Crescent City/Del Norte County

Hazard Mitigation Plan
Volume 1: Planning-Area-Wide Elements

DRAFT

July 2010

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Crescent City/Del Norte County

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

DRAFT

July 2010

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Hazard Mitigation Plan
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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Disaster Mitigation Act (DMA; Public Law 106-390) is federal legislation enacted to promote proactive pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. It established a Pre-Disaster Mitigation Program and new requirements for the national post-disaster Hazard Mitigation Grant Program.

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

A planning partnership made up of Del Norte County, Crescent City, and several special purpose districts worked together to create this Crescent City/Del Norte County Hazard Mitigation Plan, fulfilling the DMA requirements for all participating partners. This effort was funded by a Pre-Disaster Mitigation Program planning grant from the Federal Emergency Management Agency (FEMA), administered by the California Emergency Management Agency (CalEMA).

PLAN PURPOSE

Several factors initiated this planning effort for Crescent City, Del Norte County and its planning partners:

- The Del Norte County area has significant exposure to numerous natural hazards that have caused millions of dollars in past damage.
- Limited local resources make it difficult to be pre-emptive in risk reduction initiatives. Being able to leverage federal financial assistance is paramount to successful hazard mitigation in the area.
- The partners wanted to be proactive in their preparedness for natural hazards

With these factors in mind, Crescent City and Del Norte County prepared the plan by attaining grant funding for the effort, establishing a planning partnership, and securing technical assistance to facilitate a planning process that would achieve compliance with program requirements.

THE PLANNING PARTNERSHIP

A planning partnership consists of Crescent City, Del Norte County and 12 special purpose districts. This partnership represents approximately 40 percent of the eligible local governments in the planning area as defined under the DMA. Jurisdictional annexes for the seven partners who completed all required phases of this plan's development are included in Volume 2 of the plan. Jurisdictions not covered by this process can link to this plan at a future date by following the procedures identified in Appendix B of Volume 2.

PLAN DEVELOPMENT METHODOLOGY

Development of the Crescent City/Del Norte County Hazard Mitigation Plan included seven phases:

- Phase 1—Organization of Resources

- Phase 2—Hazard Identification and Profiling
- Phase 3—Asset Inventory and Vulnerability Analysis
- Phase 4—Development of Mitigation Initiatives
- Phase 5—Preparation of Draft Plan
- Phase 6—Plan Review and Revision
- Phase 7—Plan Adoption and Submittal.

Phase 1—Organize Resources

Under this phase, grant funding was secured to fund the effort, a Planning Partnership was formed and a Steering Committee was assembled to oversee the development of the plan, consisting of Planning Partners and other stakeholders in the planning area. A multimedia public involvement strategy, centered on a hazard preparedness questionnaire and a program website, was implemented under this phase. This phase also included coordination with local, state and federal agencies involved in hazard mitigation, and a comprehensive review of existing programs in the planning area that may support or enhance hazard mitigation actions.

Phases 2 & 3—Hazard Identification, Profiling & Vulnerability Assessment (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 identification and profiling
- The impact of hazards on physical, social and economic assets
- Vulnerability identification
- Estimates of the cost of damage or costs that can be avoided through mitigation.

The risk assessment for this plan meets the requirements of Code of Federal Regulations Chapter 44 (44CFR) Section 201.6.c.2. Phase 2 occurred simultaneously with Phase 1, with the two efforts using information generated by one another to create the best regionally applicable risk assessment.

Phase 4—Review/Develop Mitigation Measures

This phase addressed several key requirements of the DMA: development of a guiding principle, goals and measurable objectives; comprehensive review of mitigation alternatives to use for a catalog of actions; development of a benefit/cost review methodology to prioritize actions; ranking of risk to support prioritization of actions; review of jurisdiction-specific capabilities, identification of actions and prioritization of those actions.

Phase 5—Assemble the Mitigation Plan

The Steering Committee assembled key information from earlier phases into a document to meet the DMA requirements. The document was produced in two volumes: Volume 1 includes all information that applies to the entire planning area; and Volume 2 includes jurisdiction-specific information. Per section 201.6 of 44CFR, a local hazard mitigation plan must include the following:

- A description of the planning process

- Risk assessment (applicable to each planning partner)
- Mitigation Strategy
  – Goals
  – Review of alternatives
  – Prioritized "action plan"
- Plan maintenance section
- Documentation of adoption

Phase 6—Plan Review and Revision

Under this phase the draft plan was circulated to planning partners, stakeholders, and agencies to solicit comment on the actions proposed. The plan was presented to the public for review and comment via the public involvement strategy developed under Phase 1. The principal methods for engaging the public were web-based tools and public meetings. A pre-adoption review draft of the plan was prepared along with a DMA compliance "crosswalk," which was submitted to the California Office of Emergency Services (CAOES) for review and approval. After determining that the plan complies with Section 201.6 of 44CFR, CAOES will forward the plan to FEMA for approval.

Phase 7—Plan Adoption

Once pre-adoption approval has been granted by both CalEMA and FEMA, the final adoption phase will begin. Under this phase each planning partner must adopt the plan according to its own adoption protocol. The planning team provided support in the form of model resolutions, and presentation materials.

MITIGATION GUIDING PRINCIPLE, GOALS AND OBJECTIVES

The following guided the Steering Committee and the Planning Partnership in selecting the initiatives contained in this plan:

- **Guiding Principle—"**Reduce the vulnerability to natural hazards in order to protect the health, safety, welfare and economy of Del Norte County."
- **Goals**
  1. Save or protect lives from the impact of natural hazards.
  2. Protect property from the impact of natural hazards.
  3. Protect the environment.
  4. Maintain economic viability after a disaster event.
  5. Promote efficient use of public funds.
- **Objectives—**Ten objectives were identified that would play a key role in the prioritization of actions identified by this plan. These objectives are listed in Table ES-1.

TABLE ES-1.
CRESCENT CITY/DEL NORTE COUNTY HAZARD MITIGATION PLAN OBJECTIVES

Objective Number	Objective Statement	Goals for which it can be applied
O-1	Consider the impacts of natural hazards in all planning mechanisms that address current and future land uses within Del Norte County.	1, 2, 3, 4
O-2	Sustain reliable local emergency operations and facilities before during and after a disaster.	1, 2, 4, 5
O-3	Pursue implementation of all feasible measures that reduce the risk exposure of public and private property within Del Norte County.	1, 2, 3, 4, 5
O-4	Seek mitigation projects that provide the highest degree of natural hazards protection in a cost-effective manner.	1, 2, 4, 5
O-5	Inform the public on the natural-hazard risk exposure and ways to increase the public's capability to prepare for, respond to, recover from, and mitigate the impacts of natural-hazard events.	1, 2, 4, 5
O-6	Increase resilience and the continuity of operations of identified critical facilities within Del Norte County.	1, 2, 4, 5
O-7	Consider codes that require new construction to take into account the impacts of natural hazards.	1, 2, 3
O-8	Utilize the best available data, science and technologies to improve understanding of the location and potential impacts of natural hazards, the vulnerability of building types, community development patterns, and the measures needed to protect life safety.	1, 2, 3
O-9	Enhance emergency management capability within the planning area.	1, 2, 4, 5
O-10	Address identified/known repetitive losses within the planning area.	1, 2, 5

MITIGATION INITIATIVES

Mitigation initiatives are activities undertaken to reduce or eliminate losses resulting from natural hazards. The mitigation initiatives are the key element of the hazard mitigation plan. It is through the implementation of these initiatives that the planning partners can strive to become disaster-resistant.

Although one of the driving influences for preparing this plan was grant funding eligibility, its purpose is more than just access to federal funding. It was important to the Planning Partnership and the Steering Committee to look at initiatives that will work through all phases of emergency management. Some of the initiatives outlined in this plan are not grant eligible—grant eligibility was not the focus of the selection. Rather, the focus was the initiatives' effectiveness in achieving the goals of the plan and whether they are within each jurisdiction's capabilities.

This planning process resulted in the identification of 71 mitigation actions for implementation by the Planning Partners, as presented in Volume 2. In addition, a series of countywide initiatives were identified by the Steering Committee and the Planning Partnership. These are initiatives that benefit the whole partnership, to be implemented by pooling resources based on capability. These initiatives are summarized in Table ES-2.

TABLE ES-2.
ACTION PLAN—COUNTYWIDE MITIGATION INITIATIVES

Mitigation Initiative	Hazards Addressed	Administrating Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-1. To the extent possible based on available resources, provide coordination and technical assistance in the application for grant funding that includes assistance in cost vs. benefit analysis for grant eligible projects	All	County OES and Crescent City jointly	Existing programs for the two lead agencies Grant funding	Short-term, Ongoing	4, 8
CW-2: Encourage the development and implementation of a county-wide hazard mitigation public-information strategy that meets the needs of all planning partners.	All	County OES and Crescent City jointly, with participation of all planning partners	Cost sharing from the Partnership General Fund Allocations Cost sharing with Stakeholders	Short-Term, Depends on Funding	5, 8, 9
CW-3: Coordinate updates to land use and building regulations as they pertain to reducing the impacts of natural hazards, to seek a regulatory cohesiveness within the planning area. This can be accomplished via a commitment from all planning partners to involve each other in their adoption processes, by seeking input and comment during the course of regulatory updates or general planning.	All	Governing body of each eligible planning partner.	General funds	Short-Term, Ongoing	1, 5, 7, 8
CW-4: Sponsor and maintain a natural hazards informational website to include the following types of information: • Hazard-specific information such as GIS layers, private property mitigation alternatives, important facts on risk and vulnerability • Pre- and post-disaster information such as notices of grant funding availability • CRS creditable information • Links to Coalition Partners' pages, FEMA, Red Cross, NOAA, USGS and the National Weather Service. • Information such as progress reports, mitigation success stories, update strategies, Steering Committee meetings.	All	County OES and Crescent City jointly	County General Fund through existing programs Grant Funding	Short-Term, Ongoing	5, 8
CW-5: The Steering Committee will remain as a viable body over time to monitor progress of the plan, provide technical assistance to planning partners and oversee the update of the plan according to schedule. This body will continue to operate under the ground rules established at its inception.	All	County OES and Crescent City jointly	Funded through existing, on-going programs	Short-term	All
CW-6: Amend or enhance the Crescent City/Del Norte County Hazard Mitigation Plan on an "as needed" basis to seek compliance with state or federal mandates (i.e., CA. Assembly Bill # 2140) as guidance for compliance with these programs become available.	All	County OES and Crescent City jointly Each planning partner	Ongoing programs. Grant funding depending on the mandate.	Long-term Ongoing	All

**TABLE ES-2.
ACTION PLAN—COUNTYWIDE MITIGATION INITIATIVES**

Mitigation Initiative	Hazards Addressed	Administrating Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-7: All planning partners that fully participated in this planning effort will formally adopt this plan once pre-adoption approval has been granted by CalEMA and FEMA Region IX. Additionally, each planning partner will adhere to the plan maintenance protocol identified chapter 7 of the plan.	All	County OES	To be funded under existing programs for all planning partners	Short-term	All

a. Short term = 1 to 5 years; Long Term= 5 years or greater

CONCLUSION

Full implementation of the recommendations of this plan will take time and resources. The measure of the plan’s success will be the coordination and pooling of resources within the Planning Partnership. Keeping this coordination intact will be key to the successful implementation of the plan. Teaming together to seek financial assistance at the state and federal level will be a priority to initiate projects that are dependent on alternative funding sources. This plan was built upon the effective leadership of a multi-disciplined Steering Committee and a process that relied heavily on public input and support. It will succeed for the same reasons.

PART 1— BACKGROUND INFORMATION

BACKGROUND INFORMATION

ACKNOWLEDGMENTS

Crescent City

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Tetra Tech

- Rob Flaner, CFM
- Ed Whitford, HAZUS Lead
- Cara McCafferty, Cartographer

Freshwater Environmental Services

- Orin Plocher
- Stan Theisen

Special Acknowledgments

The development of this plan would not have been possible without the dedication and commitment of the Crescent City/Del Norte County Hazard Mitigation Plan Steering Committee and all of the Planning Partners. Bringing together 14 local governments to create a uniform natural hazard mitigation strategy was a major accomplishment. Their input, timely review of documents, and energy given to the development of this plan are greatly appreciated.

Additionally, the participation of the citizens of Del Norte County in this process via the public involvement strategy contributed greatly to the outcome of the planning process.

The following table lists the Partnership representatives who contributed to the development of the plan.

CRESCENT CITY/DEL NORTE COUNTY HAZARD MITIGATION PLAN
PLANNING PARTNERSHIP REPRESENTATIVES

Jurisdiction	Point of Contact	Telephone #	E-mail Address
Crescent City	Eric Taylor	707-464-9506	etaylor@crescentcity.org
Del Norte County	Cindy Henderson	707-465-0430 ext. 376	chenderson@co.del-norte.ca.us
Crescent City Harbor District	Richard Young	707-464-6174 ext. 24	Richard@ccharbor.com
Gasquet FPD	Buzz Parlasca	707-954-0389	ihaban@gte.net
Gasquet CSD	Wally Borgeson	707-951-1648	wborgeson@charter.net
Del Norte County Library District	Russell Long	707464-9794	delnorterlong@yahoo.com
Smith River CSD	Charlaine Mazzei	707-464-1496	cmconsulting@charter.net
Smith River FPD	Charlaine Mazzei	707-464-1496	cmconsulting@charter.net
Big Rock CSD	Craig Bradford	707-458-9933	craig_bradford@charter.net
Fort Dick FPD	Randy Crawford	707-487-8185	fdfd81@aol.com
Crescent City FPD	Steve Wakefield	707-464-2421	stevewakefield@charterinternet.com
Del Norte RCD	Robin Galea	707-487-7630	Robin.galea@ca.usda.gov
Klamath FPD	Lonnie Levi	707-464-6319	llevi@crescentcity.org
Del Norte County Office of Education	Rodney Jahn	707-464-0200	rjahn@delnorte.k12.ca.us

CSD = Community Services District; FPD = Fire Protection District; RCD = Resource Conservation District

HOW TO USE THIS PLAN

This multi-jurisdictional hazard mitigation plan has been set up in two volumes to distinguish elements that are specific to individual jurisdictions from those that apply to all of Del Norte County:

- **Volume 1**—Volume 1 includes all federally required elements of a disaster mitigation plan that apply to the entire county. This includes the description of the planning process, public involvement strategy, goals and objectives, countywide hazard risk assessment, countywide mitigation initiatives, and a plan maintenance strategy.
- **Volume 2**—Volume 2 includes all federally required jurisdiction-specific elements, in annexes for each participating jurisdiction. It includes a description of the participation requirements, as well as instructions and templates that participants used to complete their annexes. Volume 2 also outlines procedures for eligible, non-participating jurisdictions that wish to adopt the hazard mitigation plan in the future.

All participating jurisdictions will adopt Volume 1 in its entirety and at least the following parts of Volume 2: Part 1; the partner's jurisdiction-specific annex; and the appendices. Some jurisdictions may find it easier to adopt Volume 2 in its entirety.

DEFINITION OF TERMS AND ACRONYMS

Appendix A to this volume provides a glossary of technical terms and acronyms. First references to terms included in the glossary are highlighted in ***bold italics*** throughout the body of the plan. When encountering a term in bold italics, please refer to the glossary for definitions and explanations.

PART 2—THE PLANNING PROCESS

CHAPTER 1.
INTRODUCTION TO THE PLANNING PROCESS

1.1 WHY PREPARE THIS PLAN?

1.1.1 The Big Picture

Disasters can have significant impacts on communities. They can destroy or damage life, property and infrastructure, local economies, and the environment. Hazard mitigation is any sustained action taken to permanently eliminate or reduce long-term risks to human life and property from natural disasters. This is an essential component of emergency management, along with preparedness, response and recovery.

The federal Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390) requires state and ***local governments*** to develop hazard mitigation plans as a condition for federal grant assistance. Prior to 2000, federal funding for hazard mitigation planning was limited. The DMA highlights the importance of communities planning for disasters before they occur. It emphasizes pre-disaster infrastructure mitigation planning to reduce disaster losses and the streamlining of federal disaster programs to promote mitigation.

The Crescent City/Del Norte County Hazard Mitigation Plan outlines careful, long-term planning to be completed prior to disasters to help reduce the impacts of natural hazards and increase the community's resilience through awareness and implementation of mitigation actions. Fewer lives, homes and businesses will be lost and a disaster event's disruption to the community will be lessened. Ultimately, a community that is hazard-resilient is more likely to remain intact economically, structurally, socially and environmentally, even when disaster does occur.

1.1.2 Local Concerns

Several factors initiated this planning effort for Crescent City, Del Norte County and their planning partners:

- The Del Norte County area has significant exposure to numerous natural hazards that have caused millions of dollars in past damage.
- Limited local resources make it difficult to be pre-emptive in risk reduction initiatives. Being able to leverage federal financial assistance is paramount to successful hazard mitigation in the area.
- The partners wanted to be proactive in its preparedness for the probable impacts of natural hazards.

With these factors in mind, Crescent City committed to the preparation of the plan by attaining grant funding for the effort and then securing technical assistance to facilitate a planning process that would comply with all program requirements.

1.2 WHY PREPARE A MULTI-JURISDICTIONAL PLAN?

Having initiated the planning process, Crescent City needed to choose between preparing a plan that would cover only the city or seeking out other planning partners with similar hazard exposures and capabilities. The latter approach allows planning partners to pool resources that would support the planning effort, and was chosen based on the following considerations:

- Del Norte County is a natural planning partner in that it provides many services on a countywide basis that influence or directly impact Crescent City.
- Due to the rural nature of Del Norte County, many of the local jurisdictions in the county lack the financial or technical resources to prepare a DMA-compliant plan.
- As the principal economic center of Del Norte County, Crescent City could be directly impacted by mitigation activities throughout the county.
- The Federal Emergency Management Agency (FEMA) promotes multi-jurisdictional planning under the Disaster Mitigation Act. Forming a multi-jurisdictional partnership would enhance the potential for obtaining grant funding that would fund this effort.
- The State of California's Standardized Emergency Management System encourages multi-jurisdictional efforts for emergency planning and establishes the "***operational area***," consisting of a county and all political subdivisions within the county area, as one of the five state-defined levels for use in all emergencies and disasters involving multiple agencies or multiple jurisdictions.

CHAPTER 2.
PLANNING AREA AND PLANNING PARTNERS

The planning area for this hazard mitigation plan is defined by the Del Norte County boundary, shown in Figure 2-1. Crescent City and Del Norte County are among 14 jurisdictions that participated to varying degrees in this planning process. The City and County contacts for the partnership are as follows:

- Crescent City—Eric Taylor, City Planner
- Del Norte County—Cindy Henderson, Emergency Services Manager

It is estimated that 30 special purpose districts within the planning area meet the definition of "local government" in Title 44 of the Code of Federal Regulations (44CFR, Emergency Management and Assistance, Section 2.1.2). Crescent City extended an invitation to participate in this plan to all eligible special purpose districts; 12 provided letters of intent to participate. The participating special purpose districts and their contacts for the planning process are identified in Table 2-1.

**TABLE 2-1.
SPECIAL DISTRICT COALITION PLANNING PARTNERS**

District	Point of Contact	Title
Crescent City Harbor District	Richard Young	CEO/Harbormaster
Gasquet Fire Protection District	Buzz Parlasca	Fire Chief
Gasquet Community Services District	Wally Borgeson	
Del Norte County Library District	Russell Long	Library Director
Smith River Community Services District	Charlaine Mazzei	
Smith River Fire Protection District	Charlaine Mazzei	
Big Rock Community Services District	Craig Bradford	President
Fort Dick Fire Protection District	Randy Crawford	Fire Chief
Crescent City Fire protection District	Steve Wakefield	Fire Chief
Del Norte Resource Conservation District	Becky Crockett	District Manager
Klamath Fire Protection District	Lonnie Levi	Fire Chief
Del Norte County Office of Education	Rodney Jahn	Deputy Superintendant

Section 201.6 44CFR stipulates that all local governments seeking coverage under a multi-jurisdiction plan must participate in the plan's development. To ensure compliance with this requirement, the Steering Committee (see Section 3.1.4) defined expectations for participation in the planning effort. The expectations were disclosed to all potential planning partners. All planning partners that met these parameters (see Volume 2, Section 1.4) will adopt it in compliance with federal requirements (44CFR Section 201.6.c(5)). Any currently non-participating local government in Del Norte County or any partner not meeting the participation requirements can "dock" to this plan by following the procedures defined in Appendix B of Volume 2.

Figure 2-1. Del Norte County Hazard Mitigation Planning Area

CHAPTER 3.
PLAN DEVELOPMENT METHODOLOGY

3.1 PLANNING RESOURCE ORGANIZATION

The first phase in the development of the Crescent City/Del Norte County Hazard Mitigation Plan was to organize the resources needed. Under this phase, Crescent City and Del Norte County assessed their readiness to plan by securing FEMA grant funds, establishing a planning team, seeking technical assistance, and engaging the public to determine public perception of risk and support of hazard mitigation. This phase also included coordination with other local, state and federal agencies involved in hazard mitigation in the region to ensure a consistent platform with other ongoing efforts. This phase had seven primary objectives to define its scope of work:

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

The following sections describe the activities for the first six of these objectives; the public involvement element is discussed in Chapter 4.

3.1.1 Grant Funding

This planning effort was supplemented by a FEMA Hazard Mitigation Planning grant from the Pre-Disaster Mitigation (PDM) grant program. The PDM program provides funds for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. PDM grants are awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds

3.1.2 Formation of the Planning Team

Once commitment for the planning process was established by Crescent City, it was determined by City personnel that staff resources to complete this task were not sufficient to achieve all of the desired objectives of the plan. A decision was made to hire a consultant to assist with the development and implementation of a planning process that would achieve DMA compliance for the City and its planning partners. The City hired Tetra Tech, Inc. to facilitate the planning process. Freshwater Environmental Services was included on the Tetra Tech Team as a subcontractor to support the planning effort as the local presence. The Tetra Tech project manager assumed the role of the lead planner and reported directly to a project manager assigned by the City.

Once the technical assistance was secured, a planning team was formed that would lead the planning effort according to a defined scope of work. Table 3-1 lists the members of this planning team.

**TABLE 3-1.
PLANNING TEAM MEMBERS**

Name	Department/Agency	Role
Will Caplinger	Crescent City Planning Department	Supervising Planner, Project Oversight
Eric Taylor	Crescent City Planning Department	Project Manger
Rob Flaner, CFM	Tetra Tech, Inc.	Lead Project Planner
Ed Whitford	Tetra Tech, Inc.	GIS/ HAZUS Lead
Bill Bohn	Tetra Tech, Inc	HAZUS QA/QC
Orin Plocher	Freshwater Environmental Services	Local Facilitation Manager
Stan Thiesen	Freshwater Environmental Services	GIS Support

3.1.3 Establish a Planning Partnership

A planning kickoff meeting was held in Crescent City on March 27, 2008. All eligible local governments within the planning area were invited to attend. Various agency and citizen stakeholders were also invited to this meeting. The purpose of this session was to:

- Provide an overview of the Disaster Mitigation Act
- Outline the Crescent City work plan
- Explain the benefits of multi-jurisdictional planning
- Solicit planning partners
- Form a Steering Committee

All interested local governments were provided with a list of planning partner expectations developed by the planning team and were informed of the obligations required for participation. Local governments wishing to join the planning effort were asked to provide the planning team with a "notice of intent to participate" that agreed to the planning partner expectations and designated a point of contact for their jurisdiction. In all, formal commitment was received from 14 planning partners, and the Del Norte County Planning Partnership was formed.

3.1.4 The Steering Committee

By working together on hazard mitigation planning, a broad range of ***stakeholders*** can identify and create partnerships that pool resources to achieve a common vision for the community. The work plan established for this process was built around this concept by the formation of a steering committee that would oversee all phases of the plan's development. Thirteen representatives volunteered to serve in this capacity. Table 3-2 lists the committee members.

Leadership roles and ground rules were established during the Steering Committee's initial meeting on June 11, 2008. The Steering Committee met on the third Wednesday of every month as needed throughout the course of the plan's development. The Planning Team facilitated each Steering Committee meeting, which addressed a set of objectives based on the work plan established for the plan. The Steering Committee met eight times from June 2008 to November 2009. Meeting agendas, minutes and attendance logs were maintained by the planning team and are available for review upon request. All Steering Committee meetings were advertised on the Crescent City website and were open to the public.

**TABLE 3-2.
STEERING COMMITTEE MEMBERS**

Name	Title	Jurisdiction/Agency	Representing
Richard Young[a]	CEO/Harbormaster	Crescent City Harbor District	Planning Partner (District)
Will Caplinger[a]	Supervising Planner	Crescent City Planning Department	Planning Partner (Municipal)
Eric Taylor[a]	Planner	Crescent City Planning Department	Planning Partner (Municipal)
Cindy Henderson	Emergency Services Manager	Del Norte County Emergency Management	Stakeholder
Allen Winogrdov	Systems Administrator	Del Norte County	Planning Partner (District)
Craig Bradford	President	Big Rock Community Services District	Planning Partner (District)
Dennis Louy	District Safety Coordinator	Del Norte Co. Unified School District	Planning Partner (District)
Charlaine Mazzei		Smith River Community Services District / Fire District	Planning Partner (District)
Jay Serina	Assistant County Administrative Officer	Del Norte County	Planning Partner (Municipal)
Ron Sandler		Del Norte County Ambulance	Stakeholder
Brian O'Callaghan		Rural Human Services	Stakeholder
Terri Camarena	Tribal Administrator	Elk Valley Rancheria	Stakeholder
Labecca Nessier		Yurok Tribe	Stakeholder
Lonnie Levi		Crescent City Fire District	Planning Partner (District)

a. Will Caplinger was the representative for Crescent City and initial chairperson of the Steering Committee. He left the employ of Crescent City in December 2008, and was replaced on the Steering Committee by Eric Taylor. Richard Young assumed the role of Chair from that point forward.

3.1.5 Coordination with Other Agencies

Federal emergency management regulations require that hazard mitigation planning efforts provide involvement opportunities for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development, businesses, academia and other private and nonprofit interests (44CFR Section 201.6.b(2)). This goal was achieved through the formation of the Planning Partnership and Steering Committee and through outreach to other agencies. The following agencies were invited to participate in the process from the beginning and were kept apprised of plan development milestones:

- Federal Emergency Management Agency (FEMA) Region IX
- California Office of Emergency Services
- California Department of Transportation
- Bureau of Land Management
- California Department of Forestry and Fire Protection
- California State Parks

- Red Cross

All of these agencies received meeting announcements, meeting agendas and meeting minutes via e-mail. They were also invited to provide comment and input on the draft plan during the public review phase of the planning process

3.1.6 Review of Existing Programs

Federal emergency management regulations require that a hazard mitigation planning process include a review and incorporation, as appropriate, of existing plans, studies, reports, and technical information (44CFR Section 201.6.b(3)). Chapter 9 summarizes laws and ordinances that could affect hazard mitigation efforts in the planning area. The following planning programs also could affect mitigation initiatives:

- Del Norte County Emergency Response Plan—This emergency support function plan directs emergency response actions in the planning area.
- Del Norte County General Plan—Most recently amended in January 2003, this plan directs land use policy in Del Norte County.
- Del Norte County Comprehensive Economic Development Strategy (CEDS)—The CEDS emerged from a planning process developed with broad-based community participation to address the economic problems and potential of the planning area.

All planning partners reviewed their own regulatory, planning, technical and financial capability as part of the preparation of the jurisdictional annexes in Volume 2. The annexes identify the regulatory capability of each planning partner. This review also included identification of existing plans and programs that will enhance or support the hazard mitigation initiatives identified by this plan.

3.2 PLAN DEVELOPMENT CHRONOLOGY

Development of the Crescent City/Del Norte County Hazard Mitigation Plan included seven phases:

- Phase 1—Project Start Up, Initial Coordination and Coordination
- Phase 2—Hazard Identification and Profiling
- Phase 3—Asset Inventory and Vulnerability Analysis
- Phase 4—Develop Mitigation Initiatives
- Phase 5—Prepare Draft Plan
- Phase 6—Plan Review and Revision
- Phase 7—Plan Adoption and Submittal

Table 3-3 summarizes important milestones in the plan's development.

**TABLE 3-3.
PLAN DEVELOPMENT CHRONOLOGY/MILESTONES**

Date	Event	Milestone	Attendance
2006			
12/1	Crescent City submits “notice of interest” to submit a planning grant application to California Office of Emergency Services for the FY 2007 Pre-Disaster Mitigation grant program	Crescent City’s initial commitment to completing a hazard mitigation plan pursuant to the Disaster Mitigation Act.	N/A
2007			
1/10	Crescent City submits PDM planning grant application to FEMA.	Crescent City commits to a “multi-jurisdictional planning effort that will include the County and other special district planning partners.	N/A
7/15	Crescent City receives notice of PDM grant award from FEMA.	Secured the funding for the planning effort	N/A
8/13	Crescent City solicits consultant to facilitate the planning process	Assembly of the planning team	N/A
10/2	Crescent City selects Tetra Tech, Inc to facilitate plan development	Assembly of the planning team	N/A
11/18	Planning Team identifies local districts within the planning area.	Assembly of the planning partnership.	N/A
2008			
3/27	Planning partner kickoff meeting	Assembly of the planning partnership	20
4/25	Letters of intent to participate due from all committed planning partners	Commitment to planning partner expectations.	N/A
5/1	Nominations for Steering Committee representatives due.	Formation of the Steering Committee	N/A
6/11	1st Steering Committee Meeting	Organize Steering Committee and establish a public involvement strategy.	16
7/16	2nd Steering Committee Meeting	Introduction to HAZUS, define “critical facilities,” provide comments on State Hazard Mitigation Plan, identify “hazards of concern” to be addressed by the plan, finalize public involvement strategy	11
8/20	3rd Steering Committee meeting	Identify a guiding principal for the plan and organize public meeting format and schedule, finalize questionnaire content and dissemination means.	12
8/28-8/31	Del Norte County Fair	Implementation of public involvement strategy-initial press release, dissemination of questionnaire	N/A

**TABLE 3-3 (continued).
PLAN DEVELOPMENT CHRONOLOGY/MILESTONES**

Date	Event	Milestone	Attendance
2008 (continued)			
9/8	Public Meeting #1	Implementation of public involvement strategy-gage the public's perception of risk.	11
9/9	Public Meeting #2	Implementation of public involvement strategy-gage the public's perception of risk.	20
9/10	Public Meeting #3	Implementation of public involvement strategy-gage the public's perception of risk.	10
9/11	Public meeting #4	Implementation of public involvement strategy-gage the public's perception of risk.	9
9/30	Questionnaires due	Implementation of public involvement strategy	N/A
10/15	4th Steering Committee Meeting	Public meeting review, review questionnaire results, identify goals for the plan	10
11/19	5th Steering Committee Meeting	Finalize goals, identify objectives for the plan	8
2009			
1/29	6th Steering Committee Meeting	Re-organize the Steering Committee, confirm objectives	9
3/2	Jurisdictional annex workshop	"Strengths, Weaknesses, Opportunities, and Obstacles" session to develop mitigation catalog; training of all planning partners on how to complete the template for their jurisdictional annex.	27
4/15	7th Steering Committee meeting	New tsunami mapping was reviewed by committee. Steering Committee approved plan maintenance and "linkage" procedures	7
2010			
4/12	Draft Plan Public comment period	Draft plan posted on Crescent City for 2 week public comment period. Press release disseminated by the City advertising that the draft plan is available for public review and comment.	N/A
7/12	Pre-adoption review request	Draft plan sent to CalEMA for pre adoption review and approval.	N/A
TBD	Pre-Adoption Approval	Pre-adoption approval of draft plan granted by FEMA Region IX and CalEMA.	N/A
TBD	Adoption Process	Final Plan adopted by Crescent City, Del Norte County and all Planning Partners	N/A
TBD	Final Plan approval	Final plan approval granted by FEMA Region IX. Beginning of 5-year performance period	

CHAPTER 4.
PUBLIC INVOLVEMENT STRATEGY

Federal emergency management regulations require that the public have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44CFR Section 201.6.b(1)). The Community Rating System (CRS) expands on these requirements by making CRS credits available for optional public involvement activities. With these factors in mind, the planning team drafted a comprehensive public involvement strategy using multiple media sources available within Del Norte County.

4.1 STRATEGY

The Steering Committee considered the public involvement strategy to be a key component in gauging the public's perception of risk, vulnerability and mitigation. Public involvement efforts introduced the concept of mitigation to the public, and gave the steering committee feedback to use in developing the components of this plan. A complete strategy was developed for involving the public, emphasizing the following elements:

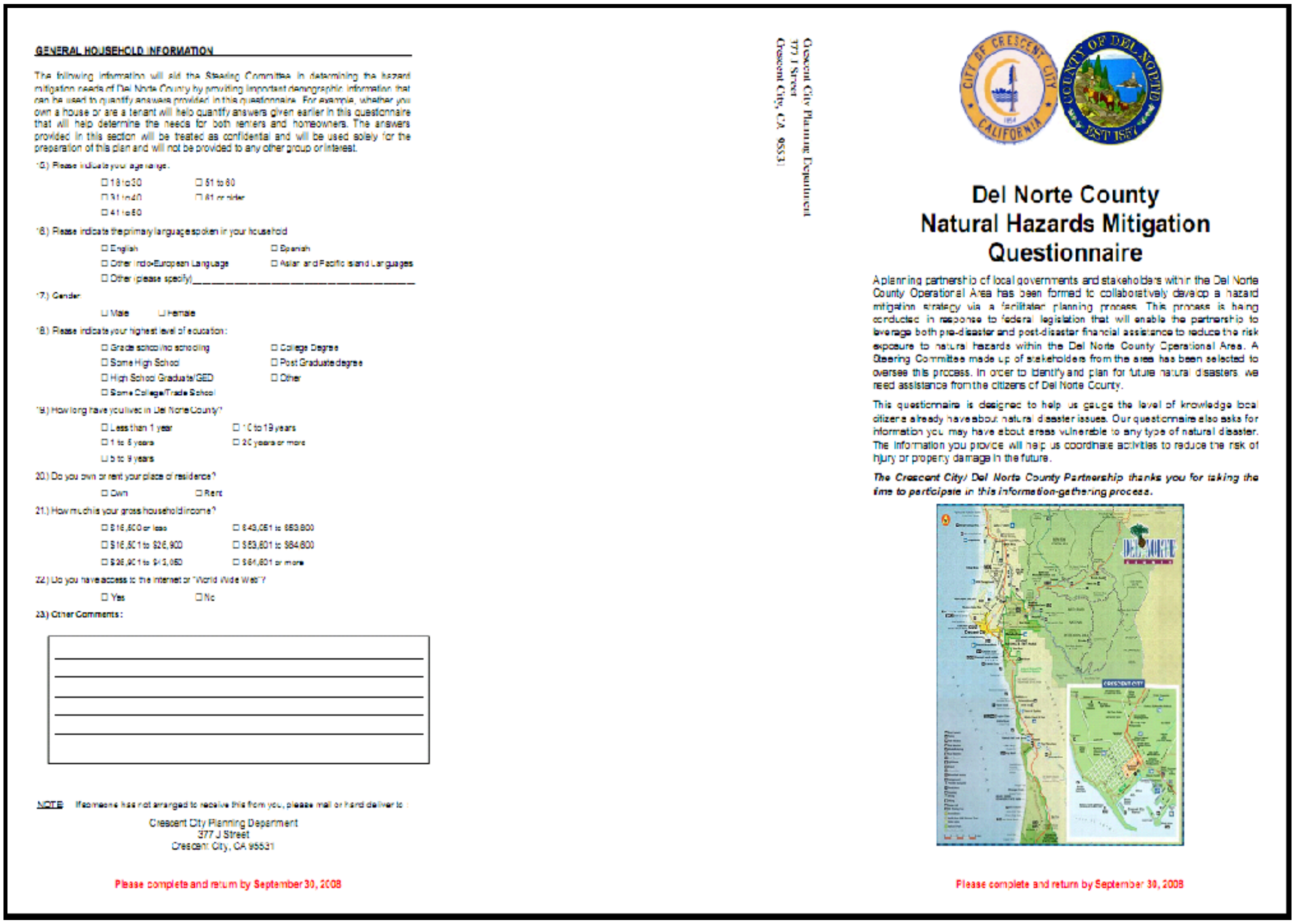
- Identify and involve stakeholders in the planning area by inviting them to participate on the Steering Committee
- Use a questionnaire to gauge the public's perception of risk and support of hazard mitigation and to get direction on alternatives.
- Attempt to reach as many citizens in the planning area as possible through the use of multiple media.

