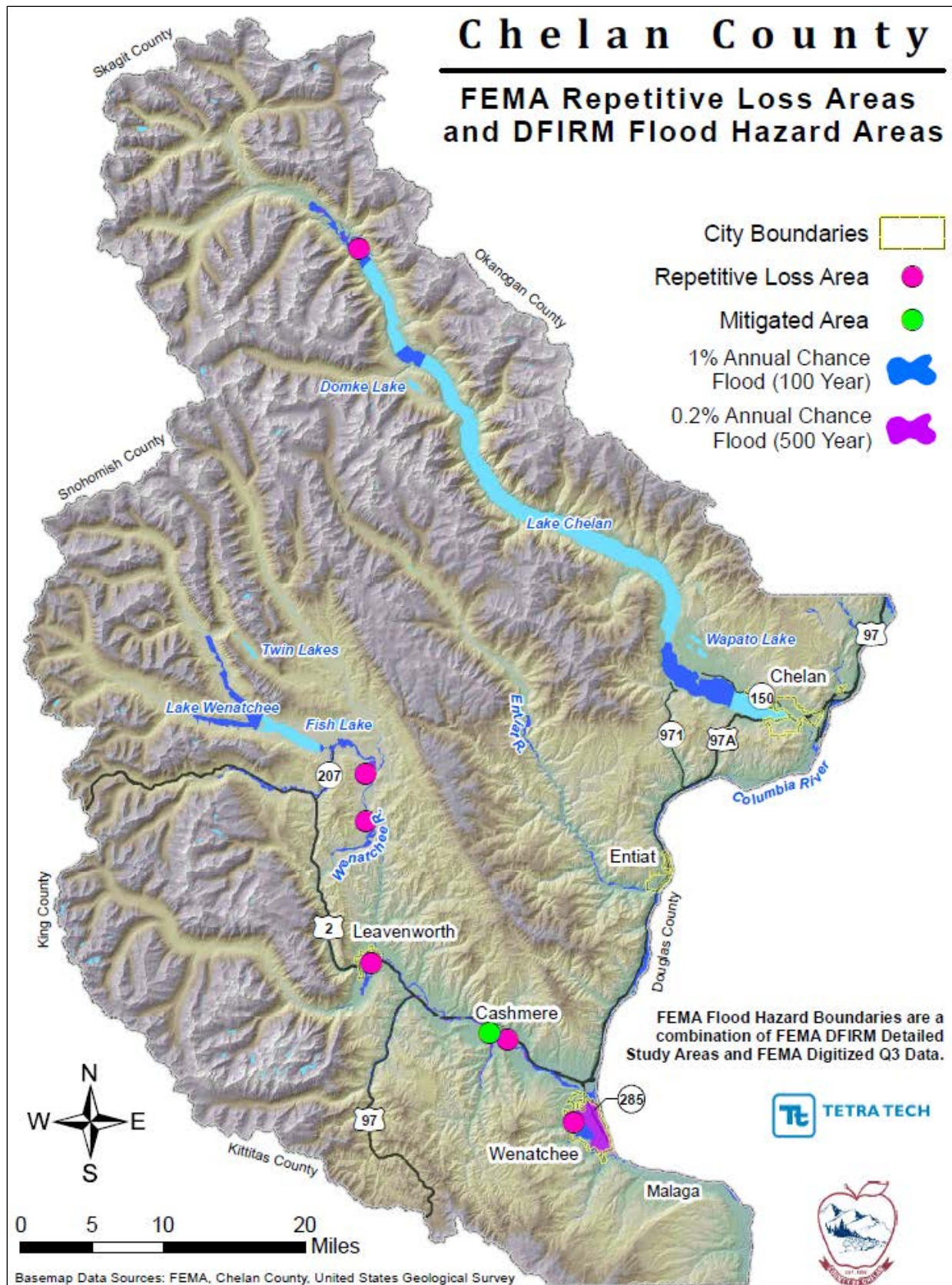


Figure 9-1. Repetitive Loss Areas in Chelan County

Table 9-5. Repetitive Loss Properties in Chelan County

	Repetitive Loss Properties	Properties That Have Been Mitigated	Number of Corrections	Corrected Number of Repetitive Loss Properties
Cashmere	2	1	0	1
Chelan	1	0	0	1
Leavenworth	2	0	0	2
Unincorporated	1	0	0	1
Total	6	1	0	5

Based on FEMA Report of Repetitive Losses, 12/31/2015

A further review of the repetitive loss data found that all dates of repetitive losses coincide with dates of known flooding in the County. Additionally, all of the identified properties are located within a FEMA designated special flood hazard area (SFHA). This indicates that the overall cause of repetitive flooding is the same as has been profiled in this plan and is covered by available mapping. With the potential for flood events every two to five years, Chelan County considers all of the mapped floodplain areas as susceptible to repetitive flooding. These areas are subject to provisions of flood damage prevention ordinances in effect within Chelan County. Once the County enrolls in the CRS program, flood protection information will be disseminated to these areas on an annual basis.

9.3 CRITICAL FACILITIES AND INFRASTRUCTURE

Hazus assesses the potential damage to critical facilities from flooding using depth/damage function curves. Based on historical averages, these curves indicate potential damage amounts as a percentage of the value of structures or contents. Actual damage to facilities may be less than these conservative estimates. For critical buildings, Hazus also estimates functional down-time, which is the time it might take to restore a facility to 100 percent of its functionality after flood damage occurs. Results for the 100-year and 500-year flood events are summarized in Table 9-6 through Table 9-8.

The assessment shows that the percentage of critical facilities and infrastructure expected to experience any damage at all is small, and that the amount of damage for each affected facility is small:

- Of the 153 inventoried critical facilities identified in the planning area (see Table 3-2), only 14 are within the 100-year floodplain (see Table 8-6). All of these facilities would be expected to experience damage from a 100-year event (see Table 9-6). Estimated damages range from 5 to 13 percent of the total building value.
- Of the 379 pieces of critical infrastructure identified in the planning area (see Table 3-3), only 80 are located within the 100-year floodplain (see Table 8-7). Of these facilities seven would be expected to experience more than negligible damage (see Table 9-8). Seventy-three bridges in the planning area may also experience damage; however, this damage is expected to negligible based on the parameters of the Hazus model.

Table 9-6. Estimated Damage to Critical Facilities from 100-Year Flood

	Number of	% of Total Value Damaged (Each Facility)		Days to 100%
	Facilities Affected	Building	Contents	Functionality
Protective Function	2	7%	8%	480
Schools	7	5%	27%	480
Other	5	5% – 13%	27% – 73%	480 - 630

Note: Sources of data used in Hazus modeling are described in Section 6.2.2.

Table 9-7. Estimated Damage to Critical Facilities from 500-Year Event

	Number of	% of Total Value Damaged (Each Facility)		Days to 100%
	Facilities Affected	Building	Contents	Functionality
Medical and Health	5	3%	19%	384
Government Function	15	Less than 1%	5%	32
Protective	6	23%	4%	160
Hazardous Materials	5	5%	15%	—
Schools	19	12%	10%	177
Other	13	0% -14%	18% -58%	0-630

Note: Sources of data used in Hazus modeling are described in Section 6.2.2.

Table 9-8. Estimated Damage to Critical Infrastructure from Flood Events

	100-Year Flood		500-Year Flood	
	Number of Facilities Affected	% of Total Value Damaged (Each Facility)	Number of Facilities Affected	% of Total Value Damaged (Each Facility)
Bridges	73	Less than 1%	90	Less than 1%
Wastewater	0	N/A	2	7%
Power	6	12%	15	11%
Communications	1	2%	1	2%
Other	0	N/A	5	5%

Note: Sources of data used in Hazus modeling are described in Section 6.2.2.

9.4 ENVIRONMENT

The environment vulnerable to the flood hazard is the same as the environment exposed to the hazard. The principle environmental impact from flood is the loss of aquatic habitat. One possible measure of environmental impacts from flooding is the amount of debris that that would be generated by each scenario flood event. Hazus includes a debris estimation component. These estimates can provide local governments information on the potential exposure to debris carried by flood water as well as estimates useful for planning for recovery. The Hazus debris estimates for each of the scenario flood events are shown in Table 9-9.

Table 9-9. Estimated Flood-Caused Debris

	Debris to Be Removed (tons) ^a	
	100-Year Flood Event	500-Year Flood Event
Cashmere	258	971
Chelan	230	229
Entiat	77	67
Leavenworth	1,245	1,300
Wenatchee	4,365	38,117
Unincorporated County	8,996	11,181
Total	15,171	51,865

a. The Hazus flood debris model focuses on building-related debris, and does not address contents removal or additional debris loads such as vegetation and sediment.

10. CLIMATE CHANGE CONSIDERATIONS FOR FLOOD HAZARD MANAGEMENT

This chapter presents an overview of current understandings of how climate change will affect Chelan County and implications for flood hazard management. Information on climate change is continually updated, and the information presented here is a snapshot of the best available information at the time this document was written.

10.1 WHAT IS CLIMATE CHANGE?

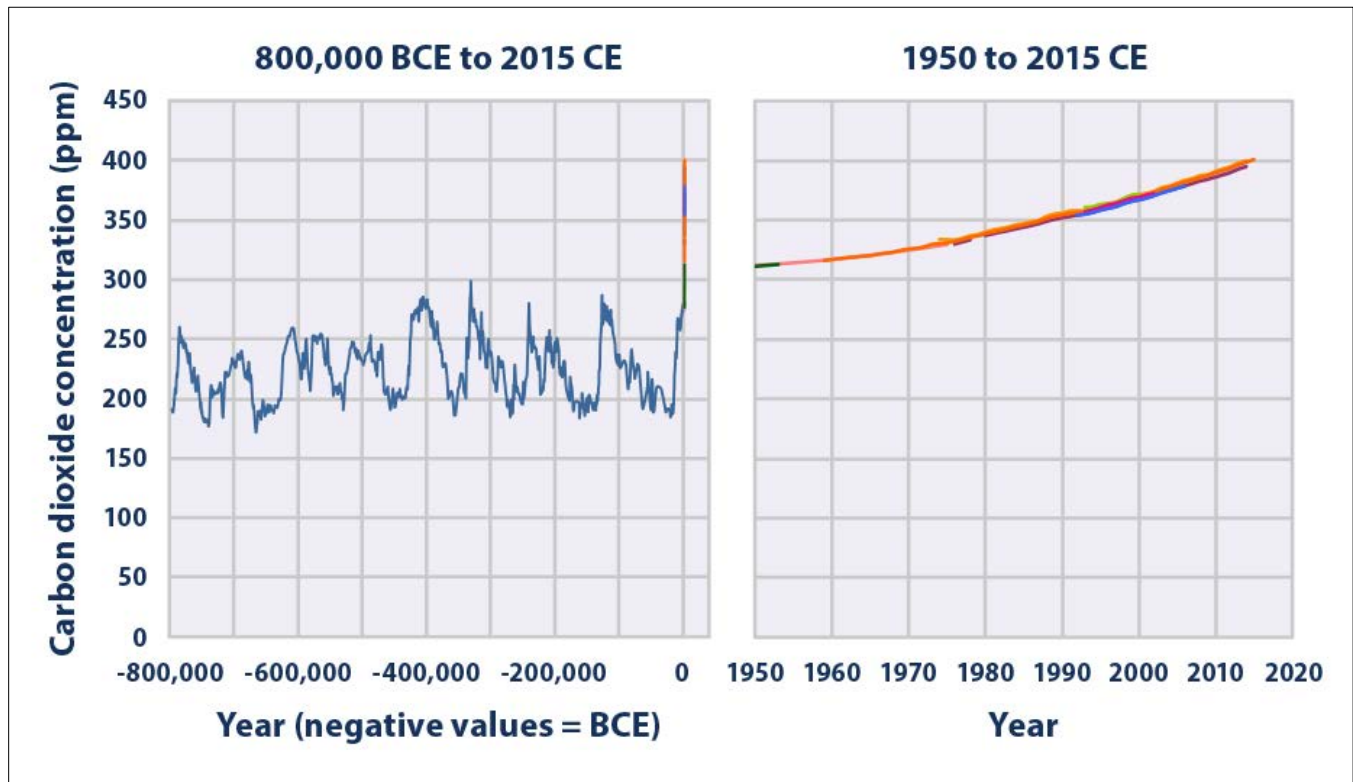
Climate, consisting of patterns of temperature, precipitation, humidity, wind, and seasons, plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. “Climate change” refers to changes in these patterns over a long period of time. Worldwide, average temperatures have increased 1.7°F since 1880 (NASA, 2016). Although this change may seem small, it can lead to large changes in climate and weather.

The warming trend and its related impacts are caused by increasing concentrations of carbon dioxide and other greenhouse gases in the earth’s atmosphere. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. Carbon dioxide is the most commonly known greenhouse gas; however, methane, nitrous oxide and fluorinated gases also contribute to warming. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels, agricultural production, changes in land use, and volcanic eruptions. According to the U.S. Environmental Protection Agency (EPA), carbon dioxide concentrations measured about 280 parts per million (ppm) before the industrial era began in the late 1700s and have risen 43 percent since then, reaching 401 ppm in 2015 (EPA, 2016) (see Figure 10-1). In addition, the concentration of methane has almost doubled and nitrous oxide is being measured at a record high of 328 parts per billion (ppb) (EPA, 2016).

Scientists are able to place this rise in carbon dioxide in a longer historical context through the measurement of carbon dioxide in ice cores. According to these records, carbon dioxide concentrations in the atmosphere are the highest that they have been in 650,000 years (NASA, 2016). According to NASA, this trend is of particular significance “because most of it is very likely human-induced and [it is] proceeding at a rate that is unprecedented in the past 1,300 years” (NASA, 2016). There is broad scientific consensus (97 percent of scientists) that climate-warming trends are very likely due to human activities (NASA, 2016). Unless emissions of greenhouse gases are substantially reduced, this warming trend and its associated impacts are expected to continue.

Climate change will affect the people, property, economy and ecosystems of Chelan County in a variety of ways. Its impacts are most frequently associated with negative consequences and increased risk, such as increased flooding or increased heat-related public health concerns. The most important effect for the development of this plan is that climate change is expected to have a measurable impact on the occurrence and severity of flooding and flood-related hazards. This chapter summarizes current understandings about climate change in order to provide a context for the recommendation and implementation of flood hazard mitigation measures in Chelan County.

Source: EPA, April 2016

**Figure 10-1. Global Carbon Dioxide Concentrations Over Time**

10.2 HOW CLIMATE CHANGE AFFECTS FLOOD HAZARD MANAGEMENT

An essential aspect of flood hazard management is predicting the likelihood of flooding in a planning area. Typically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of flood events remains essentially unchanged over time. Thus, averages based on the past frequencies of floods are used to estimate future frequencies: if a river has flooded an average of once every five years for the past 100 years, then it can be expected to continue to flood an average of once every five years. But the assumption that future flooding behavior will be equivalent to past behavior is not valid if climate conditions are changing.

Climate involves not only average temperature and precipitation but also the frequency and intensity of extreme weather events. The frequency of flooding will not remain constant if broad precipitation patterns change over time. While predicting changes in flood events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment. For this reason, an understanding of climate change is pertinent to flood hazard management activities. Information about how climate patterns are changing provides insight on the reliability of future flooding projections used in mitigation analysis.

10.3 CURRENT INDICATIONS AND OBSERVED CHANGES

10.3.1 Observed Global Changes

The major scientific agencies of the United States and the world—including the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA) and the Intergovernmental Panel on Climate Change (IPCC)—agree that climate change is occurring. Multiple temperature records from all over the world have shown a warming trend, and the IPCC has stated that the warming of the climate system is unequivocal (IPCC, 2014). Of the 10 warmest years in the 134-year record, all but one (1998) occurred since 2000, and 2015 was the warmest year on record (NASA, 2016). Worldwide, average temperatures have increased 1.7°F since 1880 (NASA, 2016).

Rising global temperatures have been accompanied by other changes in weather and climate. Many places have experienced changes in rainfall resulting in more intense rain, as well as more frequent and severe heat waves (IPCC, 2014). The planet's oceans and glaciers have also experienced changes: oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising (NASA, 2016). Global sea level has risen approximately 6.7 inches, on average, in the last 100 years (NASA, 2016). This has already put some coastal homes, beaches, roads, bridges, and wildlife at risk (USGCRP, 2009).

NASA currently maintains information on the vital signs of the planet. At the time of the development of this plan, the following trends and status of these signs are as follows (NASA, 2016):

- Carbon Dioxide—Increasing trend, currently at 404.207 parts per million
- Global Temperature—Increasing trend, increase of 1.7 degrees Fahrenheit since 1880
- Arctic Ice Minimum—Decreasing trend, 13.4 percent per decade
- Land Ice—Decreasing trend, 281.0 gigatonnes per year
- Sea Level—Increasing trend, 3.4 millimeters (0.04 inches) per year.

10.3.2 Observed Changes in the Pacific Northwest

In the Pacific Northwest average annual temperatures increased approximately 1.3°F between 1895 and 2011 (Mote et al., 2014). This has corresponded with a lengthening of the frost-free season and a higher incidence of nighttime high heat events (Dalton, Mote and Snover, 2013). In addition to these temperature related changes, several water-related impacts have been observed (Mote et al., 2014):

- **Average snowpack**—In the Cascade mountains area-averaged snowpack on April 1 has decreased about 20 percent since 1950.
- **Snowmelt timing**—Spring snowmelt is occurring as much as 30 days earlier in some locations.
- **Streamflow timing**—Streamflow levels and timing have shifted as late winter and early spring stream flows have increased and summer flows have decreased.

Like the rest of the western United States, the number and extent of wildfires in the Pacific Northwest have increased since the 1970s. This is believed to have been influenced by the onset of warmer and drier climatic conditions as well as the onslaught of pest infestations, such as mountain pine beetles, fueled at least in part by heat and drought stress (Mote et al., 2014).

10.4 FUTURE IMPACTS

10.4.1 Global Projections

Scientists project that Earth's average surface temperature will continue to rise between 0.5°F and 8.6°F by 2100 (IPCC, 2014). Some research has concluded that every increase of 2°F in average global average temperature can have the following impacts (NRC, 2011):

- 3 to 10 percent increases in the amount of rain falling during the heaviest precipitation events, which can increase flooding risks
- 5 to 10 percent decreases in stream flow in some river basins.

Although not a concern in Chelan County, the amount of sea level rise expected to occur as a result of climate change will increase the risk of coastal flooding for millions to hundreds of millions of people around the world, many of whom would have to permanently leave their homes (IPCC, 2014). By 2100, sea level is expected to rise another 1 to 4 feet, with an uncertainty range of 0.66 to 6.6 feet (Melillo et al., 2014).

10.4.2 Projections and Potential Impacts for the Pacific Northwest

Developing projections of future climate change for a specific region is challenging, especially longer term projections. The further out a prediction reaches, the more subject to changing dynamics it becomes. Modeling that is currently available is limited in its ability to produce quantitative estimates of the effect of climate change on flood hazard risks; however, an understanding of the basic features of climate change allows for qualitative assessments of impacts on flood-related hazards. This overview of projections and flood-related impacts serves as a basis for evaluating how risk will change as a result of future climate change impacts.

In the Pacific Northwest average annual temperatures are expected to continue to rise by 3.3°F to 9.7°F by the end of the century (Mote et al., 2014). It is anticipated that these changes will be most dramatic in the summer months. Projected precipitation changes in the region are ambiguous. Some models indicate that an 11 percent decrease in annual average precipitation will occur by mid-century, while other models project an increase of 12 percent for the same time period (Mote et al., 2014). The distribution of precipitation over the seasons is also uncertain, although there is some agreement amongst the models that summer precipitation is likely to decrease (Mote et al., 2014). These changes can have wider implications for stream flow and the incidence of drought and wildfires.

Projections for water-related impacts in the region are as follows (Mote et al., 2014):

- **Snowmelt timing**—By 2050 snowmelt is projected to shift three to four weeks earlier than the 20th century average.
- **Stream flow levels**—Summer stream flows are expected to be substantially diminished.
- **Flood risk**—Flood risk is expected to increase most in mixed basin watersheds (those with both rainfall and snowmelt related runoffs) and remain largely unchanged in snow dominated systems.
- **Heavy precipitation events**—It is unclear if there will be an overall increase in heavy precipitation events, but when averaged over the region models indicate that the number of days with more than one inch of precipitation is likely to increase by approximately 13 percent by mid-century. If such increases do occur, they could impact flooding in both mixed and rain-dominant systems, as well as contribute to localized flooding due to overwhelmed storm water management systems.

Water-related impacts are expected to contribute to an increased risk of wildfire in the region as water deficits stress trees and increase vulnerability to both insect infestation and combustion (Mote et al., 2014). The average

annual area burned by wildfire in the region may quadruple from the last century to 2 million acres by 2080 (Mote et al., 2014).

10.5 IMPACTS ON FLOOD-RELATED HAZARDS

10.5.1 Flood

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 future conditions.
- 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.

As hydrology changes, what is currently considered a 100-year flood (1-percent-annual-chance) may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains.

10.5.2 Dam Failure

Dams are designed partly based on assumptions about a river's hydrograph. If changes in weather patterns have significant effects on hydrographs, 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 required margins of safety. Such early releases can increase flood potential downstream.

10.5.3 Wildfire

Climate change can 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. Climate change also may increase winds that spread fires and, potentially, thunderstorms producing lightning that ignites fires. Forest response to increased atmospheric carbon dioxide could contribute to more tree growth and, thus, more fuel for fires, although the effects of carbon dioxide on mature forests are still largely unknown. In turn, increased wildfires could release stores of carbon and further contribute to the buildup of greenhouse gases.

10.6 RESPONSES TO CLIMATE CHANGE

Communities and governments worldwide are working to address, evaluate and prepare for climate changes that are likely to impact communities in coming decades. Generally, climate change discussions encompass two

separate but inter-related considerations: mitigation and adaptation. The term “mitigation” can be confusing, because it’s meaning changes across disciplines:

- Mitigation in restoration ecology and related fields generally refers to policies, programs or actions that are intended to reduce or to offset the negative impacts of human activities on natural systems. Generally, mitigation can be understood as avoiding, minimizing, rectifying, reducing or eliminating, or compensating for known impacts (40 CFR 1508.20).
- Mitigation in climate change discussions is defined as human intervention to reduce the impact on the climate system. It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks.
- Mitigation in emergency management is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters (FEMA, 2013).

In this section, mitigation is used as defined by the climate change community. In the other chapters of this plan, mitigation is primarily used in an emergency management context.

Adaptation is defined by the IPCC as “the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects” (IPCC, 2014). Mitigation and adaptation are related, as the world’s ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Some actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions. One subset of this type of strategy is known as ecosystem-based adaptation. Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change. This includes the sustainable management, conservation and restoration of specific ecosystems that provide key services. In terms of flood hazard management, many such actions are related to preserving or enhancing the natural beneficial functions of floodplain systems. Riparian forests can bind soils and hold large volumes of water during periods of significant precipitation, releasing it through the year. Floodplains can absorb large volumes of water during peak flows. Coastal ecosystems can hold out against storms, attenuating waves and reducing erosion.

Part 3. MITIGATION STRATEGY

11. MISSION STATEMENT, GOALS AND OBJECTIVES

This chapter identifies a mission statement, goals and objectives for reducing long-term vulnerabilities to flooding in the planning area (CRS Step 6). These vital planning components were developed by the Steering Committee through a facilitated process that addressed flooding issues, public support, political support and existing capabilities within the planning area. They were developed to establish a vision for reducing risk to flood hazards in Chelan County. The mission, goals and objectives are linear planning components, meaning that they all directly support one another. Goals were identified that support the mission statement. Objectives were selected that met multiple goals. Actions (identified in Table 13-1) were identified and prioritized based on the action meeting multiple objectives. Achievement of these goals and objectives will be pursued through an action plan that identifies the programs, projects and technical studies that will be implemented as resources are identified and allocated.

11.1 MISSION STATEMENT

A mission statement focuses the range of objectives and actions to be considered. The mission statement for the Chelan County Comprehensive Flood Hazard Management plan is as follows:

Through partnerships and careful planning, identify sustainable, cost-effective actions that will mitigate the impacts from flood hazards, to protect the health, safety, quality of life, environment and economy of the communities within Chelan County.

11.2 GOALS

The effectiveness of a mitigation strategy is assessed by determining how well its goals are achieved. The Steering Committee established the following goals for the 2017 Comprehensive Flood Hazard Management Plan:

1. Protect life
2. Protect property
3. Maintain sustainable operation of identified critical facilities
4. Increase the awareness of flood risk and ways to mitigate its impacts
5. Strive to protect or restore the natural and beneficial functions of floodplains
6. Encourage the development and implementation of long-term, cost effective flood mitigation projects and programs.

11.3 OBJECTIVES

The following objectives were selected that meet multiple goals:

1. Utilize the best available data, science and local knowledge to consider future conditions in planning for flood and inundation hazards.

2. Work cooperatively with public agencies and stakeholders with responsibilities for flood protection; in the planning for and understanding of the impacts from flooding.
3. Facilitate the mitigation of structures in high hazard areas, including those known to be repetitively damaged.
4. Minimize the new development of high-risk areas; or ensure that if building occurs in these area, it is done in a way to minimize the risk.
5. Collect post flood event data that will help gauge the flood hazard management efforts within Chelan County.
6. Provide/improve flood protection with flood-risk reduction projects and maintenance plans.
7. Improve early warning emergency response systems and plans.
8. Provide feasible, cost-effective flood hazard protection that strives to enhance or restore the natural and beneficial riverine floodplain functions.
9. Consider flood hazard management policies that promote resiliency and sustainable operations of identified critical facilities.
10. Inform the public on the risk exposure to flood hazards and ways to increase their capability to prepare, respond, recover and mitigate the impacts of these events.
11. Integrate flood hazard management goals and objectives into other plans and programs within the planning area that can support or enhance flood hazard management within Chelan County.

12. POLICIES

The Comprehensive Flood Hazard Management Plan policies, which are adopted by the Board of County Commissioners, provide a framework for making decisions about flood hazard management in Chelan County. These policies also provide guidance for decision-making at the program and project level and define the level of discretion Chelan County has available in flood management decisions. When a policy uses the term “shall” or “will,” it is intended that such terms be interpreted as mandatory, and that the associated action or decision is nondiscretionary. The use of “should” or “may” in a policy means that the associated action or decision is provided as guidance and indicates that there is discretion in making decisions based on such policies.

The policies in this chapter are divided into six categories:

- General
- Flood Hazard Area Land Use
- Flood Risk Reduction
- River Channel Maintenance
- Flood Warning and Emergency Response
- Funding and Financing.

The policies are intended to be consistent with any and all water resource policies in the *Chelan County Comprehensive Plan* (Chelan County, 2015), which directs land use and growth in unincorporated Chelan County. These policies do not outline policy, code or program requirements for individual jurisdictions but do call on jurisdictions to enforce policies, codes and programs they choose to adopt.

Chapter 13 of this Plan contains recommendations for flood hazard mitigation actions. These actions differ from policies in that they describe specific program and project actions that implement the Flood Plan. These actions are not mandatory. They are desirable actions that may be completed within staffing and budgetary limitations.

12.1 GENERAL POLICIES

The general policies listed below will provide a vision for Chelan County, and provide general guidance for all of its activities.

12.1.1 Flood Hazard Management

Watersheds do not follow jurisdictional boundaries. Actions taken by a city or county in one part of a drainage watershed, whether it be a land-use plan, development permit, or capital improvement project, can affect flood hazard problems experienced by other jurisdictions in the watershed, and can impact valuable ecological resources. Actions taken by a city or county can also have positive effects on neighboring jurisdictions. Cooperative flood hazard management between counties is supported by Chapter 86.13 RCW. Multi-jurisdictional approaches to watershed management can produce a multitude of public and private benefits, including flood risk reduction and improved ecosystem functions and values.

Flood hazard management includes a range of services at both the regional and local level to reduce the risk of flood hazards. The following policies have been identified to guide Chelan County in the management of the flood hazard within the Chelan County planning area.

Policy G-1: Flood Hazard Risks

Chelan County should provide regional flood hazard management planning with emphasis in those areas mapped and regulated by local, state and federal agencies and/or those areas that pose an imminent flood threat, such as post-fire burn areas, flash flooding areas, dam failure inundation areas or channels obstructed by debris accumulation. Flood hazards assessed in this plan pose a risk when either the natural process or past or current actions to control the natural process create or perpetuate:

- a. Threats to public safety,
- b. Damage to public infrastructure,
- c. Threats to identified critical facilities,
- d. Impacts on the regional economy,
- e. Impacts on ecological, natural resources, cultural resources, and productive agricultural soils, or
- f. Damage to private structures.

Policy G-2: Flood Hazard Management Actions

Chelan County should provide flood hazard management services to reduce the risk of flood hazards, including but not limited to:

- a. Prepare technical studies to further identify flood hazard areas,
- b. Provide technical information and assistance to other agencies, jurisdictions and individuals,
- c. Develop, implement and enforce flood hazard area regulations and storm water management standards within unincorporated Chelan County,
- d. Construct, monitor, maintain, repair, retrofit, or remove County managed flood protection facilities,
- e. When feasible, preserve open space in flood hazard areas,
- f. Monitor conditions in the river channels and take actions to reduce risks,
- g. Coordinate flood preparedness activities and operate a flood warning program for flood hazard areas with flood threat recognition capability,
- h. Perform emergency flood risk reduction actions,
- i. Collaborate with other jurisdictions to implement flood risk reduction actions, and
- j. Take any other action deemed necessary to reduce flood related risks and the environmental impacts of flood hazard management on a regional scale.

Policy G-3: Inter-Governmental Coordination and Cooperation

Chelan County's flood hazard management activities should be planned and implemented in close cooperation and coordination with cities, neighboring counties with watersheds that impact Chelan County, tribes, Water Resource Inventory Area (WRIA) forums, and other agencies sharing jurisdiction in each basin. This intergovernmental coordination shall also include federal agencies, including but not limited to: the U.S. Forest Service, the U.S. Army Corps of Engineers, FEMA, the Bureau of Land Management, the National Park Service, the Bonneville Power Administration, the Bureau of Reclamation, the National Resource Conservation Service, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. This policy assumes that all federal agencies will coordinate in good faith as directed under Presidential Executive Order 11988.

Policy G-4: Intra-Governmental Coordination and Cooperation

In addition to the District itself, this Plan should be implemented by multiple Chelan County departments that have a role in flood hazard management including, but not limited to, the Department of Public Works, Community Development Department, Natural Resource Department, and the Office of Emergency Management. The roles and responsibilities of each department should be determined through a memorandum of understanding to ensure flood hazard management coordination within Chelan County government.

Policy G-5: Multi-Objective Management

Chelan County's rivers and major tributaries and their associated flood hazard areas should be managed for multiple uses and objectives. Flood hazard management actions and land uses should be encouraged that support long-term flood risk reduction outcomes.

Policy G-6: Protecting Natural Functions and Values

Chelan County should protect flood storage, conveyance, and ecological values of floodplains, wetlands, and riparian corridors and, when feasible, should enhance or restore these ecological functions and values. Natural flow regimes should be protected or restored, when feasible. Flood risk reduction strategies and projects should be considered on a river-reach scale in coordination with other agencies following the WRIA, salmon recovery, or other plans identifying areas that provide natural and beneficial floodplain functions.

Policy G-7: Flood Hazard Management on Private Property

With the exception of flood emergency response functions, flood hazard management obligations of the District shall be limited to public education and awareness outreach and grant funding where the District may act as an eligible applicant agent for identified feasible and cost-effective flood hazard mitigation projects. District funds shall not be used for the betterment of private property outside of these parameters.

12.1.2 Policies for Regional Consistency

This Flood Plan is a comprehensive flood control management plan as defined under RCW 86.12. Though state law suggests that such plans are binding on jurisdictions within the planning area, Chelan County acknowledges that municipalities within the county have different levels of existing development, flood hazard management resources, and staff for enforcing regulations. Complete adoption by all cities of all policies in this Flood Plan may not be appropriate and is considered optional. Local flood hazard regulations and programmatic recommendations should strive for consistency with Chelan County's, but they may be adapted to suit each city's needs and resources.

Following adoption of the 2017 Comprehensive Flood Hazard Management Plan, Chelan County staff will be available as a resource to all cities in the planning area that seek assistance in establishing floodplain management policies consistent with those identified in this plan. Evaluation and coordination that will take place over time to maximize consistency between the adopted Flood Plan and incorporated areas may occur through WRIA forums, flood control districts, or other formal, multi-jurisdictional county-city groups. The policies below are intended to provide guidance on how consistency as defined for this plan will be supported during the performance period of this plan.

Policy G-8: Technical and Planning Assistance

Upon request, Chelan County should assist cities with which it shares jurisdiction of the major river basins in developing and adopting flood hazard management policies, regulations, and standards that are consistent with Policy G-3.

Policy G-9: NFIP Compliance and Good Standing

It should be the policy of Chelan County and all cities within the County that participate in the National Flood Insurance Program (NFIP) to maintain compliance and good standing by implementing programs that meet or exceed the minimum NFIP requirements. Such programs include but are not limited to: enforcement of an adopted flood damage prevention ordinance, limiting adverse downstream impacts from floodplain management policy, participating in floodplain mapping updates, and providing public assistance and information on

floodplain requirements and impacts. The evaluation of compliance for this policy is managed by the Department of Ecology as the Washington State NFIP Coordinating Agency, and/or FEMA Region X.

Policy G-10: Higher Regulatory Standards

Chelan County should encourage cities and towns to adopt policies and regulations that meet or exceed the standards contained in *Floodplain Management: Higher Regulatory Standards*, prepared by FEMA Region X. The policies considered should be appropriate for the risk of each community, feasible, and within the resource capability of each community.

12.1.3 National Flood Insurance Program

The National Flood Insurance Program provides a financial mechanism to respond to flood disasters by making flood insurance available to private landowners. This program provides federally backed flood insurance that encourages communities to enact and enforce flood hazard management regulations in order to qualify residents for flood insurance. Communities can also receive flood insurance premium discounts by adopting regulations that exceed federal minimum standards under the NFIP's Community Rating System (CRS) program (see Section 1.3.1 and Appendix A for additional information). Numerous local governments and agencies share jurisdiction over flooding and other issues in the County's watersheds. However, many local governments lack the staff and resources to develop new flood hazard regulations and programs. In such cases, Chelan County should provide assistance when staffing and other resources are available.

Policy G-12: National Flood Insurance Program

When feasible, Chelan County and cities should strive to not only meet, but also exceed the federal minimum standards stipulated by the NFIP utilizing the CRS as a guide to better protect public safety, reduce the risk of flood hazards to existing public and private property, and achieve flood insurance premium discounts.

12.2 FLOOD HAZARD AREA LAND USE POLICIES

Development in flood hazard areas can create two types of challenges:

- Because of its location in a hazardous area, the development may be at risk from inundation.
- The development can increase risks to neighboring properties by creating a barrier to the conveyance of floodwaters, thus causing backwater flooding upstream, and by reducing the area available to store and slowly release floodwaters, thus increasing flow velocities and erosion downstream.

This subsection contains policies to guide land-use planning and development regulations in flood hazard areas. The goal of these policies, which incorporate flood related restrictions already adopted in Chelan County's Critical Areas Ordinance, is to reduce flood risks to future developments and prevent increased risks to surrounding properties.

12.2.1 Changes to Flood Hazard Areas Based on Future Conditions

Historically, Chelan County flood hazard management regulations have been applied within the special flood hazard area as mapped by FEMA. FEMA maps are based on current or historical land use in the watershed. As watersheds develop, however, the rate and volume of runoff reaching rivers and streams can increase. In addition, changes in climate patterns can affect hydrologic conditions in flood hazard areas. The boundaries of the 100-year floodplain may change over time, creating inconsistencies between actual flood hazard conditions and those portrayed on FEMA maps. In addition, some rivers in Chelan County can migrate laterally, endangering properties along their banks. Areas that are at risk due to channel migration are sometimes outside mapped flood hazard areas, so that residents may not be aware of the risk.

Policy FLU-1: Future Conditions

The County should strive to incorporate the best available data and science that utilize future condition projections for technical studies within the watersheds and basins that contribute to the flood hazards areas within Chelan County. When feasible, land use policies and flood hazard regulations should apply to flood hazard areas that utilize future conditions hydrology.

Policy FLU-2: Channel Migration Zone Hazard Areas

Chelan County should continue to identify channel migration hazard areas through geomorphologic analyses, review of historical channel migration patterns and rates, and existing documentation. Land-use regulations should restrict unsafe development in identified channel migration hazard areas.

12.2.2 Land Use Regulations

Chelan County regulates development in flood hazard areas through a flood hazard development ordinance (Chelan County Code, Title 3, and Chapter 3.20) as well as a zoning ordinance that establishes a Frequently Flooded Areas Overlay District (Chelan County Code, Title 11, Chapter 11.84). The zoning ordinance was adopted to implement the Growth Management Act requirement to protect “frequently flooded areas.” Both of these codes includes higher standards than are required by the NFIP and state law.

The following policies support the development regulations that have already been adopted under the aforementioned Chelan County codes.

Policy LU-1: Subdividing Property

Where feasible within the parameters of adopted regulations, new subdivisions, short subdivisions, urban planned developments, and binding site plans in Chelan County shall strive to contain sufficient buildable land outside the FEMA-designated special flood hazard area or the 100-year regulated floodplain. No residential structures shall be built or placed within a FEMA-designated floodway.

Policy LU-2: Compensatory Storage

The existing storage volume of the floodplain shall be preserved.

Policy LU-3: Base Flood Depth and Base Flood Velocity

Chelan County should require a base flood depth and base flood velocity analysis for all new development in flood hazard areas where such information has not been provided on FEMA mapping.

Policy LU-4: Development in Flood Hazard Areas

New development and substantial improvements in flood hazard areas shall be constructed so that they can withstand the 100-year flood without sustaining significant damage. They shall, at a minimum, be built so that the lowest finished floor is at or above the flood protection elevation, which is at least 1-foot above the 100-year flood elevation. Areas below the lowest finished floor of residential structures shall be designed to allow for the unimpeded entry and exit of floodwaters.

Policy LU-5: Utilities

Utilities should be allowed within flood hazard areas only when no reasonable alternative location is available. When allowed they shall be flood-protected to a flood protection elevation.

Policy LU-6: Anchoring Structures

Structures in flood hazard areas shall be anchored to prevent flotation, lateral movement or collapse.

Policy LU-7: Critical Facilities

Critical facilities and land uses that have the potential to create hazardous conditions if impacted by flooding, based on their use and/or presence of hazardous materials, shall not be allowed in a 100-year floodplain or channel migration zone unless no reasonable alternative location is available. If no alternative site is available, the critical facility shall be flood protected, including the access, to 3 feet above the 100-year flood elevation or placed at the 500-year flood elevation, whichever is higher.

12.3 FLOOD RISK REDUCTION POLICIES

The policies in this section guide a comprehensive program that can implement a range of flood hazard management projects, including both structural and non-structural projects. Structural projects often involve retrofitting existing facilities, including sediment management and bank stabilization facilities. Non-structural projects could include voluntary relocation, acquisition, and elevation of flood-prone homes and the removal of existing flood hazard management structures that are no longer needed.

Policy FRR-1: Criteria for Taking Action

Chelan County should evaluate flooding and channel migration processes to determine when action should be taken to reduce the potential risks associated with these processes using the following criteria:

- a. The consequences that will result if no action is taken,
- b. The urgency of the need to take action, and
- c. The legal responsibility and authority of Chelan County.

Policy FRR-2: Selecting Flood Risk Reduction Actions

Flood risk reduction actions should be selected based on consideration of the following criteria:

- a. Action effectively meets site- and reach-specific flood risk reduction objectives,
- b. Action results in a benefit that exceeds the initial cost as well as the long-term maintenance costs,
- c. Action does not create new unmitigated flood hazard or other problems,
- d. Action recognizes riparian habitat and supports adopted Water Resource Inventory Area Plan objectives where applicable,
- e. Action achieves public benefits, and
- f. Action builds upon funding and partnering opportunities.

Policy FRR-3: Property Acquisition

Chelan County may acquire property interests in land necessary to meet flood hazard management objectives. Except under very limited circumstances, County acquisition of structures and property should be voluntary on the part of the property owner. County participation should be limited to the support of the pursuit of funding from non-county sources such as the suite of FEMA Hazard Mitigation grant programs or Washington Department of Ecology's "Floodplains by Design" initiative. Condemnation should be considered only under the following circumstances:

- a. Federal, state or local regulations prohibit reconstruction of the building,
- b. The property in question is causing significant flood damage to other properties,

- c. A property owner refuses to sell a portion of an area in which the majority of property owners have agreed to sell to the County, or
- d. A property owner refuses to sell an area needed to complete a proposed flood risk reduction project.

Policy FRR-4: Easements

Prior to participating in the construction of a new flood protection facility or maintaining, repairing or reconstructing an existing flood protection facility, Chelan County should obtain all easements necessary to construct, maintain, repair, or retrofit the flood protection facility consistent with applicable Chelan County design and construction standards and federal and state engineering guidelines.

Policy FRR-5: Management of Chelan County Properties

Chelan County shall manage its public lands and easements within flood hazard areas in accordance with the policies within this Plan. Public access to flood hazard management properties will be evaluated on a case-by-case basis to determine the impact the public may have on the facility, as well as overall public safety issues.

Policy FRR-6: Flood Facility Design and Maintenance Objectives

Chelan County should construct new flood protection facilities and maintain, repair or replace existing flood protection facilities in such a way as to:

- a. Require minimal maintenance over the long term,
- b. Ensure that flood hazard problems are not transferred to other sites,
- c. Maintain or enhance aquatic, riparian and other critical area habitat where feasible, and
- d. Minimize impacts on flood hazard areas within areas that provide fish and wildlife habitat, recreational opportunities and productive agricultural soils.

Policy FRR-7: Monitoring and Adaptive Management

Flood hazard management projects shall be monitored to assess their function relative to established performance measures. Adaptive management shall be used to modify the project in order to improve the effectiveness of the project and to inform the design and implementation of future projects.

12.4 RIVER CHANNEL MAINTENANCE POLICIES

This section recommends policies to direct future channel maintenance activities undertaken by Chelan County. The policies seek a balance between resource concerns and the protection of public property and private structures. Routine maintenance of natural drainage systems is conducted using best management practices identified by various permitting agencies.

Policy CM-1: When to Remove, Reposition or Relocate Large Woody Debris

Naturally occurring accumulations of large woody debris should be removed, repositioned or relocated for flood hazard management purposes only if they create one or more of the flood related risks described in Policy G-1 and all reasonable alternative have been considered.

Policy CM-2: Relocation of Large Woody Debris

Removal, repositioning or relocation of naturally occurring large woody debris should be accomplished within the parameters of local, state or federal permits, using the technique that results in the least disturbance to the river channel. If removed, the wood should be put back into the river in a manner that does not create new flood hazard

risks. If it is not practical or reasonable to return the large woody debris to the channel, it should be incorporated into an adjacent riparian corridor where feasible.

Policy CM-3: Comprehensive Sediment Management

Comprehensive sediment management in Chelan County shall be informed by technical sediment transport studies and consider the highly variable nature of sediment transport to achieve a balance between flood risk reduction and ecological health.

Policy CM-4: Gravel Removal

Chelan County may remove gravel from rivers for flood hazard or channel migration protection purposes when:

- a. It can be demonstrated that gravel accumulation poses a flood risk as defined in Policy G-1,
- b. Hydraulic and sediment transport studies conclude gravel removal has a benefit of flood or channel migration risk reduction,
- c. It is in a demonstrated area of gravel accumulation,
- d. It is part of a comprehensive, reach-scale flood risk reduction strategy or other applicable documents,
- e. Biologic studies determine that gravel removal does not, with mitigation, result in a net loss of ecological function, and
- f. All proper approvals have been secured.

12.5 FLOOD WARNING AND EMERGENCY RESPONSE POLICIES

Early warning of developing flood conditions is essential to effective flood risk reduction during flood events. Near-real-time weather and gage data should be interpreted and made available through a variety of means to allow agencies, organizations and private individuals to take appropriate action before and during a flood event. This section recommends policies to direct future flood warning and emergency response activities undertaken by Chelan County.

Policy FW-1: County Flood Warning

Chelan County should provide flood information and notification services during flood events assisting the National Weather Service.

Policy FW- 2: Flood Emergency Response and Recovery

Chelan County should coordinate regional flood emergency response and recovery services during and after flood emergencies through the Emergency Operations Center and Chelan County Emergency Management Department.

Policy FW-3: Sandbags

Before and during expected flood events, Chelan County may provide a location for sand bags and sand. Citizens may request them from the individual fire district or public works departments. Property owners are responsible for placing sandbags and cleaning up sandbags after the flood event, and meeting any regulations relating to sandbagging activity.

Policy FW-4: Agency Coordination

Chelan County's Flood Control Zone District shall coordinate with other departments within the county, the National Weather Service, cities, police and fire departments, and other entities as needed (e.g., Army Corps of Engineers, U.S. Forest Service, Chelan PUD, Department of Ecology, Department of Fish and Wildlife and Wenatchee Reclamation District) to improve flood warning and emergency response procedures.

Policy FW-5: Emergency Response Actions

Chelan County should consider sustainable risk reduction objectives before taking emergency response actions. Emergency response actions should be implemented in a manner that does not preclude the achievement of long-term flood risk reduction or habitat restoration objectives.

12.6 FUNDING AND FINANCING POLICIES

The recently formed FCZD requires the establishment of policies to govern when it will spend money on capital projects, maintenance of facilities, repairs, and emergency work throughout the county and the incorporated cities. The District has limited funds and cannot meet all the drainage or flood hazard reduction needs of all the communities within the county, and is designed primarily to deal with public infrastructure and safety, not small local drainage issues. The policies in this section provide a framework for making decisions about how these funding sources are used for flood hazard management in Chelan County.