4.1.1 Steering Committee

All of the Steering Committee members are residents of Del Norte County. Because of this, the knowledge level of this body on local issues is very high. Many of the members volunteer their time to serve their respective jurisdictions. Therefore, most Steering Committee members represented a specific jurisdiction as well as representing the citizens of Del Norte County. Five of the Steering Committee members represented key stakeholders within the planning area, including Tribal representatives as well as County agencies with a stake in hazard mitigation. This makeup helped to provide a well-rounded point of view from this committee.

4.1.2 Questionnaire

A hazard mitigation plan questionnaire (see Figure 4-1) was developed by the planning team with guidance from the Steering Committee. The questionnaire was used to gauge household preparedness for natural hazards and the level of knowledge about ways to reduce risk and loss from natural hazards. The questionnaire was designed to help identify areas vulnerable to one or more natural hazards. It asked 22 quantifiable questions, the answers to which could help guide the Steering Committee in selecting goals, objectives and mitigation strategies. Over 2,000 questionnaires were disseminated throughout the planning area. This is about 7 percent of the total population for the county and represents a viable sample size with an anticipated return rate of 10 percent or higher. The complete questionnaire and a summary of its findings can be found in Appendix B.



GENERAL HOUSEHOLD INFORMATION

The following information will aid the Steering Committee in determining the hazard mitigation needs of Del Norte County by providing important demographic information that can be used to quantify answers provided in this questionnaire. For example, whether you own a house or are a tenant will help quantify answers given earlier in this questionnaire that will help determine the needs for both renters and homeowners. The answers provided in this section will be treated as confidential and will be used solely for the preparation of this plan and will not be provided to any other group or interest.

15.) Please indicate your age range:

☐ 18 to 30 ☐ 51 to 60
☐ 31 to 40 ☐ 61 or older
☐ 41 to 50

16.) Please indicate the primary language spoken in your household

☐ English ☐ Spanish
☐ Other Indo-European Language ☐ Asian and Pacific Island Languages
☐ Other (please specify)________________

17.) Gender:

☐ Male ☐ Female

18.) Please indicate your highest level of education:

☐ Grade school/no schooling ☐ College Degree
☐ Some High School ☐ Post Graduate degree
☐ High School Graduate/GED ☐ Other
☐ Some College/Trade School

19.) How long have you lived in Del Norte County?

☐ Less than 1 year ☐ 10 to 19 years
☐ 1 to 5 years ☐ 20 years or more
☐ 5 to 9 years

20.) Do you own or rent your place of residence?

☐ Own ☐ Rent

21.) How much is your gross household income?

☐ $16,500 or less ☐ $43,051 to $53,800
☐ $16,501 to $26,900 ☐ $53,801 to $64,800
☐ $26,901 to $43,050 ☐ $64,801 or more

22.) Do you have access to the internet or "World Wide Web"?

☐ Yes ☐ No

23.) Other Comments:

NOTE: If someone has not arranged to receive this from you, please mail or hand deliver to:

Crescent City Planning Department
377 J Street
Crescent City, CA 95531

Please complete and return by September 30, 2008

Crescent City Planning Department
377 J Street
Crescent City, CA 95531

Del Norte County
Natural Hazards Mitigation
Questionnaire

A planning partnership of local governments and stakeholders within the Del Norte County Operational Area has been formed to collaboratively develop a hazard mitigation strategy via a facilitated planning process. This process is being conducted in response to federal legislation that will enable the partnership to leverage both pre-disaster and post-disaster financial assistance to reduce the risk exposure to natural hazards within the Del Norte County Operational Area. A Steering Committee made up of stakeholders from the area has been selected to oversee this process. In order to identify and plan for future natural disasters, we need assistance from the citizens of Del Norte County.

This questionnaire is designed to help us gauge the level of knowledge local citizens already have about natural disaster issues. Our questionnaire also asks for information you may have about areas vulnerable to any type of natural disaster. The information you provide will help us coordinate activities to reduce the risk of injury or property damage in the future.

The Crescent City/ Del Norte County Partnership thanks you for taking the time to participate in this information-gathering process.

Please complete and return by September 30, 2008

Figure 4-1. Sample Page of Questionnaire Distributed to the Public

4.1.3 Opportunity for Public Comment

The public involvement strategy focused on public meetings, press releases, and the internet, as described in the following sections.

Public Meetings for Risk Assessment

The Steering Committee determined that the planning area could be segmented into four regions that would make it easy for citizens to attend public meetings. Public meetings were held in each of the four regions during the week of September 8, 2009, to gage the public's perception of risk and to validate the risk assessment for the plan. Planning partners, Steering Committee members and the planning team were present to answer questions. Meetings were held in an open house format to give citizens a good opportunity to interact directly with the planning team and members of the Steering Committee.

The reasons for planning and the information generated for the risk assessment were shared with attendees via a short presentation by the planning team. Tables were set up for each primary hazard to which the county is most vulnerable. Attendees could see risk-based information pertinent to their geographical location. Each citizen had the opportunity to ask questions and to provide feedback to the planning team. Local media outlets were informed of these open houses by a formal press release and were in attendance during these sessions.

Figure 4-2. Public Meeting #1, September 8, 2008

Figure 4-3. Public Meeting # 3, September 10, 2008

Draft Plan Public Comment period

Once the draft plan was assembled, a public comment period was initiated on April 12, 2010 to receive public input through April 26, 2010. The draft plan was posted on the Crescent City website for the two-week public comment period. A press release advertising this public comment period was disseminated by Crescent City prior to this comment period. Once pre-adoption approval was granted by both CalEMA and FEMA Region IX, the public was provided an additional opportunity to provide comment on the plan via the adoption processes followed by both the County and Crescent City. Both jurisdictions follow an adoption process that requires an opportunity for public comment prior to submittal to their respective governing bodies for adoption.

Press Releases

Prior to all of the public meetings, press releases containing information on the meeting's time, location and purpose were disseminated throughout the planning area. The following media outlets serve Del Norte County:

- The Daily Triplicate (Newspaper)—Circulation averages 6,000 copies/day
- KPOD (Radio Station)—AM 1240, 778 Watts
- KPOD-FM (Radio Station)—FM 97.9, 6000 Watts
- KCRE (Radio Station)—FM 94.3, 25,000 Watts

Internet

A Hazard Mitigation Plan website was set up to keep the public posted on plan development milestones and to solicit information pertinent to the development of the plan. This site was part of County Office of Emergency Services page and the address was publicized in all press releases, mailings, questionnaires and public meetings:

http://www.dnco.org/cf/pubweb1.cfm?topic=Handling%20Emergencies

The web site provided information on the Steering Committee, planning partners, meetings, the planning process, the DMA, and drafts of the plan. The County intends to keep a website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

4.1.4 Stakeholders

Stakeholders are individuals, agencies and jurisdictions that have a stake in the recommendations of the plan. Each Del Norte County planning partner is considered a stakeholder in this plan. An effort was also made to include traditional stakeholders in this process by their inclusion on the Steering Committee. This helped lead to a successful public involvement strategy.

4.2 RESULTS OF PUBLIC INVOLVEMENT

4.2.1 Public Meetings

Details of attendance and comments received from the four public meetings held during this process are provided in Appendix C of this volume. Table 4-1 summarizes this data.

TABLE 4-1.
SUMMARY OF PUBLIC MEETINGS

Date	Location	Number of Citizens in Attendance	Number of Coalition Partners/Steering Committee/ Planning Team Members	Number of Comments received
September 8, 2008	Crescent City	8	3	1
September 9, 2008	Gasquet	17	3	2
September 10, 2009	Smith River	7	3	None
September 11, 2009	Klamath	7	2	None
Total		**39**	**11**	**3**

4.2.2 Natural Hazards Preparedness Questionnaire

Detailed analysis of the questionnaire findings can be found in Appendix B of this volume. The following is a summary of questionnaire response:

- Number of questionnaires disseminated—2069
- Total questionnaires analyzed—185
- Return Rate—11.2 percent.

CHAPTER 5.
GUIDING PRINCIPLE, GOALS AND OBJECTIVES

5.1 BACKGROUND

Federal emergency management regulations require a hazard mitigation plan to identify goals for reducing or avoiding long-term vulnerabilities to identified hazards (44CFR Section 201.6.c(3i)). The Steering Committee held a facilitated planning process to establish a guiding principle, a set of goals and measurable objectives for this plan. The process was based on data from the preliminary *Risk Assessment for the Del Norte County Planning Area* and the results of the public involvement strategy. Once a clear definition of mitigation was agreed upon by the Steering Committee, a list of issues that this plan should attempt to address was identified. The common issues identified by all were as follows:

- Potential damage to existing buildings
- New growth and development in identified hazard areas
- Environmental impacts
- Pooling resources
- Isolation
- Economic impact of hazard events.

The Steering Committee selected a guiding principle, goals and objectives to address these issues and guide the mitigation strategies of this plan.

5.2 GUIDING PRINCIPLE

A guiding principle focuses the range of objectives and actions to be considered. This is not a goal because it does not describe an outcome, and it is broader than a hazard-specific objective.

The Steering Committee selected the following guiding principle for the Crescent City/Del Norte County Hazard Mitigation Plan:

> **“**Reduce the vulnerability to natural hazards in order to protect the health, safety, welfare and economy of Del Norte County.”

5.3 GOALS AND OBJECTIVES

For the purposes of this plan, goals and objectives are defined as follows:

- **Goals** are general guidelines that explain what benefits are to be achieved. They are broad, long-term, policy-type statements and represent global visions. The success of a plan should be measured by the degree to which its goals have been met (that is, by the actual benefits achieved in terms of hazard mitigation).
- **Objectives** are short-term aims which, when combined, form a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

5.3.1 Goals

The Steering Committee identified the following goals for the Crescent City/Del Norte County Hazard Mitigation Plan:

1. Save or protect lives from the impact of natural hazards
2. Protect property from the impact of natural hazards
3. Protect the environment
4. Maintain economic viability after a disaster event
5. Promote efficient use of public funds.

5.3.2 Objectives

The Steering Committee selected objectives that would meet multiple goals, as listed in Table 5-1. The objectives serve as a stand-alone measurement of a mitigation action, rather than as a subset of a goal. Achievement of the objectives will be a measure of the effectiveness of a mitigation strategy. The objectives also are used to help establish priorities.

TABLE 5-1.
CRESCENT CITY/DEL NORTE COUNTY HAZARD MITIGATION PLAN OBJECTIVES

Objective Number	Objective Statement	Goals for which it can be applied
O-1	Consider the impacts of natural hazards in all planning mechanisms that address current and future land uses within Del Norte County.	1, 2, 3, 4
O-2	Sustain reliable local emergency operations and facilities before during and after a disaster.	1, 2, 4, 5
O-3	Pursue implementation of all feasible measures that reduce the risk exposure of public and private property within Del Norte County.	1, 2, 3, 4, 5
O-4	Seek mitigation projects that provide the highest degree of natural hazards protection in a cost-effective manner.	1, 2, 4, 5
O-5	Inform the public on the natural-hazard risk exposure and ways to increase the public's capability to prepare for, respond to, recover from, and mitigate the impacts of natural-hazard events.	1, 2, 4, 5
O-6	Increase resilience and the continuity of operations of identified critical facilities within Del Norte County.	1, 2, 4, 5
O-7	Consider codes that require new construction to take into account the impacts of natural hazards.	1, 2, 3
O-8	Utilize the best available data, science and technologies to improve understanding of the location and potential impacts of natural hazards, the vulnerability of building types, community development patterns, and the measures needed to protect life safety.	1, 2, 3
O-9	Enhance emergency management capability within the planning area.	1, 2, 4, 5
O-10	Address identified/known repetitive losses within the planning area.	1, 2, 5

CHAPTER 6.
PLAN ADOPTION

Federal emergency management regulations require documentation that a hazard mitigation plan has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan (44CFR Section 201.6.c(5)). For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. Pre-adoption approval of the plan was granted by the California Emergency Management Agency on _________, and by FEMA Region IX on _______. The plan adoption window for all 14 planning partners was from ________ to ________. The All 14 planning partners had completed the adoption process by ______, and the final adoption package was provided to the California Emergency Management Agency on _____. All planning partners are considered eligible for the benefits afforded under the Disaster Mitigation Act as of ______. Copies of the resolutions adopting this plan for all eligible partners can be found in Appendix C of this volume.

CHAPTER 7.
PLAN MAINTENANCE

7.1 OVERVIEW

Federal emergency management regulations require a hazard mitigation plan to provide a plan maintenance process that includes the following (44CFR, Section 201.6.c(4)):

- A method and schedule for monitoring, evaluating and updating the mitigation plan within 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 of how the community will continue public participation in the plan maintenance process.

This plan's format allows the Planning Partnership to review and update sections when new data become available. New data can be easily incorporated, resulting in a plan that will remain current and relevant. Plan maintenance is the formal process for achieving the following:

- Ensuring that the hazard mitigation plan remains an active and relevant document and that the Planning Partnership maintains its eligibility for applicable funding sources
- Monitoring and evaluating the plan annually and producing an updated plan every five years
- Integrating public participation throughout the plan maintenance and implementation process
- Incorporating the mitigation strategies outlined in this plan into existing planning mechanisms and programs, such as any relevant comprehensive land-use planning process, capital improvement planning process, and building code enforcement and implementation.

7.2 PLAN IMPLEMENTATION

The effectiveness of the Crescent City/Del Norte County Hazard Mitigation Plan depends on the implementation of the plan and incorporation of the outlined action items into all partners' existing plans, policies, and programs. The hazard mitigation plan includes a range of action items for reducing loss from hazard events that partners can choose to implement over the next five years. The planning team and Steering Committee have prioritized identified mitigation actions that will be implemented through existing plans, policies, and programs.

The Del Norte County Department of Community Development and the Office of Emergency Services (OES) will assume lead responsibility for planning and facilitating hazard mitigation plan implementation and maintenance meetings. Plan implementation and evaluation will be a shared responsibility among all Planning Partnership members and agencies identified as lead agencies in the mitigation action plans.

7.3 STEERING COMMITTEE

An ongoing committee with representation similar to the initial Steering Committee should have an active role in the maintenance strategy for the hazard mitigation plan. A steering committee of not more than 17 members should include representation from the Partnership, the citizens of county, and other stakeholders. The committee will convene two times a year at a place and time to be determined to implement annual review procedures outlined below.

7.4 ANNUAL PROGRESS REPORT

The new Steering Committee's annual review of the progress of the plan will include the following:

- Summary of any hazard events that occurred during the prior year and their impact on the planning area
- Review of successful mitigation initiatives identified in the plan
- Brief discussion about why targeted strategies were not completed
- Re-evaluation of the action plans to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term project because of funding availability)
- Recommendations for new projects
- Changes in or potential for new funding options (grant opportunities)
- Impact of any other planning programs or initiatives that involve hazard mitigation.

FEMA's Community Rating System (CRS) requires a 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 the annual progress report between June and September. The planning team will create a template to guide the new Steering Committee in preparing a progress report, and the committee will provide information to complete the template. All planning partners will be responsible for submitting progress reports to the planning team using the template. *Failure of a planning partner to show progress on initiatives may result in that partner being deemed ineligible under the provisions of the DMA.* The planning team will then prepare a formal annual progress report, to be used as follows:

- Posted on the website dedicated to the hazard mitigation plan
- Provided to local media through a press release
- Presented in the form of a council/board report to all participating jurisdictional governing bodies
- Provided as part of the CRS annual re-certification package.

7.5 PLAN UPDATE

Federal emergency management regulations require that local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits awarded under the Disaster Mitigation Act (44CFR Section 201.6.d(3)). The Partnership intends to update the plan on a five-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than 5 years based on the following triggers:

- A presidential disaster declaration that impacts the planning area
- A hazard event that causes loss of life
- A comprehensive update of a participating jurisdiction's general plan

It will not be the intent of the update process to develop a complete new hazard mitigation plan. Based on needs identified by the planning team, the update will, at a minimum, include the following elements:

- The update process will be convened through the new Steering Committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- Action plans will be reviewed and revised to account for any initiatives completed, dropped, or changed and to account for changes in the risk assessment or Partnership policies identified under other planning mechanisms (such as the general 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.
- Partners' governing bodies will adopt their respective portions of the updated plan.

7.6 CONTINUING PUBLIC INVOLVEMENT

The public will continue to be apprised of hazard mitigation activities through the website and the annual progress reports provided to the media. Copies of the plan will be distributed to the Del Norte County Library System. Upon initiation of the plan update process, a new public involvement strategy will be initiated based on guidance from the new Steering Committee. This strategy will be based on the needs and capabilities of the Partnership at the time of the update. At a minimum, this strategy will include the use of local media outlets in the planning area.

7.7 INCORPORATION INTO OTHER PLANNING MECHANISMS

The planning partners, through adoption of general plans and zoning ordinances, have planned for the impact of natural hazards, and these documents are considered to be integral parts of this hazard mitigation plan. The hazard mitigation planning process provided the partners with an opportunity to review and expand on policies contained within these documents, based on the best science and technology available at the time this plan was prepared. The partners should use their general plans and the hazard mitigation plan as complementary documents to achieve the ultimate goal of reducing risk exposure to citizens of the planning area. A comprehensive update to a general plan may trigger an update to the hazard mitigation plan. Other partner planning processes and programs that should be coordinated with the recommendations of this plan include the following:

- Emergency response plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments.

Some action items do not need to be implemented through regulation but can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation.

PART 3—RISK ASSESSMENT

CHAPTER 8.
INTRODUCTION TO RISK ASSESSMENT

"What would happen if a natural disaster occurred in Del Norte County?" Answering this fundamental question is the cornerstone of hazard mitigation planning. 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 focuses on the following elements:

- Hazard identification—The systematic use of all available information to determine what types of disasters may affect a jurisdiction, how often these events can occur, and the potential severity of their consequences.
- Vulnerability identification—The process of determining the impact of these events on the people, property, environment, economy and lands of a region
- Estimation of the cost of damage or cost that can be avoided through mitigation.

In addition to benefiting mitigation planning, the identification of potential hazards and vulnerable assets allows emergency management personnel to establish early response priorities.

The risk assessment for the Crescent City/Del Norte Hazard Mitigation Plan evaluates the risk of the following natural hazards prevalent within the planning area:

- Dam failure
- Earthquake
- Flooding
- Landslide
- Severe weather
- Tsunami
- Wildland fire.

CHAPTER 9.
DEL NORTE COUNTY PROFILE

9.1 INTRODUCTION

Del Norte County is at the far northwest corner of the State of California on the Pacific coast, adjacent to Oregon. The county's name (commonly pronounced *del nort*) is from the Spanish for "the land of the north" (*la tierra del norte*). Because of its rugged terrain and sparse population, it is one of the least known areas in California. The county is known for its recreational fishing and hunting areas and for its natural wonders, in particular the coastal redwoods, scores of unique plants and flowers, dozens of species of coastal birds, rocky, primitive beaches and sea stacks, pristine rivers, and historic lighthouses. The county seat is Crescent City, the county's only incorporated city.

9.2 HISTORICAL OVERVIEW

The first Europeans to explore the Del Norte County area were most likely the Spanish who arrived by ship in the 17th and 18th centuries. The area was described by George Vancouver in his journal in 1792. The first American to explore the region was Jedehiah Smith in the early 1800s. Smith and his party of trappers were the first to reach the area overland on foot. The party established trade with the Native Americans of the region, discovered Lake Earl and established base camps in the area now known as Crescent City.

In 1848, gold was discovered along the Trinity River by Major Pierson B. Reading. By 1850, northwestern California, including the Del Norte County area, was teeming with miners. Klamath City, at the mouth of the Klamath River, was founded in 1851 and was intended to be a port city and provide access to the gold-rich back country. However, shifting sand bars at the mouth of the river made navigation uncertain and the town was deserted soon after.

The Town of Crescent City was established in 1853 by J.F. Wendell, who was issued a land warrant for 230 acres. Crescent City became a bustling shipping and trade center, catering to and supplying the miners. In 1855 Congress authorized the building of a lighthouse at "the battery point" (a high tide island on the coast of Crescent City) to facilitate the use of Crescent Bay as a harbor. This lighthouse is still functioning today as an historic landmark.

Gold discoveries in the immediate vicinity of Crescent City and along the south fork of the Smith River fueled a major growth boom in the Del Norte County area. However, within a few years, a decline in the production from local mines and the opening of more promising fields elsewhere in the state drew all but a handful of miners from the area. By the late 1850s, the population boom for Del Norte County was over. Del Norte County was officially founded in 1857, from part of the Territory of Klamath County.

9.3 GEOGRAPHICAL SETTING

Del Norte County is the northernmost county along California's coast line. The county is bounded on the north by Curry County, Oregon; on the east by Siskiyou County; on the south by Humboldt County and on the west by the Pacific Ocean. The county encompasses 1,070 square miles, 80 percent of which is forestlands, protected redwoods and recreation areas. Most of the county is located in Six Rivers National Forest. Elevations in the county range from sea level to 6,424 feet at Bear Mountain along the county's eastern boundary. Geographically, the county is defined by its coastal plain, mountainous region and rivers.

9.3.1 Planning Regions

The Del Norte County General Plan divided the county into five regions for planning purposes:

- **Smith River**—The Smith River region is in the northwestern portion of the county. Its boundaries are the Oregon border to the north, the Pacific Ocean to the west, the Smith River National Recreation Area to the east, and the Smith River to the south. Approximately 75 percent of the region has mountainous terrain; the remaining 25 percent is in the coastal plain and in a low coastal strip from the north bank of the Smith River to the Oregon border. Much of the county's prime agricultural land, as well as the unincorporated community of Smith River, lies in this region.
- **Smith River Canyons**—The Smith River Canyons region encompasses the north-central and northeastern portions of the county. Its boundaries are the Oregon border to the north, the Smith River National Recreation Area boundary and the Humboldt meridian to the west, the Klamath region to the south, and Siskiyou County to the east. The entire planning area is mountainous and includes the majority of the Smith River and Illinois River watersheds. The unincorporated communities of Hiouchi and Gasquet are within this region.
- **Fort Dick/King Valley**—The Fort Dick/Kings Valley region is south of the Smith River region and north of the Crescent City region. Its boundaries are the Smith River to the north, the Pacific Ocean to the west, the Crescent city area to the south and the Humboldt Meridian to the east. Over 90 percent of the region is in the coastal plain, with the remaining portion in the mountainous area east of Kings Valley Road. The unincorporated community of Fort Dick, Lakes Earl and Talawa, and a portion of the county's primary agricultural area lie within the region.
- **Crescent City**—The Crescent City region is defined by the county's only incorporated city. This region is in the northwestern portion of the county between the Fort Dick and Klamath regions. It is on the coastal plain of the county and includes the southern portion of the Lake Earl area, the unincorporated portions of the Crescent City area, and half of the Crescent City Harbor. Highway 101 bisects this region. Northcrest/Lake Earl Drive, Elk Valley Road, and Washington Boulevard are the primary local transportation routes.
- **Klamath**—The Klamath region encompasses the southern portion of the county. Its boundaries are the Smith River Canyons region on the north, the Pacific Ocean on the west, the Crescent City region on the northwest, the Humboldt County border on the south, and the Siskiyou County border on the east. The region is mostly mountainous except for the river plains and estuaries of the Klamath River and its tributaries. The unincorporated communities of Klamath and Klamath Glen lie in this planning area.

9.3.2 Climate

Del Norte County is an area of moderate temperatures and considerable precipitation. Annual precipitation in the county is commonly 96 to 150 inches, with 90 percent falling between October and April. While some precipitation is in the form of snow, primarily above 4,000 feet, most is rain that soaks into forest soils, seeps into stream channels or recharges aquifers. Temperatures along the coast vary only 10 degrees from summer to winter, although a greater range is found over inland areas. The average high temperature for July is 69ºF, while the average low temperature during January is 38.4ºF.

9.3.3 Geology

Del Norte County can be divided into two topographic regions: the eastern mountainous belt in the Northern Coast Range and the Klamath Mountains; and the coastal lowlands, extending from Crescent

City to the Oregon border. The wide part of the coastal lowlands is referred to as the Smith River Plain, which encompass approximately 75 square miles.

The mountainous portion of the county, which extends to the coastline 5 miles south of Crescent City, covers 92 percent of the county. The rocks of the western portion of this mountainous terrain consist predominantly of sandstone (greywacke variety) and shale of the Franciscan Complex, an intensely sheared and dismembered assemblage of mainly marine rocks deposited 90 million to 145 million years ago. Other rocks present in lesser quantities in this assemblage are metamorphosed igneous rocks (green stones), cherts, and conglomerates. These rocks were deformed during and following their deposition. The presence of numerous shear zones within this region, combined with the abundant shales, often creates serious slope stability problems in the moist climate of Northern California. To the east of the Franciscan rocks lie the older and more variable rocks of the Klamath Mountains province. While the geology of the Klamath Mountains and Northern Coast Range has been partially mapped, many details remain obscure.

9.3.4 Soils

The soils of Del Norte County reflect the geologic materials of the Klamath Mountain province and coastal plain, the vegetation of the county's extensive forests and coastal plain, high annual rainfall and resulting hydrology, and a mild climate. The coastal plain includes most of the prime agricultural lands in the county, which are defined in the county land use plan on the basis of soils and area in contiguous ownership. The soils in the area were mapped by the University of California, Davis in 1966. The mapping identified five classifications of soil within the coastal plain:

- **Arcata Soils**—The Arcata series consists of well drained alluvial soils situated on old marine terraces. With a medium texture profile and good internal drainage characteristics, this soil type is considered good to excellent for agricultural uses. Fertilizer applications and irrigation are necessary for the production of pasture or bulbs. Arcata soils are found southeast of Crescent City, east of Lake Earl, and north of the mouth of the Smith River.
- **Carlotta Soils**—The Carlotta series consist of moderately well drained, medium-texture soils developed in alluvial materials. Only the Carlotta loam (Ca 2) is considered very good to excellent for agriculture. The major limiting factor with Carlotta soils is their generally low nutrient levels. Fertilized and irrigated pastures, however, can be productive.
- **Ferndale Soils**—Ferndale soils are some of the county's better, more extensive agricultural soils. They are medium-texture soils of recent alluvial origin and little profile development. The Ferndale silt loam (Fe 2) and Ferndale sandy loam (Fe 3) are rated for high agricultural production. Irrigation and annual applications of nitrogen and phosphate fertilizers are known to increase yields. Permanent pasture and some field crops are the predominant uses for this soil type.
- **Rowdy Soils**—The Rowdy series consists of young soils developed on alluvial fans. Rowdy loam (Ry 2, Ry 3) and Rowdy gravelly clay loam (Ry 4) are designated as very good to excellent agricultural soils. Because of generally low nutrient levels in these soils, however, annual fertilizer applications are required to maintain productivity. The principal uses of Rowdy soils are as permanent pasture and lily bulb production. Rowdy soils are located on gently sloping lands near Rowdy Creek above the Smith River and Klamath River basins.
- **Russ Soils**—Russ soils, which occur primarily along small streams, develop from sedimentary rock alluvium. The overriding factor in the utilization of Russ soils is drainage. Russ silt loam (Ru 2) and Russ fine sandy loam (Ru 3) are, however, moderately well-to-well-drained and, therefore, rated as productive soils. Pasture and supplementary feed crops are the major uses. Russ soils are located adjacent to Rowdy and Wilson Creeks.

9.4 DEMOGRAPHICS

9.4.1 Why Consider Demographics in Hazard Mitigation Plans?

It is important for hazard-related plans to consider the demographics of the communities they seek to protect. Some populations experience greater risk from hazard events not because of their geographic proximity to the hazard but because of decreased resources and/or physical abilities. Elderly people, for example, may be more likely to be injured in a disaster and are more likely to require additional assistance after a disaster. Research has shown that economically disadvantaged households, the elderly and 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.

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 a hazard event, and access to resources for post-disaster recovery. There is a need for increased awareness of these differences.

9.4.2 Del Norte County Population Trends

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is a critical part of planning because it directly relates to land needs (housing, industry, stores, public facilities and services, and transportation). Population changes are generally seen as socio-economic indicators. A growing population generally indicates a growing economy while a declining population signifies economic decline.

The California Department of Finance estimated Del Norte County's population at 29,547 as of January 1, 2009, 46th in population out of 58 California counties. The population increased an average of 1.6 percent per year between 1990 and 2000 and a total of 7.06 percent (2090 people) from 2000 to 2009.

As of January 1, 2009, 26 percent of county residents live in Crescent City, which is considered the economic center of Del Norte County. Overall growth in the city was 4.34 percent from 2000 to 2009; unincorporated areas of the county grew 7.81 percent during the same time frame. Table 9-1 shows the population of Crescent City and the rest of the county from 2000 to 2009.

TABLE 9-1.
POPULATION OF CITIES AND UNINCORPORATED COUNTY

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Crescent City	7,347	7,319	7,270	7,365	7,569	7,647	7,669	7,726	7,668	7,680
Unincorporated County	20,160	20,234	20,478	20,710	20,887	21,158	21,303	21,416	21,684	21,867
Total	**27,507**	**27,553**	**27,748**	**28,075**	**28,456**	**28,805**	**28,972**	**29,142**	**29,352**	**29,547**

Although there has been a net increase in population within the county since 1990, there have been periods of instability. As shown in Figure 9-1, population increased sharply between 1990 and 1995, but then fell between 1995 and 2000. This inconsistency is indicative of a potentially unstable economy. These population spikes could be attributed to the availability of jobs within the county.

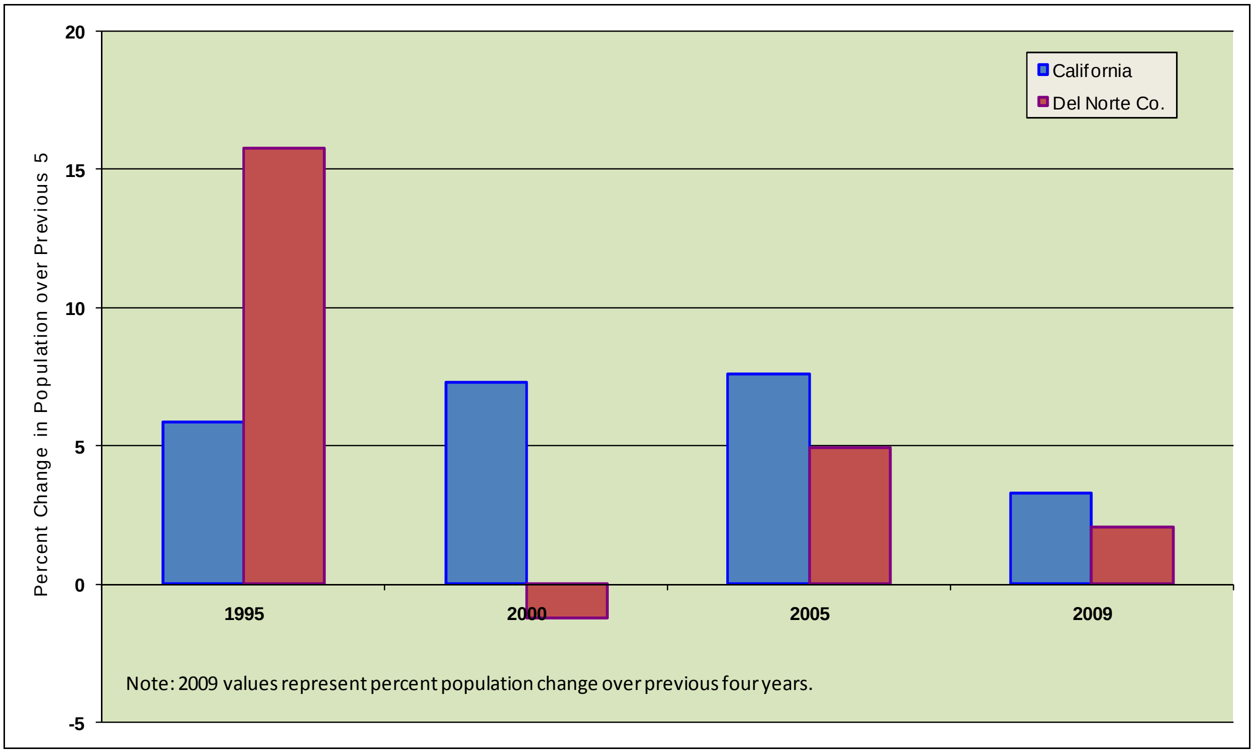


Figure 9-1. Five-Year Population Growth Rates 1990-2009

9.4.3 Income

For the purposes of this risk assessment, the Steering Committee has defined "economically disadvantaged" as households with a net annual income of $10,000 or less based on county demographic data and national standards. Economically disadvantaged populations tend to make decisions on their risk exposure based on the net economic impact on their family. It costs money for people to evacuate their homes. If the level of risk is not perceived as high, people will tend to think they will be able to "ride out" the probable impacts of hazard events.

Economically disadvantaged households also typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes, tsunamis, and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, which is particularly susceptible to damage during earthquakes. Furthermore, economically disadvantaged residents are less likely to have insurance to compensate for losses incurred from natural disasters.

According to the U.S. Census Bureau, the 2007 estimate for per capita income in Del Norte County was $16,696, and the median household income was $33,173. These figures represent 2007 dollars, adjusted for inflation. It is estimated that there are 2,133 households with less than $10,000 in income and benefits per year. This represents 19.1 percent of the county population.

9.4.4 Age Distribution

Specific attention for the elderly is an important consideration for hazard mitigation planning. As a group, the elderly face the following disadvantages in disaster preparation and response:

- They are more apt to lack physical and economic resources necessary for disaster response.

- They 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.
- They are more likely to live in assisted-living facilities, where emergency preparedness occurs at the discretion of operators. These facilities are typically identified as “critical facilities” by emergency managers because they need extra notice for evacuation.
- They are more likely to need special medical attention, which may not be available during natural disasters due to isolation caused by the event.
- They have more difficulty leaving their homes and could be stranded in dangerous situations.

According to U.S. Census Bureau data, the median age in Del Norte County is 35.6 years, and 14.1 percent of the county’s population (4,061 people) is 65 or older. This is greater than the state average of 10.5 percent. Of this group, 52 percent have disabilities of some kind, and 10.3 percent are economically disadvantaged.

Children under 14 are vulnerable because of their young age and dependence on others for basic necessities such as food, water and clothing. Very young children are also vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards. An estimated 16.5 percent of the county’s population (4,764 people) is under the age of 14. This is less than the state average of 22.8 percent.

Figure 9-2 shows the age distribution for Del Norte County.