Policy FF-1: Management of the District

The Board of County Commissioners, also identified as the Board of Supervisors, are the ex officio managers of the District. The District Administrator (County Engineer) will exercise best professional judgment in conjunction with the direction of the Board of Supervisors to determine the appropriate courses of action for all circumstances or events within the province of the FCZD, whether or not such events or circumstances are anticipated and addressed in this document. A separate document titled *Financial Policies* has been adopted by the Board of Supervisors, providing financial guidance to the District. This document is on file at the Chelan County Public Works Department. The financial guidance expands upon Policies FF-2, FF-3, and FF-4 below.

Policy FF-2: Designated Emergency Fund Balance

Chelan County should strive to establish a designated emergency fund balance reserve to be used exclusively for flood emergency response. To the extent practicable, these funds should be used to leverage state and federal funds, but should also be sufficient to allow Chelan County to respond to emergencies when state and federal funding is not readily available. The reserve allocation should be based on the projected costs for the local share of flood disaster recovery plus a margin of error.

Policy FF-3: Regional Funding

New or expanded regional funding sources should be identified to meet the need for enhanced or expanded flood hazard management projects and programs to address flood impacts.

Policy FF-4: Grant Funding

Chelan County, cities in Chelan County, and other local government agencies should identify, evaluate, and coordinate grant funding sources to determine their suitability and assess consistency with the goals and objectives of this Plan, and apply for grants to leverage local sources of funding for flood risk reduction projects.

13. MITIGATION ACTIONS

13.1 ALTERNATIVES ANALYSIS

This section identifies a comprehensive range of alternatives that the County could consider to mitigate the flood issues identified by the Flood Plan. It provides a wide range of activities to ensure that all possible measures are explored, beyond the traditional approaches of flood control, acquisition, and regulation of land use. Presenting a complete range of possible alternatives diversifies the Comprehensive Flood Hazard Management Plan and positions it to be able to respond to changing conditions affecting the flood hazard. An action that might not be feasible today could become feasible in the future due to a change in programs, capabilities or available resources. The items in this section provide options for the County to consider as it implements and maintains this Plan, in order to address changing conditions in mapped flood hazard areas.

A Steering Committee session was held on January 27, 2016 to assess local strengths, weaknesses, obstacles and opportunities related to flood hazard management. This meeting was the basis for considering and selecting mitigation actions for the flood hazard management plan. The planning team prepared a catalog of mitigation alternatives based on the findings of this meeting (CRS Step 7). The Steering Committee reviewed and updated the catalog based on findings of public outreach efforts, the risk assessment results, and standard flood hazard management “best management practices.” The resulting catalog includes alternatives that are categorized in three ways:

- By who would have responsibility for implementation:
 - Public sector (citizens of Chelan County)
 - Private sector (non-governmental parties)
 - Government sector (federal, state and local).
- By what the alternative would do:
 - Manipulate the flooding hazard
 - Reduce exposure to the flooding hazard
 - Reduce vulnerability to the flooding hazard
 - Increase the ability to respond to or be prepared for the flooding hazard.

The catalog provides a baseline of mitigation alternatives that are backed by a planning process, are consistent with the goals and objectives, and are within the capabilities of Chelan County to implement. However, not all the alternatives meet all the selection criteria considered by the Steering Committee. The enhanced catalog was used by the planning team to select flood hazard mitigation actions.

13.1.1 Public Sector Actions

The following actions by the public sector have the potential to mitigate the flood hazard:

- Manipulate the flooding hazard:

- Refrain from obstructing stormwater drains, culverts and other related infrastructure
- Increase water conservation efforts
- Install localized stormwater systems
- Reduce exposure to the flooding hazard:
 - Locate outside of hazard area
 - Elevate utilities above base flood elevation
 - Institute low impact development techniques on property
 - Assess projects to determine if they may inadvertently increase flood risk
- Reduce vulnerability to the flooding hazard:
 - Retrofit house (elevate house above base flood elevation)
 - Elevate items within house above base flood elevation
 - Build new house above base flood elevation
 - Floodproof non-residential structures
 - Retrofit, protect, or replace scour-critical bridges
 - Replace undersized culverts
- Increase the ability to respond to or be prepared for the flooding hazard:
 - Comply with National Flood Insurance Program
 - Buy flood insurance
 - Develop household mitigation plan, such as retrofit savings, communication capability with outside, 72-hour self-sufficiency during and after an event
 - Be aware of evacuation routes
 - Educate yourself on flood risk from related hazards, such as wildfire
 - Participate in Community Emergency Response Team training if and when available.

13.1.2 Private Sector Actions

The following actions by the private sector have the potential to mitigate the flood hazard:

- Manipulate the flooding hazard:
 - Refrain from obstructing stormwater drains, culverts, and other related infrastructure
 - Increase water conservation efforts
 - Install localized stormwater systems
- Reduce exposure to the flooding hazard:
 - Locate business critical facilities or functions outside hazard area
 - Institute low impact development techniques on property
 - Assess projects to determine if they may inadvertently increase flood risk
- Reduce vulnerability to the flooding hazard:
 - Build redundancy for critical functions; retrofit critical buildings
 - Provide flood-proofing measures when new critical infrastructure must be located in flood hazard areas

- Increase the ability to respond to or be prepared for the flooding hazard:
 - Increase capability by having cash reserves for reconstruction
 - Support and implement hazard disclosure for the sale of property in identified risk zones
 - Solicit cost-sharing through partnerships with other private or public sector stakeholders on projects with multiple benefits

13.1.3 Government Sector Actions

The following actions by governments have the potential to mitigate the flood hazard:

- Manipulate the flooding hazard:
 - Design and encourage stormwater systems
 - Maintain stormwater drains, culverts, and other related infrastructure
 - Perform dredging and levee construction/maintenance, providing retention areas
 - Provide/maintain structural flood control: levees, dams, channelization, revetments
 - Construct regional stormwater facilities, flood debris basins
 - Stabilize areas with significant erosion concerns
 - Promote/retain natural vegetation in areas with significant erosion concerns
 - Identify and implement sediment management strategies
 - Increase water conservation efforts
 - Continue to pursue holistic flood hazard management and opportunities for promoting or preserving natural floodplain function
- Reduce exposure to the flooding hazard:
 - Locate or re-locate critical facilities outside of hazard areas
 - Acquire or relocate structures from identified governmental repetitive loss properties
 - Promote open space uses in identified high hazard areas via techniques such as planned unit developments, easements, setbacks, greenways, or sensitive area tracks
 - Adopt land development criteria such as planned unit developments, density transfers and clustering
 - Institute low impact development techniques on property
 - Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff
 - Perform a buildable lands analysis to determine areas where exposure may increase
 - Comply and work with provisions protecting endangered species within the County
- Reduce vulnerability to the flooding hazard:
 - Strengthen existing infrastructure
 - Provide redundancy for critical functions and infrastructure
 - Adopt appropriate regulatory standards, such as cumulative substantial improvement/damage, freeboard, lower substantial damage threshold and compensatory storage
 - Adopt/enhance stormwater management regulations and master planning
 - Adopt no-adverse-impact flood hazard management policies that strive to avoid increasing the flood risk on downstream communities
 - Encourage mitigation of private property
 - Perform regular inspections and assessments of locally owned or maintained flood control infrastructure
 - Replace undersized culverts

- Provide permanent protection for pump stations at risk of flooding
- Identify and mitigate drainage issues resulting in ponding
- Enhance road drainage programs
- Ensure that the permitting process is consistent with the adopted flood hazard development ordinance
- Elevate or relocate roads subject to frequent flooding
- Retrofit, protect, or replace scour critical bridges
- Develop guidelines for floodplain fringe protections
- Increase freeboard regulations
- Account for changing climate conditions in relevant codes
- Develop and assist in maintenance of emergency warning systems
- Increase the ability to respond to or be prepared for the flooding hazard:
 - Produce more accurate flood hazard maps or identify areas for further study
 - Provide technical information and guidance
 - Enact tools to help manage development in hazard areas (stronger controls, tax incentives, information, enforcement of the NFIP)
 - Include retrofit or replacement of critical systems in capital improvement programs
 - Develop strategy to take advantage of post-disaster opportunities
 - Warehouse critical infrastructure components
 - Develop and adopt a continuity of operations plan
 - Improve and build on Community Rating System program classification
 - Maintain existing data and gather new data needed to define risks and vulnerability
 - Provide training for staff and decision-makers in flood hazard management
 - Create a building and elevation inventory of structures in flood hazard areas
 - Develop and implement a public information strategy
 - Charge a hazard mitigation fee on all new permits to create a hazard mitigation funding source for actions or grant cost-share requirements
 - Develop a flood task force
 - Integrate flood hazard management policies into other local planning mechanisms
 - Develop and maintain a system for perishable data collection after a flood event
 - Develop a framework and continue efforts for cooperation between agencies and districts in flood mitigation activities (e.g. sand and sand bag deployment)
 - Retain good standing in National Flood Insurance Program
 - Integrate flood mitigation opportunities into capital improvement programs
 - Create a fund or earmark funds for in-kind contributions as grant opportunities become available
 - Produce after-action reports on flood events
 - Develop and update evacuation routes
 - Participate in information sharing with other agencies (e.g. Corps of Engineers, NWS)
 - Develop and update memorandums of understanding with other local jurisdictions and continue to coordinate emergency response and preparedness activities
 - Identify sources of nuisance flooding
 - Review and, if needed, update flood hazard development ordinances
 - Require or encourage rapid damage assessment training
 - Map locations of storm drains, catch basins, dry wells and other stormwater infrastructure so they may be maintained and cleared when needed
 - Identify debris collection sites
 - Continue to develop post-fire outreach strategies for impacted residents
 - Develop public outreach materials
 - Educate residents on types of projects that may inadvertently increase flood risk

- Educate residents on the nexus between water conservation, drought and flood
- Continue to identify opportunities for partnerships
- Promote the Flood Control Zone District as a taxing authority to generate funding or identify sustainable funding solutions
- Support and implement hazard disclosure for the sale of property in identified risk zones and increase enforcement of disclosure provisions
- Map and create an inventory of open spaces with potential for beneficial functions
- Incorporate invasive species management into flood hazard management activities
- Continue improving upon emergency services capabilities and public awareness of preparedness
- Sponsor/encourage/promote local Community Emergency Response Team activities (if and when available)
- Identify and monitor drainage problem areas.

13.2 SELECTED MITIGATION ACTIONS

The Planning Team and Steering Committee determined that some actions from the flood hazard mitigation catalog could be implemented to provide flood hazard mitigation benefits. Table 13-1 lists the identified actions, the lead agency for each, and the proposed timeline. The parameters for the timeline are as follows:

- Short-term—Action to be completed in 1 to 5 years
- Long-term—Action to be completed in greater than 5 years
- Ongoing—Action currently being funded and implemented under existing programs.

13.3 BENEFIT/COST REVIEW

The action plan is prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (CRS Step 8). 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 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.

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.

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.

Table 13-1. Flood Mitigation Action Plan Matrix

Applies to new or existing assets	Flood Hazards Mitigated	Objectives Met (see Section 11.3)	Lead Agency	Estimated Cost	Sources of Funding	Timeline
Action #1 —Define regional flood hazard management consistency pursuant to RCW 86.12 for the planning area. This definition will strive to exceed minimum NFIP standards and will be developed thru a facilitated planning effort with all cities within Chelan County.						
New and Existing	Any floodplain	2,9,11	FCZD, Community Development, All Chelan County Cities	Medium	FCZD	Short-term
Action #2 —Chelan County will continue with the Community Rating System (CRS) application and classification process and will mentor Chelan County cities that show interest in CRS participation.						
New and Existing	All floodplains	2,3,4,9,10,11	FCZD, Community Development, All Chelan County Cities	Low	FCZD, Chelan County Cities	Short-term
Action #3 —Define floodplain mapping criteria that takes into account future flood hazard conditions and/or expected worst case conditions to be applied to all future flood studies within the planning area.						
New and Existing	All floodplains	1,4,5,10,11	Public Works, FCZD, Stormwater Utility	Low	FCZD, Stormwater Utility	Long-term
Action #4 —Identify alternative sources of funding to leverage FCZD funding to perform new flood studies in identified areas of need based on risk.						
New and Existing	All areas of known flood risk	2,11	FCZD	Low	FCZD, identified alternative funding sources, HUD	Long term
Action #5 —Inform all future mapping by maintaining a database on known flood risk that tracks historical flood conditions to include, but not limited to: high water marks, recorded damages, photos, observed flood conditions, etc.						
New and Existing	All areas of known flood risk	1,5,10	FCZD, Public Works, Stormwater Utility	Medium	FCZD	Short term
Action #6 —Continue to implement the Stormwater Management Program that includes facility identification, design, construction and maintenance within the stormwater utility jurisdictional authority.						
New and Existing	Surface water flooding	1,3,11	Stormwater Utility	Low	Stormwater Utility	Short-term, ongoing
Action #7 —For areas outside of the Stormwater Utility, clearly define the stormwater management program based on existing programs and capabilities.						
New and Existing	Surface water flooding	1,3,11	Public Works	Medium	Road Fund	Short-Term
Action #8 —Develop a facility maintenance operations and maintenance protocol for FCZD funded facilities as they are developed.						
New	All flooding	2,6,9	FCZD	High	FCZD	Long-term
Action #9 —Investigate solutions to issues associated with modification to the landscape that increase runoff, including sediment, to adjacent properties and infrastructure.						
New	Erosion based flooding	1,2,5,11	Public Works, Community Development, Conservation District, Cities, USFS	Medium	Responsible entities	Short-term
Action #10 —When requested, FCZD may act as the applicant agent for mitigation grant opportunities for private property requesting to participate in the grant program.						
Existing	All flooding	2,3,10	FCZD	Medium	Grant funding with private property owner contribution	Short-term, on-going
Action #11 —Develop a flood informational website on the FCZD web page.						
New and Existing	All flooding	1,2,10	FCZD	Low	FCZD	Short-term

Applies to new or existing assets	Flood Hazards Mitigated	Objectives Met (see Section 11.3)	Lead Agency	Estimated Cost	Sources of Funding	Timeline
Action #12 —Deploy public information and outreach program targeting at risk properties within the planning area.						
New and Existing	All flooding	1,2,10	FCZD	Low	FCZD	Short-term
Action #13 —Coordinate with FEMA Region X on deploying flood insurance workshops for agents, lenders and citizens within the performance period for this plan.						
New and Existing	All FEMA mapped flooding	1,2,10	FCZD, FEMA	Low	FCZD, FEMA Region X	Short-Term
Action #14 —Investigate feasible, cost-effective solutions to flood issues within No. 1 Canyon.						
New	Alluvial fan flooding	1,3,6,8	FCZD, Stormwater Utility, City of Wenatchee	Medium	FCZD, City of Wenatchee, possible grant funding	Short-term
Action #15 —Identify a feasible, cost-effective solution to Slide Ridge debris flow issues.						
New and Existing	Alluvial fan flooding	1,3,6,8	FCZD	High	FCZD, possible grant funding	Long-term
Action #16 —Investigate feasible, cost-effective solutions to flood issues within No. 2 Canyon.						
New and Existing	Alluvial fan, post-fire flooding	1,3,6,8	FCZD, Stormwater Utility, City of Wenatchee	High	FCZD, City of Wenatchee, possible grant funding	Long-term
Action #17 —Investigate feasible, cost-effective solutions to flood issues within Dry Gulch (south of City of Wenatchee).						
New and Existing	Alluvial fan, post-fire flooding	1,3,6,8	FCZD, Stormwater Utility, City of Wenatchee	High	FCZD, City of Wenatchee, possible grant funding	Long-term
Action #18 —Investigate feasible, cost effective solutions to flood issues within Mission Creek.						
New and Existing	Riverine flooding	1,3,6,8	FCZD, City of Cashmere	High	FCZD, City of Cashmere, possible grant funding	Long-term
Action #19 — Investigate feasible solutions to flood issues within Ski Hill Basin.						
New and Existing	All flooding	2,9,11	FCZD, Public Works	Medium	Public Works	Short-tem
Action #20 —Coordinate with City of Cashmere on options for the maintenance and management of the levee system within the City.						
Existing	Riverine	1,3,6,8	FCZD, City of Cashmere	High	FCZD, City of Cashmere, possible grant funding	Long-term
Action #21 —Maintain database of flood control needs within the planning area as needs become identified for incorporation into future updates and progress reporting to this plan.						
New and existing	All flooding	1,2,5,8	FCZD	Low	FCZD	Short-tem, on-going
Action #22 —Mitigate flood related risk to publicly owned county bridges.						
Existing	All flooding	1,3,6,8	Public Works, FCZD	High	FCZD, Public Works, possible grant funding	Long-term
Action #23 —Maintain the county Critical Areas Ordinance (CAO) pursuant to the requirements of the State Growth Management Act.						
New and existing	Frequently flood areas under jurisdiction of CAO	1,2,4,9,11	Community Development	Low	Community Development	On-going

Applies to new or existing assets	Flood Hazards Mitigated	Objectives Met (see Section 11.3)	Lead Agency	Estimated Cost	Sources of Funding	Timeline
Action #24 —Identify feasible opportunities with like goals for natural resource protection within identified flood risk areas based on available funding.						
New and existing	All flooding	2,9,11	FCZD, Natural Resource Department (County), Conservation District, fisheries enhancement groups	Low	Grants	Long-term
Action #25 —Coordinate with watershed planning and program implementation to identify opportunities to leverage available funding for like goals between watershed and FCZD plans and programs.						
New and existing	All flooding	1,2,4,9,11	FCZD, Watershed Planning Groups	Low	FCZD	Short-term
Action #26 —Utilizing the best available data, science and technology, enhance the existing flood notification program, striving to identify a notification protocol within systems that have real-time flood threat recognition capability.						
New and existing	All flooding	1,7,11	FCZD, Emergency Management	High	FCZD, Emergency Management, possible grant funding	Long-term
Action #27 —Update the County emergency response plan to reflect any changes to flood notification protocol within the County.						
New and existing	All flooding	1,7,11	FCZD, Emergency Management	Medium	FCZD, Emergency Management, possible grant funding	Short-term, on-going
Action #28 —Conduct annual exercises of the County Emergency Operations Plan in compliance with NIMS standards, such that flood response actions of the County are reviewed, evaluated, and adapted based on observations from the exercises.						
New and existing	All flooding	1,7,11	FCZD, Cities, Public Works, Emergency Management, Sheriff's Office	Low	FCZD, Public Works, Emergency Management	Short-term, on-going
Action #29 —Draft a prioritized list of road segments and bridges that should be elevated above the 100-year flood hazard area and culverts that will fail under flood flow. Upgrade these structures if funding become available.						
Existing	All flooding	1,3,8	FCZD, Public Works, Natural Resource Department (County)	High	FCZD, Public Works, possible grant funding,	Long-term
Action #30 —Integrate the Chelan County Comprehensive Flood Hazard Management Plan into other appropriate plans and programs that can support or enhance the County's efforts to reduce flood risk as these plans and programs are updated. Examples of such plans/programs would include, but are not limited to: Chelan County Hazard Mitigation Plan, Chelan County Comprehensive Plan, and Chelan County Shorelines Master Plan.						
New and existing	All flooding	1,9,11	FCZD, Community Development, All Cities	Medium	FCZD, Community Development	Long-term
Action #31 —Utilizing the best available data, science and technology, maintain and enhance as data becomes available the Level 2, user-defined HAZUS-MH model that was constructed to support this planning effort.						
New and existing	All flooding	1,9,11	FCZD, Public Works	Medium	FCZD	Short-term, on-going

Applies to new or existing assets	Flood Hazards Mitigated	Objectives Met (see Section 11.3)	Lead Agency	Estimated Cost	Sources of Funding	Timeline
Action #32 —Establish a sediment management program that includes expanded channel monitoring, establishment of thresholds to trigger actions, and analysis of sediment management action alternatives.						
New and existing	Sediment transport flooding	1,2,5,6	FCZD, Public Works, Natural Resource Department (County), applicable Cities	Medium	FCZD	Long-term
Action #33 —As FCZD projects are constructed, monitor projects using identified performance measures and adaptive management to track the effectiveness of completed projects to inform the design and implementation of future projects.						
New	All flooding	1,2,11	FCZD, Public Works	Medium	FCZD	On-going, Long-term
Action #34 —Respond to inquiries and complaints from citizens and other public and private agencies and tracking per Community Rating System requirements.						
New and existing	All flooding	1,2,6,10	FCZD, Public Works, All Cities	Low	FCZD, Public Works	Short-term, on-going
Action #35 —Maximize federal, state, and local funding opportunities through grant application submittals in support of capital improvement projects, technical studies, and other flood hazard management activities.						
New and existing	All flooding	2,3,8	FCZD, Public Works, All Cities	Medium	FCZD, Public Works	Long-term
Action #36 —Continue to provide flood hazard management technical support to all Chelan County departments and cities proposing activities or projects that affect floodplain functions.						
New and existing	All flooding	2,9,11	FCZD, Community Development, Natural Resource Department (County), All Chelan County Cities	Low	FCZD, Public Works	Short-term, on-going
Action #37 —Continue to maintain good standing under the National Flood Insurance Program by implementing programs that meet or exceed the minimum NFIP requirements. Such programs include enforcing an adopted flood damage prevention ordinance, participating in floodplain mapping updates, and providing public assistance and information on flood hazard requirements and impacts.						
New and Existing	All FEMA mapped Flood Hazards	2,3,4,9,10,11	FCZD, Community Development, All Chelan County Cities	Low	FCZD, Chelan County Cities	Short-term, on-going
Action #38 — Develop and implement a stand-alone floodplain development permit for all new development and/or substantial improvements within the unincorporated County regulated floodplain.						
New and Existing	All regulated flood hazards	4,9,11	Public Works, Community Development	Low	Public Works	Short-term

Note: FCZD: Chelan County Flood Control Zone District

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.

For many of the strategies identified in this action plan, Chelan County may seek financial assistance under the FEMA HMGP or Hazard Mitigation Assistance 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, Chelan County reserves the right to define “benefits” according to parameters that meet the goals and objectives of this Plan.

13.4 ACTION PLAN PRIORITIZATION

Table 13-2 lists the priority of each action as assigned by the Planning Team, using the same parameters used in selecting the actions.

A qualitative benefit-cost review was performed for each of these actions. The priorities are defined as follows:

- **High Priority**—A project that meets multiple objectives, has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for a grant program. High priority projects can be completed in the short term (1 to 5 years). The key factors for high priority projects are that they have funding secured and can be completed in the short term.
- **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. Project can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured. The key factors for medium priority projects are that they are eligible for funding, but do not yet have funding secured, and they can be completed within the short-term.
- **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 FEMA grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority projects may be eligible for grant funding from other programs. Low priority projects are “blue-sky” projects. How they will be financed is unknown, and they can be completed over the long-term.

13.5 ANALYSIS OF MITIGATION ACTIONS

Each identified action was classified based on the type of mitigation it involves. Mitigation types used for this categorization are as follows:

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, flood hazard management laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection**—Modification of public buildings, roads, or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform citizens and elected officials about flood hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.

Table 13-3 presents the results of this analysis.

Table 13-2. Prioritization of Mitigation Actions

Action	# 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)
#1	3	Medium	Medium	Yes	No	Yes	High
#2	6	Medium	Low	Yes	No	Yes	High
#3	5	Medium	Low	Yes	No	Yes	High
#4	2	Low	Low	Yes	No	Yes	High
#5	3	Medium	Medium	Yes	Yes	No	Medium
#6	3	Medium	Low	Yes	Yes	Yes	High
#7	3	Medium	Medium	Yes	Yes	No	Medium
#8	3	High	High	Yes	No	No	Medium
#9	4	Medium	Medium	Yes	No	No	Medium
#10	3	Medium	Medium	Yes	Yes	No	Medium
#11	3	Low	Low	Yes	No	Yes	High
#12	3	Low	Low	Yes	No	Yes	High
#13	3	Low	Low	Yes	No	Yes	High
#14	4	High	Medium	Yes	Yes	Yes	High
#15	4	High	Medium	Yes	Yes	Yes	High
#16	4	High	Medium	Yes	Yes	Yes	High
#17	4	High	Medium	Yes	Yes	Yes	High
#18	4	High	Medium	Yes	Yes	Yes	High
#19	3	High	Medium	Yes	Yes	Yes	High
#20	4	Low	Low	Yes	No	Yes	High
#21	4	High	High	Yes	Yes	No	Medium
#22	5	High	Low	Yes	No	Yes	High
#23	3	Medium	Low	Yes	Yes	Yes	High
#24	5	High	Low	Yes	Yes	Yes	High
#25	3	High	High	Yes	Yes	No	Medium
#26	3	High	Medium	Yes	Yes	Yes	High
#27	3	High	Low	Yes	Yes	Yes	High
#28	3	High	High	Yes	Yes	No	Medium
#29	3	Medium	Medium	Yes	No	No	Medium
#30	3	Medium	Medium	Yes	Yes	No	Medium
#31	4	High	Medium	Yes	Yes	No	Medium
#32	3	High	Medium	Yes	No	Yes	High
#33	4	Medium	Low	Yes	No	Yes	High
#34	3	Medium	Medium	Yes	Yes	Yes	High
#35	3	Medium	Low	Yes	No	Yes	High
#36	6	Medium	Low	Yes	No	Yes	High
#37	3	Medium	Low	Yes	No	Yes	High
#38	3	Medium	Medium	Yes	Yes	Yes	High

Table 13-3. Analysis of Mitigation Actions

Mitigation Type	Applicable Mitigation Actions
1. Prevention	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 22, 23, 24, 25, 29, 30, 33, 34, 35, 36, 37, 38
2. Property Protection	2, 21, 28, 36
3. Public Education and Awareness	2, 11, 12, 13, 30, 33, 36
4. Natural Resource Protection	2, 22, 23, 24, 36
5. Emergency Services	2, 25, 26, 27, 30, 36
6. Structural Projects	14, 15, 16, 17, 18, 20, 31, 32, 38

Part 4. PLAN MAINTENANCE

14. PLAN ADOPTION

This chapter documents formal adoption of the Chelan County Comprehensive Flood Hazard Management Plan by Chelan County's governing body (CRS Step 9). This plan will be submitted for a pre-adoption review to the Insurance Services Office (ISO) prior to adoption. Once pre-adoption approval has been provided, Chelan County will formally adopt the plan. A copy of the resolution is provided in Figure 14-1.

Insert Plan Adoption Resolution

Figure 14-1. Resolution Adopting Comprehensive Flood Hazard Management Plan

15. PLAN MAINTENANCE STRATEGY

This chapter presents a plan maintenance process that includes the following (CRS Step 10):

- A section describing the method and schedule of monitoring, evaluating, and updating the flood hazard management 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 Flood Plan maintenance process.

The plan maintenance strategy is the formal process that will ensure that the Comprehensive Flood Hazard Management Plan remains an active and relevant document. It includes a schedule for monitoring and evaluating the Flood Plan annually and producing an updated plan every five years. The strategy also describes how public participation will be integrated throughout the plan maintenance and implementation process. It explains how the mitigation strategy 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 Flood 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.

15.1 PLAN IMPLEMENTATION

The effectiveness of the Comprehensive Flood Hazard Management Plan depends on its implementation and incorporation of its action items into existing local plans, policies and programs. Together, the action items in the Flood Plan provide a framework for activities that Chelan County 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.

Chelan County's Flood Control Zone District in cooperation with the Public Works Department will have lead responsibility for overseeing the Flood Plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all agencies identified as lead agencies in the mitigation action plan.

15.2 STEERING COMMITTEE

The Steering Committee is a stakeholder body that oversaw the development of the Flood 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 that of the 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 include representation from stakeholders in the planning area.

The principle role of a steering committee in this plan maintenance strategy will be to review the annual progress report and to provide input to Chelan County's Flood Control Zone District on possible enhancements to be considered at the next update. Future plan updates will have participation 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. It will 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.

15.3 ANNUAL PROGRESS REPORT

The minimum task of the ongoing annual steering committee meeting 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 flood 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 that involve hazard mitigation.

The planning team has created a template for preparing a progress report (see Appendix C). The plan maintenance steering committee and identified lead agencies 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 Flood Control Zone District program website page dedicated to the Comprehensive Flood Hazard Management Plan
- Provided to the local media through a press release
- Presented to the Chelan County Commissioners to inform them of the progress of mitigation actions implemented during the reporting period
- 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.

Annual progress reporting is credited under CRS Step 10.

15.4 PLAN UPDATE

Chelan County intends to update the Comprehensive Flood Hazard Management Plan on a 5-year cycle from the date of initial plan adoption (CRS Step 10). 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 flood hazard event that causes loss of life
- An update of Chelan County comprehensive plan.

It will not be the intent of future updates to develop a completely new Comprehensive Flood Hazard Management 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 plan will be reviewed and revised to account for any actions completed, dropped, or changed and to account for changes in the risk assessment or new 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 Chelan County Board of Commissioners will adopt the updated plan.

It is Chelan County's intention to fully integrate this Comprehensive Flood Hazard Management Plan into the Natural Hazards Mitigation Plan for Chelan County at some time. This will allow for a uniform update cycle for both plans and eliminate redundant planning.

15.5 CONTINUING PUBLIC INVOLVEMENT

The public will continue to be apprised of the plan's progress through the Flood Control Zone District website and by providing copies of annual progress reports to the media. The website will not only house the final plan, it will become the one-stop shop for information regarding the Flood Plan and plan implementation. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from the steering committee. This strategy will be based on the needs and capabilities of Chelan County at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area.

15.6 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 Chelan County Comprehensive Plan is considered to be an integral part of this plan. Chelan County, through adoption of a comprehensive plan and zoning ordinance, has planned for the impact of flooding. The Flood Plan development process provided the opportunity to review and expand on policies in these planning mechanisms. Chelan County's Comprehensive Plan and the Comprehensive Flood Hazard Management Plan are complementary documents that work together to achieve the goal of reducing flood-risk exposure. An update to the county's comprehensive plan may trigger an update to the Comprehensive Flood Hazard Management Plan.

Chelan County has identified a medium priority action to link the Comprehensive Flood Hazard Management Plan and Chelan County Comprehensive Plan. Other planning processes and programs to be coordinated with the recommendations of the Comprehensive Flood Hazard Management Plan include the following:

- Chelan County Hazard Mitigation Plan
- Emergency response plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Stormwater management programs
- Water system vulnerability assessments.

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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GLOSSARY

ACRONYMS

ADA—Americans with Disabilities Act

ASHRAE—American Society of Heating, Refrigerating and Air-Conditioning Engineers

BATool™—Baseline Assessment Tool

CAO—Critical Areas Ordinance

CDBG-DR—Community Development Block Grants, Disaster Resilience

CFR—Code of Federal Regulations

CIP—Capital Improvement Plan

CRS—Community Rating System

CWA—Clean Water Act

DMA —Disaster Mitigation Act

EPA—U.S. Environmental Protection Agency

ESA—Endangered Species Act

ESD—Employment Security Department (Washington state agency)

FCAAP—Flood Control Assistance Account Program

FCZD—Flood Control Zone District

FEMA—Federal Emergency Management Agency

FF—Funding and Financing

FIRM—Flood Insurance Rate Map

FRR—Flood Risk Reduction

GIS—Geographic Information System

GMA—Growth Management Act

H&H—Hydrology and Hydraulics

Hazus-MH—Hazards, United States-Multi Hazard (Hazus)

HMGP—Hazard Mitigation Grant Program

IPCC—Intergovernmental Panel on Climate Change

ISO—Insurance Services Office

LIDAR—Light Detection and Ranging

NASA—National Aeronautics and Space Administration
NEPA—National Environmental Policy Act
NFIP—National Flood Insurance Program
NIMS—National Incident Management System
NOAA—National Oceanic and Atmospheric Administration
NRCS—National Resources Conservation Service
NSFHA—Non-Special Flood Hazard Area
NWS—National Weather Service
OFM—Office of Financial Management (Washington state agency)
ppb—Parts Per Billion
ppm—Part Per Million
RCW—Revised Code of Washington
RIP—Rehabilitation and Inspection Program
SEPA—State Environmental Policy Act
SFHA—Special Flood Hazard Area
TRI—Toxic Release Inventory
USDA—U.S. Department of Agriculture
USFS—U.S. Forest Service
USGS—U.S. Geological Survey
WAC—Washington Administrative Code
WRIA—Water Resource Inventory Area

DEFINITIONS

100-Year Flood: The 100-year flood is the flood that has a 1 percent chance of being equaled or exceeded in any given year. 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.

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 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 actions, 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 flooding. 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.

Consistency: Consistency for the Chelan County Comprehensive Flood Hazard Management Plan is defined as maintaining compliance and good standing under the program requirements of the NFIP. Maintaining compliance is contingent upon a jurisdiction's strict enforcement of its adopted codes and policies that govern development in the regulated floodplain. If a jurisdiction adopts a higher standard, strict application of that standard with no variance is expected under this definition of consistency. Compliance status is monitored by state or federal NFIP coordinating offices.

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: A critical facility is one that is deemed vital to the planning area's ability to provide essential services while protecting life and property. A critical facility may be a system or an asset, either physical or virtual, the loss of which would have a profound impact on the security, economy, public health or safety, environment, or any combination of thereof, across the planning area.

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**.

Economically Disadvantaged Populations: Households with household incomes of \$15,000 or less.

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.

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.

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.

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.

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.

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 Comprehensive Flood Hazard Management 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 or Hazus) 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.

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.

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.

Natural: Any reference to the term “natural” in this Flood Plan is meant to imply the normal functions of the floodplain before being altered by development. *A Unified National Program for Floodplain Management* (FEMA-248, 1994) has defined this to include the following:

- Water Resources
 - Natural Flood and Erosion Control
 - Provide flood storage and conveyance
 - Reduce flood velocities
 - Reduce peak flows
 - Reduce sedimentation
 - Water Quality Maintenance
 - Filter nutrients and impurities from runoff
 - Process organic wastes
 - Moderate temperature fluctuations
 - Groundwater Recharge
 - Promote infiltration and aquifer recharge
 - Reduce frequency and duration of low surface flows
- Biological Resources
 - Biological Productivity

- Promote vegetative growth through rich alluvial soils
- Maintain biodiversity
- Maintain integrity of ecosystems
- Fish and Wildlife Habitats
 - Provide breeding and feeding grounds
 - Create and enhance waterfowl habitat
 - Protect habitats for rare and endangered species

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.

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.

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.

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.

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%.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, 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 down-gradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

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.

Chelan County Comprehensive Flood Hazard Management Plan

Appendix A. CRS and FCAAP Guidelines

A. CRS AND FCAAP GUIDELINES

COMMUNITY RATING SYSTEM PLANNING PROCESS GUIDELINES

A. Floodplain Management Planning

1. Organize to prepare the plan (Maximum credit: 10 points). The credit for this step is the total of the following points, which are based on how the community organizes to prepare its floodplain management plan:

- (a) if the planning process is under the supervision or direction of a professional planner;
- (b) if the planning process is conducted through a committee composed of staff from those community departments that will be implementing the majority of the plan's recommendations;
- (c) if the planning process and/or the committee are formally created or recognized by action of the community's governing board.

The plan document must discuss how it was prepared, who was involved in the planning process, and how the public was involved during the planning process. (REQUIRED) When a multi-jurisdictional plan is prepared, at least one representative from each community seeking CRS credit must be involved on the planning committee that is credited under item (b).

2. Involve the public (Maximum credit: 85 points). The planning process must include an opportunity for the public to comment on the plan during the drafting stage and before plan approval (REQUIRED). The term "public" includes residents, businesses, property owners, and tenants in the floodplain and other known hazard areas as well as other stakeholders in the community, such as business leaders, civic groups, academia, non-profit organizations, and major employers. The credit for this step is the total of the following points based on how the community involves the public during the planning process.

- (a) if the planning process is conducted through a planning committee that includes members of the public. If this is the same planning committee credited under step 1, items (b) and (c), at least one half of the members must be representatives of the public, including residents, businesses, or property owners from the flood-prone areas. The committee must hold a sufficient number of meetings that involve the members in planning steps 4 through 9 (e.g., at least one meeting on each step).
- (b) if one or more public information meetings are held in the affected area(s) at the beginning of the planning process to obtain public input on the natural hazards, problems, and possible solutions. At least one meeting must be held separate from the planning committee meetings in item (a).
- (c) for holding at least one public meeting to obtain input on the draft plan. The meeting must be at the end of the planning process, at least two weeks before submittal of the recommended plan to the community's governing body.
- (d) if surveys are distributed asking the public for information on their natural hazards, problems, and possible solutions. The surveys must be distributed to at least 90% of the floodplain residents.

- (e) if written comments and recommendations are solicited from neighborhood advisory groups, homeowners' associations, parent-teacher organizations, the Chamber of Commerce, or similar organizations that represent the public in the affected area(s).
- (f) if other public information activities are implemented to explain the planning process and encourage input to the planner or planning committee.

3. Coordinate (Maximum credit: 25 points). Other agencies and organizations must be contacted to see if they are doing anything that may affect the community's program and to see if they could support the community's efforts.

Examples of "other agencies and organizations" include neighboring communities; local, regional, state, and federal agencies; and businesses, academia, and other private and non-profit organizations affected by the hazards or involved in hazard mitigation or floodplain management. The credit for this step is the total of the following points. To receive credit for this step, the coordination must include items (a) and (b).

- (a) if the planning includes a review of existing studies, reports, and technical information and of the community's needs, goals, and plans for the area. (REQUIRED)
- (b) if 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 are given an opportunity to be involved in the planning process. (REQUIRED)
- (c) if neighboring communities, the state NFIP Coordinator, the state water resources agency, the county and state emergency management agency, the FEMA Regional Office, and (where appropriate) the state's coastal zone management agency are contacted at the beginning of the planning process to see if they are doing anything that may affect the community's program and to see how they can support the community's efforts.
- (d) if other governmental and nongovernmental organizations, such as the National Weather Service, Red Cross, homebuilders association, and environmental groups are contacted at the beginning of the planning process to see if they are doing anything that may affect the community's program and to see how they can support the community's efforts.
- (e) if the coordination effort includes holding meetings with representatives of the other agencies and organizations to review common problems, development policies, mitigation strategies, inconsistencies, and conflicts in policies, plans, programs, and regulations.
- (f) for sending the draft action plan to the other agencies and organizations contacted under items (b), (c), (d), and (e) and asking them to comment by a certain date.

4. Assess the hazard (Maximum credit: 20 points). The credit for this step is the total of the following points based on what the community includes in its assessment of the hazard. To receive CRS credit for this step, the assessment must include item (a). If the community wants the plan to also qualify as a FEMA multi-hazard mitigation plan, item (b) must also be completed.

- (a) for including an assessment of the flood hazard in the plan. If the community is a Category B or C repetitive loss community, this step must cover all of its repetitive loss areas (REQUIRED). The assessment must include at least one of the following items:
 - (1) a map of the known flood hazards. "Known flood hazards" means the floodplain shown on the Flood Insurance Rate Map (FIRM), repetitive loss areas, areas not mapped on the FIRM that have flooded in the past, and surface flooding identified in existing studies. No new studies need to be conducted for this assessment.

- (2) a description of the known flood hazards, including source of water, depth of flooding, velocities, and warning time.
- (3) a discussion of past floods.
- (b) if the plan includes a map, description of the magnitude or severity, history, and probability of future events for other natural hazards, such as erosion, tsunamis, earthquakes, and hurricanes. The plan should include all natural hazards that affect the community. At a minimum, it should include those hazards identified by the state's hazard mitigation plan. (REQUIRED FOR PLANS TO BE CREDITED UNDER THE DISASTER MITIGATION ACT OF 2000)

5. Assess the problem (Maximum credit: 35 points) The credit for this step is the total of the following points, based on what is included in the assessment of the vulnerability of the community to the hazards identified in the previous hazard assessment step. To receive credit for this step, the assessment must include item (a) and must evaluate the hazard data in light of their impact on the community. Simply listing data, such as the names of the critical facilities or the number of flood insurance claims, will not suffice for credit.

- (a) if the plan includes an overall summary of the jurisdiction's vulnerability to each hazard identified in the hazard assessment (step 4) and the impact on the community. (required)
- (b) if the plan includes a description of the impact that the hazards identified in the hazard assessment (step 4) have on: (1) life, safety, and health and the need and procedures for warning and evacuating residents and visitors. (5 points) (2) critical facilities and infrastructure. (5 points) (3) the community's economy and tax base. (5 points)
- (c) for including the number and types of buildings subject to the hazards identified in the hazard assessment.
- (d) if the assessment includes a review of all properties that have received flood insurance claims (in addition to the repetitive loss properties) or an estimate of the potential dollar losses to vulnerable structures.
- (e) if the plan describes areas that provide natural and beneficial functions, such as wetlands, riparian areas, sensitive areas, and habitat for rare or endangered species.
- (f) if the plan includes a description of development, redevelopment, and population trends and a discussion of what the future brings for development and redevelopment in the community, the watershed, and natural resource areas.

When a multi-jurisdictional plan is prepared, the critical facilities, building counts, and similar data must be presented for each community.

6. Set goals (Maximum credit: 2 points). The two credit points for this step are provided if the plan includes a statement of the goals of the community's floodplain management or hazard mitigation program. (REQUIRED)

7. Review possible activities (Maximum credit: 30 points) The plan must describe those activities that were considered and note why they were or were not recommended (e.g., they were not cost-effective or they did not support the community's goals). (REQUIRED)

If an activity is currently being implemented, the plan must note whether it should be modified. The discussion of each activity needs to be detailed enough to be useful to the lay reader. The credit for this step is the total of the following points based on which floodplain management or hazard mitigation activities are reviewed in the plan.

- (a) if the plan reviews preventive activities, such as zoning, stormwater management regulations, building codes, and preservation of open space and the effectiveness of current regulatory and preventive standards and programs;
- (b) if the plan reviews property protection activities, such as acquisition, retrofitting, and flood insurance;
- (c) if the plan reviews activities to protect the natural and beneficial functions of the floodplain, such as wetlands protection;
- (d) if the plan reviews emergency services activities, such as warning and sandbagging;
- (e) if the plan reviews structural projects, such as reservoirs and channel modifications; and
- (f) if the plan reviews public information activities, such as outreach projects and environmental education programs.

8. Draft an action plan (Maximum credit: 70 points). The action plan specifies those activities appropriate to the community's resources, hazards, and vulnerable properties.

For each recommendation, the action plan must identify who does what, when it will be done, and how it will be financed. The actions must be prioritized and include a review of the benefits of the proposed projects and their associated costs. (REQUIRED) A multi-hazard mitigation plan must identify actions that address both existing and new infrastructure and buildings. The credit for this step is based on what is included in the action plan. Credit is provided for a recommendation on floodplain regulations, provided it recommends a regulatory standard that exceeds the minimum requirements of the NFIP.

- (a) if the action plan includes flood-related recommendations for activities from two of the six categories credited in step 7, Review possible activities.
- (b) if the action plan includes flood-related recommendations for activities from three of the six categories credited in step 7, Review possible activities.
- (c) if the action plan includes flood-related recommendations for activities from four of the six categories credited in step 7, Review possible activities.
- (d) if the action plan includes flood-related recommendations for activities from five of the six categories credited in step 7, Review possible activities.
- (e) additional points are provided if the action plan establishes post-disaster mitigation policies and procedures.
- (f) additional points are provided if the action plan's recommended natural resource protection activities include recommendations from a Regional Habitat Conservation Plan as credited under Section 511.c.
- (g) additional points are provided if the plan includes action items (other than public information activities) to mitigate the effects of the other natural hazards identified in the hazard assessment (step 4, item (b)).

If the plan calls for acquiring properties, there must be a discussion of how the project(s) will be managed and how the land will be reused. When a multi-jurisdictional plan is prepared, it must have action items from at least two of the six categories that directly benefit each community seeking CRS credit.

9. Adopt the plan (Maximum credit: 2 points) The 2 credit points for this step are provided if the plan and later amendments are officially adopted by the community's governing body. (REQUIRED)

When a multi-jurisdictional plan is prepared, it must be adopted by the governing board of each community seeking CRS or multi-hazard mitigation plan credit.

10. Implement, evaluate, and revise (Maximum credit: 15 points) The credit for this step is the total of the following points based on how the community monitors and evaluates its plan.

- (a) if the community has procedures for monitoring implementation, reviewing progress, and recommending revisions to the plan in an annual evaluation report. The report must be submitted to the governing body, released to the media and made available to the public. (REQUIRED)
- (b) if the evaluation report is prepared by the same planning committee that prepared the plan that is credited in step 2(a) or by a successor committee with a similar membership that was created to replace the planning committee and charged with monitoring and evaluating implementation of the plan.

To maintain this credit, the community must submit a copy of its annual evaluation report with its recertification each year and update the plan at least every five years.

B. Repetitive Loss Area Analysis

Up to 50 points are provided for conducting area analyses of all of the community's repetitive loss areas. An area analysis is prepared according to the following criteria:

- 1. All repetitive loss areas must be mapped as described in Section 503.b. If the community does not conduct an analysis of all the areas, it will be reflected through the impact adjustment in Section 512.
- 2. Data must be collected on each building in the area(s) using the "limited data view" of the National Flood Mitigation Data Collection Tool. The database file created by the National Flood Mitigation Data Collection Tool must be made available to FEMA and the state, upon request.
- 3. A five-step process must be followed. The steps do not have to be done in the order listed.
 - Step 1. Advise all the property owners in the repetitive loss areas that the analysis will be conducted. This must be sent directly to each property owner and cannot be done via a newspaper or newsletter notice or article.
 - Step 2. Collect data on each building and determine the cause(s) of the repetitive damage.
 - Step 3. Review alternative approaches and determine whether any property protection measures or drainage improvements are feasible. The review must look at all of the property protection measures listed in Figure 510-2 that are appropriate for the types of buildings affected.
 - Step 4. Contact agencies or organizations that may have plans that could affect the cause or impacts of the flooding.
 - Step 5. Document the findings, including a map showing all parcels in the area, recommendations, and how the recommendations will be funded.
- 4. Each area analysis document must be approved by the head of the appropriate community department. It does not have to be circulated to or adopted by the community's governing board, but it does have to be made available to any inquirer, including residents of the repetitive loss area(s).
- 5. The community must prepare an annual report on progress toward implementing the recommendations.