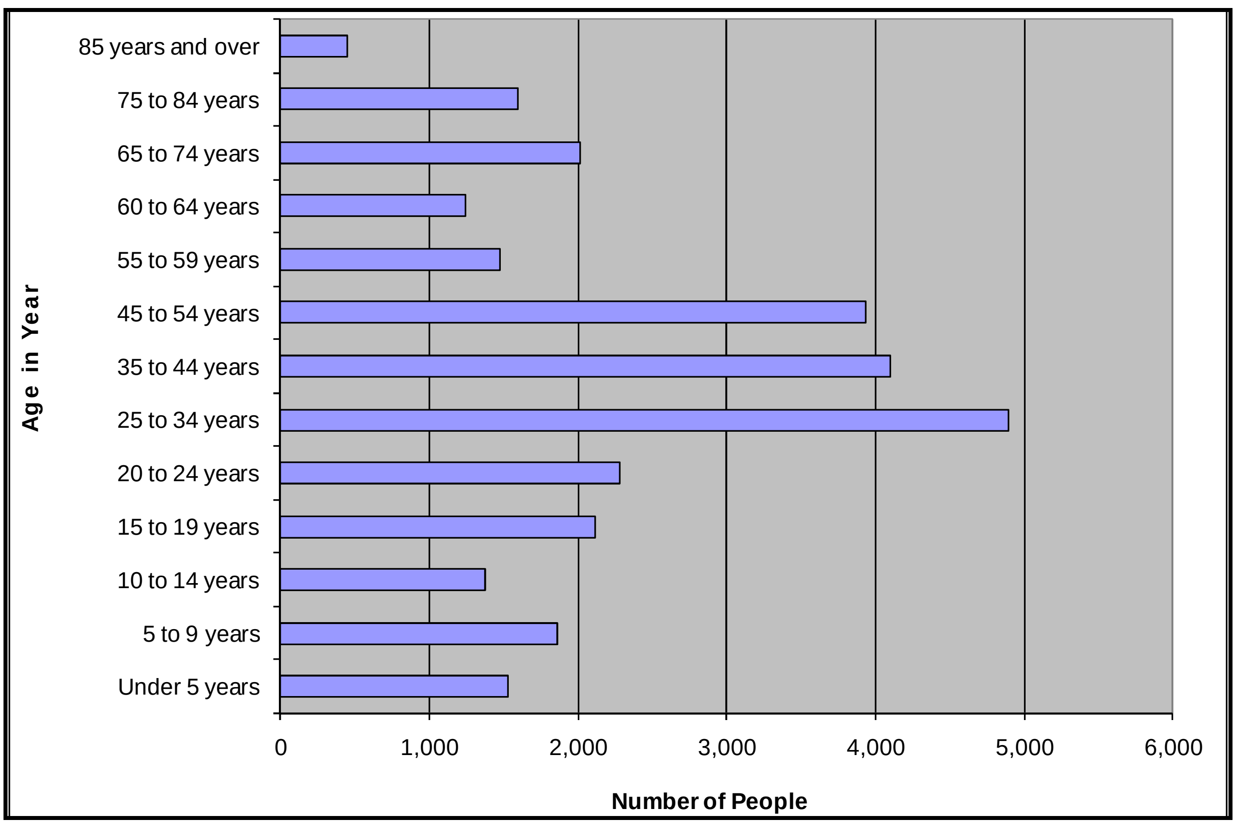


Figure 9-2. Del Norte County Age Distribution

9.4.5 Race, Ethnicity and Language

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during disaster events, and that post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Because higher proportions of ethnic minorities are economically disadvantaged than the majority white population, poverty can compound vulnerability.

Del Norte County is a racially homogenous area; about 73.8 percent of the population is listed as white according to the U.S. Census. The largest minority population is American Indian at 7.8 percent of the total county population, followed by the black/African American population at 3.3 percent. Figure 9-3 shows the racial distribution within the county.

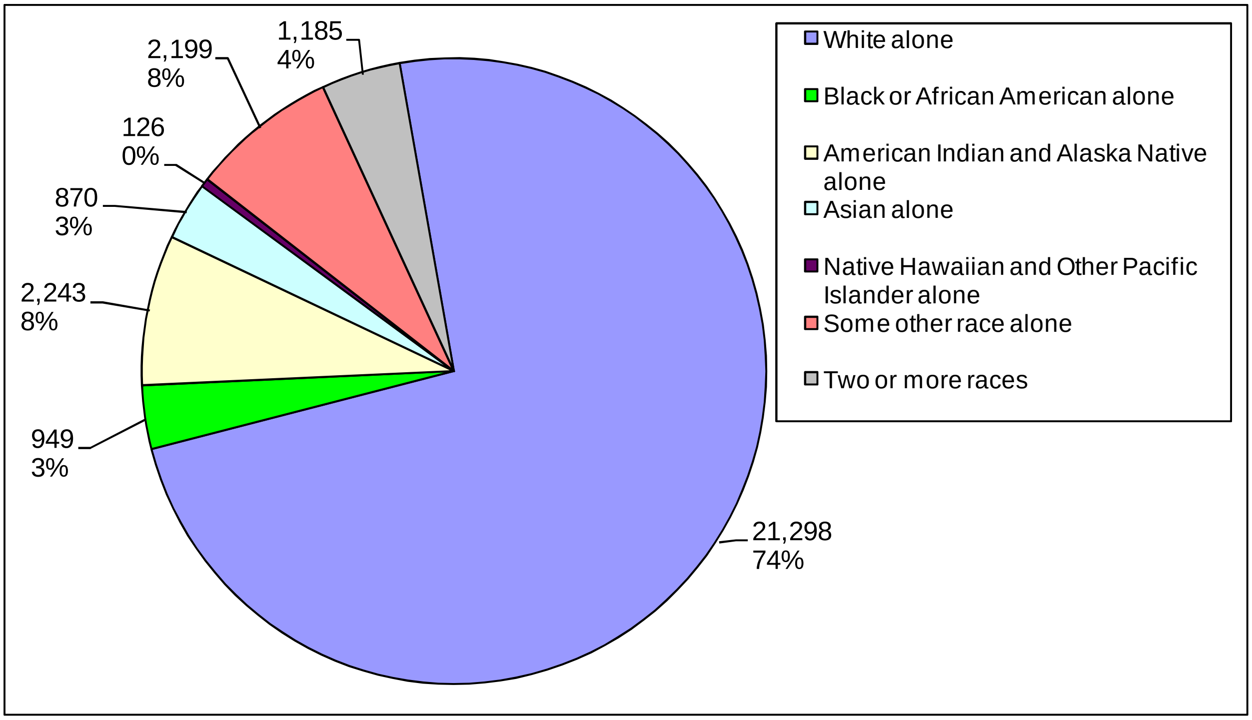


Figure 9-3. Del Norte County Race Distribution

Del Norte County has a 6.4-percent foreign-born population. According to Census data, 4.9 percent of Del Norte County's residents 5 years and older (1,332 people) reported speaking English "less than very well." The language other than English spoken by the largest group of residents was Spanish.

9.4.6 Disabled Populations

People with disabilities are significantly more likely to have difficulty responding to a hazard event than the general population. This segment of the population will require assistance during the 72 hours after a disaster event, the period generally reserved for self-help. Disabilities can vary greatly in severity and permanence, making populations difficult to define and track. There is no "typical" disabled person, which can complicate disaster-planning processes that attempt to incorporate them. Furthermore, disability is likely to be compounded with other vulnerabilities, such as age, economic disadvantage and ethnicity, all of which mean that housing is more likely to be substandard. Table 9-2 summarizes the number and percentage of Del Norte County residents with disabilities by age group.

**TABLE 9-2.
DISABILITY STATUS OF NON-INSTITUTIONALIZED POPULATION**

Age	Number of People with Disabilities	Percent of Age Group
5 to 15 years	260	7.1
16 to 64 years	3,760	22.6
65 years and over	2,049	52.4

9.5 ECONOMY

The economy of Del Norte County is a resource-extraction-oriented economy. The area's many natural resources have supported its primary industries of timber, fisheries, agriculture and recreation-tourism.

Del Norte County has experienced dramatic changes in its local economy as it has moved from a timber/lumber-based manufacturing economy to a service-sector economy. The timber industry declined dramatically between the early 1970s and mid-1990s, due largely to two critical factors: the creation and expansion of Redwood National Park and the institution of environmental regulations limiting logging activity. The county's timber mills are no longer operational and the timber that is cut from the forests is shipped elsewhere for processing.

The Crescent City Harbor was once a dynamic seaport with a strong commercial fishing industry. A combination of declining resources and strict federal and state regulations caused the fish catch to decline by 64 percent from 1991 to 2001 along the northern California coast. Since 2002, warm water is believed to be the cause of several juvenile fish kills in the Klamath River, and spawning salmon populations are well below healthy population levels in this river. In 2005, ocean salmon fishing was severely restricted from the California-Oregon state line to Point Sur, California, and it is believed that restrictions will continue. The salmon in the Smith River are at healthy population levels.

The county brought in Pelican Bay State Prison in 1990, which now accounts for about 1,476 jobs. Prison jobs account for approximately 18 percent of total county employment. Annexation of the 270-acre prison into Crescent City increased the City's population sufficiently for it to be eligible for a number of grants. Government is the predominant industry, accounting for more than 46 percent of the total employment in the county. Government jobs excluding the prison make up 28 percent of the total county workforce.

The county's recreational resources attract visitors who spend time and money in the area. Tourism is an $85 million industry in Del Norte County and it employs approximately 1,760 people. Tourism creates more jobs than any other private sector industry in the county, which demonstrates the continual transition from a resource production base to a diverse economic base led by the travel and tourism industry. Combined, the retail, transportation, leisure/hospitality and other service industries account for 26 percent of total employment in the county, supporting the tourism and recreation sector of the local economy. Private education and health industry jobs make up around 13 percent of the workforce.

The largest growth in the next few years is projected to be in services, retail trade, transportation and public utilities.

9.5.1 Employment Trends

Figure 9-4 compares Del Norte County's unemployment rate and the state rate. The county's annual average unemployment rate of 8.8 percent in 2008 was up from 2007's average annual rate of 7.5 percent.

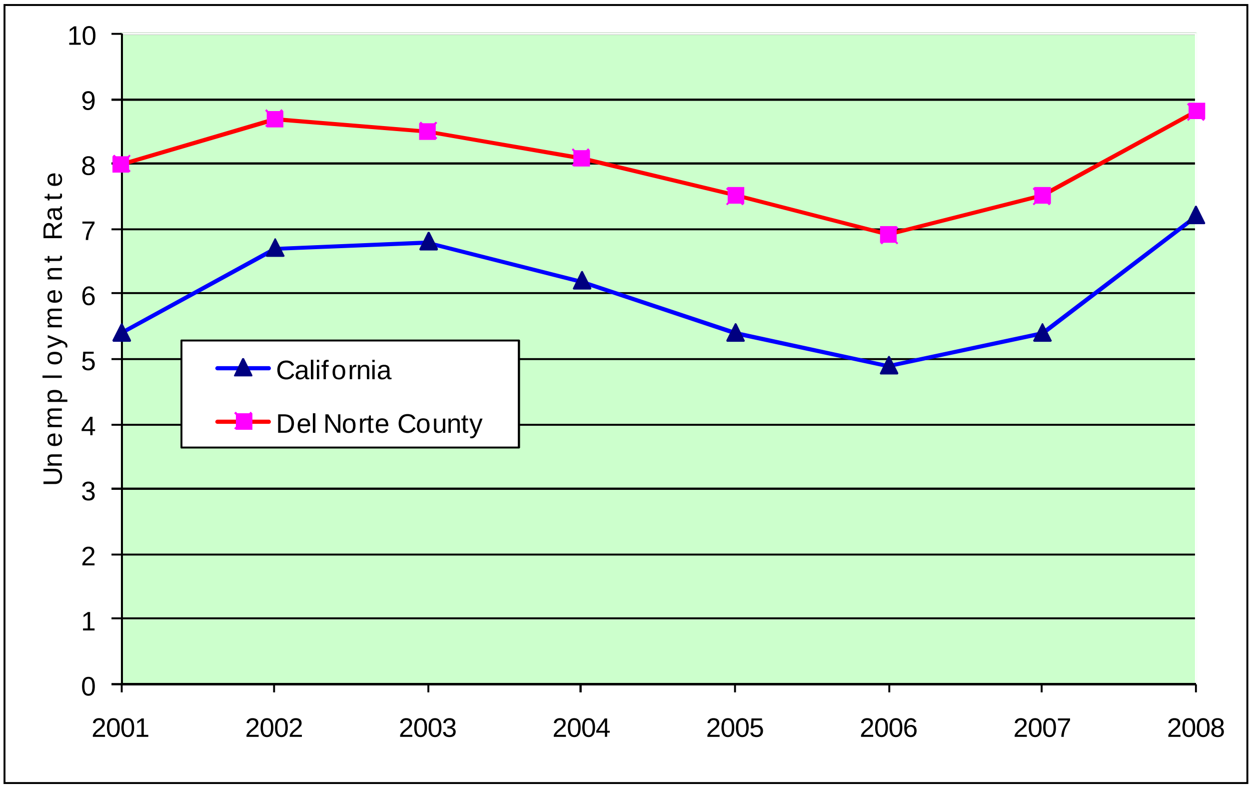


Figure 9-4. Del Norte County Employment 2001-2005

The 2008 unemployment rate peaked in December at 10.3 percent. In 2007, the rate ranged from a low of 6.9 percent in May to a high of 8.4 percent in November. The unemployment picture in Del Norte County is compounded by the fact that 24 percent of the adult population is considered functionally illiterate, according to the California State Association of Counties Handbook.

9.5.2 Industry

Figure 9-5 shows the distribution of Del Norte County employment by industry for 2005 through 2007. The educational, health and social services industry was the largest employer, employing about 26 percent of the working population. Other major employment industries included public administration (14.5 percent of the working population) and arts, entertainment, recreation, accommodation and food services (11.5 percent of the working population). Agriculture, forestry, fishing and other related industries make up 7.5 percent of employment, or about 776 jobs.

9.5.3 Occupation

In Del Norte County, the top three occupations are service occupations (29 percent), management, professional, and related occupations (26.1 percent), and sales and office occupations (20.3 percent). Farming, fishing, and forestry occupations account for only 5.8 percent of occupations in the county, a significant shift from 30 to 50 years ago when these were the top occupations in the region.

The Census estimates that mean travel time to and from work is 14.6 minutes, compared to the state average of 27 minutes. This suggests that the work force in Del Norte County lives relatively close to the workplace.

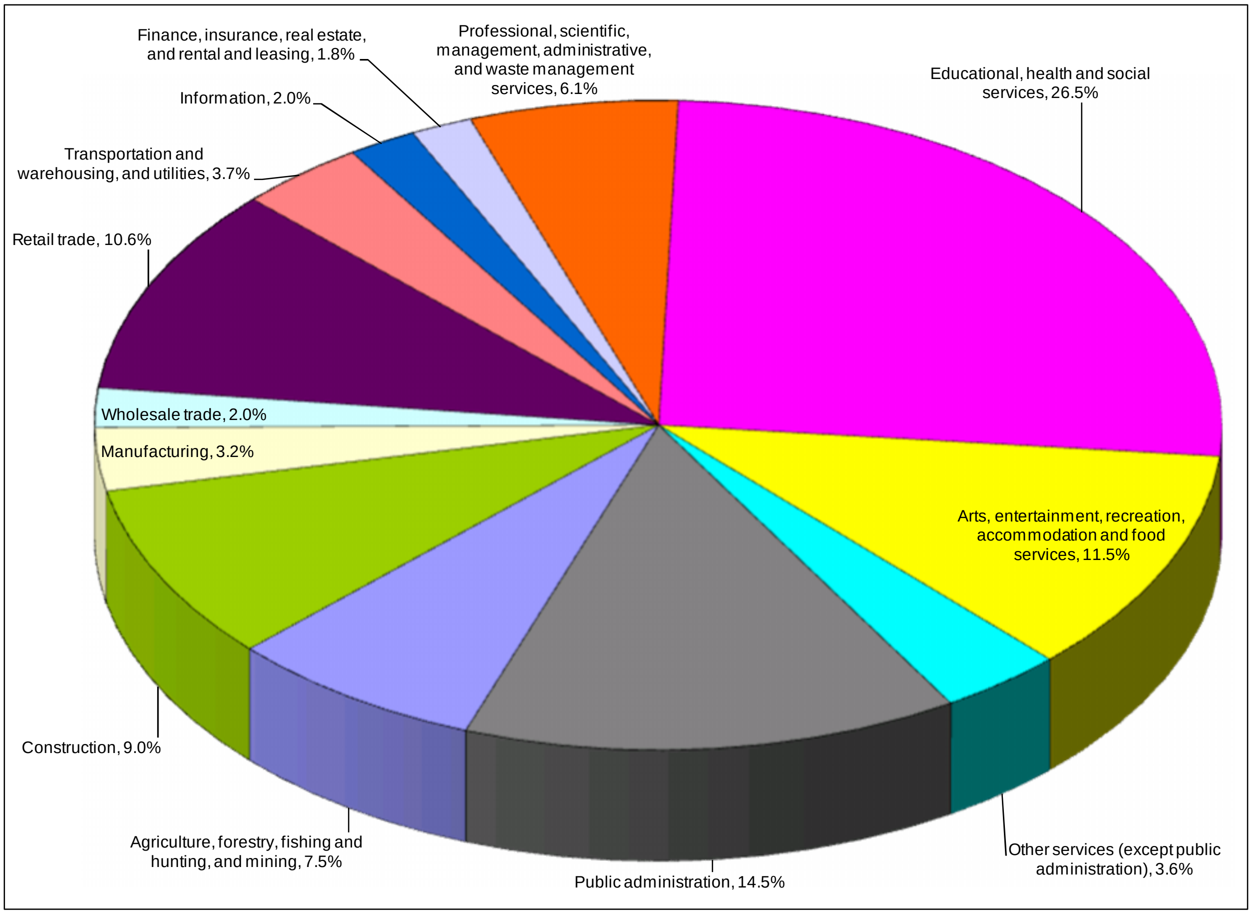


Figure 9-5. Industry in Del Norte County 2005-2007

9.6 LAWS AND ORDINANCES

This section reviews laws and ordinances that can support or impact hazard mitigation initiatives identified in this plan. It focuses on state or federal mandated programs, which tend to generate plans, studies, reports and programmatic initiatives that will augment or support the mitigation initiatives identified in this plan. The Planning Partnership for this effort is diverse in that it includes jurisdictions with permit authority, special purpose districts with junior taxing authority, and private non-profit entities. Each of these partners will individually review existing plans, studies, reports, and technical information under their jurisdiction.

9.6.1 Federal

Disaster Mitigation Act (DMA 2000)

The DMA 2000 is the latest federal legislation addressing hazard mitigation planning. It reinforces the importance of mitigation planning and emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Grant Program funds are available to communities. This hazard mitigation plan is designed to meet the requirements of DMA 2000, giving the Planning Partners eligibility for future hazard mitigation funds.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species that are 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.

The purposes of the ESA are to provide a means of conserving the ecosystems upon which endangered and threatened species depend; provide a program for conserving those species; and take steps necessary to achieve the purposes of international treaties and conventions. The policy of Congress is that 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 for a threatened species may be less restrictive than if it were endangered.
- **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**—Even when a listing has only been proposed, all federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed 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 (see the discussion below on Section 9), 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 Northwest and Northern California. Although some areas of the Pacific Northwest have been more impacted by the ESA than others due to the known presence of listed species, the entire region has been impacted, based on the presumption of the presence of listed species. This has had a tremendous impact on rural counties such as Del Norte County in that they must now take into account the impact of their programs on habitat.

The Clean Water Act

The Clean Water Act (CWA) is the cornerstone of surface water quality protection in the United States (it does not deal directly with groundwater or with water quantity issues.) The statute employs a variety of 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 waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

CWA activity over the last decade has shifted 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. Issues addressed go beyond those subject to CWA regulatory authority. Involvement of stakeholder groups in strategies for achieving and maintaining state water quality and other environmental goals is another hallmark of this approach

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting and enforcing floodplain regulations. Since its inception in 1968, the NFIP has been successful in requiring new buildings to be protected from probable damage by 100-year flood events. Requirements for participation in this program are stipulated in Parts 59 through 79 of 44CFR. Del Norte County and Crescent City participate in the NFIP and have adopted and enforced floodplain management regulations that meet or exceed the requirements of the NFIP. Compliance and good standing under the NFIP is a principle prerequisite for FEMA mitigation grant programs.

Presidential Disaster Declarations

Presidential-declared disasters are disaster events that cause more damage than state and local governments/resources can handle without federal assistance. There is not generally a specific dollar threshold that must be met. A Presidential Major Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, and designed to help disaster victims, businesses, and public entities. A Presidential Emergency Declaration can also be declared, but assistance is limited to specific emergency needs.

9.6.2 State

California General Planning Law

California state law requires that every county and city adopt a comprehensive long-range plan as a guide for community development. The general plan is mandated by state law (Cal. Gov. Code §65300 et seq.), and forms the basis for most local government land use decision-making. It expresses the community's goals, visions, and policies relative to future public and private land uses.

The plan must consist of an internally consistent set of goals, policies, and implementation measures. It must focus on issues of the greatest concern to the community and be written in a clear and concise manner. City actions—such as those relating to land use allocations, annexations, zoning, subdivision and design review, redevelopment and capital improvements—must be consistent with the plan.

Assembly Bill 162: Flood Planning, Chapter 369, Statutes of 2007

California State Assembly Bill (AB) 162 requires cities and counties to address flood-related matters in the land use, conservation, and safety and housing elements of their general plans. The land use element must identify and annually review the areas covered by the general plan that are subject to flooding as identified by floodplain mapping by either FEMA or the state Department of Water Resources (DWR). Upon the next revision of the housing element on or after January 1, 2009, the conservation element of the general plan must identify rivers, creeks, streams, flood corridors, riparian habitat, and land that may accommodate floodwater for the purposes of groundwater recharge and stormwater management. The safety element must identify information regarding flood hazards including:

- Flood hazard zones
- Maps published by FEMA, the Corps of Engineers, various state agencies, etc.
- Historical data on flooding
- Existing and planned development in flood hazard zones.

Cities and counties also must establish goals, policies and objectives to protect from unreasonable flooding risks including:

- Avoiding or minimizing the risks of flooding new development
- Evaluating whether new development should be located in flood hazard zones
- Identifying construction methods to minimize damage.

AB 162 establishes goals, policies and objectives to protect from unreasonable flooding risks and it establishes procedures for the determination of available land suitable for urban development, which may exclude lands where FEMA or DWR has determined that the flood management infrastructure designed to protect that land is not adequate to avoid the risk of flooding.

AB 2140: General Plans: Safety Element, Chapter 739, Statutes of 2006

This bill provides that the Legislature may allow for more than 75 percent of public assistance funding under the California Disaster Assistance Act only if the local agency is in a jurisdiction that has adopted a local hazard mitigation plan as part of its General Plan. The local hazard mitigation plan needs to include elements specified in this legislation. This bill requires the Governor's Office of Emergency Services to give federal mitigation funding preference to cities and counties that have adopted local hazard mitigation plans. The intent of the bill is to encourage cities and counties, through the incentive of increased reimbursement of state public assistance project costs, to create local hazard mitigation plans and to adopt them as part of the safety element of their general plans.

AB 70: Flood Liability, Chapter Number 367, Statutes of 2007

This bill provides that a city or county may be required to contribute its reasonable share toward property damage caused by a flood, to the extent that it has increased the state's exposure to liability for property damage by unreasonably approving new development in a previously undeveloped area that is protected by a state flood control project, unless the city or county meets specified requirements.

California Coastal Act

The California Coastal Act (CCA) (Public Resources Code 30000 et seq.) requires each city or county within the "coastal zone" to prepare a Local Coastal Program (LCP) for Coastal Commission certification. Once an LCP has been certified, the local government may issue coastal development permits. In the absence of an LCP for a specific city or county, coastal development permits are issued by the Coastal Commission. Coastal development permits issued by local governments are subject to appeal to the Coastal Commission.

Coastal development permits issued by the Coastal Commission prior to LCP certification must comply with wetland and other policies established under the CCA and the Coastal Commissions statewide interpretive guidelines for wetlands. These allow wetlands to be filled only for water-dependent activities when no feasible upland alternatives exist. They also require wetland impacts to be avoided or minimized. Coastal development permits issued by local governments following LCP certification must conform to wetland and other policies set forth in the certified LCP.

The CCA defines the "coastal zone" as the area of the state that extends 3 miles seaward and generally about 1,000 yards inland. In particularly important and generally undeveloped areas where there can be considerable impact on the coastline from inland development, the coastal zone extends to a maximum of 5 miles inland from mean high tide line. In developed urban areas, the coastal zone extends substantially less than 1,000 yards inland. Almost all development within the coastal zone requires a coastal development permit from either the Coastal Commission or a local government with a certified LCP.

The CCA defines wetlands as "lands within the coastal zone which may be covered periodically or permanently with shallow water and include saltwater marshes, swamps, mudflats, and fens" (Pub. Res. Code §30121). The CCA also:

- Sets forth specific uses, including restoration, for which diking, filling or dredging of wetlands may be permitted in the coastal zone.
- Provides for additional review and approvals for proposed actions within designated sensitive coastal areas.
- Directs each city or county within the coastal zone to prepare an LCP for Coastal Commission certification.

California State Building Code

California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code (BSC), is a compilation of building standards from three sources:

- Building standards that have been adopted by state agencies without change from building standards contained in national model codes

- Building standards that have been adopted and adapted from the national model code standards to meet California conditions
- Building standards, authorized by the California legislature, that constitute extensive additions not covered by the model codes and that have been adopted to address particular California concerns.

The BSC is authorized by California Building Standards Law (Health and Safety Code Sections 18901 through 18949.6) to administer the processes related to the adoption, approval, publication, and implementation of California's building codes. These building codes serve as the basis for the design and construction of buildings in California. Processes include, but are not limited to, the adoption/approval of model building codes that serve as the basis for California's building codes, the adoption/approval of building standards not addressed by model codes, and the publication of California's building codes.

The national model code standards adopted into Title 24 apply to all occupancies in California except for modifications adopted by state agencies and local governing bodies. Since 1989, the BSC has published complete editions of Title 24 every three years.

Standardized Emergency Management System

CCR Title 19 establishes the Standardized Emergency Management System (SEMS). SEMS is intended to standardize response to emergencies involving multiple jurisdictions or multiple agencies. It is intended to be flexible and adaptable to the needs of all emergency responders in California. SEMS requires emergency response agencies to use basic principles and components of emergency management, including the state's Incident Command System, multi-agency or inter-agency coordination, the operational area concept, and established mutual aid systems. State agencies must use SEMS. Local government must use SEMS in order to be eligible for state funding of response-related personnel costs. Individual agencies' roles and responsibilities contained in existing laws or the state emergency plan are not superseded by these regulations.

SEMS regulations specify that all local governments within a county geographic area be organized into a single operational area and that the county board of supervisors be responsible for its establishment. The county government serves as the lead agency of the operational area unless another member agency assumes that responsibility by written agreement with the county government. All local governments should cooperate in organizing an effective operational area, but the operational area authority and responsibility is not affected by the non-participation of any local government. The lead agency of the operational area is responsible for:

- Coordinating information, resources and priorities among the local governments within the operational area
- Coordinating information, resources and priorities between the regional level and the local government level
- Using multi-agency or inter-agency coordination to facilitate decisions.

California State Hazard Mitigation Plan

In response to DMA 2000, the state developed the California State Hazard Mitigation Plan to do the following:

- Document statewide hazard mitigation planning in California
- Describe strategies and priorities for future mitigation activities

- Facilitate the integration of local and tribal hazard mitigation planning activities into statewide efforts
- Meet state and federal statutory and regulatory requirements
- Serve as an annex to the State Emergency Plan.

This plan identifies past and present mitigation activities, current policies and programs, and mitigation strategies for the future. It also guides hazard mitigation activities by establishing hazard mitigation goals and objectives. The plan will be reviewed and updated annually to reflect changing conditions and new information, especially information on local planning activities. The Plan:

Governor's Executive Order S-13-08

Given the serious threat of sea level rise to California's water supply and coastal resources and the impact it would have on the state's economy, population and natural resources, Governor Arnold Schwarzenegger issued Executive Order S-13-08 to enhance the state's management of climate impacts from sea level rise, increased temperatures, shifting precipitation and extreme weather events. The Executive Order outlines four key actions:

- Initiate California's first statewide climate change adaptation strategy that will assess the state's expected climate change impacts, identify where California is most vulnerable and recommend climate adaptation policies by early 2009.
- Request that the National Academy of Science establish an expert panel to report on sea level rise impacts in California to inform state planning and development efforts.
- Issue interim guidance to state agencies for how to plan for sea level rise in designated coastal and floodplain areas for new projects.
- Initiate a report on critical existing and planned infrastructure projects vulnerable to sea level rise.

The Executive Order will facilitate California's first comprehensive climate adaptation strategy. This will improve coordination within state government so that better planning can more effectively address climate impacts on human health, the environment, the state's water supply and the economy.

9.6.3 Cities and County

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

CHAPTER 10.
RISK ASSESSMENT METHODOLOGY, TOOLS AND GENERAL CONCEPTS

10.1 METHODOLOGY

A risk assessment provides a foundation for a community's decision-makers to evaluate mitigation measures that can help reduce the impacts of a hazard when one occurs. The risk assessment process used for this plan is consistent with the steps presented in *State and Local Mitigation Planning How-to Guide, Understanding Your Risks – Identifying Hazards and Estimating Losses* (FEMA 386-2, 2001):

- Step 1—Identify the hazards of concern. FEMA's current regulations require an evaluation only of natural hazards. Natural hazards are natural events that threaten lives, property, and many other assets. Where they tend to occur repeatedly in the same geographical locations, natural hazards often can be predicted because they are related to weather patterns or physical characteristics of an area.
- Step 2—Prepare a profile for each hazard of concern:
  - The impacts associated with a specific hazard can vary depending on the magnitude and location of each event (a hazard event is a specific, uninterrupted occurrence of a particular type of hazard).
  - The probability of occurrence of a hazard in a given location impacts the priority assigned to that hazard.
  - Each hazard will impact different communities in different ways, based on geography, local development, population distribution, age of buildings, and mitigation measures already implemented.
- Steps 3 and 4: Evaluate community assets and which assets are exposed or vulnerable to the identified hazards of concern. Hazard profile information, combined with data regarding population, demographics, general building stock and critical facilities at risk, prepares the community to develop risk scenarios and estimate potential losses for each hazard.

This process identifies the hazards of concern and assesses the vulnerability of assets at risk in the community (population, structures, critical facilities and the economy). Chapters 11 through 17 present risk assessments for each of seven identified hazards of concern for Del Norte County.

10.2 IDENTIFICATION OF HAZARDS OF CONCERN

The Steering Committee considered the full range of natural hazards that could impact the area, and then identified and ranked the hazards that present the greatest concern. The identification process incorporated input from the County and participating jurisdictions; review of the California State Hazard Mitigation Plan and previous hazard identification efforts; local, state and federal information on the frequency, magnitude and costs associated with hazards that have impacted or could feasibly impact the region; and qualitative or anecdotal information regarding natural hazards and the perceived vulnerability of the study area's assets to them. In summary, the bases for the selection of the hazards of concern to be addressed by this plan were as follows:

- The California State Hazard Mitigation Plan identified Del Norte County as being susceptible to the hazard.

- Historical occurrence of the hazard within Del Norte County has caused fatalities, injury, or damage to property.
- There is local knowledge and perception that the hazard could significantly impact the planning area, regardless of past occurrence.

Based on review of all available resources, seven natural hazards were identified as hazards of concern for the entire planning area:

- Dam failure
- Earthquake
- Flooding (coastal and riverine)
- Landslide
- Severe weather
- Tsunami
- Wildland fire

Other natural hazards of concern have occurred within Del Norte County, but have a low potential to occur and/or result in significant impacts within the county. Therefore, these hazards will not be further addressed within this version of the Plan. However, if deemed necessary by the County, these hazards may be considered in future versions of the Plan. Each chapter elaborates on the hazard definition, the county's vulnerabilities and probable event scenarios.

Technological hazards (e.g. hazardous material incidents) and man-made hazards (e.g. terrorism) are not addressed in this plan. The DMA 2000 regulations do not require consideration of such hazards, and due to limited funding, the planning partners chose not to include them in this plan.

10.3 NATURAL HAZARD EVENT HISTORY

A review of the history of past natural hazard events can help establish the probability of reoccurrence for each hazard. Table 10-1 shows the disasters that have affected Del Norte County through 2007 (records date back to 1954).

10.4 RISK ASSESSMENT TOOLS

10.4.1 Flood, Dam Failure and Earthquake—HAZUS-MH

Overview

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 wind (hurricanes) and flood (riverine and coastal) hazards.

HAZUS-MH is a geographic information system (GIS)-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data (demographics, building stock, critical facility, transportation, utility lifelines, etc.) and multiple models to estimate potential losses from natural disasters.

TABLE 10-1.
HISTORICAL DEL NORTE COUNTY NATURAL HAZARD EVENTS

Type of Event	FEMA Disaster # (if applicable)	Date
Tsunami	DR-169	0/1/1964
Heavy rains, Flooding	DR-183	12/24/1964
Severe storms, Flooding	DR-212	1/22/1966
Tsunami	N/A	7/26/1971
Severe Storms, Flooding	DR-329	4/5/1972
Tsunami	N/A	10/3/1974
Winter Storms	DR-677	2/9/1983
Severe Storms, Flooding	DR-758	2/18/1986
Tsunami	N/A	5/7/1986
Wildland fire (lightning)	GP-1987	9/10/1987
Earthquake	DR-943	4/25/1992
Tsunami	N/A	4/25/1992
Tsunami	N/A	9/1/1994
Fishing Losses (El Nino effect)	DR-1038	9/20/1994
Severe Winter storms	DR-1044	1/13/1995
Severe Winter storms	N/A	12/9/1995
Severe storms, Flooding	DR-1155	1/4/1997
El Nino Floods	DR-1203	2/9/1998
Earthquake	N/A	3/16/2000
Earthquake	N/A	9/20/2001
Earthquake	N/A	1/13/2001
Earthquake	N/A	6/17/2002
State road damage(landslide)	GP-2003	1/1/2003
Earthquake	N/A	8/15/2003
Earthquake	N/A	6/14/2005
Severe Storms, flooding, landslides	DR-1628	2/3/2006
Earthquake	N/A	3/25/2006
Earthquake	N/A	7/16/2006
Tsunami	N/A	11/15/2006
Tsunami	N/A	1/13/2007
Earthquake	N/A	2/26/2007

The HAZUS-MH program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent platform and methodology for assessing risk across geographic and political entities.
- Provides a framework in which to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates the review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports FEMA grant application processes in calculating benefits using FEMA's definitions and terminology.
- Produces outputs that can be used to support communication and interaction with local stakeholders, a requirement of the mitigation planning process.
- The model is left with the local government and can be utilized to manage and update a hazard mitigation plan throughout its implementation.

The version used for this plan was HAZUS-MH MR3, released by FEMA in September 2007. New data and tools released with MR3 include the following:

- Building valuations updated to R.S. Means 2006
- Building counts based on census housing unit counts for single-family dwellings and manufactured housing instead of calculated building counts
- New tools in the flood model that enable the user to import user-supplied flood maps and flood depth grids or generate a flood depth grid using specified Digital Flood Insurance Rate Map (DFIRM) floodplain boundaries and digital elevation grids.

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

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

Application for This Plan

The guidance *Using HAZUS-MH for Risk Assessment: How-to Guide* (FEMA 433) was used to support the application of the model for this plan. The following methods were used to assess specific hazards:

- **Flood**—A modified Level 1 analysis was performed. The valuation of general building stock and the estimates of losses in Del Norte County were based on the default general building stock database provided in HAZUS-MH MR3, which is based on U.S. Census 2000 data. The general building stock valuations are 2006 replacement cost values from R.S. Means. An updated inventory, provided by the County and Steering and Planning Committees, was used in place of the HAZUS-MH defaults for essential facilities, transportation features, utilities and user-defined facilities. Current DFIRMs for Del Norte County (September 26, 2008) were used to delineate the flood hazard areas and estimate the population and general building stock exposed and general building stock potential losses from the 100- and 500-year flood events. Using the DFIRM floodplain boundaries and digital elevation grids, a flood depth grid was generated. The flood depth grid was integrated into the model and the riverine hydraulic analysis was run for mean return periods.