C. Habitat Conservation Plan

If the community has adopted a regional Habitat Conservation Plan or other plan that explains and recommends actions to protect rare, threatened, or endangered aquatic or riparian species. The plan must have been adopted by the community's governing board and there must be documentation that the plan is being implemented. The plan must identify:

- the species in need of protection,
- the impact of new development on their habitat,
- alternative actions that could be taken to protect that habitat,
- what actions are recommended to protect that habitat and why they were selected from the alternatives, and

- how the recommendations will be funded.

If the plan has also been accepted as a Habitat Conservation Plan by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service.

FLOOD CONTROL ASSISTANCE ACCOUNT PROGRAM GUIDELINES

(1) Determination of the need for flood control work.

- (a) Description of the watershed;
- (b) Identification of types of watershed flood problems;
- (c) Location and identification of specific problem areas;
- (d) Description of flood damage history;
- (e) Description of potential flood damage;
- (f) Short-term and long-term goals and objectives for the planning area;
- (g) Description of rules that apply within the watershed including, but not limited to, local shoreline management master programs, and zoning, subdivision, and flood hazard ordinances;
- (h) Determination that the in-stream flood control work is consistent with applicable policies and rules.

(2) Alternative flood control work.

- (a) Description of potential measures of in-stream flood control work;
- (b) Description of alternatives to in-stream flood control work.

(3) Identification and consideration of potential impacts of in-stream flood control work on the following in-stream uses and resources.

- (a) Fish resources;
- (b) Wildlife resources;
- (c) Scenic, aesthetic, and historic resources;
- (d) Navigation;
- (e) Water quality;
- (f) Hydrology;
- (g) Existing recreation;
- (h) Other impacts.

(4) Area of coverage for the comprehensive plan shall include, as a minimum, the area of the one-hundred-year frequency flood plain within a reach of the watershed of sufficient length to ensure that a comprehensive evaluation can be made of the flood problems for a specific reach of the watershed. The plan may or may not include an entire watershed. Comprehensive plans shall also include flood hazard areas not subject to riverine flooding such as areas subject to coastal flooding, flash flooding, or flooding from inadequate drainage. Either the meander belt or floodway must be identified on aerial photographs or maps that will be included with the plan.

(5) Conclusion and proposed solution(s). The Comprehensive Flood Control Management Plan must be finalized by the following action from the appropriate local authority:

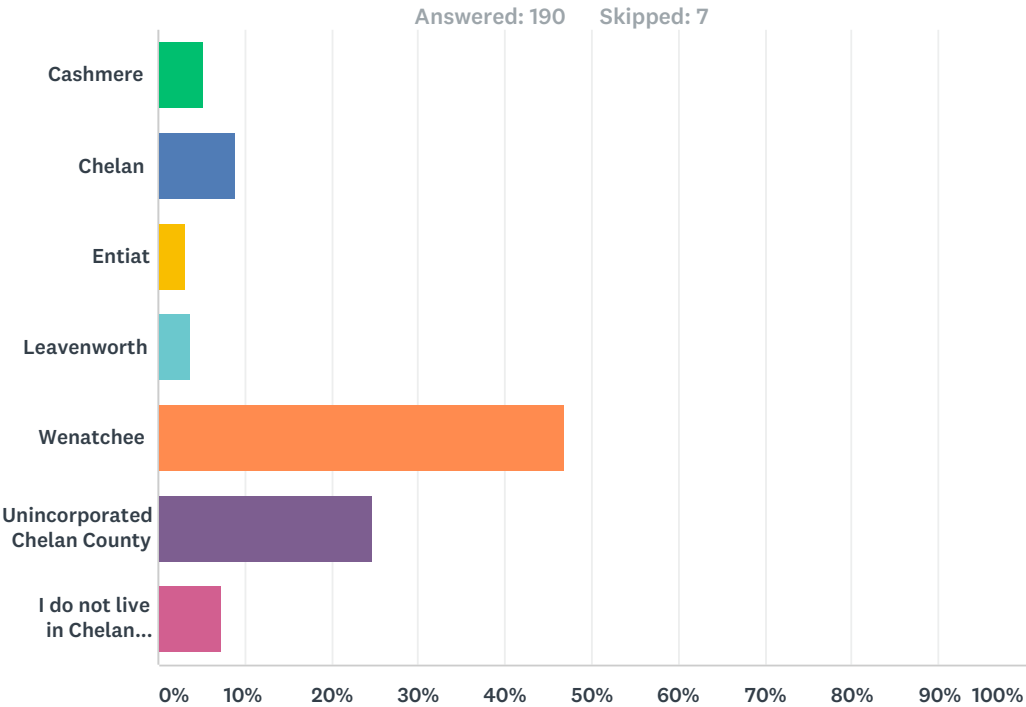
- (a) Evaluation of problems and needs;
- (b) Evaluation of alternative solutions;
- (c) Recommended corrective action with proposed impact resolution measures for resource losses; and
- (d) Corrective action priority.

(6) A certification from the state department of community, trade, and economic development that the local emergency management organization is administering an acceptable comprehensive emergency operations plan.

Chelan County Comprehensive Flood Hazard Management Plan

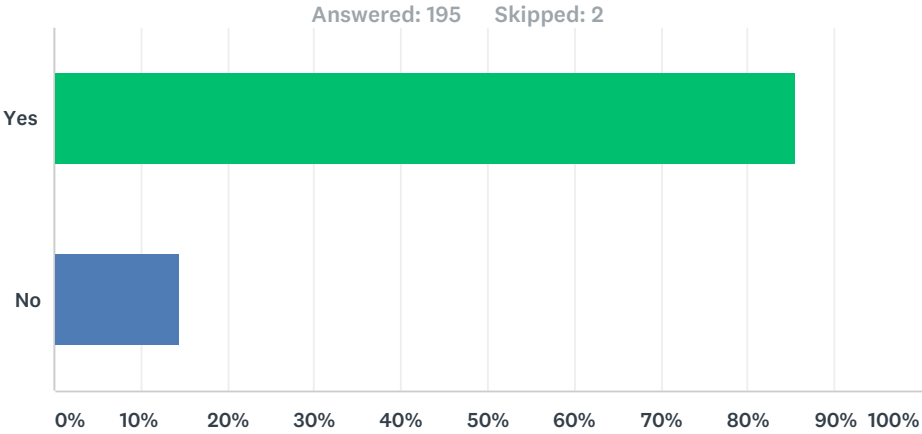
Appendix B. Public Outreach Materials

Q1 Where in Chelan County do you live?



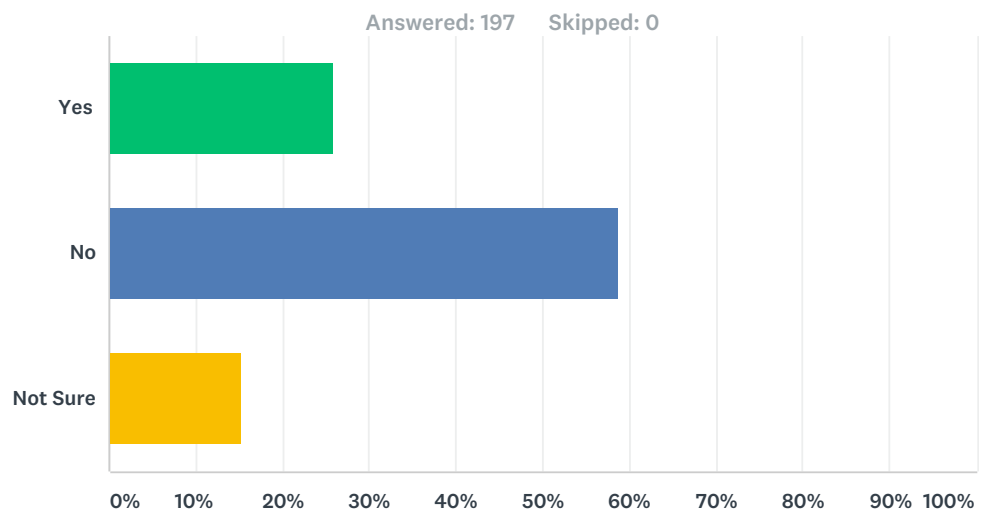
Answer Choices	Responses	
Cashmere	5.26%	10
Chelan	8.95%	17
Entiat	3.16%	6
Leavenworth	3.68%	7
Wenatchee	46.84%	89
Unincorporated Chelan County	24.74%	47
I do not live in Chelan County	7.37%	14
Total		190

Q2 Do you work in Chelan County?



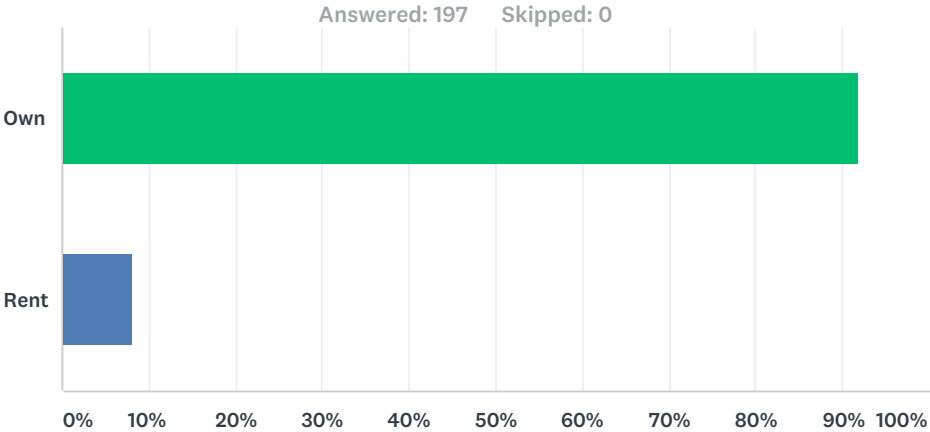
Answer Choices	Responses	
Yes	85.64%	167
No	14.36%	28
Total		195

Q3 Do you live in a known floodplain or an area that has been subject to flooding?



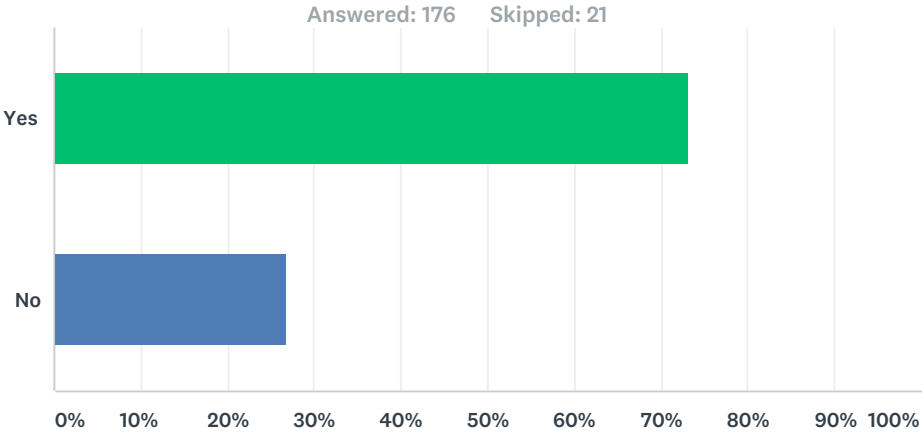
Answer Choices	Responses	
Yes	25.89%	51
No	58.88%	116
Not Sure	15.23%	30
Total		197

Q4 Do you own or rent your place of residence?



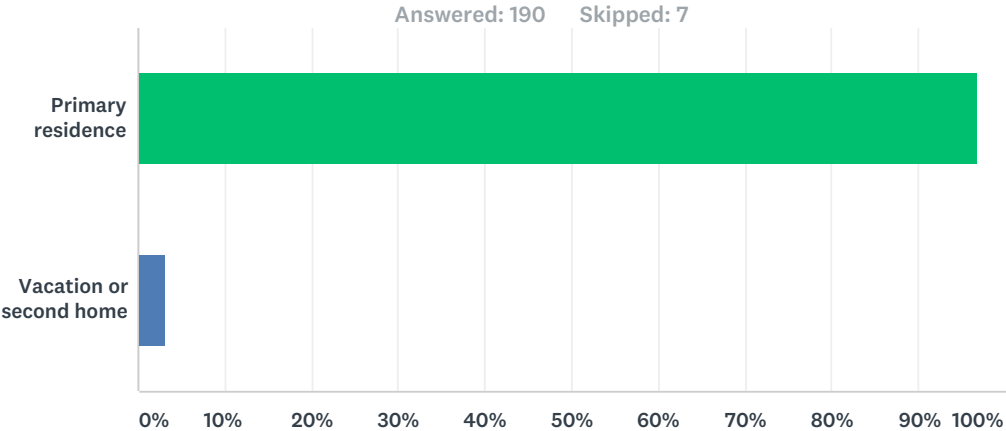
Answer Choices	Responses	
Own	91.88%	181
Rent	8.12%	16
Total		197

Q5 Do you have a mortgage?



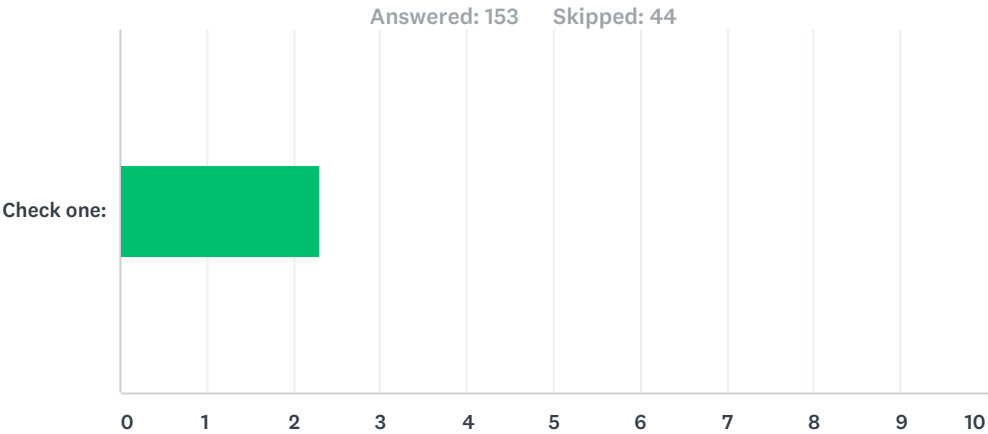
Answer Choices	Responses	
Yes	73.30%	129
No	26.70%	47
Total		176

Q6 Is this your primary residence or is it your vacation/second home?



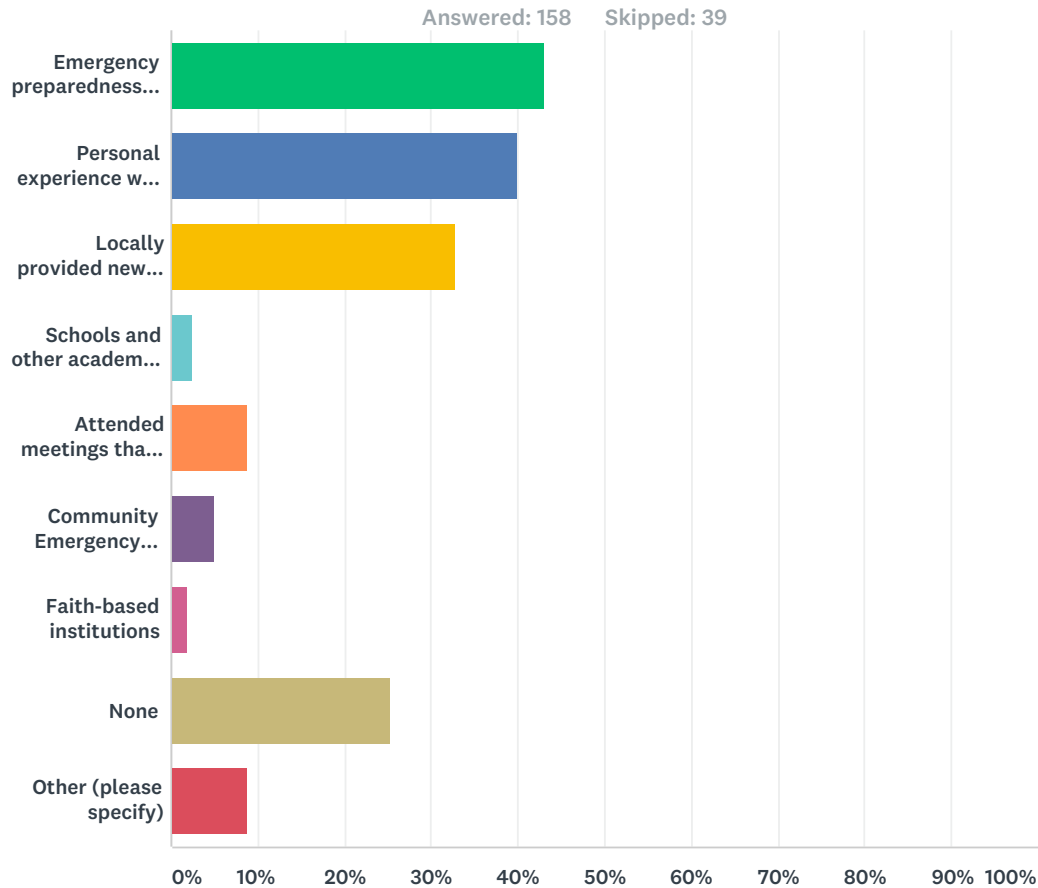
Answer Choices	Responses	
Primary residence	96.84%	184
Vacation or second home	3.16%	6
Total		190

Q7 How prepared is your household to deal with a flood event?



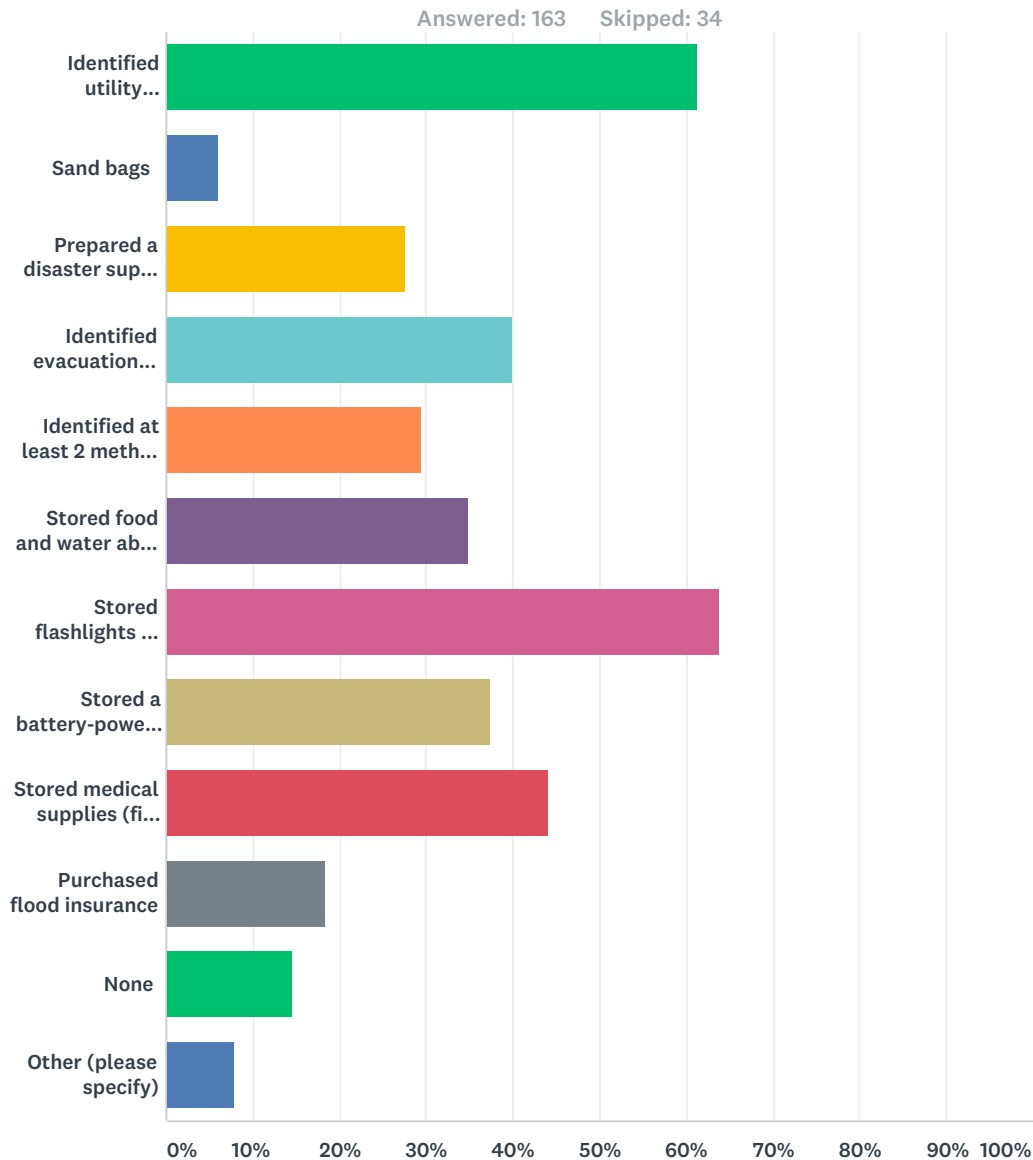
	Not at All Prepared	Somewhat Prepared	Adequately Prepared	Well Prepared	Very Well Prepared	Total	Weighted Average
Check one:	21.57% 33	44.44% 68	21.57% 33	7.19% 11	5.23% 8	153	2.30

Q8 Which of the following have provided you with useful information to help you be prepared for a flood event? (Check all that apply)



Answer Choices	Responses
Emergency preparedness information from a government source (e.g., federal, state, or local emergency management)	43.04% 68
Personal experience with flood events	39.87% 63
Locally provided news or other media information	32.91% 52
Schools and other academic institutions	2.53% 4
Attended meetings that have dealt with flood preparedness	8.86% 14
Community Emergency Response Training (CERT)	5.06% 8
Faith-based institutions	1.90% 3
None	25.32% 40
Other (please specify)	8.86% 14
Total Respondents: 158	

Q9 Which of the following steps has your household taken to prepare for a flood event? (Check all that apply)