- **Dam Failure**—Dam failure inundation mapping for Del Norte County was obtained from Humboldt County. This data was imported into HAZUS-MH and a modified Level 1 analysis was run using the flood methodology described above, focusing on the 500-year floodplain within the dam failure inundation areas.
- **Earthquake**—A Level 1 HAZUS-MH analysis was performed to analyze the earthquake hazard losses for Del Norte County. An updated inventory of essential facilities, transportation features, utilities and user-defined facilities was used in place of the HAZUS-MH defaults. Earthquake maps prepared by the U.S. Geological Survey (USGS) and California Geological Survey were used for the analysis of this hazard.

10.4.2 Tsunami—Modified HAZUS-MH

Although HAZUS-MH does not directly model tsunami damage, the inputs, including damage functions may be changed to help better assess the hazard. HAZUS-MH MR3 has been adapted by Tetra Tech, Inc. to analyze the tsunami hazard. Damage functions from coastal storm surge models contained in HAZUS-MH were modified and applied to general building stock and critical facilities inventories. This level of analysis is considered to be Level 2 or higher.

To model the tsunami hazard, a tsunami hazard zone was created using state and local map data as well as reviewing historical events. This enabled the planning team to identify probable scenarios. A tsunami generated near the coast is a worst-case scenario since the public will have little to no evacuation time. California State University at Humboldt created a model that shows the possible depth of flooding and the water velocity as it strikes the coastline. This information is based on historical observed data and was developed primarily for emergency response planning and public education. At the time of this analysis, this is considered to be the best available information.

Two procedures were used to analyze and model the potential damage due to tsunami. The first procedure involved identifying the exposure to the tsunami hazard. The second procedure involved altering the HAZUS-MH coastal flood model to develop loss estimates.

To analyze exposure, the tsunami hazard zones were overlaid with the HAZUS-MH inventory. Buildings in the hazard zones were then added. This is not a true loss estimate since it shows all buildings in the tsunami hazard zone.

FEMA has developed a methodology to model storm surge during a hurricane using HAZUS-MH. This methodology involves setting up a coastal flood scenario using the surge height as the 100-year still-water elevation. After running the analysis, the 100-year results show damage due to the storm surge. A similar methodology was used to model the tsunami loss. Tsunami heights taken from the hazard zones created by Humboldt State University were input into the model as the incremental still-water elevations.

The tsunami damage functions are different from those of a typical coastal storm, but damage functions may be edited in HAZUS-MH. To edit the damage functions, the tsunami damage components were compared to those of a coastal flood. The components of a tsunami damage function include the following:

- Breaking wave forces—Breaking wave forces typically take place offshore with the exception of very steep slope beaches. Due to the beaches' physical characteristics derived from the elevation data, these forces were removed from consideration.
- Hydrostatic forces—Hydrostatic forces act on buildings during a tsunami.
- Buoyant forces—Buoyant forces act vertically through the center of mass of the displaced volume and are a major concern for wood frame buildings. This component needs to be captured for certain structures.
- Hydrodynamic forces—Hydrodynamic forces occur when steady water flows around a building. These forces are captured in the model's damage function but they need to be modified slightly. In the model's damage function, water deeper than 3 feet causes substantially more damage than water less than 3 feet. In a tsunami, there may be substantial damage below 3 feet, so this component was modified accordingly.
- Surge forces—Surge forces are caused by the leading edge of a surge of water.
- Impact forces—Impact forces are caused by debris impacting the structures. This component may be significant near piers and ports, where boats may be used as missile-like debris. HAZUS was used to identify the pier and port locations. A separate damage function was developed for census tracts near these locations.

10.4.3 Landslide, Severe Weather and Wildland Fire

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

- **Landslide**—Landslide data including slope, soil stability and historical occurrence mapping were obtained from the California Department of Conservation's Division of Geology and Mines.
- **Severe Weather**—Severe weather data involving historical events and storm patterns were obtained from the National Climatic Data Center and the National Oceanic and Atmospheric Administration (NOAA).
- **Wildland Fire**—Wildland fire data, including wildland-urban interface areas and historical fire starts, were provided by the California Department of Forestry Fire and Resource Assessment Program.

10.4.4 Limitations

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

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

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

10.5 CLIMATE CHANGE

It is generally perceived in the emergency management community that climate change will have a measurable impact on the occurrence and severity of natural hazards around the world. Impacts include:

- Higher temperatures
- Changing landscapes
- Wildlife at risk
- Sea level rise
- Increased risk of drought, fire and floods
- Stronger storms and increased storm damage
- More heat-related illness and disease
- Economic losses

All of these impacts are relevant to the Del Norte County planning area. In the preparation of this hazard mitigation plan, the Planning Partnership had two choices in addressing the impacts of climate change. The first choice was to consider climate change as a stand-alone natural hazard. This option has been used by some communities around the country, but has proven to be problematic in that it is difficult to assess the risk of this hazard due to the lack of established models and damage functions. The second choice, which was chosen by the Steering Committee, was to address climate change as a subset or secondary impact on each of the natural hazards of concern. Therefore, each chapter of this plan addressing one of the seven hazards of concern includes a section on the probable impacts of climate change for that hazard of concern. This approach is consistent with protocols established by Governor’s Executive Order S-13-08.

10.6 IDENTIFICATION OF PLANNING UNITS

The following planning units were defined to further break down Del Norte County into geographic regions for the risk assessment.

- Crescent City

- Crescent City Urban Growth Area (UGA)
- Fort Dick
- Gasquet
- Hiouchi
- Klamath
- Smith River
- Other county (unincorporated)

These planning units correlate with census block boundaries contained in the HAZUS-MH model. All risk assessment components for each hazard of concern were analyzed for each planning unit. Figure 10-1 shows the planning unit boundaries.

10.7 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 any hazard event. Critical facilities are typically defined to include police and fire stations, schools and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need and the utilities that provide water, electricity and communication services to the community. Also included are Tier II facilities and railroads, which hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event. The Steering Committee created the following definition of critical facilities and infrastructure specific to Del Norte County:

- A local (not state or federal) facility in either the public or private sector that is critical to the health and welfare of the population and that is especially important following hazard events, including but not limited to the following:
  - Structures or facilities that produce, use , or store highly volatile, flammable, explosive, toxic and/or water-reactive materials
  - Hospitals, nursing homes, and housing facilities likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a natural hazard event
  - Mass gathering facilities that may be utilized as evacuation shelters
  - Infrastructure such as roads, bridges and airports that provide sources for evacuation before, during and after natural hazard events
  - Police stations, fire stations, government facilities, vehicle equipment and storage facilities, and emergency operation centers that are needed for response activities before, during and after a natural hazard event
  - Public and private utility facilities that are vital to maintaining and restoring normal services to damaged areas before, during and after natural hazard events.

Critical facilities and infrastructure were broken down into categories associated with their function:

- Critical facilities:
  - Medical and health services
  - Government function—Government functions are those associated with continuity of operations at the federal, state or local level.

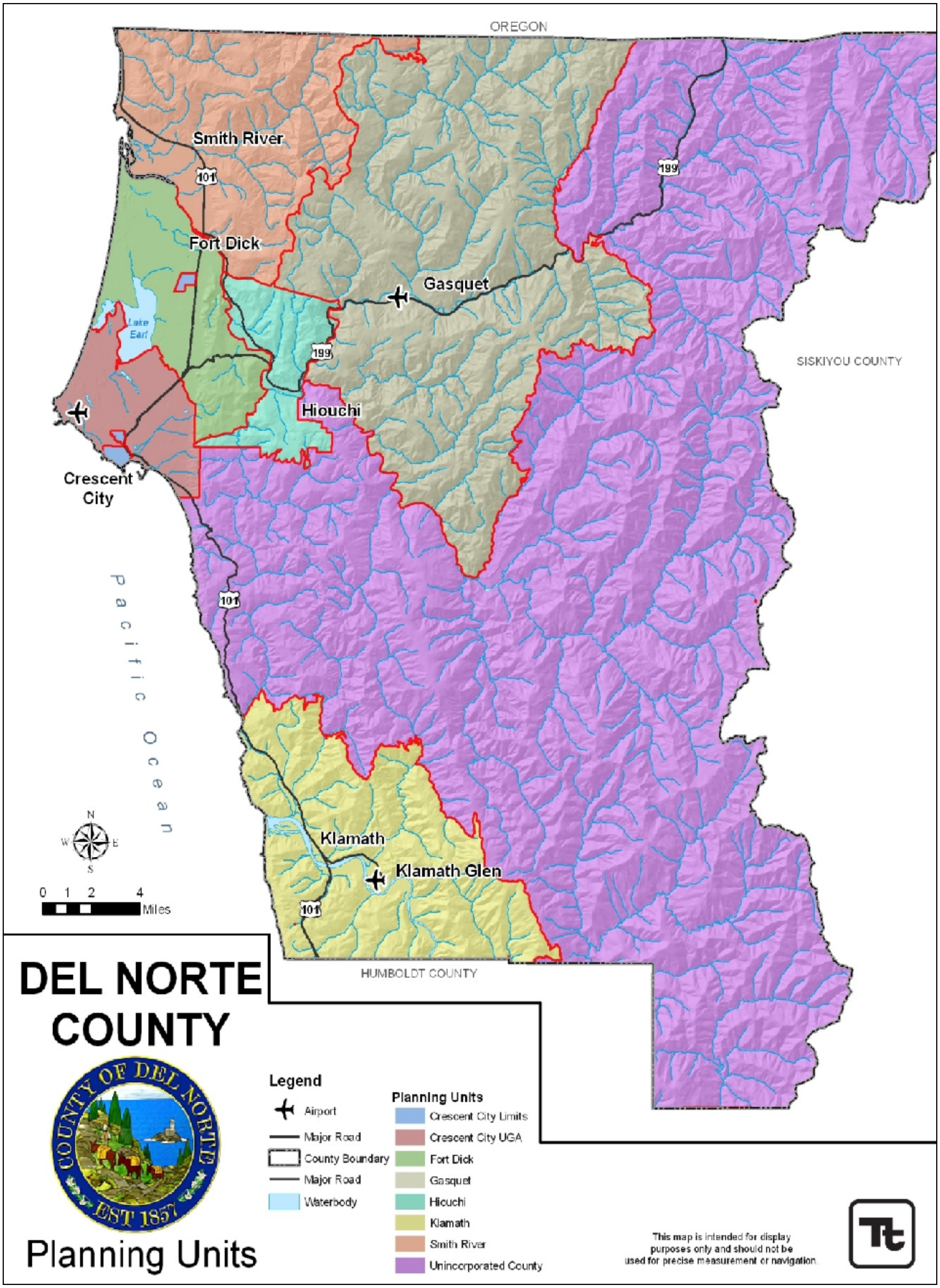


Figure 10-1. Del Norte County Planning Units

  - Protective function—Protective functions are those associated with protecting the public and include police, fire and ambulance.
  - Schools
  - Societal function—Societal functions include facilities that aid society in dealing with the impacts of natural disasters.
  - Hazmat—Facilities with potentially hazardous materials
  - Other critical function—Other critical functions include all of those facilities that have been identified to provide critical functions, but do not fit into an assigned category.
- Critical infrastructure:
  - Water supply
  - Wastewater
  - Power
  - Fuel Storage
  - Communications
  - Bridges

The planning team identified 79 critical facilities and 115 components of critical infrastructure in the planning area. Table 10-2 and 10-3 provide breakdowns of the numbers and types of facilities and infrastructure. Due to the sensitivity of this information, a detailed list of facilities is not provided in this plan. The list is on file with each of the planning partners in this effort. An exposure analysis was performed for each critical facility and infrastructure to determine the hazards likely to affect it. In each hazard discussion, critical facilities and infrastructure that are affected by the hazard are listed as exposed.

TABLE 10-2.
CRITICAL FACILITIES WITHIN DEL NORTE COUNTY

Planning unit	Medical & Health Services	Government Function	Protective Function	Schools	Societal Function	Hazmat	Other Critical Function	**Total**
Crescent City	1	12	4	2	8	1	0	**28**
Crescent City UGA	3	8	2	5	7	1	1	**27**
Fort Dick	0	0	2	2	2	0	0	**6**
Gasquet	0	0	1	1	1	0	1	**4**
Hiouchi	0	0	0	0	0	0	0	**0**
Klamath	0	0	1	1	2	0	3	**7**
Smith River	0	0	1	1	3	0	1	**6**
Other County	0	1	0	0	0	0	0	**1**
Total	**4**	**21**	**11**	**12**	**23**	**2**	**6**	**79**

TABLE 10-3.
CRITICAL INFRASTRUCTURE WITHIN DEL NORTE COUNTY

Planning unit	Water Supply	Wastewater	Power	Fuel storage	Communications	Bridges	**Total**
Crescent City	1	2	2	1	2	0	**8**
Crescent City (UGA)	3	0	3	2	12	3	**23**
Fort Dick	5	0	1	0	2	5	**13**
Gasquet	1	0	0	0	2	17	**20**
Hiouchi	2	0	0	0	0	7	**9**
Klamath	2	4	0	0	2	15	**23**
Smith River	1	0	2	0	0	6	**9**
Other County	0	0	0	0	0	10	**10**
Total	**15**	**6**	**8**	**3**	**20**	**63**	**115**

10.8 LAND USE

The total land area of Del Norte County is 1,070 square miles, and 71.7 percent of the land is in public ownership, most of it is held by the federal Government in the Smith River National Recreation Area and Redwood National Park. With extensive federal and state land ownership, the planning partners exercise land use regulatory jurisdiction over only 28.5 percent of the land in the county, as shown in Figure 10-2. This means that decisions concerning development on almost three-quarters of the land in the county are out of the control of the municipal entities under this plan. This makes strategic land use planning difficult to accomplish without extensive cooperation among the jurisdictions with regulatory control over land use for the balance of the county (federal, state and Native American governments). Land use in the planning area is dictated by the Del Norte County General Plan, dated January 28, 2003. Figure 10-3 shows the land use designations.

10.9 FUTURE TRENDS IN DEVELOPMENT

The Del Norte County planning area has experienced a sporadic rate of growth over the past 20 years, due to the area’s change from a timber-based economy to a tourism-based economy. It is anticipated that the growth rate will stabilize, with growth being low to moderate over the next 10 years. Considering these historical trends and future population projections, anticipated development trends for the planning area are considered low, consisting primarily of residential development with the exception of the Crescent City UGA (see Volume 2 for jurisdiction-specific growth trends). Higher rates of growth tend to increase demand for new development.

Del Norte County is subject to state general planning law and the California Coastal Act. These processes govern land use policy making. The County and Crescent City have adopted General Plans with their associated Safety Elements pursuant to these laws. This plan will work together with these programs to support wise land use in the future. Maintaining or enhancing the rich abundance of natural resources of Del Norte County is a high priority for its land use programs and managers.

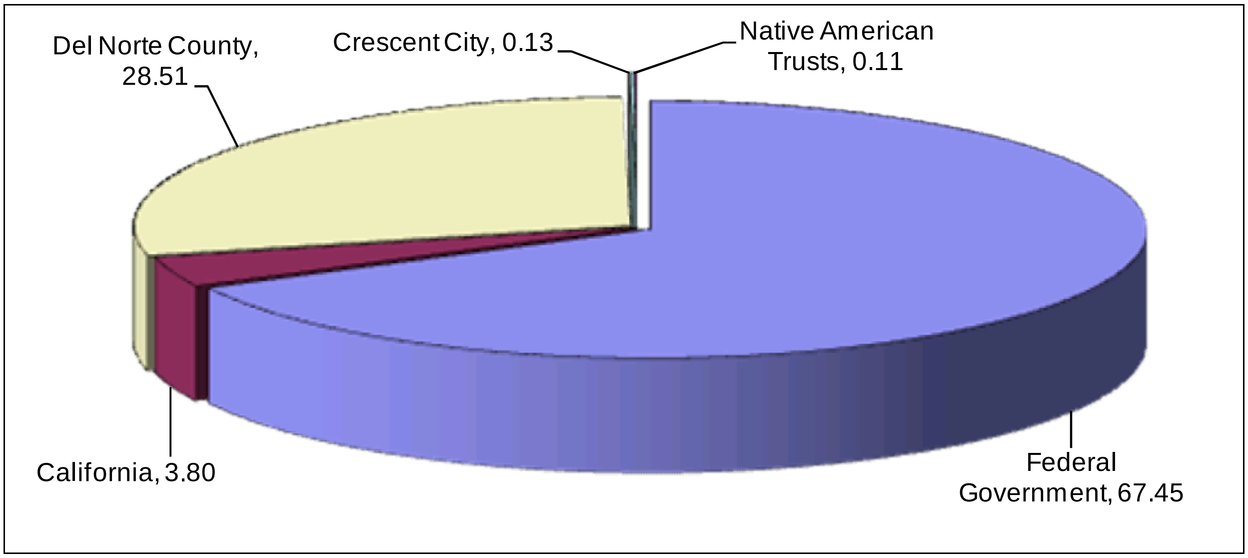


Figure 10-2. Regulatory Jurisdiction of Land within Del Norte County

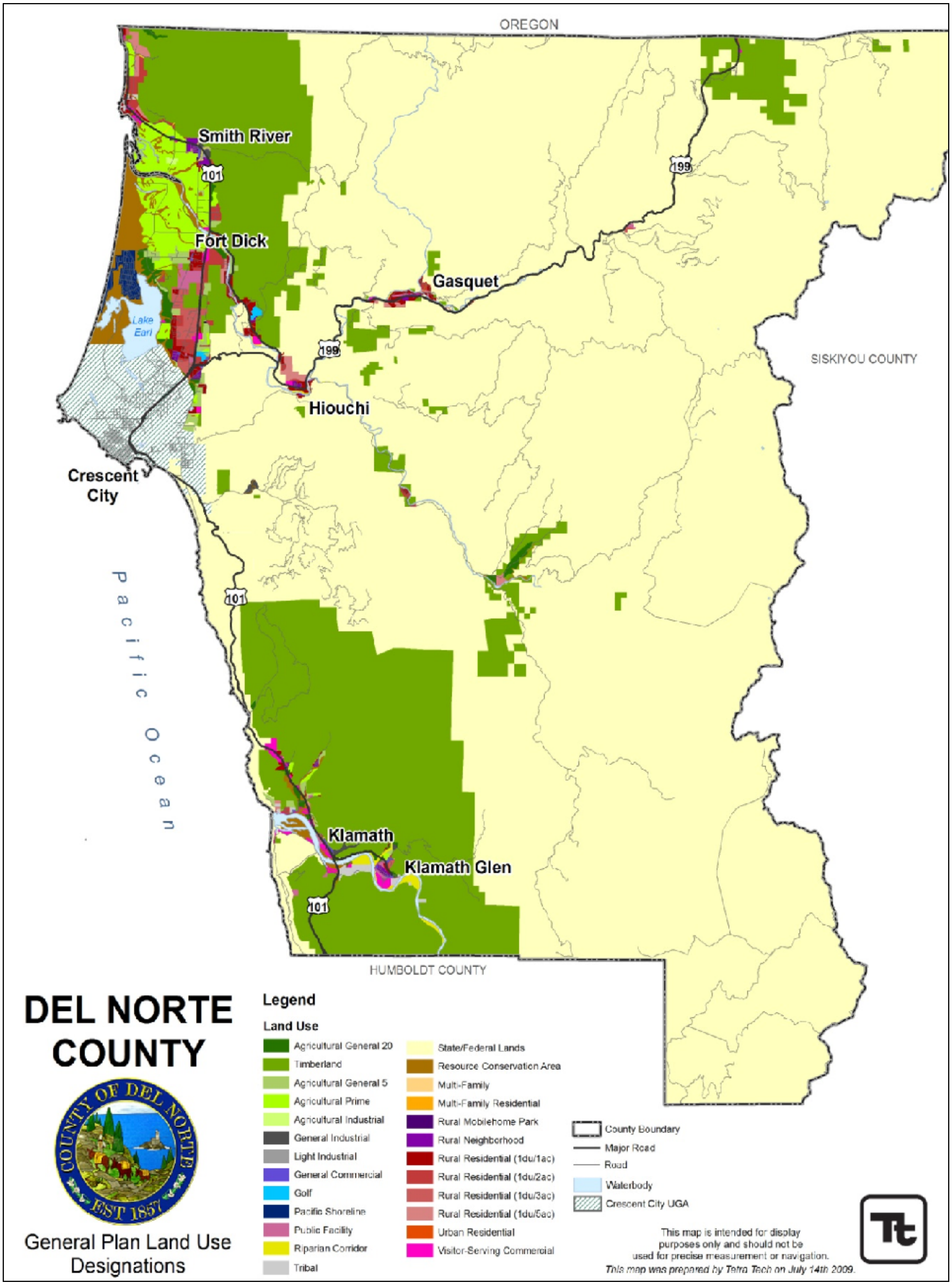


Figure 10-3. Del Norte County Land Uses

CHAPTER 11.
DAM FAILURE

11.1 DAM FAILURE DEFINED

The following definitions apply in the discussion of dam failure hazards:

- ***Dam***—Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.
- ***Dam Failure***—An uncontrolled release of impounded water due to structural deficiencies in the water barrier.

11.2 GENERAL BACKGROUND

Dam failures can be catastrophic to human life and property downstream. The potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The Corps of Engineers became responsible for inspecting U.S. dams that meet the size and storage limitations of the act, in order to evaluate their safety. The Corps inventoried dams; surveyed each state and federal agency's capabilities, practices, and regulations regarding the design, construction, operation, and maintenance of the dams; developed guidelines for the inspection and evaluation of dam safety; and formulated recommendations for a comprehensive national program (Corps of Engineers, 1997).

The National Dam Safety Program requires a thorough periodic engineering analysis of every major dam in the country. The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public. The California Department of Water Resources Division of Safety of Dams monitors the program at the state level. When a new dam is proposed, Division engineers and geologists inspect the site and the subsurface exploration to learn firsthand of the geologic conditions. Upon submittal of an application, the Division thoroughly reviews the plans and specifications prepared by the owner to ensure that the dam is designed to meet minimum requirements and that the design is appropriate for the known geologic conditions. After approval of the application, the Division inspects all aspects of the construction to ensure that the work is being done in accordance with the approved plans and specifications. After construction, the Division inspects each dam on an annual basis to ensure that the dam is performing as intended and is not developing problems. Roughly a third of these inspections include in-depth instrumentation reviews. Lastly, the Division periodically reviews the stability of dams and their major appurtenances in light of improved design approaches and requirements, as well as new findings regarding earthquake hazards and hydrologic estimates in California (DWR Website, 2007).

Dam failures in the United States typically occur in one of four primary ways:

- Overtopping of the primary dam structure, which accounts for 34 percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30 percent of all dam failures.

- Failure due to piping and seepage accounts for 20 percent of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10 percent of all failures.

The remaining 6 percent are due to other miscellaneous causes. Many of the historical dam failures in the United States were secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage. Figure 11-1 shows the distribution of dam failures by primary cause.

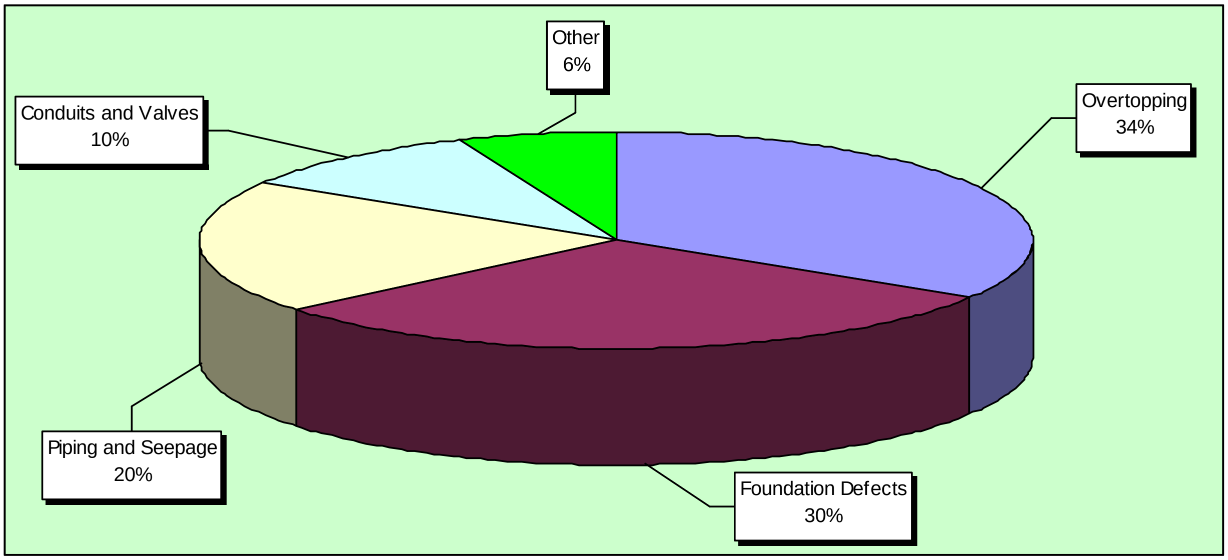


Figure 11-1. Historic Causes of Dam Failure

There are no dams in Del Norte County. However, inundation areas from dams outside the county have been identified in the southern portion of the county along the Klamath River. The most likely natural disaster related causes of dam failure that would impact Del Norte County are earthquakes, overtopping caused by excessive rainfall and landslides of dams within Siskiyou and Trinity Counties. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a conscientious program of regular inspections. Terrorism and vandalism are concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

11.3 HAZARD PROFILE

11.3.1 Past Events

No known failures have occurred on dams that impact Del Norte County. However, dam failures have occurred in California. In 1928, The Francisquito Canyon Dam near Los Angeles collapsed. The released water killed over 400 people (EDM, 2007). In 1963, the dam impounding the Baldwin Hills Reservoir, also near Los Angeles, failed and the subsequent wall of water and mud damaged or destroyed 123 homes and 670 apartment units (EDM, 2007).

11.3.2 Location

Table 11-1 lists the dams that could impact portions of Del Norte County if they were to fail. Worst-case scenarios of inundation areas are displayed in Figure 11-2. The total impact area is 22,769 acres—just over 3 percent of the total area of Del Norte County. Because stream-side and river-front properties are often more heavily populated and more highly valued than other areas, the potential impact of dam failure on human lives and land values in the county is significant and must be mitigated for.

**TABLE 11-1.
DAMS WITH INUNDATION AREAS IMPACTING DEL NORTE COUNTY**

	Copco No. 1	Copco No. 2	Iron Gate	Trinity
County	Siskiyou	Siskiyou	Siskiyou	Trinity
Water Course	Klamath River	Klamath River	Klamath River	Trinity River
Owner	PacifiCorp	PacifiCorp	PacifiCorp	U.S. Bureau of Reclamation
Year Built	1922	1925	1962	1962
Crest Elevation (feet)	2,613.00	2,484.00	2,343.00	2,395.00
Dam Type	Gravity	Gravity	Earth and Rock	Earth
Crest Length (feet)	415	148	745	2,450
Height (feet)	132	37	188	458
Storage Capacity (acre-feet)	77,000	55	58,000	2,447,650
Use	Storage, Diversion, Power	Diversion, Power	Storage, Regulation, Power	Multi-Purpose, Irrigation, Recreation, Power

11.3.3 Frequency

Dam failure events are infrequent and usually coincide with the events that may cause them, including earthquakes, landslides and overtopping due to excessive rainfall and snowmelt. No recorded dam failures have occurred to dams that impact Del Norte County.

11.3.4 Severity

Dam failure can be catastrophic to all life and property downstream. The U.S. Army Corps of Engineers developed the classification system shown in Table 11-2 for the hazard potential of dam failures.

11.3.5 Warning Time

Warning time for dam failure varies depending on conditions. In events of extreme precipitation or anticipated massive snowmelt, evacuations can be planned with sufficient time. However, it is possible that there would be no warning time in the event of a structural failure due to earthquake.

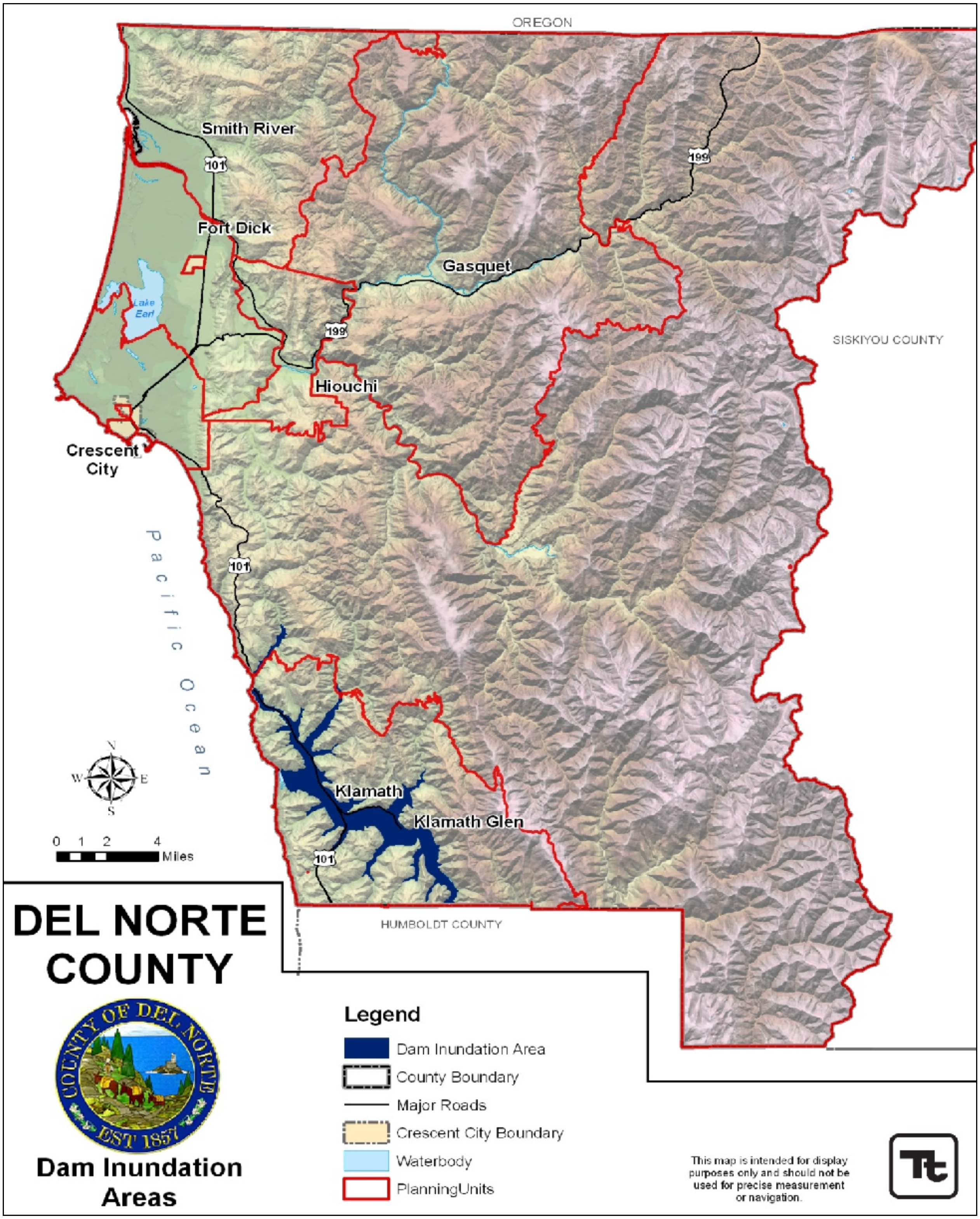


Figure 11-2. Dam Inundation Areas

TABLE 11-2.
HAZARD POTENTIAL CLASSIFICATION

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

a. Categories are based on project performance and do not apply to individual structures within a project.
b. Loss of life potential based on inundation mapping of area downstream of the project, taking into account the population at risk, time of flood wave travel, and warning time.
c. Indirect threats to life caused by the interruption of lifeline services due to project failure, or operation, i.e. direct loss of (or access to) critical medical facilities.
d. Direct economic impact of property damage to project facilities and downstream property and indirect economic impact due to loss of project services, i.e. impact on navigation industry of the loss of a dam and navigation pool, or impact upon a community of the loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond that which would normally be expected for the magnitude flood event under which the failure occurs.

Source: Corps of Engineers, 1995

A dam's structural type is a significant factor in determining warning time. Earthen dams, which outnumber all other types of dams, do not tend to completely fail, nor do they fail instantaneously. Once a developing breach has been initiated, the discharging water will erode the breach until either the reservoir water is depleted or the breach resists further erosion. Concrete gravity dams also tend to have a partial breach as one or more monolith sections formed during the dam construction are forced apart by the escaping water. The time for breach formation is in the range of a few minutes to a few hours (Corps of Engineers, 1997).

The warning time for dam failure on the Trinity and Klamath Rivers before the resulting floodwaters reach a significant area of the county will be approximately 7 hours. The number of people to be alerted and evacuated can vary tremendously. There may be few persons along the river in the winter months when only permanent residents are apt to be present, and there may be many persons in the summer when many seasonal cabins are occupied and there are fishermen and campers along all the rivers. Another factor that must be considered is the initial flow in the river when the failure occurs. The initial flow is normally very low on all the rivers from May through October. During the winter, the initial flow is much higher and at times may even be equal to or greater than flood stage. This wide variation in initial flow has a significant impact on the areas that must be evacuated.

11.4 SECONDARY HAZARDS

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

11.5 CLIMATE CHANGE IMPACTS

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

Additionally, dams are constructed with safety features know as "spillways." Spillways are put in place on dams as a safety measure so that if the reservoir fills too fast. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. Dam operators face increased probability of design failures due to weather impacts from climate change.

So while the impacts of climate change will not increase the probability of catastrophic dam failure but may increase the probability of design failures. Throughout the west and Pacific Northwest, communities downstream of dams are already seeing the impacts from climate change due to increases in stream flows from earlier releases from dams.

11.6 EXPOSURE

The Level 1 HAZUS-MH protocol was used to assess the risk and vulnerability to dam failure in the planning area using the flood module. HAZUS-MH uses census data at the block level and FEMA floodplain data. The level of accuracy of the data generated by HAZUS-MH is acceptable for planning purposes. Where possible, the HAZUS-MH data was enhanced using GIS data from county, state and federal sources.

Failure of any of the four dams that impact Del Norte County would threaten life and property to some degree. The inundation area shown in Figure 11-2 was used to determine the degree of occupancy, the value of parcels, and the number of critical facilities in inundation areas.

11.6.1 Population

Failure at any of the dams of concern is likely to cause loss of human life. All populations located in the dam failure inundation zones would be exposed to the risk of a dam failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. The estimated population living in the inundation areas is 2,478, or 8.4 percent of the county's population.

11.6.2 Property

GIS analysis was used to determine the land use types of parcels within the mapped inundation areas. These properties range from just downstream of the dams to properties on coastal riverfronts. Table 11-3 shows the land use of the parcels exposed to potential inundation due to dam failure.

TABLE 11-3.
GENERAL PLAN LAND USES WITHIN IDENTIFIED DAM FAILURE AREAS

Land Use	Land Use Code	Acres	% of Total Hazard Area
Agricultural General (20 acres)	AG-20	314.99	3.99
Agricultural General (5 acres)	AG-5	185.99	2.36
Agricultural Prime	AP	154.47	1.96
Tribal Lands	BIA	385.34	4.89
General Commercial	GC	117.25	1.49
General Industrial	GI	119.45	1.51
Multifamily Residential (6 to 15 du/ac)	MF	2.75	0.03
Public Facilities	PF	149.08	1.89
General Commercial	GC	1020.83	12.95
Resource Conservation Area	RCA	1347.24	17.08
Rural Neighborhood	RN	123.80	1.57
Rural Residential (1 du/ac)	RR1A	116.88	1.48
Rural Residential (1 du/2 ac)	RR2A	33.23	0.42
Rural Residential (1 du/3 ac)	RR3A	6.28	0.08
Rural Residential (1 du/5 ac)	RR5A	3.47	0.04
State and Federal Lands	SFL	457.51	5.80
Timberland	TBR	2734.82	34.68
Urban Lands-Residential (2 to 6 du/ac)	UR	19.66	0.25
Visitor-Serving Commercial	VSC	592.63	7.53
Totals		**7,885.67**	**100.00**

du/ac = dwelling units per acre

An estimated 973 structures are exposed to the risk of inundation in the event of dam failure. Of these, nearly 95 percent are residential.

11.6.3 Critical Facilities

GIS analysis was used to determine the number of critical facilities in the mapped dam inundation areas. As Table 11-4 shows, seven of the county’s 79 critical facilities (8.9 percent) are in the inundation areas.

11.6.4 Environment

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

TABLE 11-4.
CRITICAL FACILITIES IN DAM FAILURE INUNDATION AREAS IN DEL NORTE COUNTY

Planning unit	Medical & Health Services	Government Function	Protective Function	Schools	Societal Function	Hazmat	Other Critical Function	**Total**
Crescent City	0	0	0	0	0	0	0	**0**
Crescent City UGA	0	0	0	0	0	0	0	**0**
Fort Dick	0	0	0	0	0	0	0	**0**
Gasquet	0	0	0	0	0	0	0	**0**
Hiouchi	0	0	0	0	0	0	0	**0**
Klamath	0	0	1	0	1	2	3	**7**
Smith River	0	0	0	0	0	0	0	**0**
Other County	0	0	0	0	0	0	0	**0**
Total	**0**	**0**	**1**	**0**	**1**	**2**	**3**	**7**

11.7 VULNERABILITY

11.7.1 Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system.

11.7.2 Property

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

It is estimated that there could be up to $72.5 million of loss from a dam failure affecting the planning area. This represents 26.18 percent of the total exposure within the inundation area, or 2.9 percent of the total assessed value of the county. Table 11-5 summarizes the loss estimates for dam failure.

TABLE 11-5.
EXPOSURE LOSS ESTIMATES FOR DAM FAILURE

Planning Unit	Population Exposed	Building Count	Loss Estimate	% of Assessed value
Klamath	1,046	964	$36,278,000	1.45%
Other County	1,258	9	$36,284,000	1.45%
Total	**2,304**	**973**	**$72,562,000**	**2.9%**

11.7.3 Critical Facilities

HAZUS estimated that critical facilities would receive 10.65 percent damage to the structure and 45.27 percent damage to the contents during a dam failure event. The estimated functional down-time to restore these facilities to 100 percent of their functionality is 555 days.

11.7.4 Environment

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

11.8 FUTURE TRENDS IN DEVELOPMENT

The data required for a “buildable lands analysis” was not available at the time of the development of this plan. No rapid influx of new development in the dam failure inundation areas is anticipated in the short term. State requirements dealing with land use in identified hazard areas should help the Planning Partnership address growth pressures in these areas should they arise.

11.9 SCENARIO

In a worst-case scenario, a shallow fault-generated earthquake with a magnitude of 7.5 could be enough to cause failure of the dams that impact Del Norte County. An earthquake such as this could lead to liquefaction of the ground soils where the dams are located. This could occur without warning in the middle of the night when residents in river-front homes and campers are asleep and unprepared to evacuate. A human-caused failure such as a terrorist attack also could trigger a catastrophic failure of one of the dams that impact the planning area.

11.10 ISSUES

The most significant issue associated with dam failure involves the properties and populations in the inundation zones. Flooding as a result of a failure would significantly impact these areas. Additionally, there is often little or no warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides and severe weather, which limits their predictability and compounds the hazard.

The impacts from climate change could heighten the impact of this hazard. County emergency managers and dam operators need to collaborate as new data becomes available, to monitor these impacts as they develop.

CHAPTER 12.
EARTHQUAKE

12.1 EARTHQUAKE DEFINED

The following definition applies in the discussion of earthquake hazards:

- **Earthquake**—An earthquake is the shaking of the ground caused by an abrupt shift of rock along a fracture in the earth such as a fault or a contact zone between tectonic plates. Earthquakes are typically measured in both magnitude and intensity.

12.2 GENERAL BACKGROUND

California is seismically active because it sits on the boundary between three of the earth's tectonic plates. Most of the state - everything east of the San Andreas Fault - is on the North American Plate. Monterey, Santa Barbara, Los Angeles, and San Diego are on the Pacific Plate, which trends offshore at Cape Mendocino. North of Cape Mendocino, the offshore subducting Gorda Plate strongly influences seismicity of Humboldt and Del Norte counties. The relative movement between the Pacific and North American plates is primarily a strike-slip movement, whereas the movement between the Gorda and North American plates is primarily a thrust subduction. The area where the three tectonic plates intersect is known as the Mendocino Triple Junction.

The constant motion of the plates causes stress in the brittle upper crust of the earth. These tectonic stresses build as the rocks are gradually deformed. The rock deformation, or strain, is stored in the rocks as elastic strain energy. When the strength of the rock is exceeded, rupture occurs along a fault. The rocks on opposite sides of the fault slide past each other as they spring back into a relaxed position. The strain energy is released partly as heat and partly as elastic waves called seismic waves. The passage of these seismic waves produces the ground shaking in earthquakes.

California has thousands of recognized faults, hundreds of which have names, but only some are known to be active and pose significant hazards. The motion between the Pacific and North American plates occurs primarily on the faults of the San Andreas system and the eastern California shear zone. North of Cape Mendocino, the Little Salmon and the Mad River fault zones are seismically important.

Faults are more likely to have future earthquakes on them if they have more rapid rates of movement, have had recent earthquakes along them, experience greater total displacements, and are aligned so that movement can relieve the accumulating tectonic stresses. Geologists classify faults by their relative hazards. "Active" faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). "Potentially active" faults are those that displaced layers of rock from the Quaternary period (the last 1,800,000 years). Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault. Although there are probably still some unrecognized active faults, nearly all the movement between the two plates, and therefore the majority of the seismic hazards, are on the well-known active faults.

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

A direct relationship exists between a fault's length and location and its ability to generate damaging ground motion at a given site. In some areas, smaller, local faults produce lower magnitude quakes, but ground shaking can be strong, and damage can be significant as a result of the fault's proximity to the area. In contrast, large regional faults can generate great magnitudes but, because of their distance and depth, may result in only moderate shaking in the area.

Earthquakes are classified according to the amount of energy released as measured by magnitude or intensity scales. While several scales have been defined, currently the most commonly used are the moment magnitude (Mw), and the modified Mercalli intensity. Estimates of moment magnitude roughly agree with estimates using other scales, such as the local magnitude scale (ML) commonly called the Richter magnitude scale. One advantage of the moment magnitude scale is that, unlike other magnitude scales, it does not saturate at the upper end. That is, there is no particular value beyond which all large earthquakes have about the same magnitude. For this reason, moment magnitude is now the most often used estimate of large earthquake magnitudes. Table 12-1 presents a classification of earthquakes according to their magnitude. Table 12-2 compares the moment magnitude scale to the modified Mercalli intensity scale.

Another element of earthquake hazard assessment is the calculation of expected ground motion values. This involves determining the annual probability that certain ground motion accelerations will be exceeded, then summing the annual probabilities over the time period of interest. The most commonly mapped ground motion parameters are the horizontal and vertical ***peak ground accelerations*** (***PGA***) for a given site classification (soil or rock type). Maps of PGA values form the basis of seismic zone maps that are included in building codes, including the International Building Code (IBC) and its predecessor the Uniform Building Code.

Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" (i.e. single-family dwellings, the most common structures in Del Norte County). Maps of longer period spectral response components may also need to be developed to determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 12-3 lists the damage potential by PGA factors as compared to the Mercalli scale.

TABLE 12-1.
MAGNITUDE CLASSES

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

TABLE 12-2.
EARTHQUAKE MAGNITUDE AND INTENSITY

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

TABLE 12-3.
MERCALLI SCALE AND PEAK GROUND ACCELERATION COMPARISON

MM	Potential Damage	Estimated PGA
I	None	0.017
II-III	None	0.017
IV	None	0.014-0.039
V	Very Light	0.039-0.092
VI	None to Slight; USGS-Light	0.02-0.05
	Unreinforced Masonry-Stair Step Cracks; Damage to Chimneys; Threshold of Damage	0.04-0.08 0.06-0.07 0.06-0.13 0.092-0.18
VII	Slight-Moderate; USGS-Moderate	0.05-0.10
	Unreinforced Masonry-Significant; Cracking of parapets	0.08-0.16 0.10-0.15
	Masonry may fail; Threshold of Structural Damage	0.1 0.18-0.34
VIII	Moderate-Extensive; USGS: Moderate-Heavy	0.10-0.20
	Unreinforced Masonry-Extensive Cracking; fall of parapets and gable ends	0.16-0.32 0.25-0.30 0.13-0.25 0.2 0.35-0.65
IX	Extensive-Complete; USGS-Heavy	0.20-0.50
	Structural collapse of some un-reinforced masonry buildings; walls out of plane. Damage to seismically designed structures	0.32-0.55 0.50-0.55 0.26-0.44 0.3 0.65-1.24
X	Complete ground failures; USGS- Very Heavy (X+); Structural collapse of most un-reinforced masonry buildings; notable damage to seismically designed structures; ground failure	0.50-1.00

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, liquefaction and distance from the source of the quake. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics so that locations potentially subject to liquefaction may be identified. Table 12-4 summarizes NEHRP soil classifications.

**TABLE 12-4.
NEHRP SOIL CLASSIFICATION SYSTEM**

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

12.3 HAZARD PROFILE

Del Norte County is located within the two highest of five seismic risk zones specified by the Uniform Building Code, and offshore Cape Mendocino has the highest concentration of earthquake events anywhere in the continental United States. Nine quaternary faults have been identified in the region that could impact the planning area.

The subducting Gorda Plate and the Juan de Fuca Plate form the "Cascadia Subduction Zone," which runs north offshore of Humboldt and Del Norte Counties, Oregon, and Washington. Recent investigations have shown that this system has moved in unison in a series of great earthquakes (magnitude 8 to 9) over the last 20,000 years, most recently about 300 years ago, with events occurring at 300- to 500-year intervals. The seismic setting has the potential to cause significant ground shaking, leading to the following hazards:

- A serious liquefaction and subsidence hazard, particularly around the muds and sands of Crescent City
- A near-shore tsunami striking the coast within 15 minutes of ground-shaking
- A significant landslide hazard countywide
- Surface fault rupture along the San Andreas, and possibly along the Little Salmon and Mad River fault zones, and other active or potentially active faults in the county.

12.3.1 Past Events

According to the California State Hazard Mitigation Plan, Del Norte County has been impacted by at least one recorded earthquake between 1950 and 2003 that caused sufficient damage for the state to proclaim a state of emergency: the Cape Mendocino Earthquake on April 25, 1992, which also warranted a Presidential disaster declaration (DR-943). Table 12-5 lists seismic events with a magnitude of 5.0 or larger that were felt within the planning area since 2000.

TABLE 12-5.
RECENT EARTHQUAKES MAGNITUDE 5.0 OR LARGER FELT WITHIN DEL NORTE COUNTY

		Epicenter Location		
Date	Magnitude	Distance	Direction	Nearest City
February 26,2007	5.4	51 km	W	Ferndale, CA
July 16, 2006	5.0	6 km	WNW	Punta Gorda, CA
March 25, 2006	5.0	3 km	WNW	Punta Gorda, CA
June 14, 2005	7.2	156 km	W	Trinidad, CA
August 15, 2003	5.3	121 km	WNW	Ferndale, CA
June 17, 2002	5.27	37 km	W	Eureka, CA
September 20, 2001	5.10	80 km	WNW	Punta Gorda, CA
January 13, 2001	5.19	92 km	WNW	Ferndale, CA
March 16, 2000	5.59	N/A	N/A	Offshore Punta Gorda, Point Mendocino

Source: Earthquake Catalogs, Northern California Earthquake Data Center, 2007

12.3.2 Location

The impact of an earthquake is largely a function of the following components:

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

To map the extent and location of areas within Del Norte County considered vulnerable to seismic risk, the planning team utilized two principle tools: Probabilistic “Shake Maps” showing predicted ground motion, and soils mapping that shows the stability of soils in response to seismic events.

Shake Maps

Earthquake shaking is measured by instruments called accelerographs that are triggered by the onset of shaking and record levels of ground motion at stations throughout a region. These readings are recorded by state and federal agencies tasked with monitoring and predicting seismic activity. A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. It is probabilistic in the sense that the analysis takes into consideration the uncertainties in the size and location of earthquakes and the resulting ground motions that can affect a particular site.

The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10-percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas. Figure 12-1 shows the estimated ground motion for a 100-year probabilistic earthquake, and Figure 12-2 shows the estimated ground motion for a 500-year probabilistic earthquake.

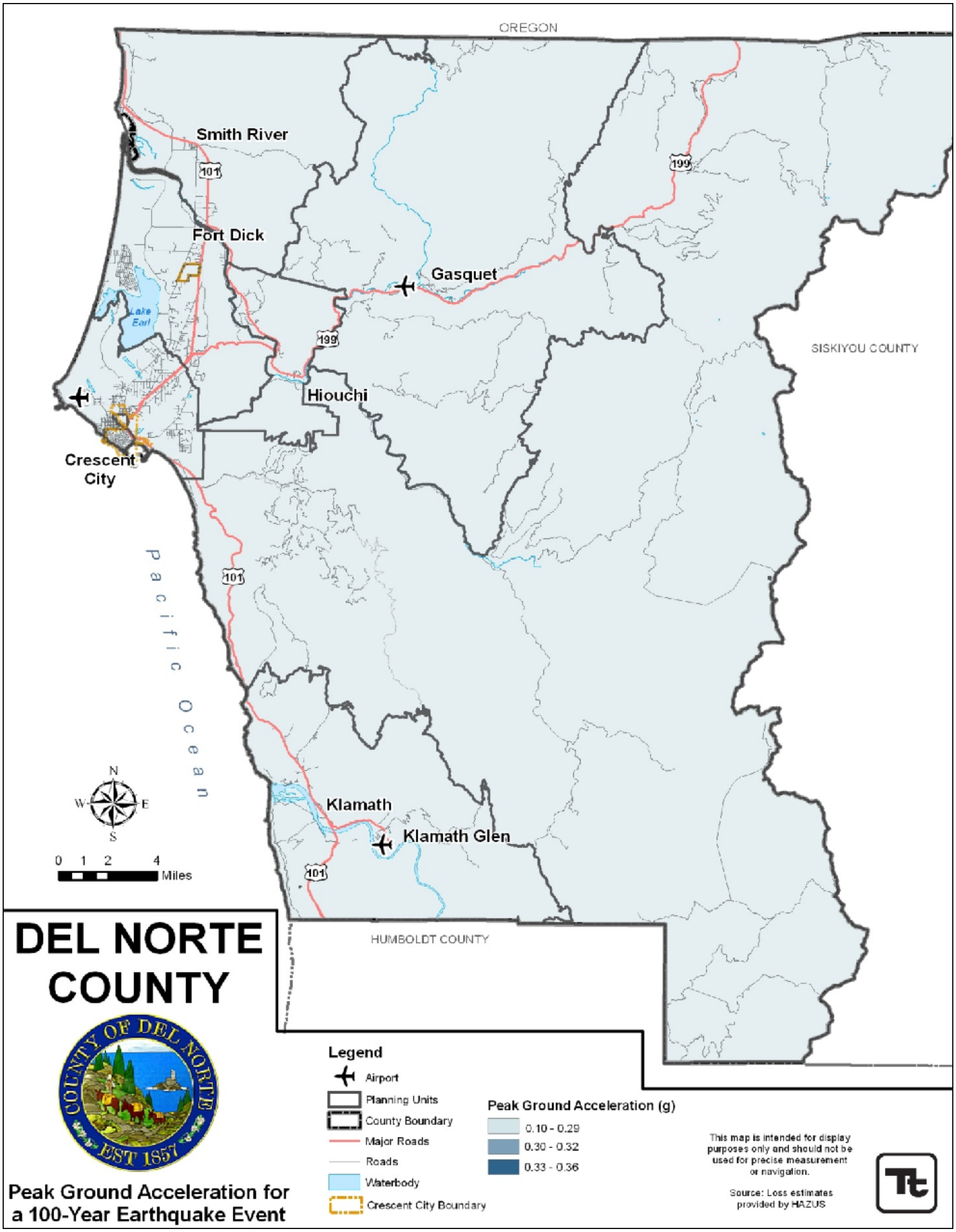


Figure 12-1. 100-Year Probabilistic Ground Motion Map for Del Norte County

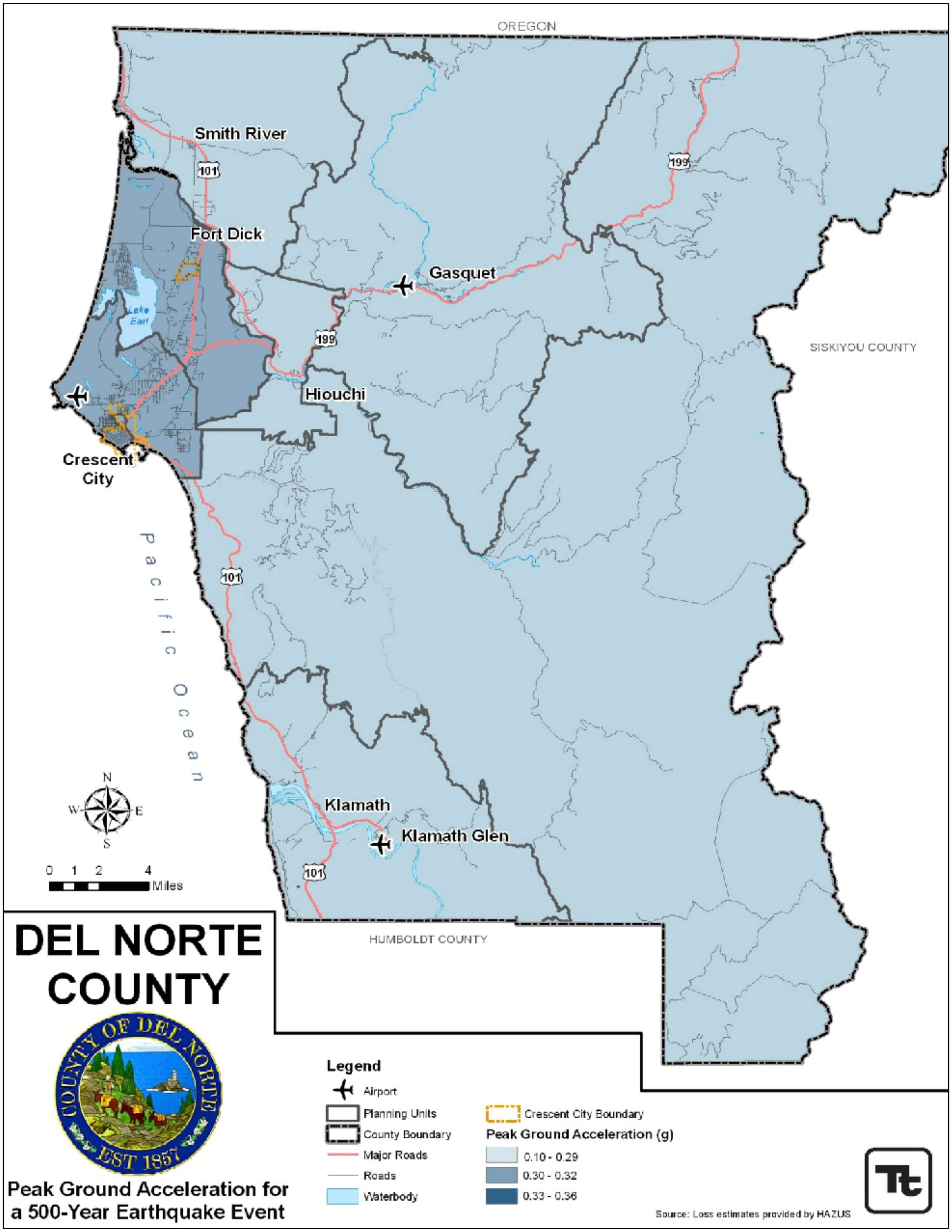


Figure 12-2. 500-Year Probabilistic Ground Motion Map for Del Norte County

NEHRP Soils

NEHRP soil types define the locations in the county that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. In general these areas are also most susceptible to ***liquefaction,*** a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Figure 12-3 shows NEHRP soil classifications throughout the county.

12.3.3 Frequency

Del Norte County is susceptible to regular earthquake activity, as evidenced by the nine seismic events with a magnitude of 5.0 or higher experienced from 2000 through 2007 (see Table 12-5) The USGS has created a probabilistic hazard map based on peak ground acceleration that takes into account new information on several fault zones. The northern California area, including Del Norte County, is in a moderate-risk area, with a 10-percent probability in a 50-year period of ground shaking from a seismic event exceeding 20 percent of gravity. Figure 12-4 shows the expected peak horizontal ground motions for this probability (USGS Website, 2007).

12.3.4 Severity

The severity of an earthquake can be expressed in terms of both intensity and magnitude. Intensity is based on the observed effects of ground shaking on people, buildings, and natural features. It varies from place to place within the disturbed region depending on the location of the observer with respect to the earthquake epicenter. Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments, which have a common calibration. Magnitude is thus represented by a single, instrumentally determined value

Past events suggest that earthquakes typical for Del Norte County would cause light to moderate damage. However, severity can increase based on proximity to the hypocenter of the event, and the surrounding soil type. There are soft soils within Del Norte County that have a high degree of vulnerability to earthquakes. The USGS estimates that there is at least a 0.5-percent probability of an earthquake with a magnitude of 7.0 or greater occurring within 50 km of the planning area within the next five years (Figure 12-5). This probability of occurrence mixed with potentially unstable soils could lead to a scenario of an earthquake event causing severe damage in the planning area.

12.3.5 Warning Time

Earthquake early warning systems are designed to provide a few seconds warning prior to damaging ground shaking in an earthquake. The further the earthquake is from a region, the more warning time there will be. There is presently no current method to accurately determine when and where an earthquake may occur.

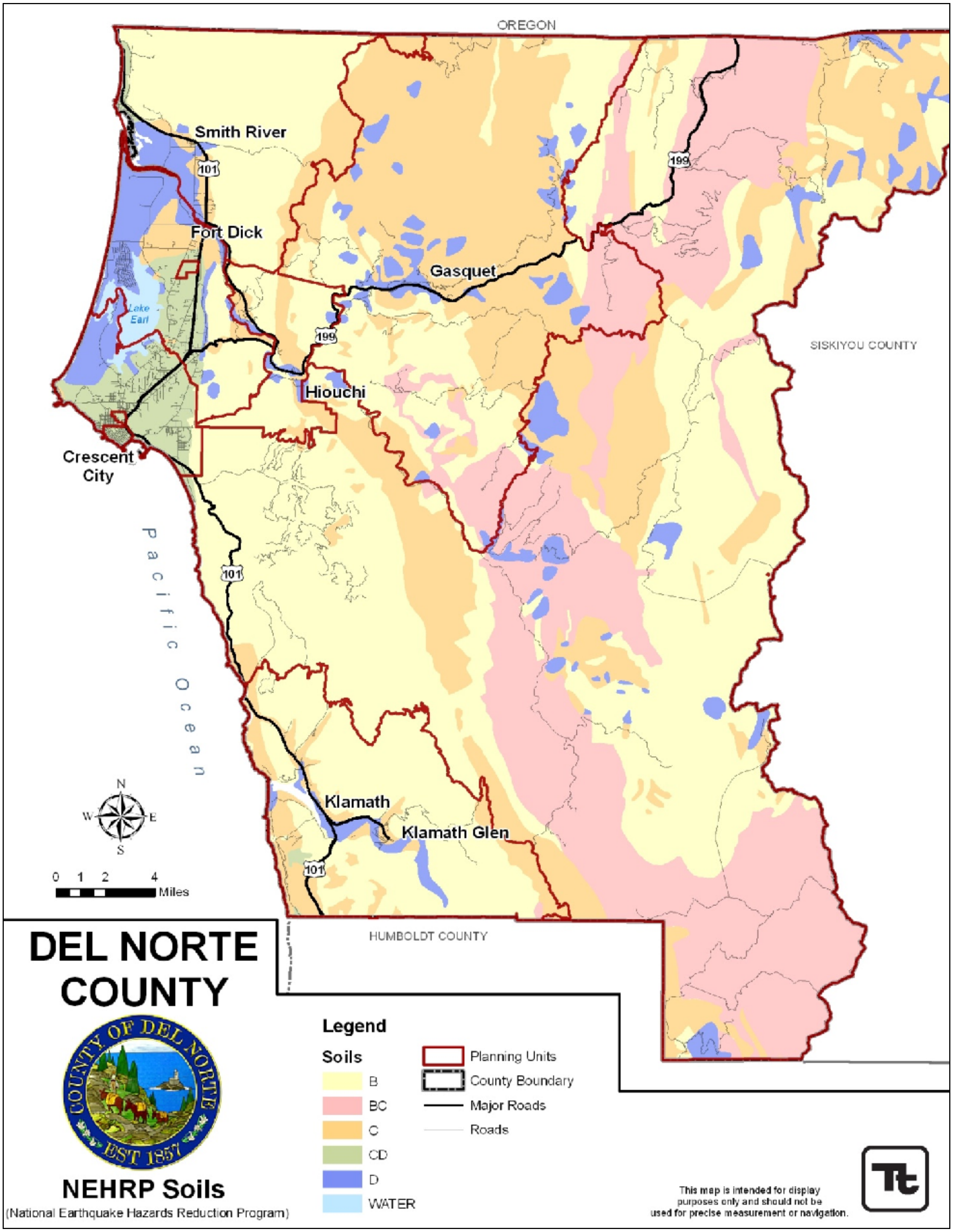


Figure 12-3. NEHRP Soil Classifications in Del Norte County

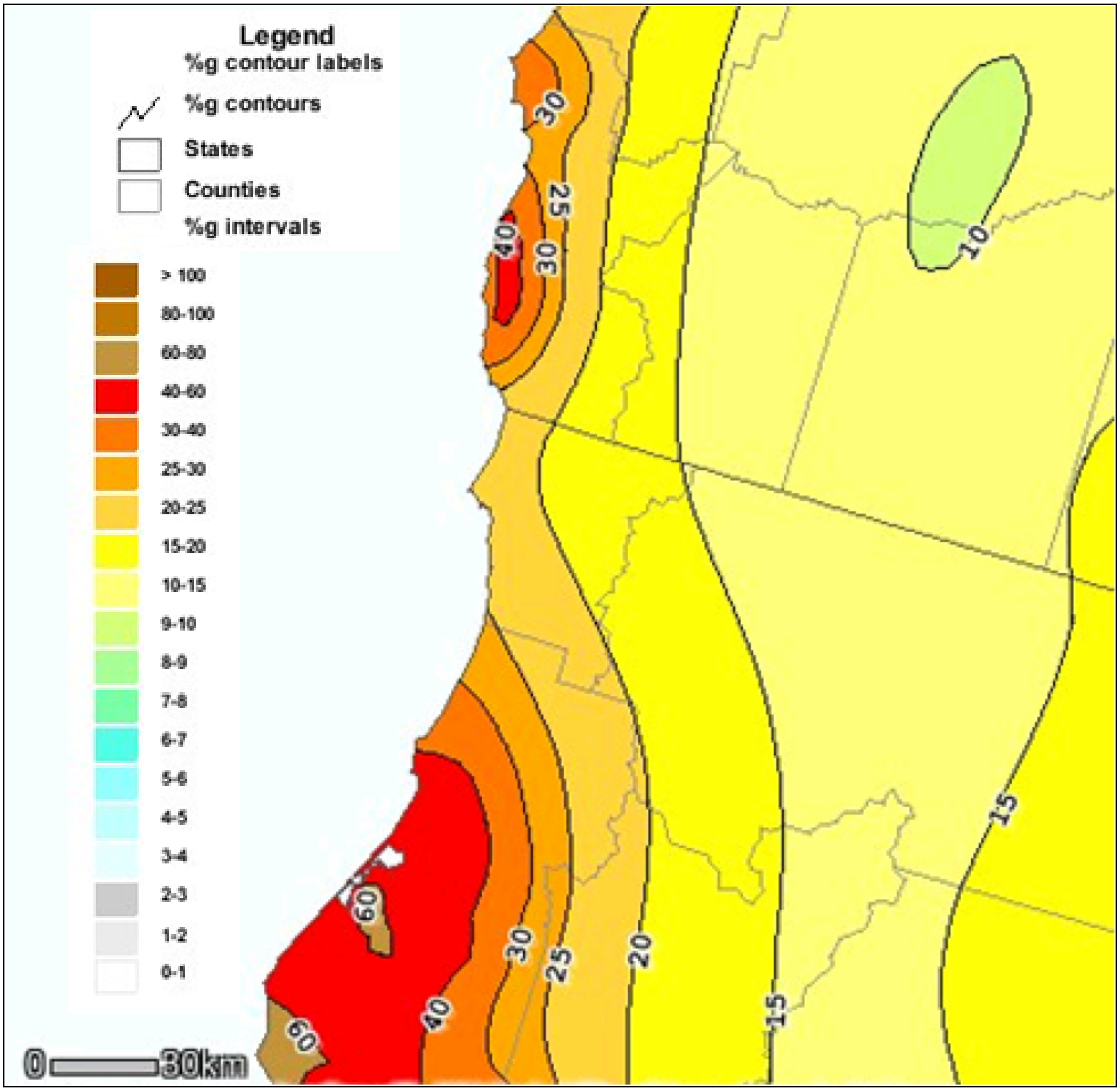


Figure 12-4. Peak Horizontal Acceleration with 10% Probability of Exceedance in 50 Years

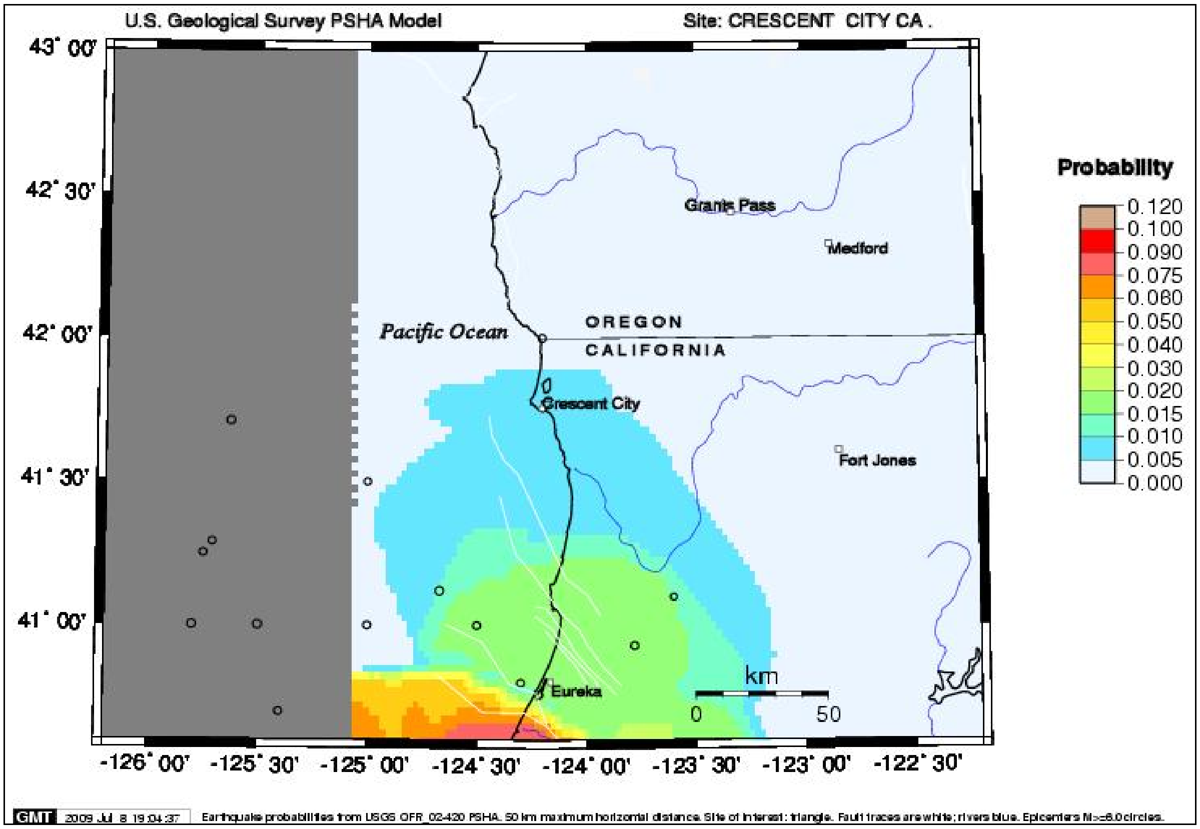


Figure 12-5. Probability of Earthquake with M > 7 Within 5 Years and 50 Kilometers

12.4 SECONDARY HAZARDS

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

12.5 CLIMATE CHANGE IMPACTS

The general perception in the emergency management community is that the impacts of global climate change on earthquake probability are unknown. Some scientists say melting glaciers could induce tectonic activity. As ice melts and waters runs off, tremendous amounts of weight are lifted off of Earth's crust. As the newly freed crust settles back to its original, pre-glacier shape, it can cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. In a new study, NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA, 2004).

The secondary impacts of earthquakes could be significantly enhanced due to the impacts of climate change. Soils saturated from repetitive, isolated storms could fail prematurely during seismic activity due to this increased saturation. Dams, storing increased volumes of water due to changes in the hydrograph triggered by climate change could fail during seismic events. Wildland fire risks associated with earthquakes could be significantly enhanced by drought conditions triggered by climate change. There are currently no models available to estimate these impacts. Therefore, local governments are forced to utilize the best data available at the time of the preparation of these plans.

12.6 EXPOSURE

The data in this section was generated using the HAZUS-MH program for earthquakes, which uses mathematical formulas and information about building stock, local geology and the location and size of potential earthquakes, economic data, and other information to estimate potential losses. Once the location and size of a hypothetical earthquake are identified, HAZUS-MH estimates the violence of the ground shaking, the number of buildings damaged, the number of casualties, and the amount of damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

12.6.1 Population

The entire population of Del Norte County is potentially exposed to earthquakes.

12.6.2 Property

According to the Del Norte County Assessor, there are approximately 11,708 buildings within the census tracts that define the planning area. The majority of these buildings are residential use. All of these buildings are considered to be exposed to the earthquake hazard.

12.6.3 Critical Facilities and Infrastructure

Since the entire Del Norte County planning area has exposure to the earth quake hazard, all 194 critical facilities and infrastructure components are exposed to the earthquake hazard. The breakdown of the numbers and types of facilities is presented in Tables 12-6 and 12-7.

TABLE 12-6.
CRITICAL FACILITIES WITHIN DEL NORTE COUNTY

Planning unit	Medical & Health Services	Government Function	Protective Function	Schools	Societal Function	Hazmat	Other Critical Function	**Total**
Crescent City	1	12	4	2	8	1	0	**28**
Crescent City UGA	3	8	2	5	7	1	1	**27**
Fort Dick	0	0	2	2	2	0	0	**6**
Gasquet	0	0	1	1	1	0	1	**4**
Hiouchi	0	0	0	0	0	0	0	**0**
Klamath	0	0	1	1	2	0	3	**7**
Smith River	0	0	1	1	3	0	1	**6**
Other County	0	1	0	0	0	0	0	**1**
Total	**4**	**21**	**11**	**12**	**23**	**2**	**6**	**79**

**TABLE 12-7.
CRITICAL INFRASTRUCTURE WITHIN DEL NORTE COUNTY**

Planning unit	Water Supply	Waste Water	Power	Fuel storage	Communications	Bridges	**Total**
Crescent City	1	2	2	1	2	0	**8**
Crescent City UGA	3	0	3	2	12	3	**23**
Fort Dick	5	0	1	0	2	5	**13**
Gasquet	1	0	0	0	2	17	**20**
Hiouchi	2	0	0	0	0	7	**9**
Klamath	2	4	0	0	2	15	**23**
Smith River	1	0	2	0	0	6	**9**
Other County	0	0	0	0	0	10	**10**
Total	**15**	**6**	**8**	**3**	**20**	**63**	**115**

Hazardous Materials

Hazardous material releases from fixed facilities and transportation-related releases can occur during an earthquake event. Vital transit corridors such as U.S. Highways 101 and 199 and the Northwestern Pacific River Railroad can be disrupted during an earthquake, which can result in the release of hazardous materials that are being transported along these corridors to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of populations surrounding them. There are two facilities in the planning area that handle materials considered to be hazardous. During an earthquake event, structures storing these materials could rupture and leak into the surrounding area, or river, having a disastrous effect on the environment.