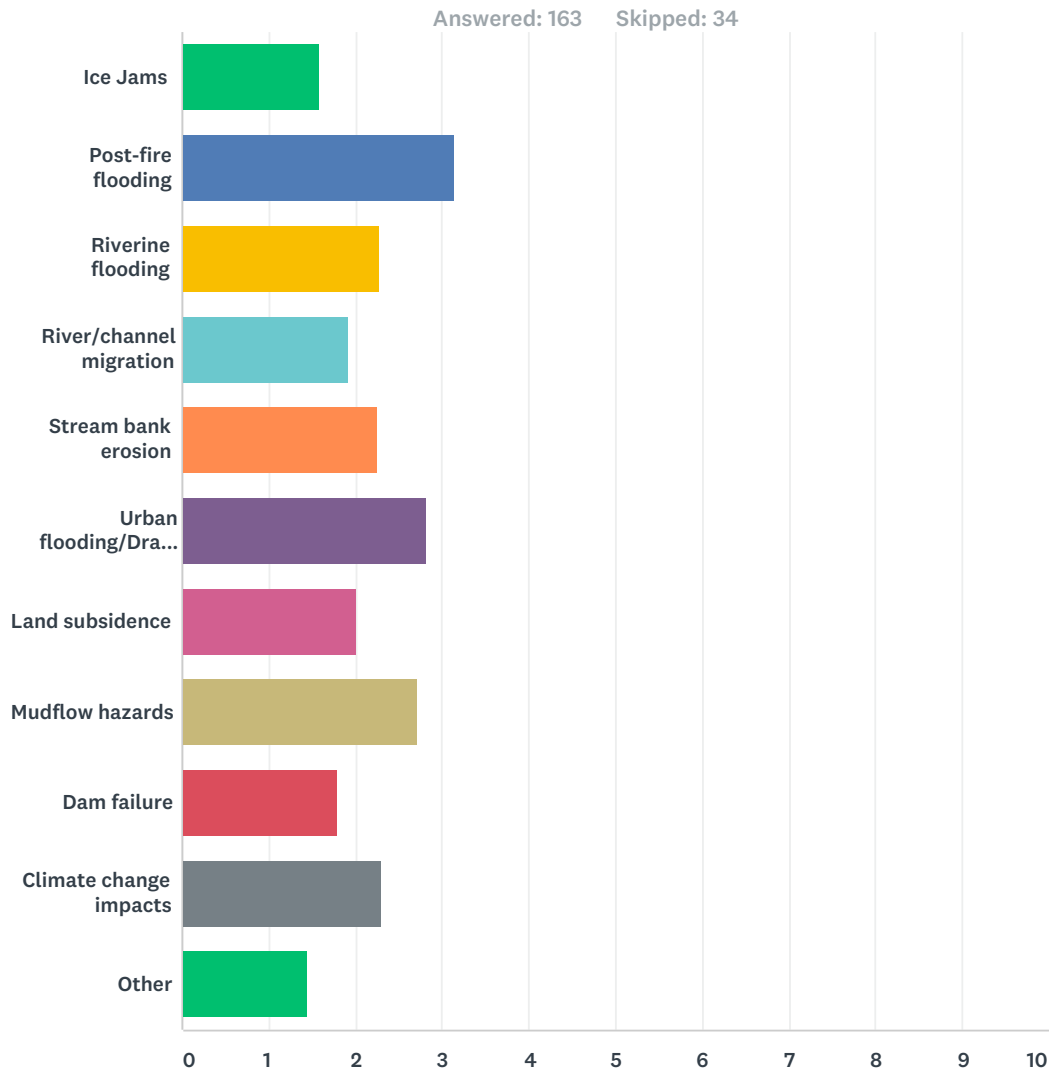


Answer Choices	Responses	
Identified utility shutoff's	61.35%	100
Sand bags	6.13%	10
Prepared a disaster supply kit	27.61%	45
Identified evacuation routes	39.88%	65
Identified at least 2 methods for receiving emergency notifications and information during emergencies	29.45%	48
Stored food and water above potential flood levels	34.97%	57
Stored flashlights and batteries	63.80%	104
Stored a battery-powered radio	37.42%	61
Stored medical supplies (first aid kit, medications)	44.17%	72

Chelan County Survey: Flood Preparedness

Purchased flood insurance	18.40%	30
None	14.72%	24
Other (please specify)	7.98%	13
Total Respondents: 163		

Q10 How concerned are you about the following flood related hazards in Chelan County? (Check one response for each hazard)

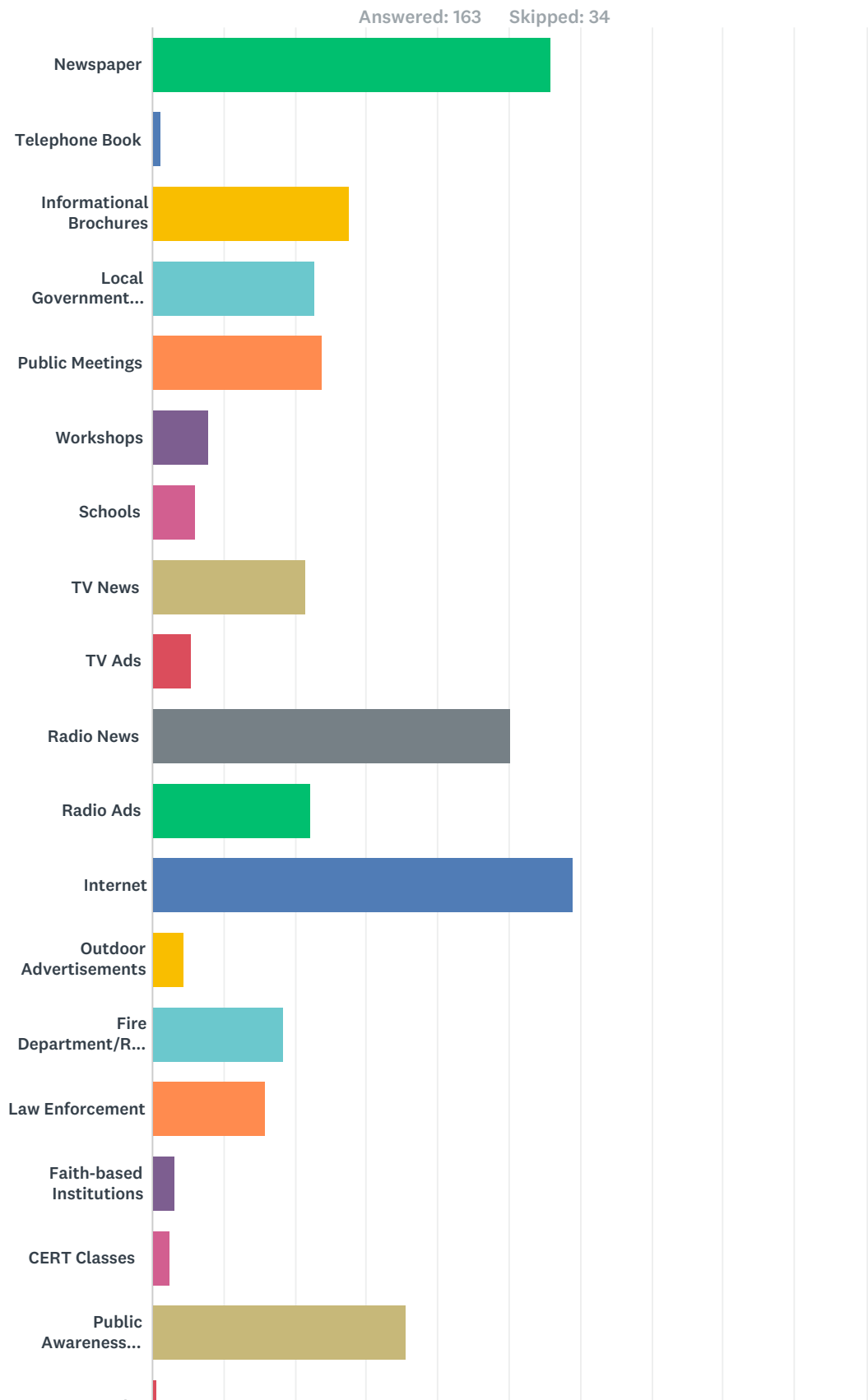


	Not Concerned	Somewhat Concerned	Concerned	Very Concerned	Extremely Concerned	Total	Weighted Average
Ice Jams	64.42% 105	23.31% 38	5.52% 9	3.68% 6	3.07% 5	163	1.58
Post-fire flooding	10.43% 17	19.63% 32	30.06% 49	25.77% 42	14.11% 23	163	3.13
Riverine flooding	31.90% 52	29.45% 48	22.09% 36	11.66% 19	4.91% 8	163	2.28
River/channel migration	46.01% 75	27.61% 45	17.18% 28	6.13% 10	3.07% 5	163	1.93
Stream bank erosion	34.36% 56	25.77% 42	24.54% 40	10.43% 17	4.91% 8	163	2.26
Urban flooding/Drainage issues	17.18% 28	26.99% 44	22.70% 37	22.09% 36	11.04% 18	163	2.83

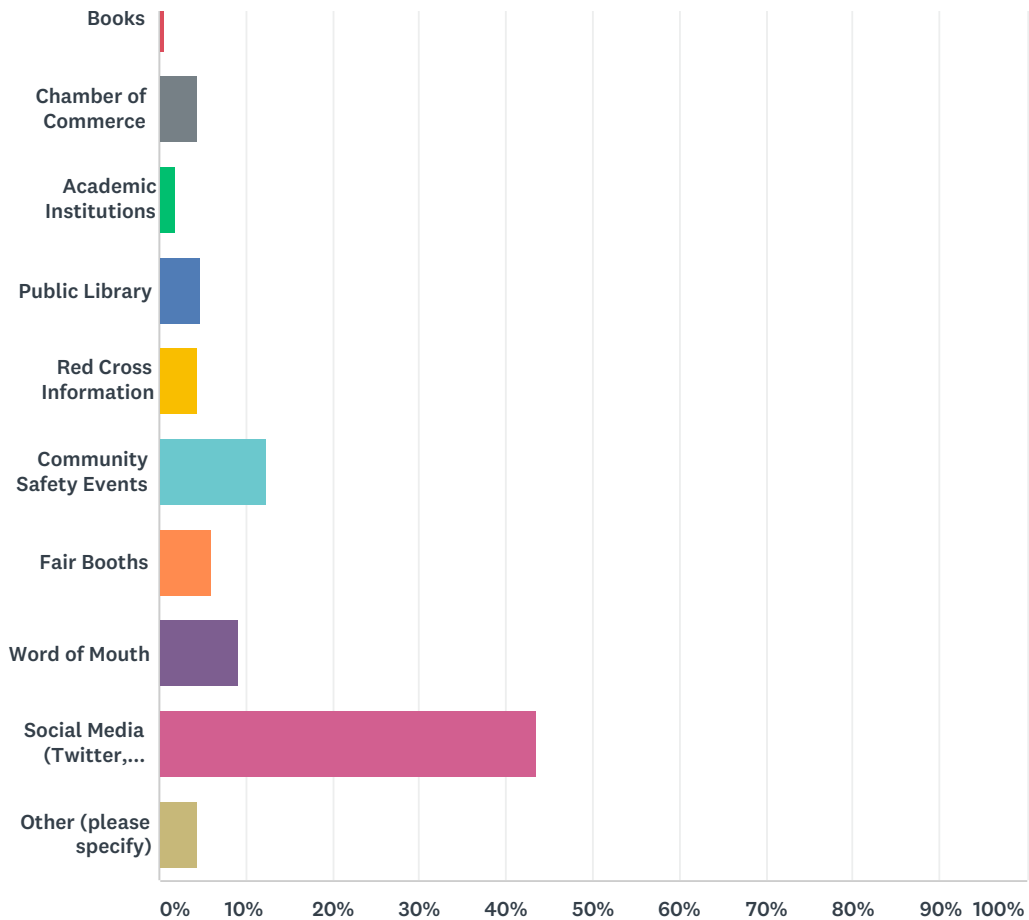
Chelan County Survey: Flood Preparedness

Land subsidence	41.72% 68	31.29% 51	16.56% 27	5.52% 9	4.91% 8	163	2.01
Mudflow hazards	17.18% 28	31.29% 51	25.15% 41	15.34% 25	11.04% 18	163	2.72
Dam failure	55.21% 90	20.25% 33	16.56% 27	4.91% 8	3.07% 5	163	1.80
Climate change impacts	38.65% 63	22.09% 36	17.79% 29	12.27% 20	9.20% 15	163	2.31
Other	82.21% 134	4.29% 7	3.68% 6	5.52% 9	4.29% 7	163	1.45

**Q11 Choose five (5) of the following methods you think are most effective for providing flood hazard and disaster information?
(Choose up to 5 answers)**



Chelan County Survey: Flood Preparedness

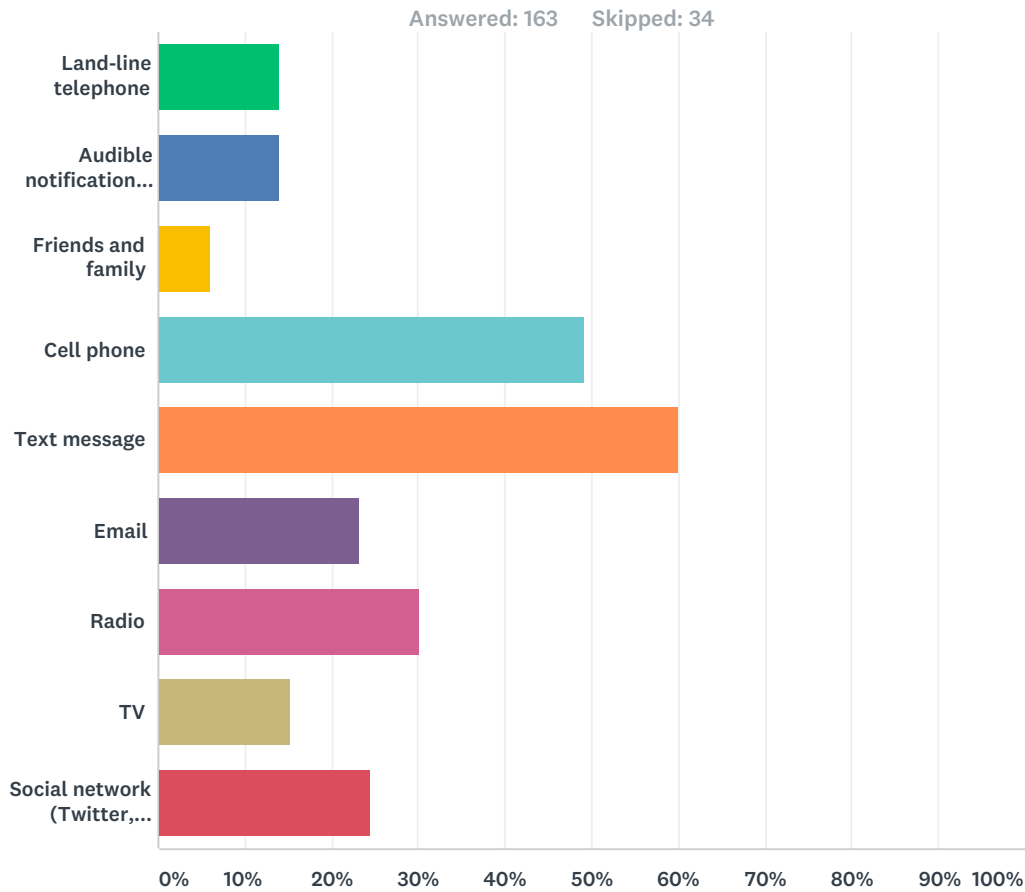


Answer Choices	Responses	
Newspaper	55.83%	91
Telephone Book	1.23%	2
Informational Brochures	27.61%	45
Local Government Newsletters	22.70%	37
Public Meetings	23.93%	39
Workshops	7.98%	13
Schools	6.13%	10
TV News	21.47%	35
TV Ads	5.52%	9
Radio News	50.31%	82
Radio Ads	22.09%	36
Internet	58.90%	96
Outdoor Advertisements	4.29%	7
Fire Department/Rescue	18.40%	30
Law Enforcement	15.95%	26

Chelan County Survey: Flood Preparedness

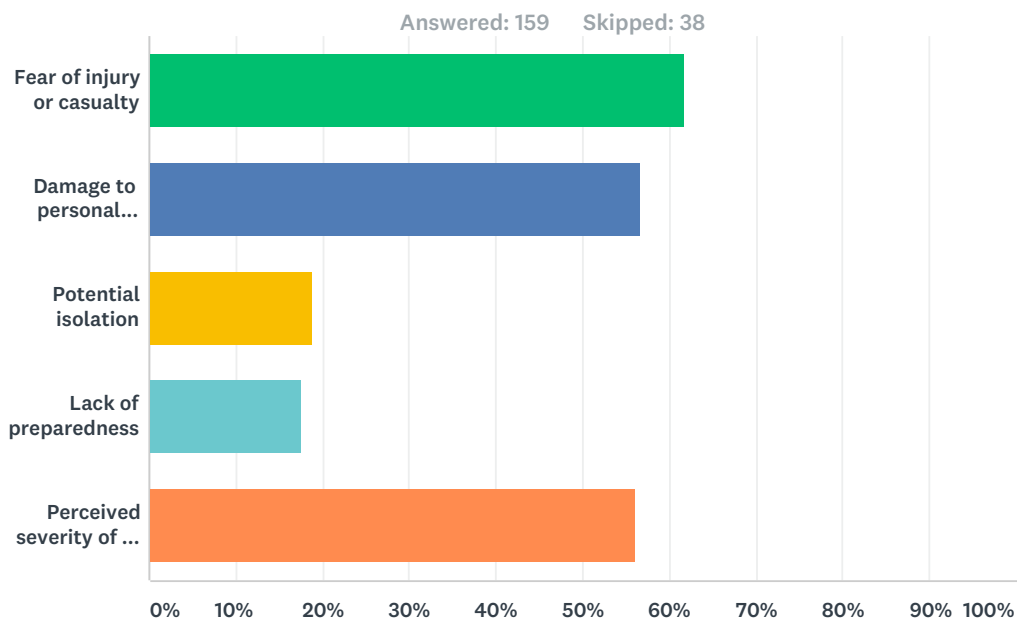
Faith-based Institutions	3.07%	5
CERT Classes	2.45%	4
Public Awareness Campaign (e.g., Flood Awareness Week, Winter Storm Preparedness Month)	35.58%	58
Books	0.61%	1
Chamber of Commerce	4.29%	7
Academic Institutions	1.84%	3
Public Library	4.91%	8
Red Cross Information	4.29%	7
Community Safety Events	12.27%	20
Fair Booths	6.13%	10
Word of Mouth	9.20%	15
Social Media (Twitter, Facebook, etc.)	43.56%	71
Other (please specify)	4.29%	7
Total Respondents: 163		

Q12 What method is best for you and your family to get time sensitive warning information or instructions for action?



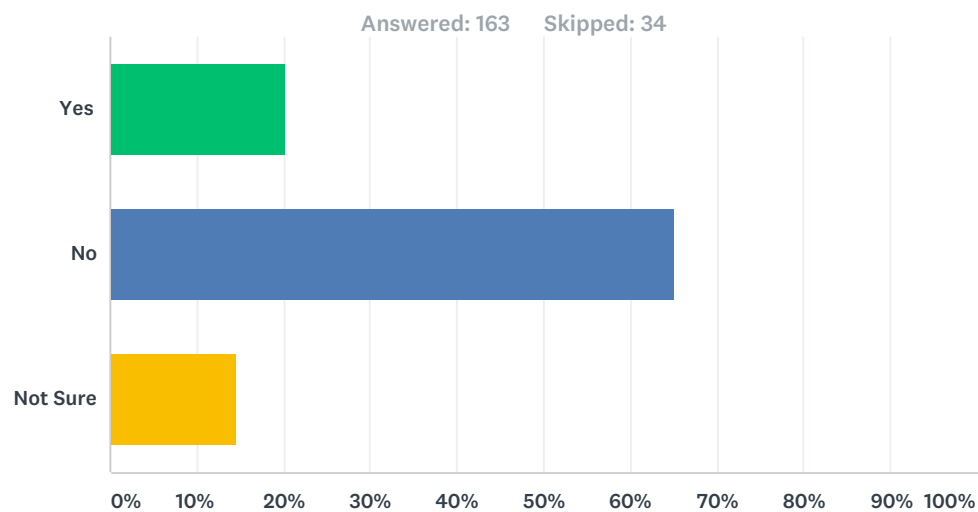
Answer Choices	Responses	
Land-line telephone	14.11%	23
Audible notification (siren)	14.11%	23
Friends and family	6.13%	10
Cell phone	49.08%	80
Text message	60.12%	98
Email	23.31%	38
Radio	30.06%	49
TV	15.34%	25
Social network (Twitter, Facebook, etc.)	24.54%	40
Total Respondents: 163		

Q13 What would drive you to action in response to an emergency notification?



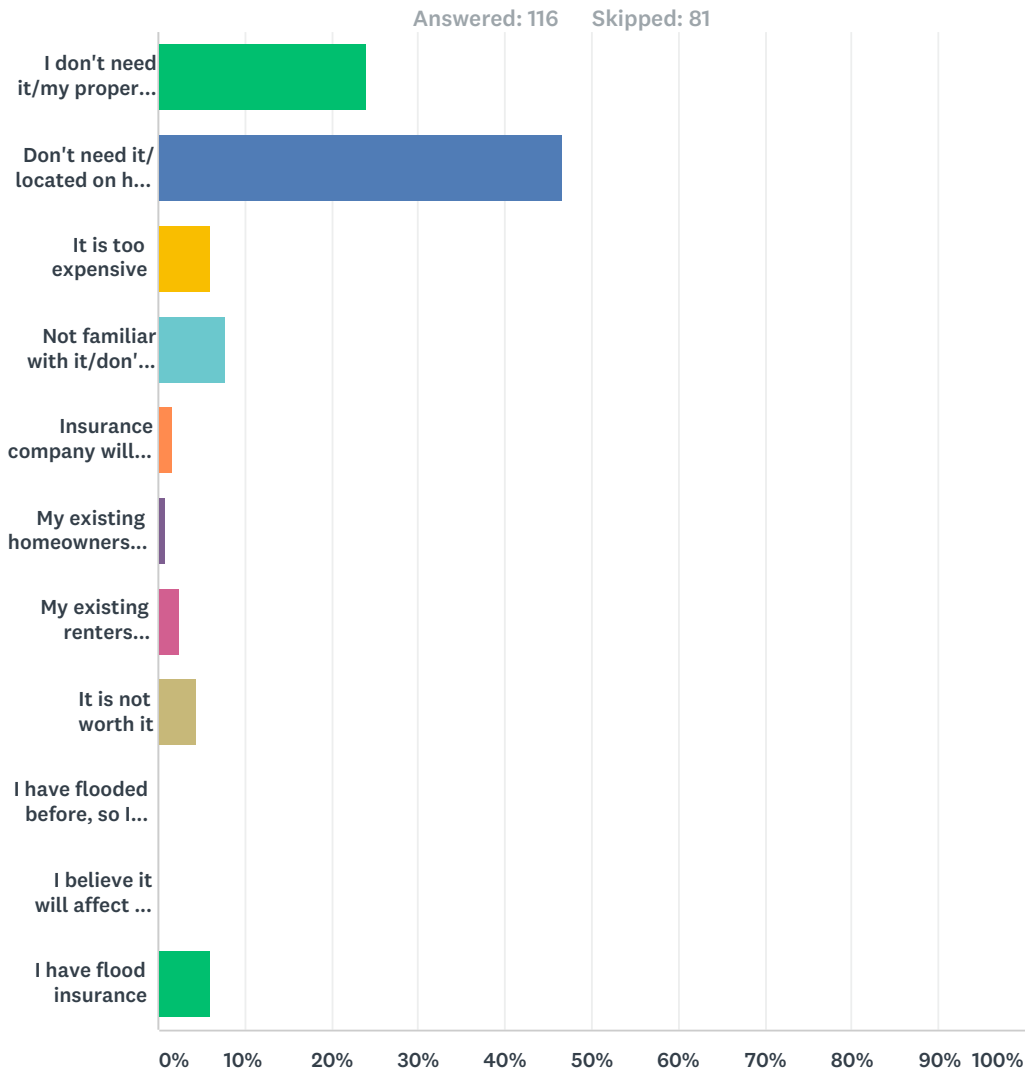
Answer Choices	Responses	
Fear of injury or casualty	61.64%	98
Damage to personal property	56.60%	90
Potential isolation	18.87%	30
Lack of preparedness	17.61%	28
Perceived severity of the incident	55.97%	89
Total Respondents: 159		

Q14 Do you have flood insurance?