Roads

There are many roads that cross earthquake-prone soils in the county. These soils have the potential to be significantly damaged during an earthquake event. Access to major roads is crucial to life and safety after a disaster event as well as to response and recovery operations.

Bridges

Earthquake events can significantly impact bridges. These are important because they often provide the only access to certain neighborhoods. Since the HAZUS-MH analysis identified soft soil regions that follow floodplain boundaries, bridges that cross water courses should be considered vulnerable. Since most of the bridges provide access across water courses, most are at least somewhat vulnerable to earthquakes. A key factor in the degree of vulnerability is the age of the facility and the type of construction, which help indicate the standards to which the facility was built.

Water and Sewer Infrastructure

Water and sewer infrastructure would likely suffer considerable damage in the event of an earthquake. This is hard to analyze due to the amount of infrastructure and the fact that water and sewer infrastructure are usually linear easements, which are difficult to inventory in a GIS environment. Without further analysis of individual components of the system, it should be assumed that these systems are exposed to potential breakage and failure.

12.6.4 Environment

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

12.7 VULNERABILITY

12.7.1 Population

A geographic analysis of demographics was performed using the HAZUS-MH model. The inventoried data included total population, age, gender, and race distribution and other data obtained from the U.S. Census Bureau and Dun & Bradstreet. The demographics for this analysis were aggregated at the Census block level. The vulnerable populations are those living in economically disadvantaged households, those over 65 and those under 16.

Although the vulnerability is low, towns are more at risk than rural areas due to higher density. Towns are also more vulnerable because they are typically located in small valleys alongside streams, which typically have softer soils. Many of these towns also have buildings that were built during the beginning of the 20th century and were not subject to the building codes implemented over the last 30 years, which require that structures be able to withstand earthquakes. Ornamentation (such as parapets) and chimneys may be shaken loose and fall on people walking below.

12.7.2 Property

Age of Structures

The California Multi-Hazard Mitigation Plan identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using these time periods, the Planning team inventoried the structures within the planning area by age of structure as summarized in Table 12-8. Only 1.30 percent of the planning area’s structures were constructed since the Uniform Building Code was amended in 1994 to include seismic safety provisions. Approximately 7.17 percent of the planning area’s structures were built before 1940 when there were no building permits, inspections or seismic standards.

Loss Potential

Loss estimates for the planning area were generated for the 100-year and 500-year earthquake events through a Level 1 analysis using HAZUS-MH. The results of this analysis are summarized in Table 12-9. The data are segregated into structural and non-structural categories. The structural values represent damage estimates to individual structures. The non-structural values represent cost estimates for contents, inventory, relocation, income loss, rental loss, and wage loss. It is estimated that there would be $61 million of damage potential during a 100-year earthquake event. This represents approximately 2.4 percent of the total assessed value for improvements to land in the planning area. For a 500-year earthquake the estimated damage potential is $596.3 million, or 23.9 percent of the total assessed value for the planning area.

TABLE 12-8.
AGE OF STRUCTURES IN DEL NORTE COUNTY

Time Period	Number of Structures Built in Del Norte County	% of Total Structures	Significance of Time Frame
Pre-1940	840	7.17%	Before 1940, there were no explicit requirements for earthquakes in building codes. State law did not require local governments to have building officials or issue building permits. In 1940, the first strong motion recording was made in El Centro.
1941-1960	2,355	20.11%	In 1960, the Structural Engineers Association of California reached the first statewide consensus on recommended earthquake provisions and published the guidelines.
1961-1979	3,937	33.63%	In 1975, significant improvements were made to lateral force requirements that were then enforced throughout the state.
1979-1994	4,424	37.79%	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994 to present	152	1.30%	Seismic code is currently enforced.
Total	**11,708**	**100%**	

TABLE 12-9.
EARTHQUAKE BUILDING LOSS POTENTIAL

	Estimated Earthquake Losses by Occupancy Class					
	100- Year Probabilistic Earthquake			500- Year Probabilistic Earthquake		
Planning Unit	Structural	Non-Structural	**Total**	Structural	Non-Structural	**Total**
Crescent City	$721,903	$4,517,708	**$5,239,611**	$8,510,554	$47,962,928	**$56,473,482**
Crescent City UGA	$2,519,084	$15,764,561	**$18,283,645**	$29,599,970	$166,816,554	**$196,416,524**
Fort Dick	$566,516	$3,545,289	**$4,111,805**	$6,807,510	$38,365,085	**$45,172,595**
Gasquet	$165,525	$1,035,866	**$1,201,391**	$1,174,025	$6,616,452	**$7,790,477**
Hiouchi	$162,761	$1,018,568	**$1,181,329**	$1,154,421	$6,505,968	**$7,660,388**
Klamath	$166,885	$1,044,360	**$1,211,245**	$1,779,276	$10,027,468	**$11,806,744**
Smith River	$531,575	$3,326,624	**$3,858,199**	$3,770,314	$21,248,361	**$25,018,676**
Other County	$3,572,035	$22,353,614	**$25,925,649**	$37,062,594	$208,873,667	**$245,936,260**
Total	**$8,406,284**	**$52,606,590**	**$61,012,874**	**$89,858,664**	**$506,416,482**	**$596,275,146**

Other potential losses estimated by HAZUS-MH include the following:

- A 100-year event could create as much as 10,920 tons of debris to be removed, and a 500-year event could create as much as 120,000 tons of debris.
- For a 100-year event, as many as 12 households would be displaced, with 10 households needing short term shelter. For a 500-year event, there would be as many as 306 households displaced, with 256 households needing short-term shelter.

12.7.3 Critical Facilities

Level of Damage

The inventory of critical facilities as defined by the steering committee was entered into HAZUS-MH to determine the vulnerability of these facilities to earthquake damage. Critical facilities were categorized into the following levels of vulnerability: no damage, slight damage, moderate damage, extensive damage, or complete damage. HAZUS-MH calculated the probability of damage under each of these categories for the 100-year and 500-year events. The results are summarized in Tables 12-10 and 12-11.

TABLE 12-10.
VULNERABILITY OF CRITICAL FACILITIES FROM A 100-YEAR EARTHQUAKE EVENT

Category	No Damage	Slight Damage	Moderate Damage	Extensive damage	Complete damage	**Total**
Medical and Health	0	4	0	0	0	**4**
Government Functions	1	18	2	0	0	**21**
Protective Functions	2	8	1	0	0	**11**
Schools	0	12	0	0	0	**12**
Societal Functions	3	16	4	0	0	**23**
Hazmat	0	2	0	0	0	**2**
Other Critical Functions	1	3	2	0	0	**6**
Total	**7**	**63**	**9**	**0**	**0**	**79**

TABLE 12-11.
VULNERABILITY OF CRITICAL FACILITIES FROM A 500-YEAR EARTHQUAKE EVENT

Category	No Damage	Slight Damage	Moderate Damage	Extensive damage	Complete damage	**Total**
Medical and Health	0	0	0	1	3	**4**
Government Functions	0	0	1	4	16	**21**
Protective Functions	0	1	2	4	4	**11**
Schools	0	1	1	1	9	**12**
Societal Functions	0	0	0	3	20	**23**
Hazmat	0	0	0	1	1	**2**
Other Critical Functions	0	0	1	1	4	**6**
Total	**0**	**2**	**5**	**15**	**57**	**79**

Time to Return to Functionality

Another analysis of critical facilities performed by HAZUS deals with the estimated time to restore critical facilities to full functional use. HAZUS reflects this data in the form of percent probability of being functional at specified time increments post-event: 1, 3, 7, 14, 30 and 90 days after the event occurs. For example, HAZUS may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. The functionality analysis was performed for all critical facilities and infrastructure components in the planning area for both the 100-year and 500-year earthquake events. Results are summarized in Tables 12-12 and 12-13.

TABLE 12-12.
FUNCTIONALITY OF CRITICAL FACILITIES, 100-YEAR EARTHQUAKE

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Crescent City	36	10	11	75	76	93	96
Crescent City UGA	50	10	11	75	76	93	96
Fort Dick	19	11	13	76	79	95	97
Gasquet	24	5	7	62	64	87	92
Hiouchi	9	6	8	65	68	90	94
Klamath	30	6	8	65	66	85	91
Smith River	15	11	13	75	77	93	96
Other County	11	20	23	87	88	97	98
Total/Average	**194**	**9.88**	**11.75**	**72.5**	**74.3**	**91.63**	**95**

TABLE 12-13.
FUNCTIONALITY OF CRITICAL FACILITIES, 500-YEAR EARTHQUAKE

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Crescent City	36	0	0	6	6	22	37
Crescent City UGA	50	0	0	6	6	22	37
Fort Dick	19	0	0	10	10	33	47
Gasquet	24	0	0	6	7	24	38
Hiouchi	9	0	0	8	9	26	39
Klamath	30	0	0	4	4	17	30
Smith River	15	0	0	8	8	29	45
Other County	11	1	2	28	29	60	70
Total/Average	**194**	**0.13**	**0.25**	**9.5**	**9.88**	**29.13**	**42.88**

12.7.4 Environment

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

12.8 FUTURE TRENDS IN DEVELOPMENT

It is assumed that development and redevelopment trends in Del Norte County are not such that there is major concern about development in identified seismic risk areas. To meet the intent of California state mandates (AB 2140 and Executive Order S-13-08), Crescent City, Del Norte County and all of their planning partners are committed to ensuring that future growth and development in the planning area take seismic risk into account, along with all of the hazards of concern addressed by this plan.

12.9 SCENARIO

Based on history and geology, the Del Norte County planning area will be frequently impacted by earthquakes. The degree and magnitude of these impacts are difficult to predict, since there are many factors to determining net impact. The worst-case scenario is a higher-magnitude event (5.0 or higher) with an epicenter within 50 miles of Del Norte County.

It is safe to assume that the damage potential from earthquakes is greater in areas with softer soils. It is also safe to assume that the older building stock in the planning area is at higher risk. Therefore, the highest degree of damage would be to older structures located on soft soils. Bridges and utilities that cross poor soils would likely fail, causing loss of critical infrastructure and utilities. River valley and coastal hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts or gravelly soils. Building and road foundations would lose load-bearing strength. Injuries could occur from debris, such as parapets and chimneys that could topple or be shaken loose and fall on those walking or driving below. An earthquake may also cause minor landslides along unstable slopes, which put at risk major roads and highways that act as sole evacuation routes. This would be even more likely if the earthquake occurred during the winter or early spring. Isolation due to the loss of critical infrastructure is an important concern.

12.10 ISSUES

Important issues associated with an earthquake in Del Norte County include but are not limited to the following:

- Isolation of neighborhoods and communities. Several vulnerable populations are on NEHRP C, CD and D soils.
- Conflagration of wooden homes, collapse of essential buildings such as fire stations, dam failure and isolation due to bridge collapse.
- Sixty-one percent of the planning area’s building stock was build prior to 1975, when seismic provisions became uniformly applied through building code applications.
- Landslides and tsunamis are major natural secondary hazards that could have a widespread effect on the county.
- There is concern about major infrastructure such as roads, bridges and railroads that cross vulnerable soils.
- With only two principal highways in and out of the county (Highway 101 and Highway 199), isolation due to severe road damage to either of these facilities is a huge concern, especially in light of the remote nature of many towns in the planning area.
- A high number of critical facilities in the planning area are at risk and would have a significant amount of functional downtime post-event. This creates a need for mitigation and for continuity of operations planning to develop procedures for providing services without access to essential facilities.

CHAPTER 13.
FLOOD

13.1 FLOOD DEFINED

The following definitions apply in the discussion of flood hazards:

- **Coastal Flooding**—Flooding of shoreline areas on the Pacific Coast and inland waters caused by storm surge, astronomical high tides, or a combination of the two.
- **Flood**—A flood is the inundation of normally dry land resulting from the rising and overflowing of a body of water.
- **Floodplain**—A floodplain is any normally dry land area that is susceptible to being inundated by water from any natural source. The ***100-year floodplain*** is the area flooded by the flood that has a 1-percent chance of being equaled or exceeded each year. The 1-percent annual chance flood is the standard used by most federal and state agencies.

13.2 GENERAL BACKGROUND

A floodplain is usually low land adjacent to a river, creek or lake. The extent of floodplain inundation depends partly on the flood magnitude, defined by the return period. Because they border water bodies, floodplains are popular sites to establish settlements, which leads to an increase in flood-related disasters.

Floodplains may be extremely broad, as when a river crosses an extensive flat landscape, or quite narrow, as when a river is confined in a canyon. Floodplains generally contain unconsolidated sediments, often extending below the bed of the stream or river. These are accumulations of sand, gravel, loam, silt, and/or clay, and are often important aquifers, providing filtering of water that is drawn from them. Geologically ancient floodplains are often represented in the landscape by terrace deposits, which remain relatively high above current deposits, and can indicate former courses of rivers and streams.

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

13.2.1 Effects of Human Activities

Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile; transportation by river is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with natural processes, resulting in inconvenience or catastrophe. These activities can affect the distribution and timing of drainage, thereby increasing flood problems. The developed environment creates 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 the initial stages of a flood event.

13.2.2 Federal Programs Related to Flooding

In 1968, Congress created the National Flood Insurance Program (NFIP) in response to the rising cost of taxpayer-funded disaster relief for flood victims and the increasing amount of damage caused by floods. The NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in communities participating in the program. For most communities participating in NFIP, FEMA has prepared a detailed ***Flood Insurance Study*** (FIS). The FIS presents water surface elevations for floods of various magnitudes, including the flood that has a 1-percent probability of being equaled or exceeded in any given year (also called the ***100-year flood*** or ***base flood***) and the flood that has a 0.2-percent probability of being equaled or exceeded in any given year (also called the ***500-year flood***). The water surface elevation of the 100-year flood event is called the base flood elevation (BFE). BFEs and the boundaries of the 100- and 500-year floodplains are shown on participating communities' ***Flood Insurance Rate Maps*** (FIRMs).

Two communities within the planning area participate in the NFIP. Del Norte County joined the NFIP on September 2, 1970, and received its Flood Insurance Rate Map (FIRM) on January 24, 1983. Crescent City joined the program on May 3, 1974 and received their first FIRM on November 23, 1982. Both communities are currently covered by a county-wide format, digital FIRM with an effective date of September 26, 2008. As of the preparation of this plan, both Crescent City and del Norte County were in full compliance and good standing under the provisions of the NFIP.

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

- 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 the flood insurance policies currently in force nationally, yet they account for 40 percent of the country's flood insurance claim payments. A report on repetitive loss structures by the National Wildlife Federation found that 20 percent of these structures are listed as outside the 100-year floodplain. In 1998, FEMA reported that the NFIP's 75,000 repetitive loss structures had cost $2.8 billion in flood insurance payments and that numerous other flood-prone structures are in the floodplain and remain at high risk. To address this ongoing issue, the government has instituted several programs that encourage communities to identify and mitigate the causes of their repetitive losses, such as the Community Rating system (CRS), the Flood Mitigation Assistance grant program, and the Pre-Disaster Mitigation grant program created under the Disaster Mitigation Act.

13.3 HAZARD PROFILE

Del Norte County lies within the North Coast hydrologic region of California, which runs along the Pacific Coast from the California-Oregon border to the mouth of the Russian River. This region is sparsely populated, with the majority of settlement in the Humboldt Bay area. The area receives larger rain totals than any other region and experiences some of the state's most spectacular and devastating flood events. The typical type of flooding that occurs in this area is represented by the 1964 late winter storms that caused $213 million in property damage.

There are two types of floodplains in Del Norte County: coastal floodplains associated with tidal action and storm surge, and riverine floodplains associated with river systems.

13.3.1 Coastal Flooding

Del Norte County has a coast shoreline length of 45.5 miles. From the Oregon border to Point St. George, there are about 14 miles of rocky coast, and 11 miles of sandy beach backed by sand dunes. The remainder of the county coastline is rocky with pocket beaches and reaches of sand such as Crescent City and the mouth of the Klamath River. This latter reach includes the Redwood National Park and the Del Norte Coast Redwood State Park, and is noted for its rugged headlands and scenic shoreline.

Flooding along the Pacific coast near Crescent City is often associated with the simultaneous occurrence of very high tides, large waves, and storm swells during the winter. Storm centers from the southwest produce the type of storm pattern most commonly responsible for most of the serious coastal flooding. The strong winds and high tides that accompany these storms can create storm surges in excess of 10 feet above mean high tide.

In the past, severe winter storms have caused major damage to the developed portions of the northern California coast. The most severe storms to hit this region occurred in 1978 and 1983, when high water levels were accompanied by a very large storm surge.

13.3.2 River System Characteristics

The Klamath and Smith Rivers are within the Klamath Mountains province; the other river systems in the county are within the Coast Range province. Drainage in the Klamath Mountains province is dendritic (streams and their tributaries have a branch-like arrangement), differing from the trellis drainage patterns typical of the Coast Range province. The rocks in the Klamath Mountains province are both metasedimentary and granitic. The Coast range province contains classic sedimentary and igneous rocks, mostly from the Franciscan formation. Northwest-trending folds and faults control the drainage patterns in the Coast Range province, leading to a fairly uniform orientation of rivers.

Significant flood hazard areas in Del Norte County are limited to the Smith River, Klamath River and Elk Creek systems because these are the river systems where development has occurred in or near the floodplain.

The Smith River

The Smith River drains a basin of 609 square miles. The river flows through the Klamath Mountains, except for the final 15 miles, where it slices through the Coastal range and crosses a broad coastal plan before emptying into the Pacific Ocean. The Smith River is classified as a “Wild and Scenic River” by the National Parks Service and is the only major river in California to flow freely for its entire length without a dam. Its floodplain includes Lake Earl, Lake Talawa, a portion of U.S. Highway 101, a portion of Lower Lake Road, agricultural land and scattered residential uses.

The Lake Earl-Lake Talawa-Lower Smith River complex covers an area of 12 miles along the Pacific Ocean between Crescent City and the Oregon border. Under normal conditions, the two lakes have a combined surface area of approximately 2,500 acres and an elevation about 4 feet above mean sea level. No natural surface drainage out of the lakes exists, but under sufficiently high stages the sandbar at the southwest end of Lake Talawa is overtopped or breached. The natural breaching action can be either from ocean waves crashing over the bar or high water in the lakes overtopping it. The breach provides drainage into the ocean until wave action by the ocean again closes it. Channeling or breaching operations through the sand bar are performed by local interests approximately three times per year in anticipation of flooding or to relieve high stages in the lakes.

The most notable flooding in the area results from intense storms occurring after extended periods of rain, which prime the lake basin and the adjacent Smith River basin for runoff. Smith River discharges of approximately 140,000 cubic feet per second (cfs)—the 10-year recurrence interval—cause overbank flow in the Smith River floodplain, which spills over into the Lake Earl-Talawa Lake complex. The Smith River basin is fan-shaped with a common focal point of the four major tributaries, which gives the basin its very sharp reaction to rainfall and runoff. As a result, floods within the basin are normally of short duration, lasting about 2 to 4 days. Floods develop rapidly, with the peak being reached in 6 to 8 hours after the most intense portion of the storm.

The Klamath River

The largest river basin in the region is the Klamath River, which originates in Oregon and drains 12,120 square miles, of which 234 square miles is in Del Norte County. The Klamath River is the second largest river in California, exceeded only by the Sacramento River. Its basin is south and east of the Smith River basin. The major tributaries to the Klamath River include the Salmon, Scott, Shasta and Trinity Rivers, none of which are in Del Norte County. The portion of the Klamath River that lies within Del Norte County is referred to by the U.S. Army Corps of Engineers as Reach I, extending from the mouth of the Klamath to the Humboldt County line. Within Reach I and the Coastal Zone lie the communities of Requa, Camp Klamath and Klamath. Due to this development, flooding along Reach I is a hazard to life and property.

Flood flows in the Klamath basin are of two types—rain and snowmelt. The rain flood flows are the more damaging. Practically all damaging flood events have occurred during the period of November through March. Usually these events have occurred from rainstorms of several days in duration. Based on USGS gage data near Klamath, the maximum record discharge of 557,000 cfs occurred on December 3, 1964, with a gage height of 55.3 feet.

Snowmelt floods usually begin in March and have not typically caused the damage associated with rain floods. Due to the size of the Klamath River basin, a true "worst-case scenario" would be a rain-on-snow event. While these types of events are not typical for the region, they are possible in light of potential climate change.

Elk Creek

Elk Creek originates in Jedediah Smith Redwood State Park. Several small tributaries flow from the park and combine just west of Elk Valley Road to form the main channel. The creek then flows southwest, draining Elk Valley, and empties into Crescent City Harbor.

Elk Creek is much smaller than the Smith and Klamath Rivers. Its watershed is approximately 6 square miles, and its recognized floodplain covers less than 1 square mile. However, due to its proximity to Crescent City, it is of considerable importance in emergency management planning.

Flooding on Elk Creek is caused by a combination of excess runoff and tidal action. Excess runoff is caused by heavy rainfall and tidal action is caused by wind, waves and tsunamis. Flooding history on Elk Creek indicates that tidal action has been the principal cause of flooding. As a prime example, during the 1964 tsunami that hit Crescent City, the Elk Creek floodplain acted as a natural inlet for water generated by the tsunami, and flooding occurred on a considerable amount of the Elk Creek floodplain, including portions of downtown Crescent City.

13.3.3 Past Events

Seventy percent of precipitation in Del Norte County occurs from November to March and major floods have resulted from a succession of intense rainstorms during these months. The two worst flood events in the county occurred in December 1955 and December 1964. These events caused tens of millions of dollars in damage and also caused numerous fatalities.

There were 13 state- or federal-declared flood disasters in Del Norte County between 1950 and 2007 (Figure 13-1). Table 13-1 lists major declared and undeclared flood events in Del Norte County since 1955. During these events, a total of $889,792 in Public Assistance (PA) was funded and a total of 267 requests for Individual Assistance (IA) under the Robert T. Stafford Act were processed. The most severe flood events in the county are described in the following sections.

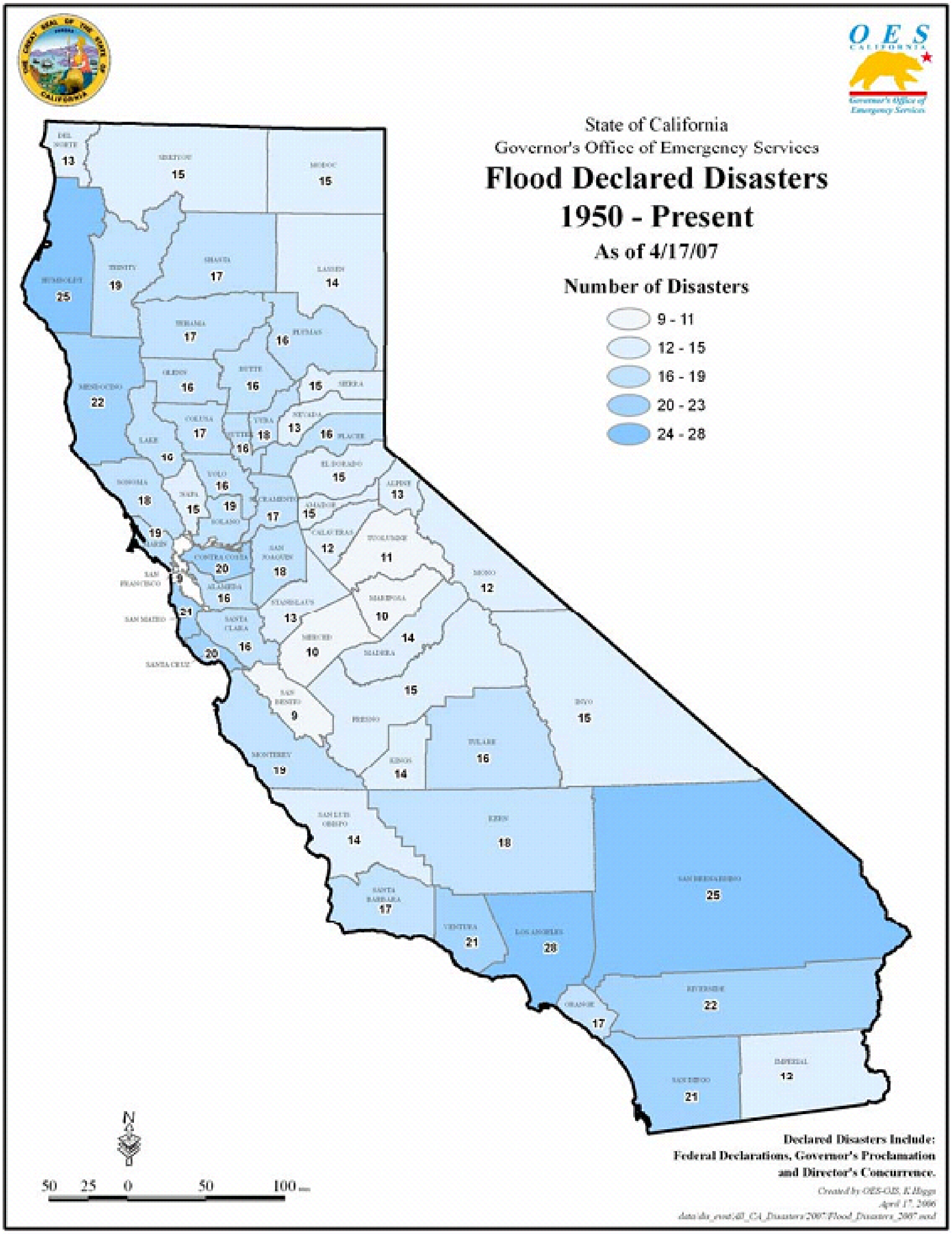


Figure 13-1. Declared Flood Disasters in California, 1950 – 2007

TABLE 13-1.
DEL NORTE COUNTY MAJOR FLOOD EVENTS

Date	Declaration #	Type of event	Type of Assistance	Estimated Damage
Feb. 3, 2006	1628	Flooding, severe winter storms, and landslides	IA, PA	$20,266,666[a]
Feb. 9, 1998	1203	Severe winter storms, flooding	PA	$1.27 million[a]
Jan. 4, 1997	1155	Severe winter storms, flooding	IA, PA	$15.15 million[a]
Dec. 1, 1995	N/A	Severe winter storms, flooding	IA, PA	$6.0 million[a]
Mar. 12, 1995	1046	Severe Winter Storms, flooding	PA	$1.0 million[a]
Jan. 9, 1995	1044	Winter storms, flooding, landslides, mud flows	IA, PA	$11.2 million[a]
Feb. 3, 1993	979	Severe storm, winter storm, mud & landslides, flooding	PA	$583,530[a]
Feb. 25, 1992	935	Snow storm, heavy rain, high winds, flooding, mudslide	IA	$10,000[a]
Feb. 21, 1986	758	Flooding	N/A	N/A
Jan. 25, 1983	677	Coastal storms, floods, slides, tornados	N/A	$500,000[a]
Jan. 1978	547	—	NA	NA
Feb. 8, 1973	364	Severe storms, High Tides, flooding	N/A	$100,493[a]
Jan. 8,1970	283	Severe storms, flooding	N/A	$104,670[a]
Dec. 1964	N/A	Severe winter storms, flooding	N/A	$17.85 million[a]
Dec. 1955	N/A	Severe winter storms, flooding	N/A	$22 million

a. Data obtained from Spatial Hazard Events and Losses Database for the United States (SHELDUS)
N/A = Information is not available

December 1955 Flood Event

The December 1955 flood occurred following weeks of above-normal precipitation in the county, with rainfall measurements reaching as high as 24 inches over three days in Klamath. Damage occurred countywide, with the majority along the Smith River. These storms produced a peak discharge of 165,000 cfs with a stage of 41.2 feet at the Smith River gauging station. It is estimated that 7,600 acres of pasture and other agricultural lands in the delta area were inundated to an average depth of about 3 feet by the Smith River and its tributaries. Floodwaters from the Smith River overflowed into Talawa Slough and raised the surface of Lake Earl. Due to the flat slope of the land adjacent to the lake, 3,200 acres of land bordering the lake were flooded. Agricultural damage consisted of silt, gravel and debris from timbering operations being deposited on pastureland.

December 1964 Flood Event

Heavy rains accompanied by runoff from an unusually large snowpack led to flooding of all river systems within the county in December 1964. The 1964 flood events are considered to be the floods of record for the Del Norte County planning area. Total damage reached $17.85 million. The flood swept away the entire town of Klamath along the Klamath River, with the nearby towns of Camp Klamath, Requa, and Klamath Glen also sustaining heavy damage and one fatality reported. Millions of board feet of lumber, thousands of acres of prime farmland, and 400 head of livestock were lost, causing a tremendous economic impact to the county.

January 1978 Flood event

A combination of high astronomical tides, strong onshore winds, high storm waves, and excessive rainfall produced an aggravated erosional condition in January 1978. A series of storms emanated from a more southern direction than normal, carrying larger amounts of precipitation and wind. These storms, in conjunction with seasonal high tides, generated large destructive storm surges that battered the northern California coastline, damaging many of the better-protected beaches. Jetties and breakwater barriers were overtopped and in some cases undermined.

Winter Storms of 1983

The winter of 1983 brought an extremely unusual series of high tides, storm surges and storm waves. Record high tides were recorded in Del Norte County, with the worst coastal flooding recorded since the 1964 Alaska tsunami.

January 1995 Flood Event

Significant and extended heavy rain and wind caused severe flooding along the California coastline. Flood damage was reported throughout much of the county, totaling an estimated $11.2 million. The county received both state and federal disaster declarations.

March 1995 Flood Event

Winter storms and flooding caused $1 million in damage throughout the county. The county received a second presidential disaster declaration.

January 1997 Flood Event

The U.S. Forest Service reported that the storms of December 1996 and January 1997 produced precipitation on the Klamath National Forest that was two to three times the monthly average. The four-day storm at the end of December produced rain above 7,000 feet. The flood of 1997 involved the movement of soil, rock, and organic debris from hill slopes to stream channels on the Klamath National Forest at a scale not experienced since about 1974. The majority of the reported damage associated with this event was from landslides and road failures. The estimated damage to road facilities exceeded $35 million within the Klamath National Forest.

January 2006 Flood Event

The year began with a New Years' weekend storm pummeling Del Norte County, damaging the Crescent City harbor, flooding Klamath and closing Highways 101 and 169. Damage exceeded $5 million. California Office of Emergency Services officials identified 64 sites as sustaining significant damage. On February 3, President Bush declared Del Norte County and nine other California counties disaster areas. A section of west Klamath Beach Road, wiped out during the storms, finally reopened on April 5 thanks to a temporary bridge that allowed one-way traffic.

13.3.4 Flooding Extent and Location

Flooding in Del Norte County has been extensively documented by gage records, high water marks, damage surveys and personal accounts. This documentation was the basis for the FIRMs generated by FEMA for Del Norte County. FEMA and the floodplain management community acknowledge that the FIRMs are not the total depiction of the flood risk in an area, but they are the most detailed and consistent data source available. The FIRMs dated September 26, 2008 are the sole source of data used in this risk assessment to map the extent and location of the flood hazard, which are shown in Figure 13-2.

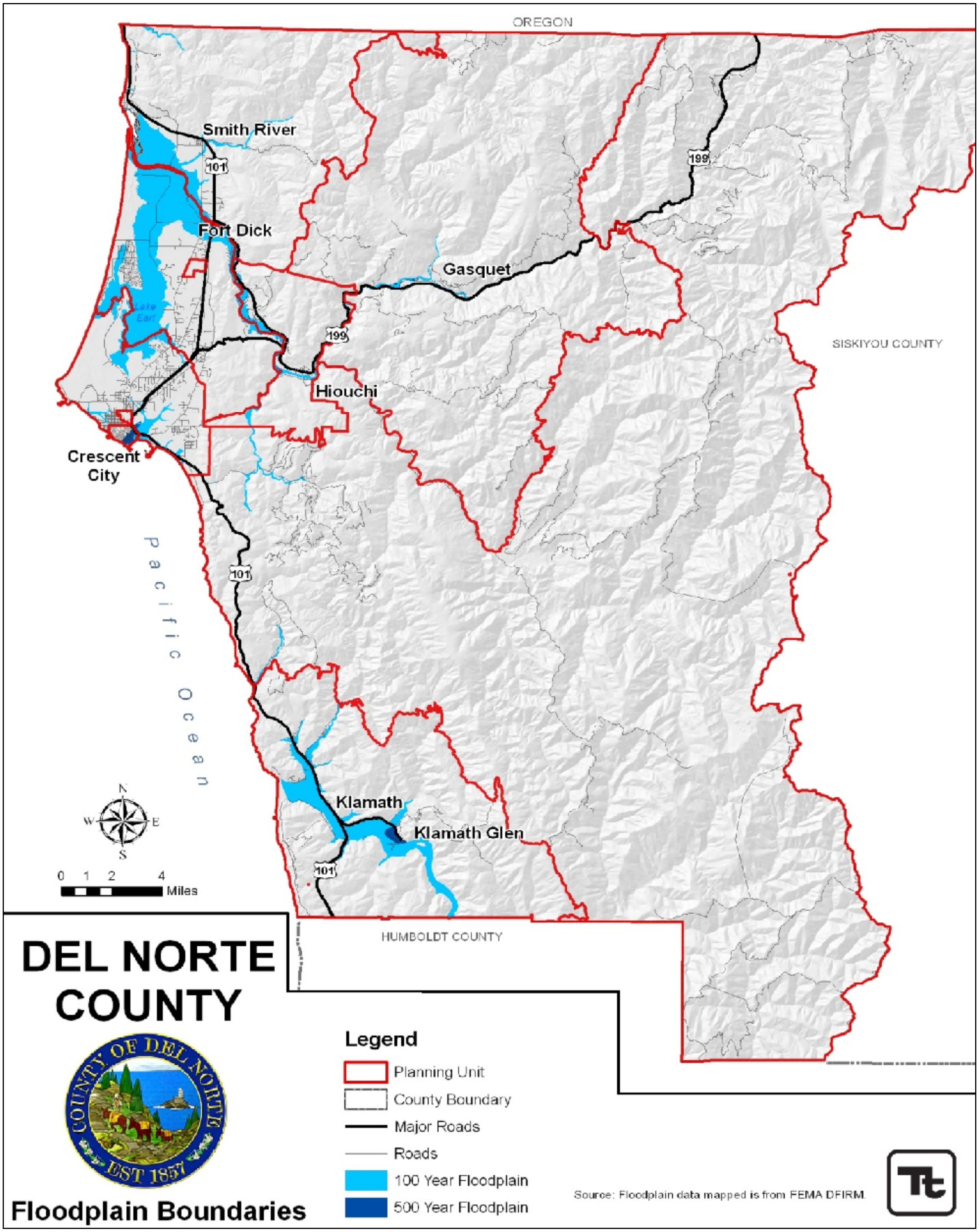


Figure 13-2. Extent and Location of the Del Norte County Flood Hazard Area

13.3.5 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 the discharges of historical floods on different rivers can help indicate the intensity of a storm over a large area. For example, the 1964 flood event was determined to have a 250-year recurrence interval on the Klamath River, while the recurrence interval for the Smith River was determined to be a 100-year event.

Recent history has shown that Del Norte County can expect an average of one episode of minor river flooding each winter. Winter floods inundate most of the county's 100-year floodplain at intervals of 3 to 10 years. Large, damaging floods typically occur every 10 years. The frequency of flooding in smaller streams and basins can be expected to increase somewhat as a result of increased development in Del Norte County, increasing the amount of impervious surfaces.

13.3.6 Severity

The severity of flooding is typically measured by the amount of damage it could cause. This can be evaluated by reviewing past flood damage estimates or by examining peak discharges used by FEMA in mapping the floodplains of Del Norte County. These are listed in Table 13-2.

TABLE 13-2.
SUMMARY OF PEAK DISCHARGES WITHIN DEL NORTE COUNTY

	Discharge (cfs)			
Source/Location	10-Year	50-Year	100-Year	500-Year
Middle Fork Smith River; 10,000 feet upstream of confluence with Smith River-Gasquet reach	21,500	30,500	34,500	44,000
North Fork Smith River; Approximately 4,000 feet upstream of confluence of middle fork Smith river and north fork Smith River.	39,500	57,000	64,200	80,000
Smith River-Gasquet Reach; Just downstream of confluence of middle fork Smith River and North Fork smith River	65,000	93,100	105,000	132,000
Smith River-Hiouchi Reach-1; Approximately 17,000 feet downstream of U.S. Highway 199 (Hiouchi Bridge)	144,000	198,000	222,000	278,000
Smith River-Hiouchi Reach-2; Approximately 16,000 feet upstream of U.S. Highway 199 (Hiouchi Bridge)	142,000	195,000	218,000	273,000
Smith River- Hiouchi Reach; Just downstream of confluence of South Fork Smith river	134,000	184,000	206,000	258,000
Smith River-Hiouchi Reach; Approximately 2500 feet upstream of confluence of South Fork Smith River	65,000	93,100	105,000	132,000
Klamath River at Klamath	N/A	N/A	N/A	N/A
Elk Creek	N/A	N/A	N/A	N/A

13.3.7 Warning Time

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 danger.

13.4 SECONDARY HAZARDS

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

13.5 CLIMATE CHANGE IMPACTS

Global climate change could trigger changes that would result in an increase in flood activity on two fronts: flooding associated with sea level rise; and flooding associated with changed atmospheric conditions that alter the frequency, duration and intensity of storm events.

13.5.1 Sea Level Rise

As the Earth heats up, sea levels rise because warmer water takes up more room than colder water, a process known as thermal expansion. Melting glaciers compound the problem by dumping more fresh water into the oceans. Rising seas threaten to inundate low-lying areas and islands, threaten dense coastal populations, erode shorelines, damage property and destroy ecosystems that protect coasts from storms.

Sea levels have risen between 4 and 8 inches in the past 100 years. Current projections suggest that sea levels could continue to rise between 4 inches and 36 inches over the next 100 years. Sea level rise associated with climate change could displace tens of millions of people in low-lying areas – including portions of Del Norte County.

13.5.2 Changes to Atmospheric Conditions

Use of historical hydrologic data has long been the standard of practice for designing and operating flood protection projects. For example historical data are used for flood forecasting models such as the National Weather Service’s River Forecast System Model 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 relatively brief period of historical hydrologic record. Paleoclimatology, which relies upon records from ice sheets, tree rings, sediment, and rocks to determine the past state of Earth’s climate system, as well as other research revealing expected impacts of climate change, indicate that the historical hydrologic record cannot be used to predict expected increases in frequency and severity of extreme events such as floods and droughts. 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. California’s resource managers have concluded the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.

- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

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

FEMA has traditionally used the 100-year flood event for federal flood insurance. As hydrology changes, what is currently considered a 100-year flood may occur more often, leaving many communities at greater risk. Moreover, as peak flows and precipitation change over time, climate change calls into question assumptions about future conditions being similar to those of the past. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, floodways, bypass channels and levees, as well as the design of local sewers and storm drains.

13.6 EXPOSURE

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

13.6.1 Population

Population counts of those living in the floodplain within the planning area were generated by analyzing census blocks that intersect with the 100-year and 500-year floodplains identified on FIRMs. Census tract and blocks groups do not follow the same boundaries as the floodplain. Therefore, the methodology used to generate these estimates evaluated census block groups whose centers are in the 100-year floodplain. Other census block groups were chosen in which the majority of the population most likely lives in or near 100-year floodplain.

This analysis indicated that there are 290 census block groups near or at least partially in the 100-year floodplain. HAZUS-MH then estimated the number of buildings within each block that are within the floodplain, and then estimated the total population by multiplying the average Del Norte County household size of 1.3 persons per household by the number of residential structures in the floodplain. Using this approach, it was estimated that the population is 4,248 (14.4 percent of the county total) within the 100-year floodplain and 5,634 (19.1 percent of the county total) within the 500-year floodplain.

13.6.2 Property

Exposed Value

The value of exposed buildings in the 100-year and 500-year floodplains within the planning area was generated using HAZUS-MH at the census block level and is summarized in Table 13-3. This methodology estimated that that there is $395 million worth of building-and-contents exposure to the 100-year flood, representing 15.8 percent of the total assessed value of the planning area, and $580 million of exposure to the 500-year flood, representing 23.2 percent of the total assessed value.

TABLE 13-3.
VALUE OF EXPOSED BUILDINGS WITHIN 100/500-YEAR FLOODPLAINS IN DEL NORTE COUNTY

	Floodplain Area (acres)		Building/Contents Exposure Value				% of Total Assessed Value	
			100-year		500-year			
Planning unit	100-Year	500-Year	Building	Contents	Building	Contents	100-year	500-year
Crescent City	64	201	$28,184,514	$20,242,486	$71,079,078	$51,049,922	11.1%	28.0%
Crescent City UGA	2043	2205	$87,454,230	$62,810,770	$143,714,424	$103,217,576	9.3%	15.2%
Fort Dick	8853	8875	$54,733,026	$39,309,974	$54,733,026	$39,309,974	24.4%	24.4%
Gasquet	392	427	$4,342,302	$3,118,698	$4,342,302	$3,118,698	12.0%	12.0%
Hiouchi	969	1011	$10,572,612	$7,593,388	$10,572,612	$7,593,388	29.8%	29.8%
Klamath	4522	4703	$17,096,832	$12,279,168	$25,708,104	$18,463,896	21.9%	32.9%
Smith River	2959	2965	$22,471,020	$16,138,980	$22,471,020	$16,138,980	19.4%	19.4%
Other County	558	558	$4,947,582	$3,553,418	$4,947,582	$3,553,418	25.0%	25.0%
Total	**20,360**	**20,945**	**$229,802,118**	**$165,046,882**	**$337,568,148**	**$242,445,852**	**15.8%**	**23.2%**

Land Use in the Floodplain

Table 13-4 shows the existing land use of all parcels in the 100-year and 500-year floodplain, including vacant parcels and those in public/open space uses. This assessment found that 84 percent of the parcels within the 100-year floodplain are zoned for either open space/resource conservation use or low density uses associated with agricultural or timber production type uses. These are lower-risk uses for land in the floodplain. The amount of the floodplain that contains vacant, developable land is not known. This would be valuable information to know for gauging the future development potential of the floodplain. A buildable lands analysis of this sort requires a high degree of GIS capability and data sets that are not currently available for the planning area.

TABLE 13-4.
LAND USE WITHIN THE 100/500-YEAR FLOODPLAIN

	Parcels in 100-Year Floodplain		Parcels in 500-Year Floodplain	
Land Use	Area (acres)	% of total	Area (acres)	% of total
Agricultural General (20 acres)	824.34	4.35%	837.42	4.37%
Agricultural General (5 acres)	340.47	1.80%	343.26	1.79%
Agricultural Prime	4485.45	23.65%	4408.11	23.00%
Tribal Lands	345.10	1.82%	345.11	1.80%
General Commercial	37.37	0.20%	65.64	0.34%
General Industrial	117.36	0.62%	117.36	0.61%
Multifamily Residential (6 to 15 du/ac)	1.40	0.01%	1.40	0.01%
Public Facilities	172.02	0.91%	209.21	1.09%
Resource Conservation Area	8,726.09	46.02%	8729.39	45.55%
Rural Neighborhood	23.37	0.12%	100.77	0.53%

TABLE 13-4 (continued).
LAND USE WITHIN THE 100/500 YEAR FLOODPLAIN

Land Use	Parcels in 100-Year Floodplain Area (acres)	Parcels in 100-Year Floodplain % of total	Parcels in 500-Year Floodplain Area (acres)	Parcels in 500-Year Floodplain % of total
Rural Residential (1 du/ac)	257.95	1.36%	307.60	1.61%
Rural Residential (1 du/2 ac)	40.53	0.21%	45.62	0.24%
Rural Residential (1 du/3 ac)	8.43	0.04%	9.05	0.05%
Rural Residential (1 du/5 ac)	4.80	0.03%	5.57	0.03%
State and Federal Lands	1410.84	7.44%	1459.00	7.61%
Timberland	1342.78	7.08%	1351.96	7.05%
Urban Lands-Residential (2 to 6 du/ac)	10.63	0.06%	10.63	0.06%
Visitor-Serving Commercial	598.00	3.15%	601.49	3.14%
Urban Residential	1.60	0.01%	1.60	0.01%
Rural Mobile Home Park	2.70	0.01%	2.70	0.01%
Agricultural Industrial	41.82	0.22%	41.82	0.22%
Light Industrial	22.94	0.12%	22.94	0.12%
Shoreline	146.93	0.77%	146.93	0.76%
Total	**18,962.92**	**100.00%**	**19,164.58**	**100.00%**

Structures in the Floodplain

The number and type of structures exposed to the 100-year and 500-year floods were estimated from the Level 2 HAZUS-MH analysis and are listed in Table 13-5.

TABLE 13-5.
STRUCTURES WITHIN 100-YEAR AND 500-YEAR FLOODPLAINS

	Residential		Commercial		Industrial		Other		**Total**	
Planning Unit	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	**100-Year**	**500-Year**
Crescent City	112	477	19	82	1	4	4	19	**136**	**578**
Crescent City UGA)	2,108	2,108	85	85	15	15	13	29	**2,221**	**2,222**
Fort Dick	583	583	16	16	7	7	4	11	**610**	**610**
Gasquet	369	369	8	8	0	0	2	2	**379**	**379**
Hiouchi	234	234	8	8	3	3	2	5	**247**	**247**
Klamath	566	832	9	16	2	5	7	14	**584**	**862**
Smith River	522	522	30	30	6	6	11	17	**569**	**569**
Other County	75	75	0	0	0	0	1	1	**76**	**76**
Total	**4,569**	**5,200**	**175**	**245**	**34**	**40**	**44**	**98**	**4,822**	**5,543**

13.6.3 Critical Facilities and Infrastructure

Tables 13-6 and 13-7 summarize the numbers of critical facilities in the floodplain.

TABLE 13-6.
CRITICAL FACILITIES IN THE 100-YEAR FLOODPLAIN

Planning Unit	Medical and Health Services	Government Function	Protective	Hazardous Materials	Schools	Societal	Other	**Total**
Crescent City	0	3	0	0	0	0	0	**3**
Crescent City UGA	0	0	0	0	0	0	0	**0**
Fort Dick	0	0	0	0	0	0	0	**0**
Gasquet	0	0	0	0	0	0	0	**0**
Hiouchi	0	0	0	0	0	0	0	**0**
Klamath	0	0	1	0	1	0	3	**5**
Smith River	0	0	0	0	0	0	1	**1**
Other County	0	0	0	0	0	0	0	**0**
Total	**0**	**3**	**1**	**0**	**1**	**0**	**4**	**9**

TABLE 13-7.
CRITICAL FACILITIES IN THE 500-YEAR FLOODPLAIN

Planning Unit	Medical and Health Services	Government Function	Protective	Hazardous Materials	Schools	Societal	Other	**Total**
Crescent City	1	8	2	0	0	2	0	13
Crescent City UGA	0	0	0	0	0	0	0	0
Fort Dick	0	0	0	0	0	0	0	0
Gasquet	0	0	0	0	0	0	0	0
Hiouchi	0	0	0	0	0	0	0	0
Klamath	0	0	1	0	1	0	3	5
Smith River	0	0	0	0	0	0	1	1
Other County	0	0	0	0	0	0	0	0
Total	**1**	**8**	**3**	**0**	**1**	**2**	**4**	**19**

Utilities/Infrastructure

Roads or railroads that are blocked or damaged can prevent access throughout the county and can isolate residents and emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris from floods also can cause isolation. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can also be backed up, causing wastes to spill into homes, neighborhoods, rivers and streams. Underground utilities can also be damaged during flood events. Thus it is critical to identify which infrastructure is exposed to flooding to determine what is vulnerable and who may be at risk if that infrastructure is damaged.

Roads

The following major roads in Del Norte County pass through the 100-year floodplain and thus are exposed to flooding:

- Highway 101
- State Route 199
- State Route 197
- State Route 169
- Lake Earl Road.

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

Bridges

Flooding events can significantly impact road bridges, which provide the only ingress and egress to some neighborhoods. An analysis showed that 63 bridges are in or cross over the floodplain.

13.6.4 Environment

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

13.7 VULNERABILITY

13.7.1 Population

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

- **Economically Disadvantaged Populations**—It is estimated that 15.3 percent of the people within the 100-year floodplain are economically disadvantaged (i.e., have household incomes of $10,000 or less).
- **Population over 65 Years Old**— It is estimated that 12 percent of the population in the census blocks that intersect the floodplain are over 65 years old. Approximately 5 percent of the over-65 population in the floodplain also have incomes considered to be economically disadvantaged and are considered to be extremely vulnerable.
- **Population under 14 Years Old**— It is estimated that 18 percent of the population within census blocks located in or near the 100-year floodplain are under 14 years of age.

13.7.2 Property

Flood Insurance

Flood insurance statistics help identify vulnerability by identifying where there is claim activity, where there is a high rate of flood insurance in force, and where flooding may be occurring in areas not identified as flood prone. Table 13-8 lists flood insurance statistics for Del Norte County. The total of $481,113 paid on 30 claims though June 30, 2006 represents an average of $16,037 per claim.

TABLE 13-8.
DEL NORTE COUNTY FLOOD INSURANCE CLAIM HISTORY

Jurisdiction	Crescent City	Unincorporated County	**Total**
Date of Entry Initial FIRM Effective Date	11/23/1982	1/24/2003	
Current FIRM Effective Date	9/26/2008	9/26/2008	
# of Flood Insurance Policies as of 04/30/2009	47	154	**201**
Total Insurance Coverage in Force	$14,636,800	$33,839,800	**$48,476,600**
Claims, Through 6/30/2006	2	28	**30**
Value of Claims paid, Through 6/30/2006	$116,626.75	$364,486.15	**$481,112.90**

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were adopted to decrease vulnerability. Properties built before the FIRM was adopted are more vulnerable to flooding and related damage because they do not meet code or are located in hazardous areas. The first FIRMs for Crescent City were available in 1982 and FIRMS for the rest of Del Norte County were available in 2003. Flood insurance statistics relevant to reducing flood hazard are as follows:

- Approximately 4.2 percent of the insurable buildings within the planning area are covered by a flood insurance policy. Based on the approximate number of primary, insurable structures in the floodplain and the insurance coverage in force within the floodplain, insurance coverage as a form of mitigation appears to be well below the national average. According to a study being conducted for the NFIP, about 49 percent of single-family homes in special flood hazard areas nationwide are covered by flood insurance.
- Approximately 38 percent of the current policies in force in the planning area are for properties located outside the 100-year floodplain.
- The total value of insurance coverage in force represents 56 percent of the total building exposure value, including contents, of structures within a 100-year floodplain.
- The total claims paid by flood insurance policies represent 11.2 percent of total requests for individual assistance since 1978.
- Of total claims paid, 21.2 percent were for properties outside the 100-year floodplain.

Repetitive Loss

The key identifiers for repetitive loss properties are claims paid by flood insurance policies. FEMA's list of repetitive loss properties identifies only one such property in the Del Norte County planning area, as of May 1, 2009. This property is isolated and lies within a mapped 100-year floodplain. The dates of loss for the property track with flood events reported to have caused significant damage within the county.

FEMA-sponsored programs, such as the Community Rating System, require participating communities to identify repetitive loss areas. Identifying such areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because of a lack of flood insurance coverage. It can be concluded that the entire mapped floodplain within Del Norte County is subject to repetitive flooding. Therefore the Planning Team has defined the repetitive loss area to be contiguous with the mapped 100-year floodplain.

Flood Loss Potential of Structures

The HAZUS-MH program calculates losses to structures from flooding by looking at depth of flooding and type of structure. Using historical flood insurance claim data, HAZUS-MH analyses these components to estimate a percentage of damage to structures and their contents by applying established damage functions to an inventory. This inventory comes pre-loaded within the HAZUS model and is based on data from the U.S. Census, state databases, the U.S. Highway Administration, etc. Default values can be overridden with locally generated data if available. There was not sufficient local data in a GIS format available to override the default values for the entire Del Norte County planning area, but there was sufficient data for the Crescent City and Crescent City UGA planning units. Therefore, the accuracy of the model should be considered enhanced for these portions of the planning area.

The analysis is summarized in Table 13-9. It is estimated that there would be up to $53 million of flood loss from a 100-year flood event within the planning area. This represents 13.6 percent of the total exposure to the 100-year flood. It is also estimated that there would be $101 million of flood loss from a 500-year flood event, representing 17.4 percent of the total exposure to a 500-year flood event.

TABLE 13-9.
ESTIMATED FLOOD LOSS FOR THE 100-YEAR AND 500-YEAR FLOOD EVENTS

	Estimated Flood Loss						% of Total Exposure in Floodplain	
	Buildings		Contents		**Total**			
	100-year	500-year	100-year	500-year	**100-year**	**500-year**	100-year	500-year
Crescent City	$1,868,000	$14,855,000	$4,278,000	$29,194,000	**$6,146,000**	**$44,049,000**	12.7%	36.1%
Crescent City UGA	$6,696,000	$7,035,000	$7,738,000	$8,277,000	**$14,434,000**	**$15,312,000**	9.6%	6.2%
Fort Dick	$4,223,000	$4,293,000	$3,260,000	$3,323,000	**$7,483,000**	**$7,616,000**	8.0%	8.1%
Gasquet	$130,000	$273,000	$84,000	$179,000	**$214,000**	**$452,000**	2.9%	6.1%
Hiouchi	$3,158,000	$3,317,000	$2,107,000	$2,206,000	**$5,265,000**	**$5,523,000**	29.0%	30.4%
Klamath	$5,014,000	$8,851,000	$4,488,000	$8,796,000	**$9,502,000**	**$17,647,000**	32.3%	40.0%
Smith River	$4,708,000	$4,713,000	$4,423,000	$4,427,000	**$9,131,000**	**$9,140,000**	23.6%	23.7%
Other County	$549,000	$549,000	$811,000	$811,000	**$1,360,000**	**$1,360,000**	16.0%	16.0%
Total	**$26,346,000**	**$43,886,000**	**$27,189,000**	**$57,213,000**	**$53,535,000**	**$101,099,000**	**13.6%**	**17.4%**

13.7.3 Critical Facilities

HAZUS-MH was used to estimate the flood loss potential to critical facilities identified as exposed to the flood risk. Utilizing depth/damage function curves to estimate the percent of damage to the building and the building contents, HAZUS-MH correlates these estimates in to an estimate of functional down-time.

Functional down-time is the estimated time it will take to restore a facility to 100 percent of its functionality.

HAZUS estimated that on average critical facilities would receive 9.4 percent damage to the structure and 37.6 percent damage to the contents during a 100-year flood event, and the estimated time to restore these facilities to full functionality would be 530 days. A 500-year flood event would damage the structures an average of 10.6 percent and the contents an average 41.9 percent, and the estimated time to restore the facilities to full functionality would be 540 days.

13.7.4 Environment

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

13.8 FUTURE TRENDS IN DEVELOPMENT

It is assumed that development and redevelopment trends in Del Norte County are not such that there is major concern about development in identified flood risk areas. Both Crescent City and Del Norte County participate in the National Flood Insurance Program, and are considered to be in good standing based on program compliance. As a participant in the NFIP, both communities have agreed to regulate new development that occurs within the mapped floodplain according to standards that equal or exceed those specified under 44CFR Section 60.3. These will ensure that any development allowed to occur in the floodplain will be constructed such that the flood risk exposure is eliminated or significantly reduced.

To meet the intent of California state mandates (AB 2140 and Executive Order S-13-08), Crescent City, Del Norte County and all of their planning partners are committed to ensuring that future growth and development in the planning area take flood risk into account, along with all of the hazards of concern addressed by this plan.

13.9 SCENARIO

The major river systems in Del Norte County flood at irregular intervals, but generally in response to a succession of intense winter rainstorms occurring between early November and late March. A series of weather events that meet these conditions can cause severe flooding. The worst-case scenario is a series of storms that flood numerous drainage basins in a short time. This would overwhelm city and County response and floodplain management departments. Major roads would be blocked, preventing critical access for many residents and critical functions. High river flows could cause rivers to scour, possibly washing out roads and creating more isolation problems. In the case of multi-basin flooding, the County would not be able to make repairs quickly enough to restore critical facilities and infrastructure.

13.10 ISSUES

Important issues associated with flood hazards in Del Norte County include but are not limited to the following:

- The true degree of vulnerability is not known due to the lack of detailed flood hazard mapping for the planning area.
- Data prepared through the California Department of Water Resources "Awareness Mapping Program" suggests that the extent and location of flood-prone areas in the planning area is not well identified by the existing mapping.
- The level of detail of the coastal flood hazard risk is less than adequate.

- The extent of the flood-protection currently provided by flood control facilities (dams, dikes and levees) is not known due to the lack of an established national policy on flood protection standards.
- In general, the structural flood-protection measures currently in place within the planning area provide little if any attenuation effect of the flood hazard. This is due primarily to the fact that the majority of these facilities were not designed with flood control as a primary function.
- The risk associated the flood hazard overlaps the risk associated with other hazards such as earthquake, landslide and fishing losses. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- There is no degree of consistency of land-use practices and regulatory floodplain management scope within the planning area.

CHAPTER 14.
LANDSLIDES AND OTHER MASS MOVEMENTS

14.1 LANDSLIDE AND MASS MOVEMENT DEFINED

The following definitions apply in the discussion of landslide and mass movement hazards:

- **Landslide**—A landslide is the sliding movement of masses of loosened rock and soil down a hillside or slope. Slope failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them. Landslides may be minor or very large, and can move at slow to very high speeds. They can be initiated by storms, earthquakes, fires, floods, volcanic eruptions, or human modification of the land.
- **Mass movements**—A collective term for landslides, debris flows, falls and sinkholes.
- **Mudslide (or Mudflow or Debris Flow)—**A river of rock, earth, organic matter and other materials saturated with water. Mudslides develop in soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud or "slurry." A debris flow can move rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds. The slurry can travel miles from its source, growing as it descends, picking up trees, boulders, cars, and anything else in its path. Although these slides behave as fluids, their hydraulic force is many times greater than that of water due to the mass of material included in them. They are among the most destructive events in nature.
- **Sinkhole**—A collapse depression in the ground with no visible outlet. Its drainage is subterranean; its size is typically measured in meters or tens of meters, and it is commonly vertical-sided or funnel-shaped.

14.2 GENERAL BACKGROUND

Landsliding (or "mass movement," which includes earth-flows, debris flow, falls and sinkholes) is caused by a combination of geological and climate conditions. The geological conditions of Del Norte County are dominated by an actively faulted and sheared older bedrock (Franciscan) overlain by younger, soft marine and fluvial sediments. Most of the region has rapid uplift rates rivaled only by the Himalayan Mountains. The cool, rainy Pacific Northwest climate ensures that soil moisture levels remain high throughout much of the year, and in fact are often at or near saturation during winter.

The combination of large rain events, easily eroded bedrock and overlying sediments, and fast uplift rates makes the county susceptible to landslides and mudslides, which can be triggered by rain and ground shaking events. The region's steep topography reflects the rapid tectonic uplift and simultaneous erosional processes. Conditions are exacerbated by the steady encroachment of residential, agricultural, commercial and industrial development and the infrastructure that supports it into the vulnerable natural setting

Landslides are caused by one or more of the following factors: change in slope gradient, increased load on the land, shocks and vibrations (ground shaking), change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes. In general, Del Norte County landslide hazard areas occur where the land has characteristics that contribute to the risk of the downhill movement of material:

- Bedrock that is sheared/faulted and easily erodible
- A slope greater than 15 percent
- A history of landslide activity during the last 10,000 years
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable
- Potential for ground shaking
- The presence of an alluvial fan, which indicates vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, mixed with granular soils such as sand and gravel.

The following are the most common types of mass movements in Del Norte County:

- Rotational Slide—A deep-seated landslide and slumping with a rotational component caused by natural groundwater pressures within a hillside, removal of the slope toe, and removal of vegetation (see Figures 14-1 and 14-2).
- Translational Slide—A shallow translational sliding feature caused by groundwater pressures within a hillside, and slope-parallel weaknesses in bedrock near the surface (see Figure 14-3).
- Fall—A block fall of soil from high bluffs, primarily along the near-vertical cliffs of the coastline and edges of river terraces.
- Flow—Shallow, rapid, liquid-like flow of the outer surface of a hillside slope consisting of course, fine-grained soils or clays materials (see Figure 14-4).

All four of these slide types are common in the planning area, occurring particularly in response to intense, short-duration storms, and/or larger earthquakes (nearby and with magnitude greater than 6.0 on the Richter scale). Shallow slides are the most common and the most probable in Del Norte County. Occasionally however, large catastrophic slides occur in most parts of the county. The largest and most destructive are deep-seated slides, although they are less common than other types. The shoreline contains many large, deep-seated dormant landslides. Most landslides in the county occur from January through March after the water table has risen during the wet months.

Flows and slides may travel along their paths in a variety of ways. The velocity of movement may range from a few centimeters per year to many meters per second (more commonly), depending on slope angle, material and water content.

14.3 HAZARD PROFILE

14.3.1 Past Events

Landside activity is common in Del Norte County, with the severity ranging from minor to severe. The most recent widespread landslide damage in the county occurred during the winter storm of 2005-06. Record high rains and winds of the 2005-06 winter storms resulted in thousands of large and small scale landslides along every major transportation corridor of the county (Highways 101, 199, 197, and 169). The result was millions of dollars in damage and much of the county cut off from the outside world. Drainage systems and catchment basins could not handle the volume of runoff, focusing the water’s energy against vulnerable slopes and manmade structures. In some cases, saturated soils became overloaded with the weight of rainwater and collapsed. Private homeowners reported significant damage, particularly in areas where natural drainage ways have been paved, diverted or otherwise modified.

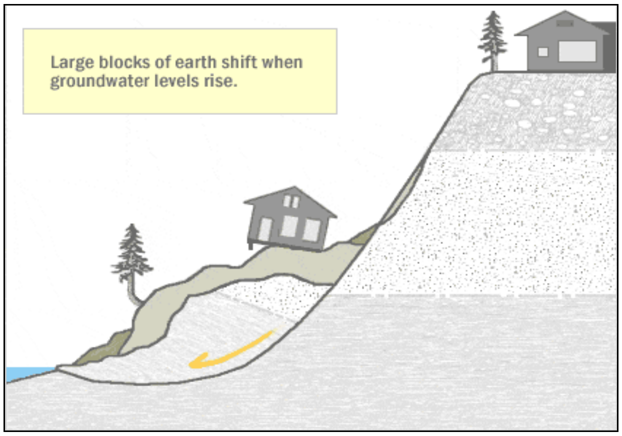


Figure 14-1. Large Rotational Slide (Deep Seated)

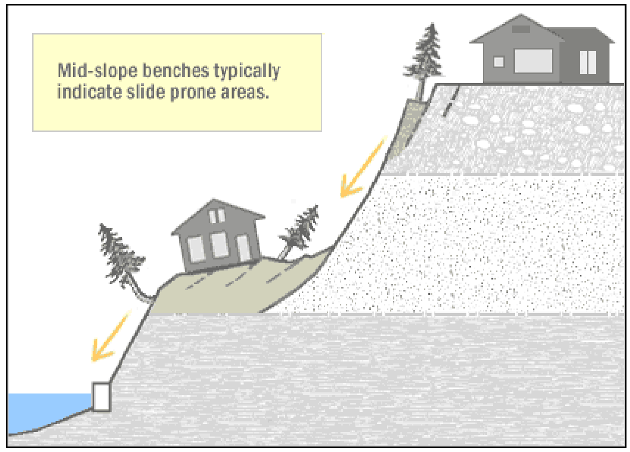


Figure 14-2. Slumps (Small Rotational) Slides

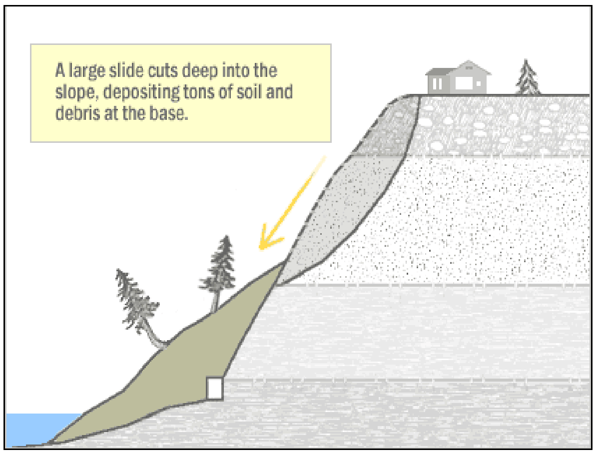


Figure 14-3. Translational Slides

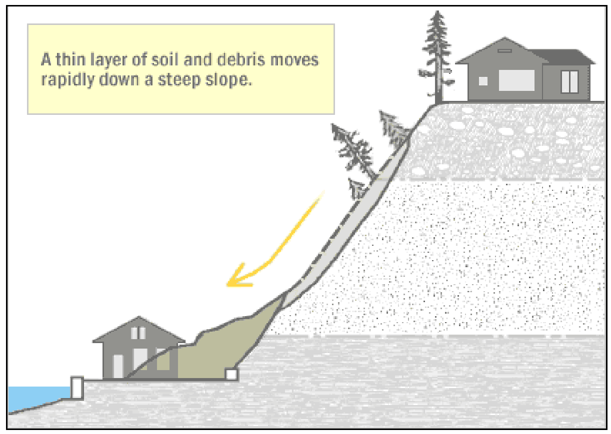


Figure 14-4. Flows

14.3.2 Location

Figure 14-5 shows relative slope stability throughout Del Norte County, based on the following sources:

- The "active" slides are those that have been mapped by the California State Geological Survey.
- Areas shown as "approximate" slide areas were delineated based on slope and soil type. The parameters for these areas are slopes equal to or exceeding 15 percent and Type C, D or E soil types as identified under the National Earthquake Hazards Reduction Program (NEHRP).
- The "observed/reported" landslide areas are areas that have been reported by citizens of Del Norte County and their boundaries are considered to be approximate. These areas were identified and validated during the public involvement phases of this plan. These are, in general, areas of the county that are more susceptible to landslides.

Highway 101, the main transportation corridor in northern coastal California, traverses a particularly rugged and landslide-prone area between Crescent City and Wilson Creek in Del Norte County. Within this corridor, landslides at Last Chance Grade have been an ongoing problem for decades (see Figures 14-6 and 14-7). Cal Trans has mapped more than 200 landslides along the Highway 101 corridor between Wilson Creek and Crescent City.

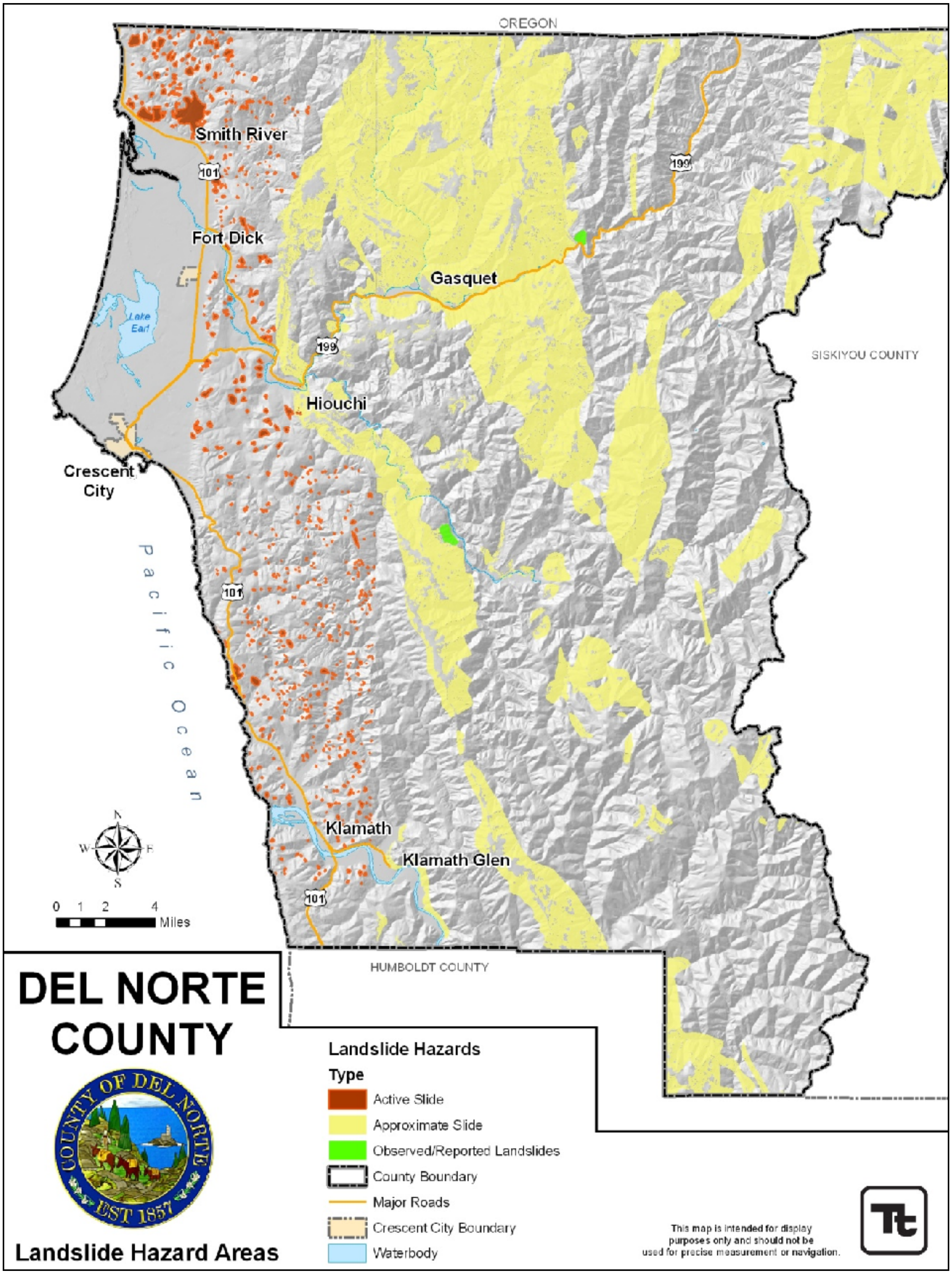


Figure 14-5. Slope Stability

Figure 14-6. Highway 101, Last Chance Grade

Figure 14-7. Highway 101 Landslide Clean Up, Winter 2005-06

Since Highway 101 is the principal supply route to the planning area, landslides that impact this travel corridor can have severe economic impact on Del Norte County. The Highway 101 corridor from Wilson Creek to Crescent City has received a great deal of attention in the form of studies and mitigation efforts by the California Department of Transportation.