Answer Choices	Responses	
Yes	20.25%	33
No	65.03%	106
Not Sure	14.72%	24
Total		163

Q15 If you do NOT have flood insurance, what is the primary reason?

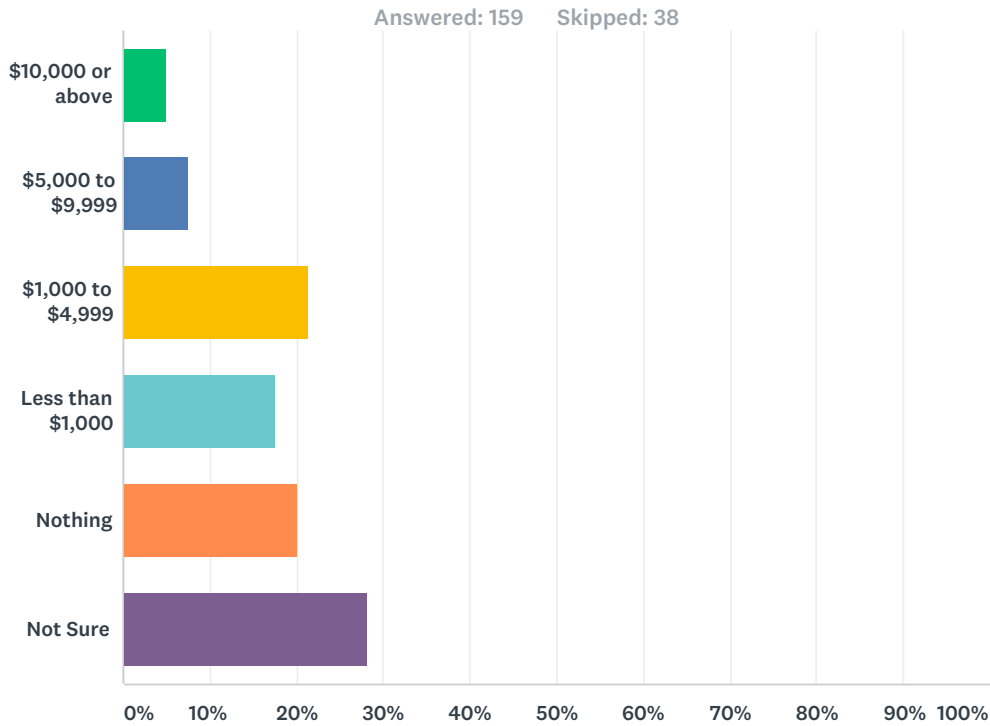


Answer Choices	Responses	
I don't need it/my property has never flooded	24.14%	28
Don't need it/ located on high ground	46.55%	54
It is too expensive	6.03%	7
Not familiar with it/don't know about it.	7.76%	9
Insurance company will not provide coverage	1.72%	2
My existing homeowners insurance provides coverage	0.86%	1
My existing renters insurance provides coverage	2.59%	3
It is not worth it	4.31%	5
I have flooded before, so I did not think I qualified for coverage	0.00%	0
I believe it will affect the value of my property	0.00%	0

Chelan County Survey: Flood Preparedness

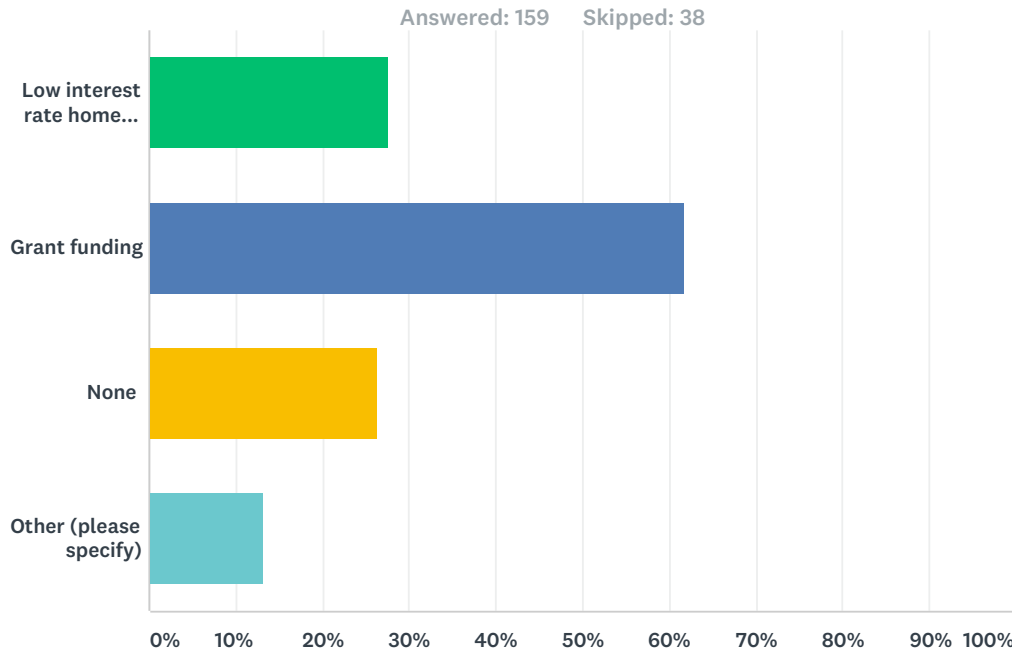
I have flood insurance	6.03%	7
Total		116

Q16 How much money would you be willing to spend to retrofit your home to reduce risks associated with flood disasters? (e.g., elevating a home above flood level, flood-proofing, building berms or floodwalls)



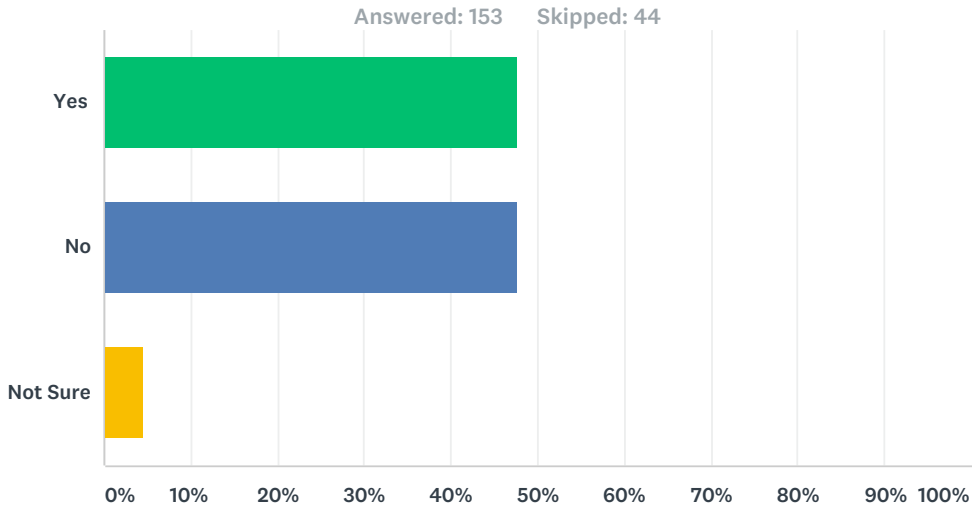
Answer Choices	Responses	
\$10,000 or above	5.03%	8
\$5,000 to \$9,999	7.55%	12
\$1,000 to \$4,999	21.38%	34
Less than \$1,000	17.61%	28
Nothing	20.13%	32
Not Sure	28.30%	45
Total		159

Q17 Which of the following incentives would encourage you to spend money to retrofit your home to protect against flood disasters? (Check all that apply)



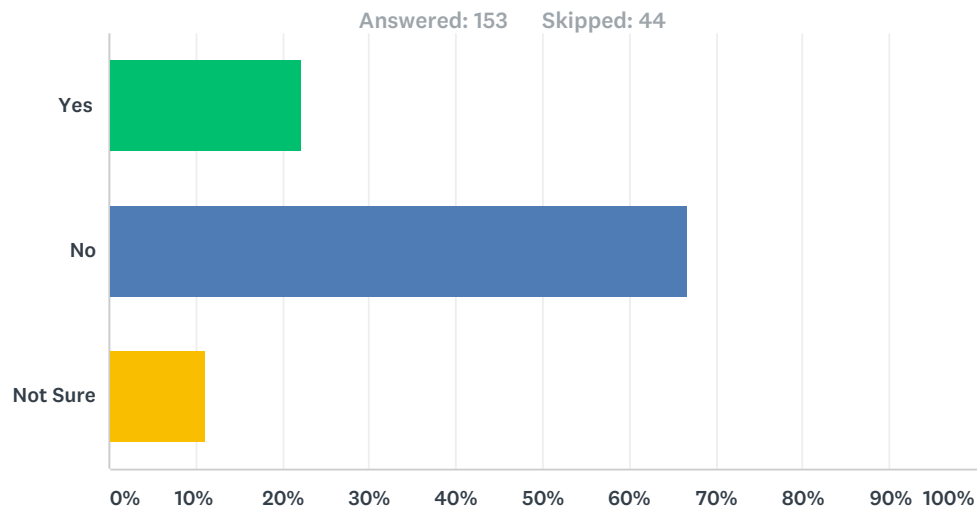
Answer Choices	Responses	
Low interest rate home improvement loan	27.67%	44
Grant funding	61.64%	98
None	26.42%	42
Other (please specify)	13.21%	21
Total Respondents: 159		

Q18 When you moved into your home, did you consider the impact a potential flood could have on your home?



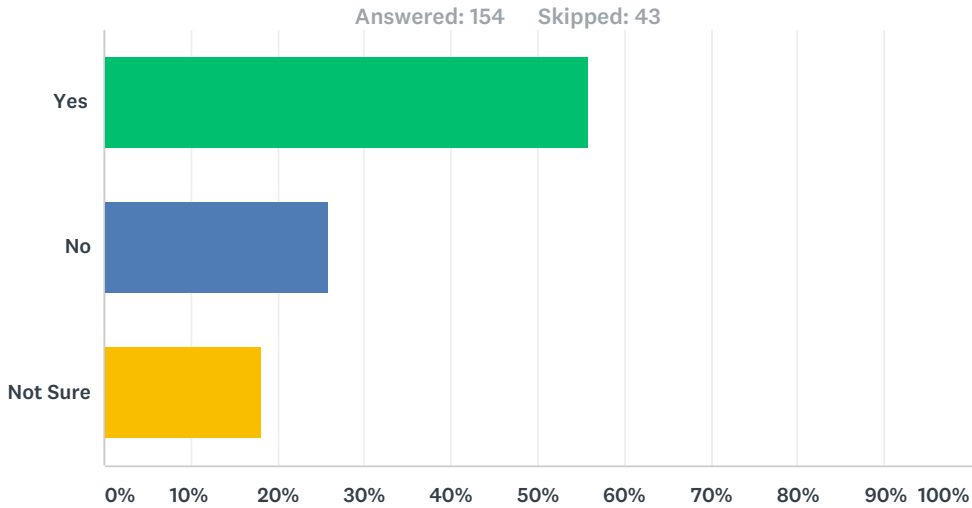
Answer Choices	Responses	
Yes	47.71%	73
No	47.71%	73
Not Sure	4.58%	7
Total		153

Q19 Was the presence of a flood hazard disclosed to you by a real estate agent, seller, or landlord before you purchased or moved into your home?



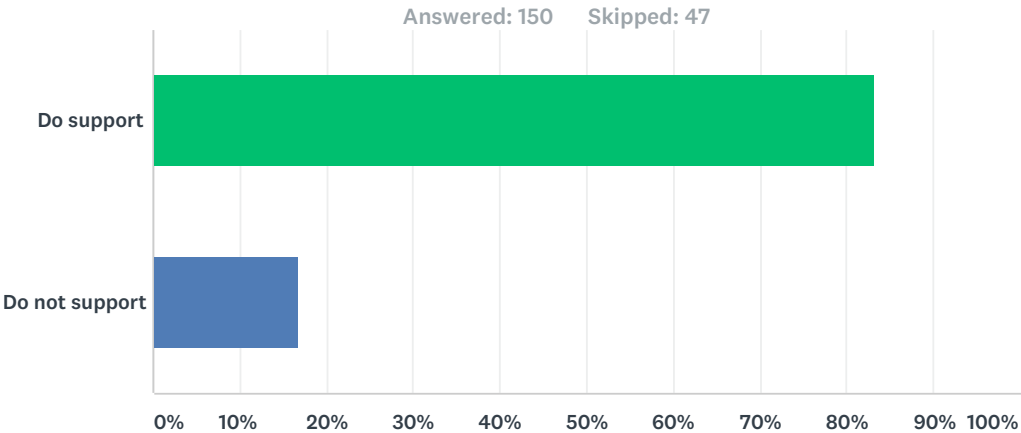
Answer Choices	Responses	
Yes	22.22%	34
No	66.67%	102
Not Sure	11.11%	17
Total		153

Q20 Would the disclosure of the flood hazard have influenced your decision to buy or rent a home?



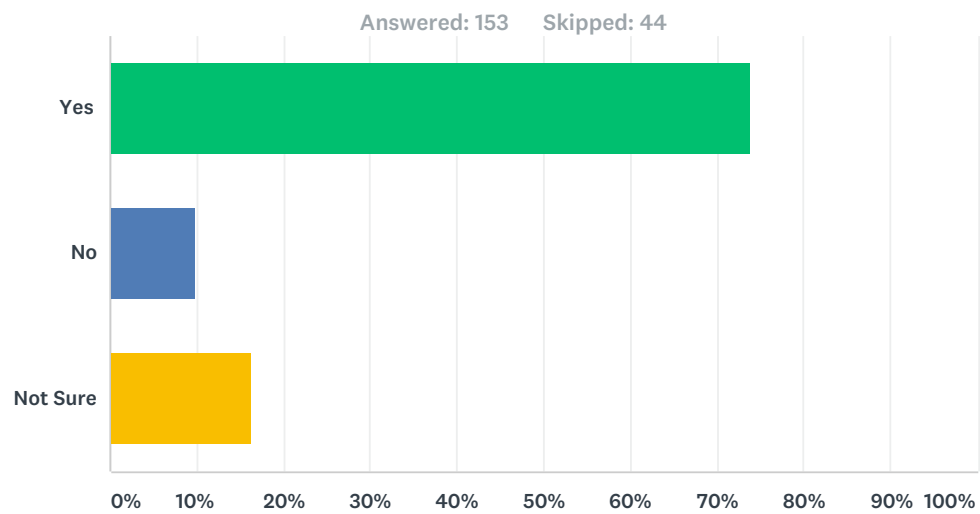
Answer Choices	Responses	
Yes	55.84%	86
No	25.97%	40
Not Sure	18.18%	28
Total		154

Q21 Do you support the preservation of natural land that contains a flood hazard?



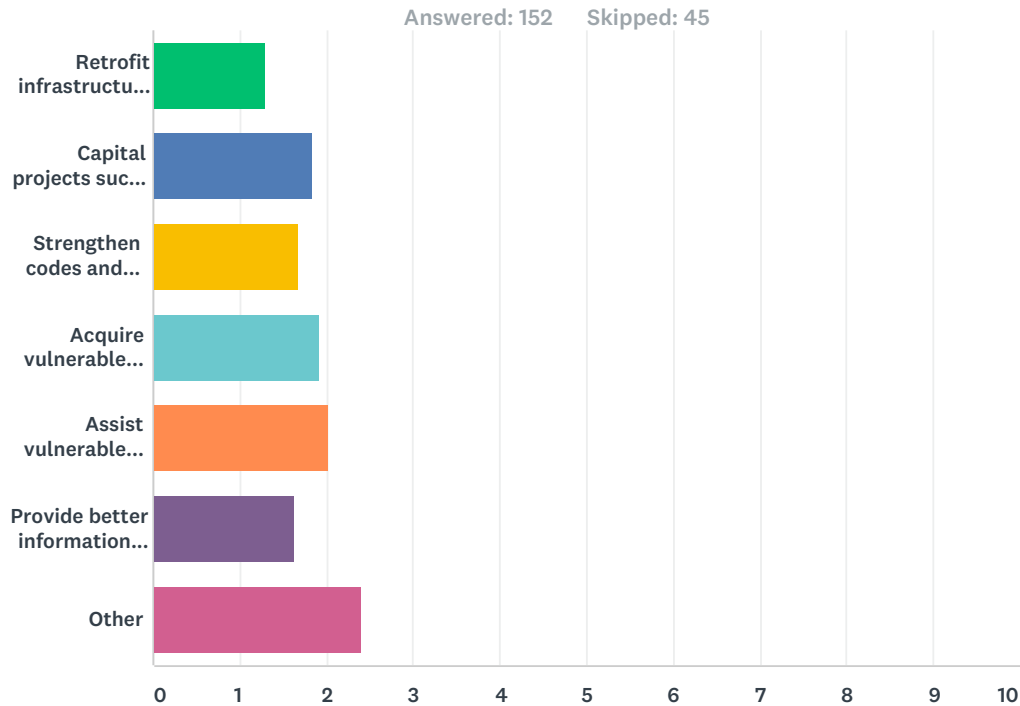
Answer Choices	Responses	
Do support	83.33%	125
Do not support	16.67%	25
Total		150

Q22 Do you support the regulation (restriction) of land uses within known, high risk, flood hazard areas?



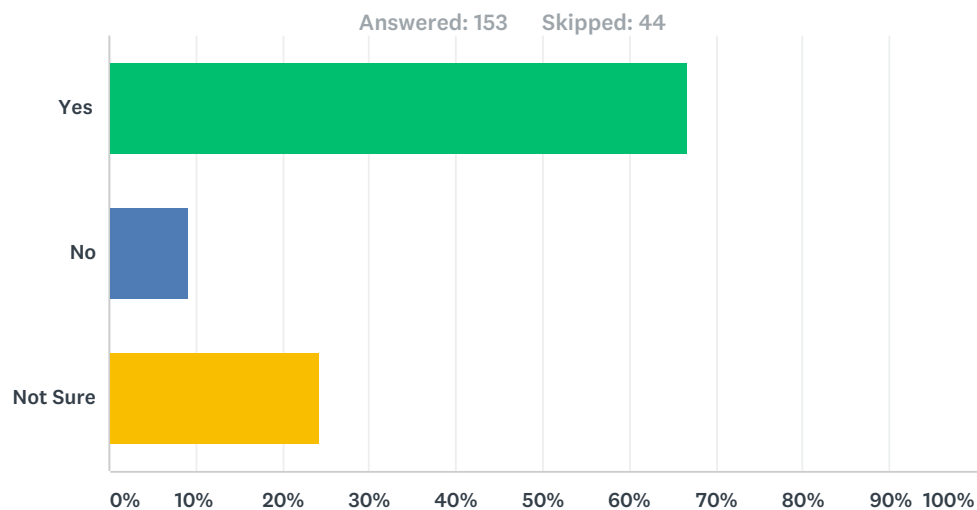
Answer Choices	Responses	
Yes	73.86%	113
No	9.80%	15
Not Sure	16.34%	25
Total		153

Q23 What types of projects do you believe the Local, State or Federal government agencies should consider to reduce damage and disruption from flooding?



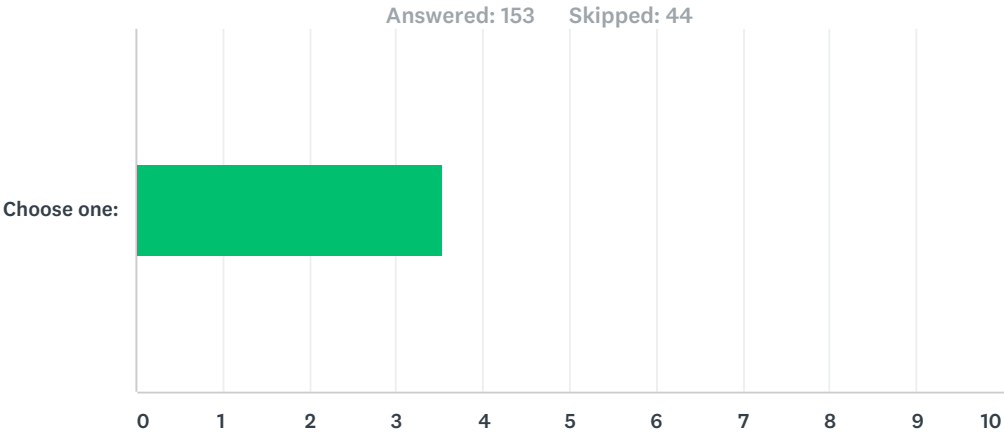
	High	Medium	Low	Total	Weighted Average
Retrofit infrastructure, such as improving culverts, bridges, and local drainage.	76.51% 114	18.12% 27	5.37% 8	149	1.29
Capital projects such as dams, levees, flood walls and drainage improvements.	39.60% 59	36.91% 55	23.49% 35	149	1.84
Strengthen codes and regulations to include higher regulatory standards in flood hazard areas.	51.01% 76	30.87% 46	18.12% 27	149	1.67
Acquire vulnerable properties and maintain as open space.	39.86% 59	27.70% 41	32.43% 48	148	1.93
Assist vulnerable property owners with securing funding for mitigation.	25.17% 37	47.62% 70	27.21% 40	147	2.02
Provide better information about flood risk to the public.	50.00% 73	36.30% 53	13.70% 20	146	1.64
Other	25.93% 21	7.41% 6	66.67% 54	81	2.41

Q24 If your property were located in a designated “high flood hazard” area or had received repetitive damages from flood events, would you consider a "buyout” offered by a public agency?



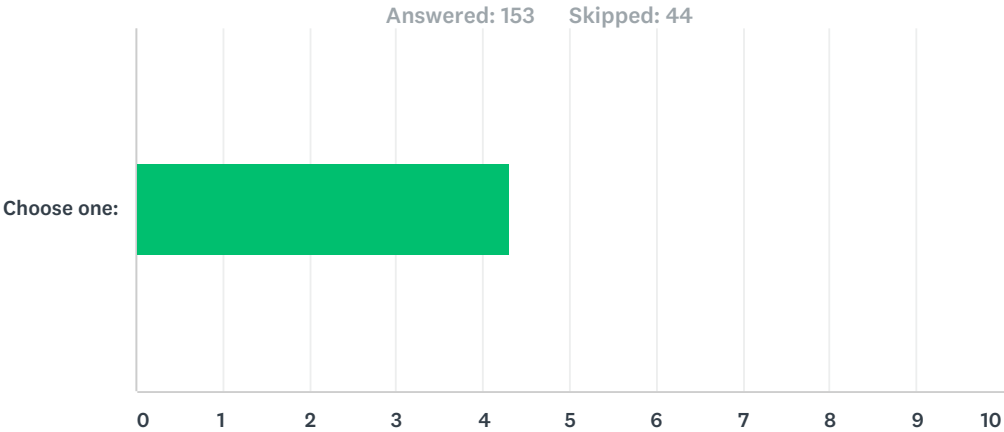
Answer Choices	Responses	
Yes	66.67%	102
No	9.15%	14
Not Sure	24.18%	37
Total		153

Q25 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 flood hazards.



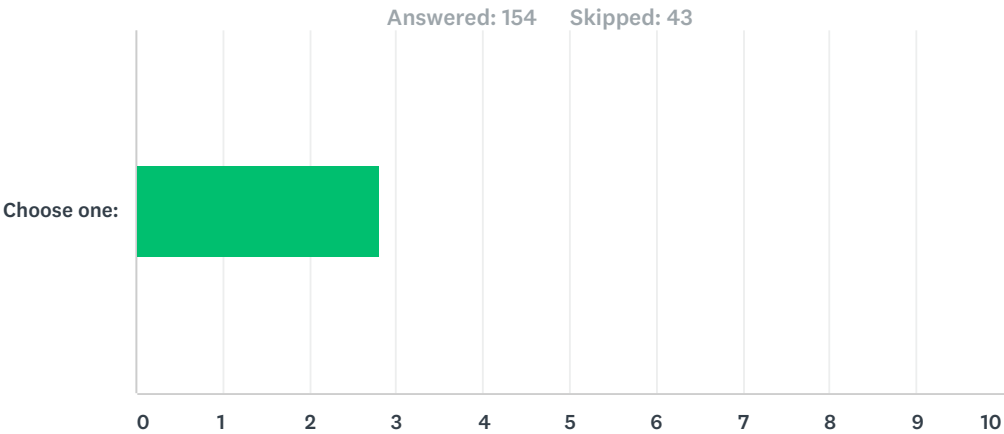
	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Weighted Average
Choose one:	11.76% 18	8.50% 13	16.34% 25	40.52% 62	22.88% 35	153	3.54

Q26 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 flood hazards.



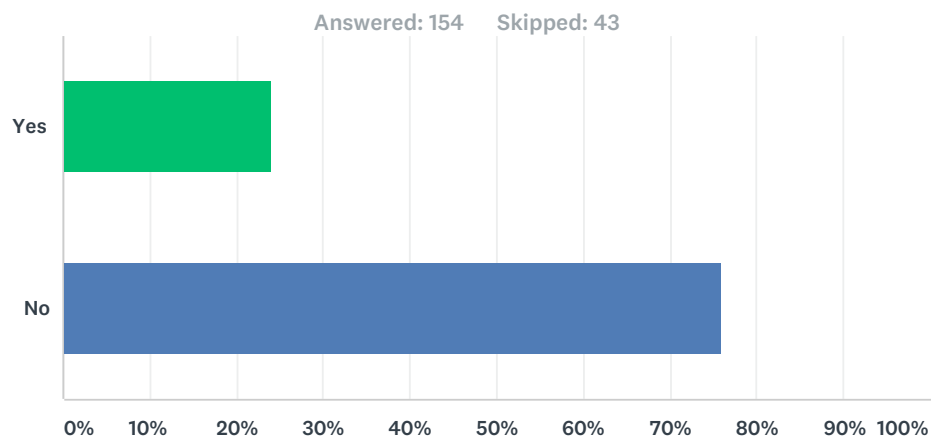
	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Weighted Average
Choose one:	5.23% 8	5.88% 9	3.92% 6	23.53% 36	61.44% 94	153	4.30

Q27 Please indicate how you feel about the following statement:Information about the risks associated with flood hazards is readily available and easy to locate.



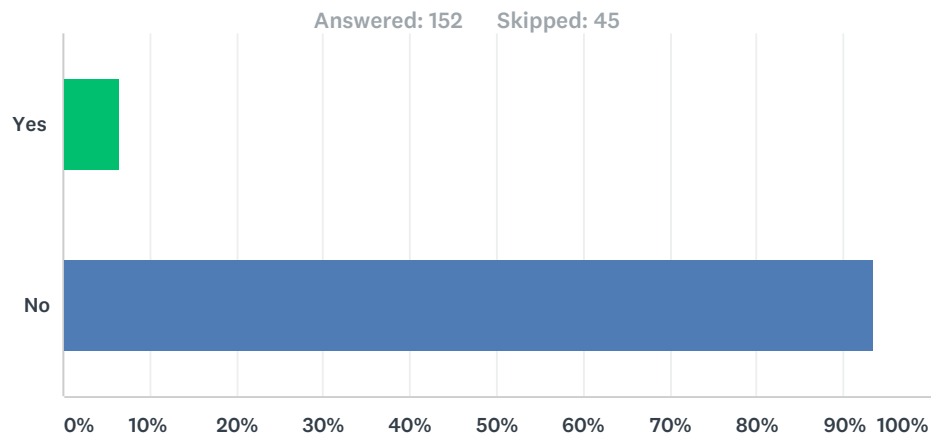
	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Weighted Average
Choose one:	10.39% 16	31.17% 48	29.22% 45	25.32% 39	3.90% 6	154	2.81

Q28 Are you aware of any local programs and policies designed to reduce risk from flood hazards?



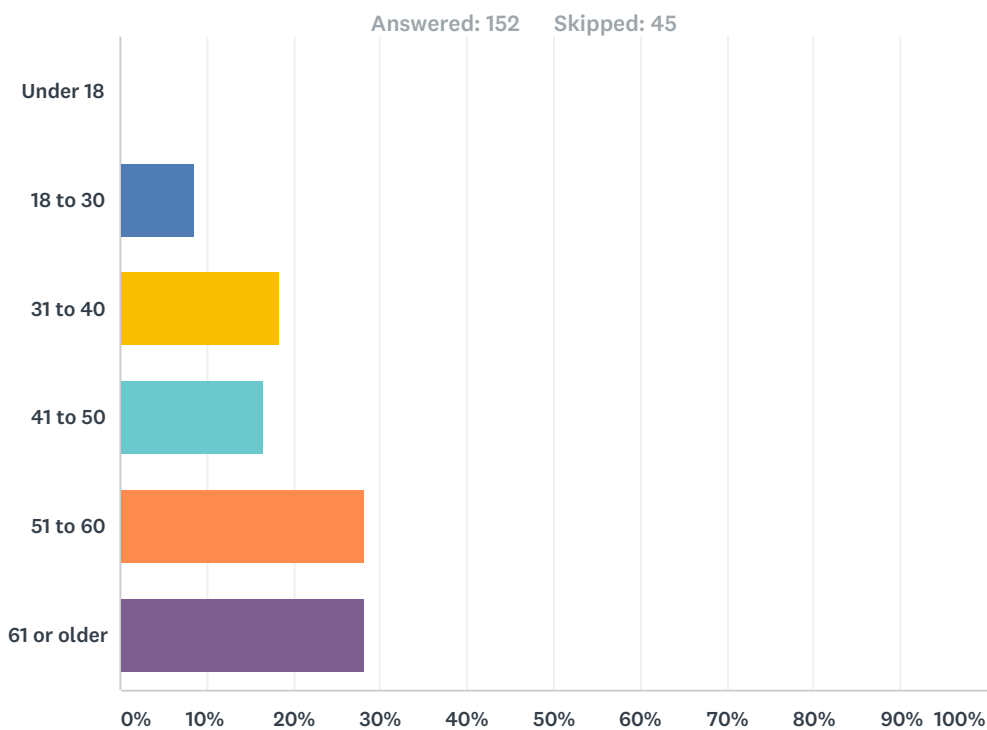
Answer Choices	Responses	
Yes	24.03%	37
No	75.97%	117
Total		154

Q29 Do you have any special access or functional needs within your household that would require early warning or specialized response during disasters?



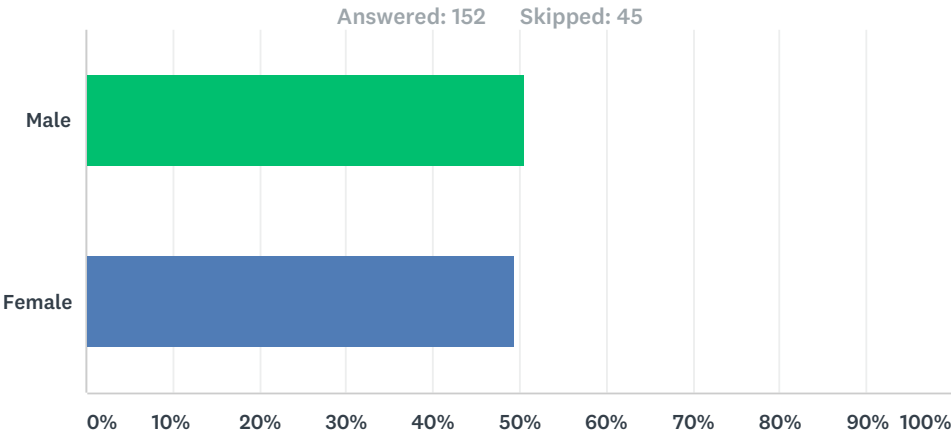
Answer Choices	Responses	
Yes	6.58%	10
No	93.42%	142
Total		152

Q30 Please indicate your age range:



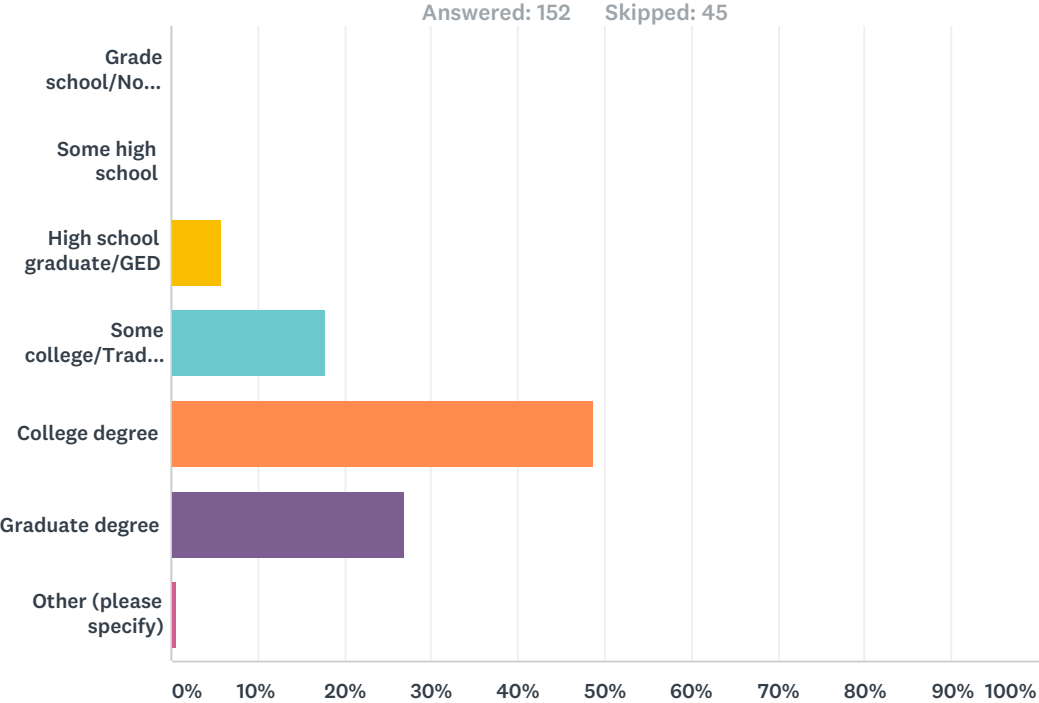
Answer Choices	Responses	
Under 18	0.00%	0
18 to 30	8.55%	13
31 to 40	18.42%	28
41 to 50	16.45%	25
51 to 60	28.29%	43
61 or older	28.29%	43
Total		152

Q31 Please indicate your gender:



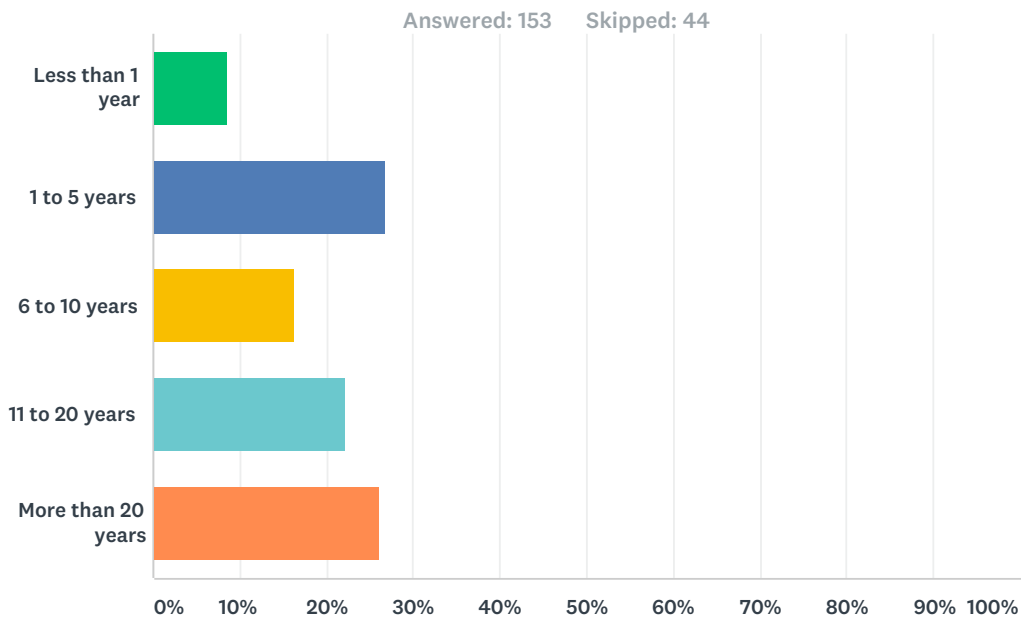
Answer Choices	Responses	
Male	50.66%	77
Female	49.34%	75
Total		152

Q32 Please indicate your highest level of education.



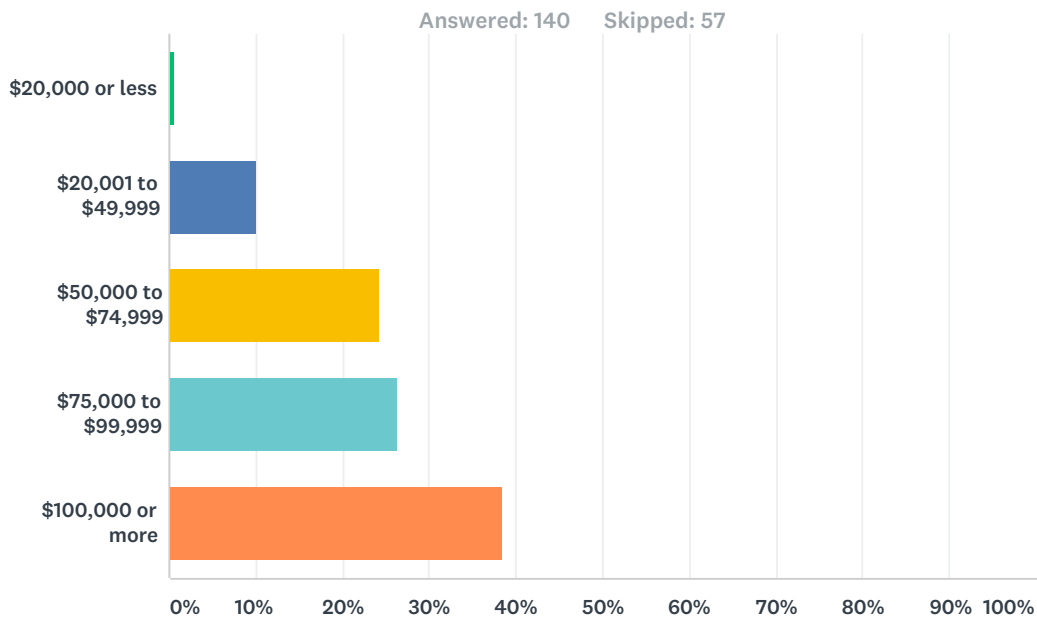
Answer Choices	Responses	
Grade school/No schooling	0.00%	0
Some high school	0.00%	0
High school graduate/GED	5.92%	9
Some college/Trade school	17.76%	27
College degree	48.68%	74
Graduate degree	26.97%	41
Other (please specify)	0.66%	1
Total		152

Q33 How long have you lived at your current residence?



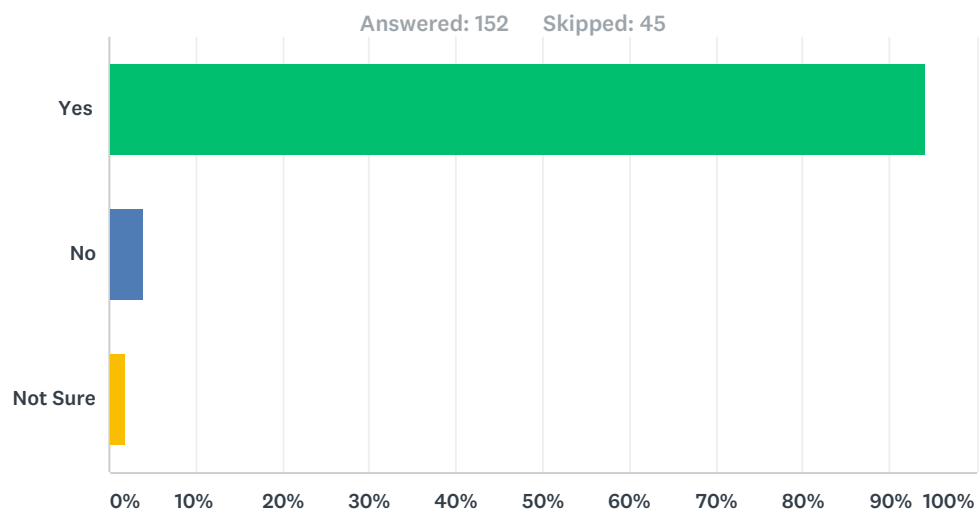
Answer Choices	Responses	
Less than 1 year	8.50%	13
1 to 5 years	26.80%	41
6 to 10 years	16.34%	25
11 to 20 years	22.22%	34
More than 20 years	26.14%	40
Total		153

Q34 How much is your gross household income?



Answer Choices	Responses	
\$20,000 or less	0.71%	1
\$20,001 to \$49,999	10.00%	14
\$50,000 to \$74,999	24.29%	34
\$75,000 to \$99,999	26.43%	37
\$100,000 or more	38.57%	54
Total		140

Q35 Do you have regular access to the Internet?



Answer Choices	Responses	
Yes	94.08%	143
No	3.95%	6
Not Sure	1.97%	3
Total		152

Chelan County Comprehensive Flood Hazard Management Plan

Appendix C. Example Progress Report

C. EXAMPLE PROGRESS REPORT

Chelan County, Washington Comprehensive Flood Hazard Management Plan Annual Progress Report

Reporting Period: *(Insert reporting period)*

Background: Chelan County developed a Comprehensive Flood Hazard Management Plan to reduce risk from flooding through identified resources, information, and strategies. To prepare the plan, Chelan County organized resources, assessed risks from flooding, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from floods. The plan can be viewed on-line:

<http://www.co.chelan.wa.us/flood-control-zone-district>

Purpose: The purpose of this report is to provide an annual update on the implementation of the action plan identified in the *Chelan County Comprehensive Flood Hazard Management Plan*. The objective is to ensure that there is a continuing and responsive planning process that will keep the floodplain management plan dynamic and responsive to the needs and capabilities of Chelan County and its stakeholders. This report discusses the following:

- Flood events that have occurred within the last year
- Changes in risk exposure within the planning area
- Mitigation success stories
- Changes in capabilities that could impact plan implementation
- Floodplain management plan implementation status
 - Review of the action plan
 - Recommendations for changes/enhancement

Flood Events within the Planning Area: During the reporting period, there were flood events in the planning area that had a measurable impact on people or property. A summary of these events is as follows:

- *(Include a narrative of each flood event. What type of flood event? When it occurred? Where it occurred? How long did it last? What types of damages did it do?)*

Changes in Risk Exposure in the Planning Area: *(Insert an overview of any flood event in the planning area that changed the probability of occurrence of flooding as presented in the floodplain management plan)*

Mitigation Success Stories: *(Insert an overview of mitigation accomplishments during the reporting period, including notably successful public outreach efforts)*

Changes That May Impact Implementation of the Flood Plan: *(Insert an overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan or on public outreach efforts. Specify any changes in technical, regulatory and financial capabilities identified during the plan’s development)*

FLOODPLAIN MANAGEMENT PLAN PROGRESS

Summary Overview of the Flood Plan’s Progress: The performance period for the floodplain management plan became effective on [REDACTED], 2017, with the adoption of the Flood Plan by the Chelan County Board of Commissioners. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur before [REDACTED], 2022. As of this reporting period, the performance period for this plan is considered to be [REDACTED]% complete. The floodplain management plan has targeted 38 flood hazard mitigation actions to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- ___ out of ___ actions (___%) reported ongoing action toward completion.
- ___ out of ___ actions (___%) were reported as being complete.
- ___ out of ___ actions (___%) reported no action taken.

The Floodplain Management Plan Steering Committee: The floodplain management plan steering committee, made up of stakeholders within the planning area, reviewed and approved this progress report at its annual meeting held on [REDACTED], 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

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 floodplain management 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]				
Initiative #__—[description]				
Initiative #__—[description]				
Initiative #__—[description]				

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]	

Completion status legend:

✓ = Project Completed

O = Action ongoing toward completion

X = No progress at this time

Recommendations for Changes or Enhancements: Based on the review of this report by the floodplain management 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 Chelan County Board of Commissioners and to local media outlets and the report is posted on the floodplain management plan website. Any questions or comments regarding the contents of this report should be directed to:

Chelan County Flood Control Zone District

316 Washington St, Suite 402

Wenatchee WA 98801

(509) 667-6341

Public.Works@co.chelan.wa.us