In addition to the coastal bluffs, landsliding is most prevalent around the slopes of the steep, northwest trending mountains and hills. Water is involved in nearly all cases; and human influence has been identified in many of the reported slides. The recognition of ancient dormant mass movement sites is important in the identification of areas most susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are more vulnerable to construction-triggered sliding than adjacent undisturbed material.

14.3.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildland fires, so the frequency of landslides is related to the frequency of these other hazards. In Del Norte County, although landslides typically occur during and after major storms, they also occur naturally in average rainfall years in remote and non-human impacted areas. Recent major events occurred during winter storms of 1963-64, 1982-83, 1992, 1998, and 2005-06, each of which generated hundreds of slides. However, due to the low population of the county and the isolation of its population centers, many of these slides caused little or no reported property damage.

14.3.4 Severity

Landslides destroy property and infrastructure and can take the lives of people. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost of about $1.5 billion. Falls, slides, and mud and debris flows caused about half of all damage during the 2005-06 storms in Del Norte County, including tens of millions of dollars of damage to road infrastructure.

14.3.5 Warning Time

Mass movements can occur suddenly or slowly. Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine what areas are at risk during general time periods. Assessing the geology, vegetation, and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for landslide hazards. Correlations can be made based on soil type, slope and rainfall amount. No known correlations have been made for the planning area. The current standard operating procedure is to monitor situations on a case-by-case basis, and respond after the event has occurred.

14.4 SECONDARY HAZARDS

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

14.5 CLIMATE CHANGE IMPACTS

Climate change has and will continue to impact storm patterns in California. This changing of the hydrograph means that the probability of more frequent, intense storms with varying duration will increase. Increase in global temperature will also affect the snowpack and its ability to hold and store water. Additionally, warming temperatures will increase the occurrence and duration of droughts, which will increase the probability of wildland fire, which impacts the vegetation that helps to support steep slopes. All of these factors working in unison would increase the probability for landslide occurrences within the planning area.

14.6 EXPOSURE

Figure 14-5 was used to determine the countywide exposure of population and structures to the landslide hazard. Hazard areas are spread throughout the county and are not associated only with areas of steepest slope. The map was used as a general assessment of countywide exposure, but should be used with caution and does not apply on a site-specific basis.

14.6.1 Population

A geographic analysis of demographics was performed using GIS data. Population figures (in census blocks) were cross-referenced with the map showing landslide hazard areas. Table 14-1 summarizes the results of this analysis.

TABLE 14-1.
DEL NORTE COUNTY POPULATION EXPOSURE TO LANDSLIDE HAZARD

Landslide Risk	Population Exposed	% of Total Exposed Population
Active	1,272	29%
Approximate	2,341	53%
Observed	820	18%
Total	**4,433**	**100%**

14.6.2 Property

Structures

An estimated 1,690 structures in Del Norte County are located on parcels exposed to landslide risk, as summarized in Table 14-2. Altogether these structures are worth about $319 million, or 12.8 percent of the total assessed value for the county. It is estimated that 95 percent of these exposed structures are dwellings. Table 14-3 shows the number and market improvement value by planning unit.

Land Use

Lands used for timber related, rural residential, and single family residential land uses are the most vulnerable to landslide hazards; lands used for schools, gravel mining, industrial, and camping are less vulnerable. The predominant land uses for parcels in the county are timber and residential related. Table 14-4 shows the general land use of parcels exposed to landslides within the planning area, by planning unit (the Crescent City planning unit is not shown because it contains no exposed parcels).

TABLE 14-2.
DEL NORTE COUNTY EXPOSURE OF STRUCTURES TO LANDSLIDE HAZARD

Landslide Risk	Number of Structures Exposed	% of Total Exposure
Active	421	25%
Approximate	1030	61%
Observed	239	14%
Total	**1,690**	**100%**

TABLE 14-3.
ASSESSED VALUE OF BUILDINGS EXPOSED TO LANDSLIDE HAZARD

Planning Unit	Building Count	Assessed Value	% of Total County Assessed Value
Crescent City	0	0	0
Crescent City UGA	63	$22,029,000	0.88%
Fort Dick	132	$37,313,000	1.49%
Gasquet	440	$61,922,000	2.48%
Hiouchi	301	$51,322,000	2.05%
Klamath	425	$76,241,000	3.05%
Smith River	189	$38,845,000	1.56%
Unincorporated County	140	$31,281,000	1.25%
Total	**1,690**	**$318,953,000**	**12.77%**

TABLE 14-4.
GENERAL PLAN LAND USE EXPOSURE TO LANDSLIDE HAZARD

Land Use Type	Area (acres)	% of Total Hazard Area
Crescent City UGA Planning Unit		
Agricultural General 5	1.2894	0.0008%
State/Federal Lands	35.8531	0.0228%
Timberland	0.5174	0.0003%
Fort Dick Planning Unit		
Agricultural General 5	1.1929	0.0008%
Riparian Corridor	0.0052	0.0000%
Rural Residential (1 dwelling unit/1 acre)	0.3863	0.0002%
Rural Residential (1 dwelling unit/3 acres)	0.9005	0.0006%
State/Federal Lands	342.0312	0.2180%
Timberland	69.6338	0.0444%
Gasquet Planning Unit		
Resource Conservation Area	10.6181	0.0068%
Riparian Corridor	16.6494	0.0106%
Rural Neighborhood	1.6911	0.0011%
Rural Residential (1 dwelling unit/1 acre)	105.0280	0.0669%
Rural Residential (1 dwelling unit/2 acres)	1.5249	0.0010%
Rural Residential (1 dwelling unit/3 acres)	3.9719	0.0025%
Rural Residential (1 dwelling unit/5 acres)	87.9520	0.0561%
State/Federal Lands	64303.828	40.9801%
Timberland	1177.5388	0.7504%
Visitor-Serving Commercial	0.7598	0.0005%

TABLE 14-4 (continued).
GENERAL PLAN LAND USE EXPOSURE TO LANDSLIDE HAZARD

Land Use Type	Area (acres)	% of Total Hazard Area
Hiouchi Planning Unit		
Resource Conservation Area	0.1377	0.0001%
Riparian Corridor	27.9515	0.0178%
Rural Neighborhood	4.2273	0.0027%
Rural Residential (1 dwelling unit/1 acre)	93.8682	0.0598%
Rural Residential (1 dwelling unit/2 acres)	33.6426	0.0214%
Rural Residential (1 dwelling unit/5 acres)	257.1192	0.1639%
State/Federal Lands	1813.5099	1.1557%
Timberland	367.7993	0.2344%
Klamath Planning Unit		
Agricultural General 20	18.0404	0.0115%
Agricultural General 5	13.2188	0.0084%
General Commercial	10.4420	0.0067%
General Industrial	6.4139	0.0041%
Public Facility	1.4288	0.0009%
Riparian Corridor	15.6455	0.0100%
Rural Residential (1 dwelling unit/1 acre)	0.5847	0.0004%
Rural Residential (1 dwelling unit/2 acres)	17.3980	0.0111%
Rural Residential (1 dwelling unit/3 acres)	19.6391	0.0125%
Rural Residential (1 dwelling unit/5 acres)	0.0225	0.0000%
State/Federal Lands	2241.0625	1.4282%
Timberland	1354.4836	0.8632%
Tribal	43.9654	0.0280%
Visitor-Serving Commercial	7.4504	0.0047%
Smith River Planning Unit		
Agricultural General 20	2.0914	0.0013%
Agricultural Prime	6.1471	0.0039%
Rural Neighborhood	5.5521	0.0035%
Rural Residential (1 dwelling unit/1 acre)	17.4943	0.0111%
Rural Residential (1 dwelling unit/2 acres)	56.4509	0.0360%
Rural Residential (1 dwelling unit/5 acres)	76.9895	0.0491%
State/Federal Lands	3796.6660	2.4196%
Timberland	2611.1598	1.6641%
Tribal	0.2231	0.0001%
Other County Planning Unit		
Agricultural General 20	32.4254	0.0207%
Agricultural General 5	1.7115	0.0011%
General Industrial	0.7755	0.0005%
Resource Conservation Area	37.6104	0.0240%
Riparian Corridor	8.6137	0.0055%
Rural Residential (1 dwelling unit/1 acre)	10.2835	0.0066%
Rural Residential (1 dwelling unit/2 acres)	43.6001	0.0278%
Rural Residential (1 dwelling unit/5 acres)	30.7969	0.0196%
State/Federal Lands	75682.2187	48.2314%
Timberland	1984.4424	1.2647%
Total	**156,914.68**	**100.0000%**

14.6.3 Critical Facilities and Infrastructure

An analysis of critical facilities inventory was performed outside of the HAZUS model to determine exposure of critical facilities to the landslide hazard. Table 14-5 summarizes the results. No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard.

TABLE 14-5.
CRITICAL FACILITY EXPOSURE TO LANDSLIDE HAZARD

Planning Unit	Medical & Health Services	Government Function	Protective	Hazardous Materials	Schools	Societal	Other	**Total**
Crescent City	0	0	0	0	0	0	0	**0**
Crescent City UGA	0	0	0	0	0	0	0	**0**
Fort Dick	0	0	0	0	0	0	0	**0**
Gasquet	0	0	1	0	1	1	1	**4**
Hiouchi	0	0	0	0	0	0	0	**0**
Klamath	0	0	0	0	0	0	0	**0**
Smith River	0	0	0	0	0	0	0	**0**
Other County	0	0	0	0	0	0	0	**0**
Total	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**4**

Infrastructure

A significant amount of infrastructure (roads, bridges, and utilities) can be exposed to mass movements. Landslides have the potential to block roads, causing isolation for part or all of the county. Roadway blockages caused by landslides can also create traffic problems resulting in delays for emergency vehicles and public and private transportation. This could result in economic losses for businesses. Other potential problems resulting from landslides are power and communication failures creating problems for vulnerable populations or businesses and potential loss of life in emergency situations.

Roads and Bridges

Most of the major roads in Del Norte County are exposed to mass movement hazards. Access to major roads is crucial to life-safety after a disaster event and can help to provide resilience during response and recovery operations. Landslides events can also significantly impact road bridges. They can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use or create conditions in which bridges are obstructed. Bridges in areas of high landslide risk often provide the only ingress and egress to large areas and in some cases to isolated areas of the county. Table 14-6 lists the exposure of roads and bridges to landslides by planning unit.

Power Lines

Power lines are generally elevated above steep slopes; nonetheless the towers supporting them can be subject to landslides. A landslide could cause the soil underneath a tower to fail, causing it to collapse, and ripping down the lines. Analysis showed that Pacific Gas & Electric lines pass through many highly unstable slope areas.

TABLE 14-6.
ROAD AND BRIDGE EXPOSURE TO LANDSLIDE HAZARD

Planning Unit	Miles of Road Exposed to Landslide Hazard	Bridges Exposed to Landslide Hazard
Crescent City	0	0
UGA	0.19	0
Fort Dick	0.15	0
Gasquet	85.66	8
Hiouchi	3.12	2
Klamath	7.59	0
Smith River	10.04	0
Other County	72.73	5
Total	**179.48**	**15**

14.6.4 Environment

Environmental problems as a result of mass movements can be numerous. Landslides fall into streams and significantly impact fish and wildlife habitat, as well as affecting water quality.

14.6.5 Other Assets at Risk

Agricultural and Timber Resources

Agricultural resources include rangelands, timberlands, cultivated farmlands, and dairy lands. Agricultural lands are an important element of the Del Norte County identity and economy. Landslides can have major consequences for such resources, primarily timberland due to the large portion of it on steep slopes in remote locations. Roads accessing timberlands are often susceptible to slides and erosional events and frequently are contributing factors to landslides. Landslide activity on these roads can remove them from production.

Scenic Resources

Del Norte County possesses numerous natural and cultural scenic resources, including redwood forests, beaches, flora and fauna habitat, wild and scenic rivers, agricultural lands, historical buildings, and coastal amenities such as sea stacks, sea cliffs, and sand dunes. Many of these resources can be directly impacted by mass movements:

- **Coastal Views**—Del Norte County's coastline allows for a wide range of scenic vistas from Highway 101 and from beaches, state parks and coastal access points. Landslides could visually impact these views or prevent access to views.
- **Forests**—Forestlands define much of the visual landscape of Del Norte County. Redwood National Park, Six Rivers National Forest, and Redwoods State Park are all significant, protected forests within the county. Forestland is abundant well beyond these protected areas. The scenic value of these natural resources, viewed from within or from outside, is of great importance. Landslides are a natural part of forest lands and can have an impact.
- **Scenic Highways**—A scenic road is defined as a roadway that, in addition to its transportation function, provides opportunities for the enjoyment of natural and scenic resources. Scenic roads direct views to areas of exceptional beauty, natural resources or

landmarks, or historic and cultural interest. Because these routes are frequently located in less developed areas, they are frequently susceptible to landslides. Currently, Del Norte County possesses only one federally designated scenic highway: the Smith River Scenic Byway. This byway predominantly follows U.S. Highway 199 from the Highway 101 intersection to the Oregon Border.

14.7 VULNERABILITY

14.7.1 Population

Due to the nature of census block group data, it is difficult to determine demographics of populations vulnerable to mass movements. In general, all persons exposed to landslides hazards are also vulnerable. Due to Del Norte County's slowly increasing population density and the fact that many man-made structures are built on "view property" atop or below bluffs and on steep slopes subject to mass movement, more lives are now endangered by this hazard than ever before.

14.7.2 Property

Past history of property damage due to failing coastal bluffs and river frontage property indicates the willingness of people to ignore signs of potential disaster in order to possess aesthetically desirable land. Although complete historical documentation of the mass movement threat in the county is lacking, the effects of slide and flow activity seen during the winter storms of 2005-06 serve as proof that a significant vulnerability to such hazards exists. Countywide, the millions of dollars in damage attributable to mass movement during those storms affected private property and public infrastructure and facilities.

HAZUS-MH does not address the landslide hazard. Loss estimations for the landslide hazard are not based on modeling utilizing damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 14-7 shows the general building stock loss estimates in steep slope areas.

TABLE 14-7.
DEL NORTE COUNTY BUILDINGS EXPOSED TO LANDSLIDE HAZARD

Planning Unit	Building Count	Assessed Value	10% Damage	30% Damage	50% Damage
Crescent City	0	0	0	0	0
Crescent City UGA	63	$22,029,000	$2,202,900	$6,608,700	$11,014,500
Fort Dick	132	$37,313,000	$3,731,300	$11,193,900	$18,656,500
Gasquet	440	$61,922,000	$6,192,200	$18,576,600	$30,961,000
Hiouchi	301	$51,322,000	$5,132,200	$15,396,600	$25,661,000
Klamath	425	$76,241,000	$7,624,100	$22,872,300	$38,120,500
Smith River	189	$38,845,000	$3,884,500	$11,653,500	$19,422,500
Other County	140	$31,281,000	$3,128,100	$9,384,300	$15,640,500
Total	**1690**	**$318,953,000**	**$31,895,300**	**$95,685,900**	**$159,476,500**

14.7.3 Critical Facilities and Infrastructure

Four critical facilities are exposed to the landslide hazard. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from mass movements should be done to determine if they could withstand impacts of a mass movement.

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

14.7.4 Environment

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

14.8 FUTURE TRENDS IN DEVELOPMENT

It is assumed that development and redevelopment trends in Del Norte County are not such that there is major concern about development in identified landslide hazard areas. However, it is important to note that any new development in the county is likely to occur in areas of high slope instability. As the population grows, more people are building and living on or otherwise modifying steep coastal bluffs and river and stream front properties. These are areas of intense development pressure. Many of the landslides occurring on these properties cannot be seen from aerial reconnaissance; they are only clearly visible from close quarters on the ground. An accurate picture of where landslides were triggered during previous storms is vital in making intelligent land use planning decisions. Consideration of existing landslide susceptibilities and potential hazards will reduce the risk to people and property both now and with future development.

14.9 SCENARIO

Major mass movements in Del Norte County occur as a result of soil conditions that have been affected by severe storms, groundwater or human development activities on steep unstable slopes. After heavy rains from November to December, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and accumulates on impermeable silt, it will subsequently cause weakness and destabilization in the slope. In addition, as rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table and poor soil exacerbate hazardous conditions.

A mass movement event is most likely to occur during the late winter when the water table is high. A short intense storm could cause the saturated soil to move, resulting in landslides. Mass movements could affect bridges that pass over landslide prone ravines, and knock out road service through the county. Most mass movements would likely be isolated events, affecting specific areas. The worst-case scenario for mass movement hazards in Del Norte County would generally correspond to a severe storm that had heavy rain and caused flooding. It is probable that private and public property including infrastructure will be affected.

It is likely that mass movements will occur anywhere in the county that has been affected by landslides in that past and in areas with steep slopes. Road obstructions caused by mass movements would most likely occur and create isolation problems for residents and businesses. It is also likely that property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in power or communication lines, cutting off power and communication access to residents.

Continued heavy rains and flooding will exacerbate this problem. As resources within Del Norte County attend to problems with flooding, it is possible they may be unavailable to assist with landslides. This will worsen the problem of isolation for residents and disrupt commerce.

14.10 ISSUES

Important issues associated with landslide hazards in Del Norte County include but are not limited to the following:

- An accurate picture of where landslides occurred during previous storms is vital in making intelligent land use planning decisions. In the past, many mass movement losses may have gone unrecorded because insurance companies do not cover such damage. Transportation network damage has often been repaired under the general category of "maintenance." Many of the landslides on Del Norte County's steep coastal bluffs and river and stream front properties cannot be seen from aerial reconnaissance; they are only clearly visible from close quarters on the ground.
- Landslides may result in isolation of the entire county (worst case) or neighborhoods and communities, due to the fact that large portions of the transportation infrastructure are in areas of high and moderate slope instability. Isolation may result in food shortages, loss of power, and severely reduced economic productivity.
- There are critical facilities in areas of unstable slopes that could have a significant amount of functional downtime post-event. This not only creates a need for mitigation but a need for continuity of operations planning to develop procedures for providing services without access to essential facilities.
- Landslides may result in loss of water quality to the environment and for drinking purposes due to increased sediment delivery into surface waterways.

CHAPTER 15.
SEVERE WEATHER

15.1 SEVERE WEATHER DEFINED

The following definitions apply in the discussion of severe weather hazards:

- **Freezing Rain**—The result of rain occurring when the temperature is below the freezing point. When this occurs the rain will freeze on impact and will result in a layer of glaze ice up to an inch thick over exposed surfaces. In a severe ice storm, an evergreen tree 20 meters high and 10 meters wide can be burdened with up to six tons of ice, creating a serious threat to power and telephone lines and transportation routes.
- **Severe Local Storm—**"Microscale" atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms and snowstorms. Typically, major impacts from a severe storm are on transportation infrastructure and utilities. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area.
- **Snowstorm**—The result of a cold low pressure system that can cover thousands of square miles with snow. Heavy snow in Del Norte County is generally confined to the mountains; heavy accumulation in the lowlands is uncommon.
- **Thunderstorm—**Typically 25 kilometers in diameter and lasting about 30 minutes, thunderstorms are underrated hazards. Lightning, which occurs with all thunderstorms, is a serious threat to human life. Heavy rains over a small area in a short time can lead to flash flooding. Strong winds, hail and tornadoes are also dangers associated with thunderstorms.
- **Tornado**—Tornadoes are funnel clouds of varying sizes that generate winds up to 500 miles per hour. A tornado is formed by the turbulent mixing of layers of air with contrasting temperature, moisture, density and wind flow. The mixing layers of air account for most of the tornadoes occurring in April, May and June, when cold, dry air meets warm, moister air moving up from the south. They can affect an area up to three-quarters of a mile wide, with a path of varying length. Tornadoes can come from lines of cumulonimbus clouds or from a single storm cloud. They are measured using the Fujita Scale ranging from F0 to F6.
- **Windstorm**—A storm featuring violent winds. Southwesterly winds are associated with strong storms moving onto the coast from the Pacific Ocean. Southern winds parallel to the coastal mountains are the strongest and most destructive winds. Windstorms tend to damage ridgelines that face into the winds.

15.2 GENERAL BACKGROUND

Del Norte County is on the windward coast in mid-latitudes and experiences a predominantly marine-type climate on the coast, while inland the climate possesses both continental and marine characteristics. The county's climate is impacted by two significant factors:

- **Mountain ranges**—The coastal mountains affect rainfall. The first major release of rain occurs along the coast, and the second is along the west slopes of the Klamath Mountains.
- **Semi-permanent high- and low-pressure areas over the North Pacific Ocean**—During summer and fall, circulation of air around a high-pressure area over the North Pacific brings a prevailing westerly and northwesterly flow of comparatively dry, cool and stable air into the Pacific Northwest. As the air moves inland, it becomes warmer and drier, resulting in a dry

season. In winter and spring, the high pressure resides further south and low pressure prevails in the Northeast Pacific. Circulation of air around both pressure centers brings a prevailing southwesterly and westerly flow of mild, moist air into the Pacific Northwest. Condensation occurs as the air moves inland over the cooler land and rises along the windward slopes of the mountains. This results in a wet season beginning in late October or November, reaching a peak in winter, and gradually decreasing by late spring.

The highest summer and lowest winter temperatures generally occur during periods of easterly winds. On the coast, summers are cool and relatively dry and winters are mild, wet and generally cloudy. The climate of the interior county has characteristics of both continental and marine climates. Summers are warmer, winters are colder, and precipitation is greater than on the coast.

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 5 to 10 knots can be expected 60 to 80 percent of the time; 10 to 15 knots, 30 to 45 percent of the time; and 20 knots or higher, 2 to 15 percent of the time. The highest wind velocities are from the southwest or west, are frequently associated with rapidly moving weather systems, and occur during the winter and spring (see Figure 15-1). Extreme wind velocities on the coast 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. In interior valleys, wind velocities reach 40 to 50 mph each winter, and 75 to 90 mph a few times every 50 years.

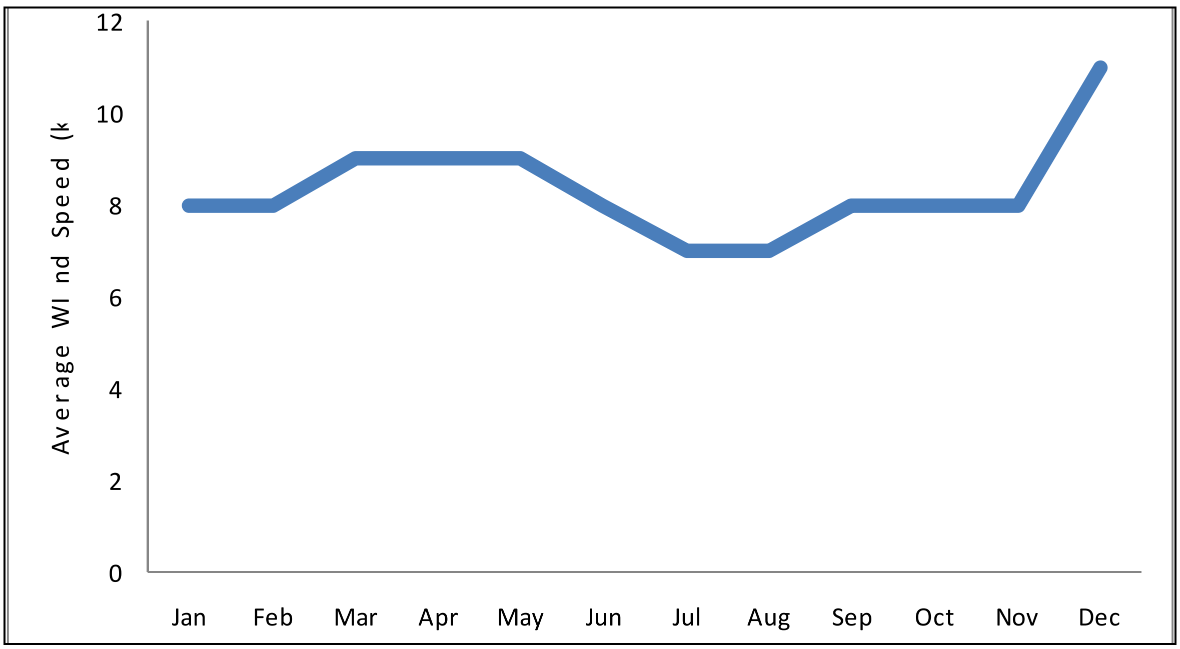


Figure 15-1. Average Wind Speed for Crescent City, January 2006 – August 2009 (NCDC 2007)

Measurable rainfall occurs on 118 days each year at Battery Point and on 190 days in the mountains. During July and August, the driest months, two to four weeks can pass with only a few showers; however, in December and January, the wettest months, precipitation is frequently recorded on 20 to 25 days or more each month. During the wet season, rainfall is usually of light to moderate intensity and continuous over a long period rather than occurring in heavy downpours for brief periods; heavier intensities occur along the windward slopes of the mountains. The range in annual precipitation is from about 70 inches in Crescent City to over 100 inches in the mountainous interior of the county (see Figure 15-2). Snowfall is light in the lower elevations and heavier in the mountains. Thunderstorms occur up to 10 days each year over lower elevations and up to 15 days in the mountainous regions. Damaging hailstorms rarely occur.

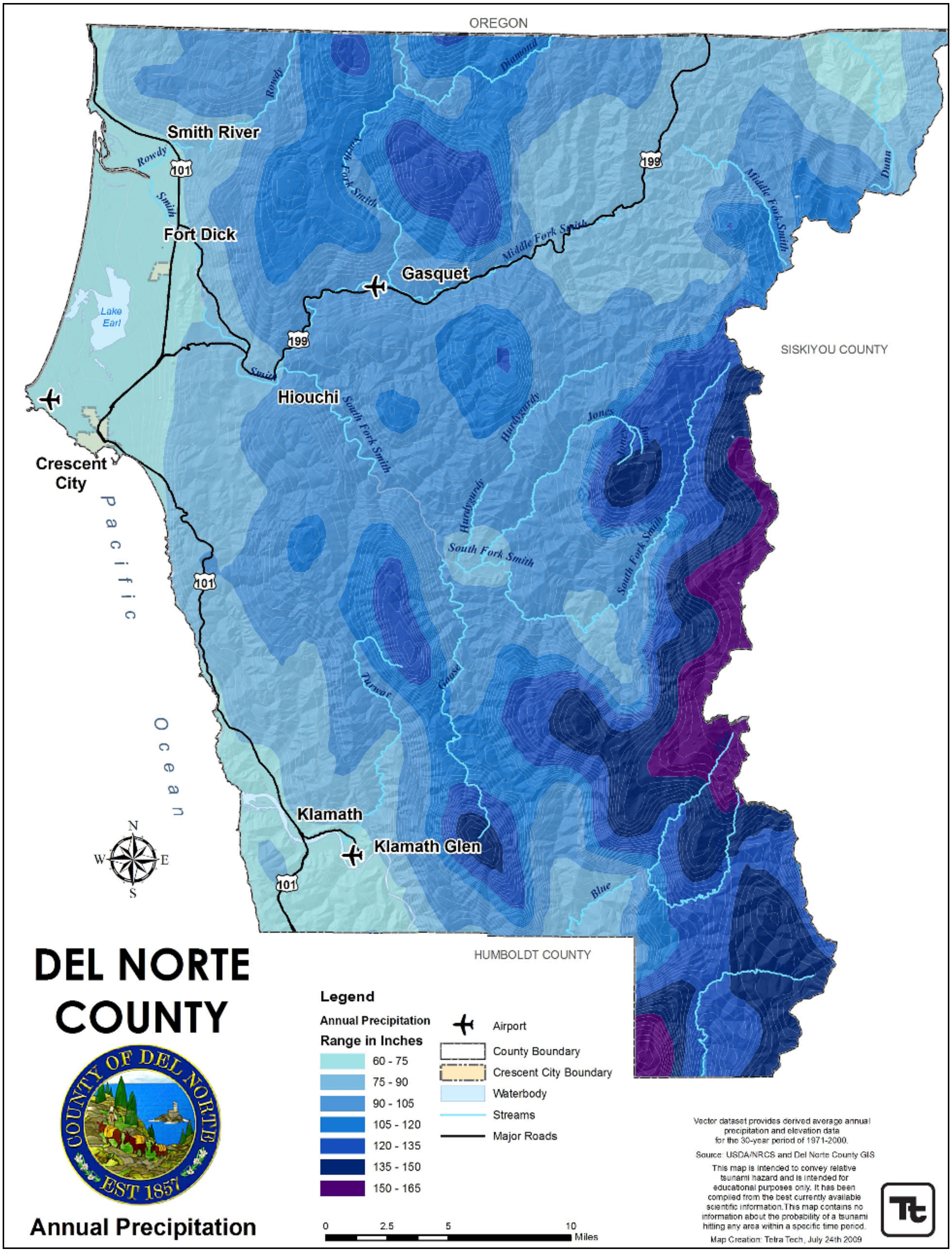


Figure 15-2. Annual Precipitation for Del Norte County

15.3 HAZARD PROFILE

The importance of extreme weather events is demonstrated when they expose the vulnerabilities of communities and the infrastructure on which they rely. Extreme weather and climate events are not simply meteorological occurrences. They impact socioeconomic systems and are often exacerbated by social stresses as well.

15.3.1 Past Events

Table 15-1 summarizes past severe weather events in Del Norte County as recorded by the National Oceanic and Atmospheric Administration since 1958. The following is a description of the 2005/2006 winter storm event, one of the most severe weather events to occur in Del Norte County.

A series of strong Pacific storm systems with a subtropical moisture tap began on December 18, 2005 and continued through the end of the month. Total precipitation for the systems ranged from 12 to 20 inches. The first 10 days of this wet period conditioned the watersheds, and flooding began on December 28. While flooding was widespread throughout Humboldt, Del Norte, and Mendocino Counties, the major flood damage occurred in the Klamath River Basin and the Russian River Basin. On the Klamath River, two boat ramps were damaged, 15 structures were flooded, and the Klamath River Bridge over Highway 101 sustained $15 million worth of damage. A major impact of this weather was rain-induced landslides. Humboldt and Del Norte Counties reported $21.5 million worth of landslide damage to county-owned roads. Also associated with this series of systems were a storm surge coastal flooding event and a short but destructive wind event. A wind gust of 64 mph was recorded at the Eureka Weather Forecast Office, and a gust of 97 mph was reported from a research vessel at dock. Combined damage from these two events was $4.9 million. Damage from the wind event included downed power lines and trees falling on structures. Damage from the coastal flooding event occurred to shore-side facilities in Del Norte, Mendocino, and Humboldt Counties.

15.3.2 Location

Severe weather events have the potential to happen anywhere in the county. Communities in low-lying areas next to streams or lakes are more susceptible to flooding. Mountainous regions experience heavier snowfall and a greater risk of road closures. Wind events are most damaging to areas that are heavily wooded. Areas along the coast are more susceptible to strong ocean surges and landslides.

15.3.3 Frequency

Severe thunderstorms and wind events have occurred at least twice a decade since 1958. Flash floods or urban stream flooding has occurred at least five times per decade since 1980.

15.3.4 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but they can occur. Roads may become impassable due to flooding, downed trees, ice or snow, or from a secondary hazard such as a landslide. Power lines may be downed due to high winds, and other services, such as water or phone, may not be able to operate without power. Lightning can cause severe damage and can be deadly. Two major concerns for snowfall are dangerous roadway conditions and collapse of structures due to heavy snow load on roofs. In addition, ice can create dangerous situations on the roadways as well as freeze pipes.

TABLE 15-1.
SEVERE WEATHER EVENTS IN DEL NORTE COUNTY SINCE 1958 (NOAA 2007)

Location	Date	Type	Magnitude	Deaths or Injuries	Property Damage
Del Norte County	01/10/1958	Tornado	F0	0	0
Del Norte County	05/13/1960	Tornado	?	0	0
Del Norte County	04/13/1967	Hail	0.75 inches	0	0
Del Norte County	12/12/1973	Thunderstorm Wind	50 knots	0	0
Del Norte County	02/09/1983	Thunderstorm Wind	0 knots	0	0
Del Norte County	12/11/1992	Tornado	F1	0	$3,000
Del Norte County	12/30/1992	Tornado	F1	0	$25,000
Smith River	01/20/1996	Tornado	F0	0	$2,000
Description: A waterspout came ashore near the mouth of the Smith River. About two dozen trees were snapped off at the 20-foot level. The largest trees were up to 2 feet in diameter. A portion of one tree fell on the porch of a residence, demolishing the porch.					
Crescent City	01/20/1996	Tornado	F0	0	$1,000
Description: A second waterspout came ashore, passed between several homes, across a vacant lot and up the middle of a street before dissipating. A wood fence in the vacant lot was damaged.					
Numerous	2/21/1998	Urban/Small Stream Flood	N/A	0	0
Description: Widespread small stream flooding in Del Norte, Humboldt and Mendocino Counties. Numerous road closures due to flooding. Del Norte County Sheriff's Dispatch described the county as "swampy." Highways 175 and 128 were closed in Mendocino County.					
Del Norte County	11/20/1998	Urban/Small Stream Flood	N/A	0	0
Description: Widespread urban and small stream flooding due to very heavy rain. Flooding was reported in the following locations: Fieldbrook, McKinleyville, Bayside (Jacoby Creek), Highway 197 near Crescent City, Arcata, Humboldt State University campus, Blue Lake					
Del Norte County	12/2/1998	Urban/Small Stream Flood	N/A	0	0
Description: Heavy rain caused flooding along many small streams in Northern/Central Humboldt County and Central Del Norte County. Streams involved include: Noisy Creek, Jacoby Creek and Elk River. Highway 101 near Sand Mine Road and Highway 197 northeast of Crescent City.					
Crescent City	03/27/2001	Rip Currents	N/A	1	0
Description: A youth visiting the beach with a group from Ashland, Oregon was swept off a rock at Preston Island by a large wave. Currents then carried the youth about 100 yards offshore where deputies lost visual contact.					
Del Norte County	12/14/2002	Urban/Small Stream Flood	N/A	0	0
Description: A powerful Pacific storm swept across Northwest California with strong winds and heavy rain.					
Crescent City	12/31/2002	Funnel Cloud	N/A	0	0
Description: Spotters reported numerous cold air funnels over the Pacific Ocean near Crescent City.					
North Coast	12/28/2005	Landslide	N/A	0	$55.9 M[a]
North Coast	12/29/2005	Flood	N/A	0	$60.8 M[a]
North Coast	12/31/2005	High Wind	64 knots	0	$3.2 M[a]

a. Costs refer to all of North Coast, including Del Norte, Humboldt, Trinity, and Mendocino County

Tornadoes are the smallest but potentially most dangerous of local storms, though they are not common in Del Norte County. If a major tornado were to strike a populated area, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Some buildings may be damaged or destroyed. Due to the often short warning period, livestock are commonly the victims of a tornado.

Windstorms are a frequent problem in Del Norte County and have been known to cause substantial damage. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher. Under most conditions, the county's highest winds come from the southwest.

The effects of an ice storm or snowstorm are downed power lines and trees and a large increase in traffic accidents. These storms can cause death by exposure, heart failure due to shoveling or other strenuous activity, traffic accidents (over 85 percent of ice storm deaths are caused by traffic accidents), and carbon monoxide poisoning. These storms also have the potential to cause large losses among livestock. Livestock losses are caused primarily by dehydration rather than cold.

15.3.5 Warning Time

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

15.4 SECONDARY HAZARDS

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

15.5 CLIMATE CHANGE IMPACTS

Climate change presents a significant risk management challenge, and dealing with weather and climate extremes is one of its more demanding aspects. The frequency of extreme weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 15-3). Understanding vulnerabilities from weather and climate extremes is a key first step in managing the risks of climate change.

The impacts on Del Norte County could be significant. Rising seas and warmer climates could have significant impacts on the jet stream, which would impact the planning area's susceptibility to severe wind events and coastal storms. The changing hydrograph caused by climate change could have a significant impact on the intensity, duration and frequency of storm events. All of these impacts could have significant consequences to an economy that is already unstable due to declining growth rates.

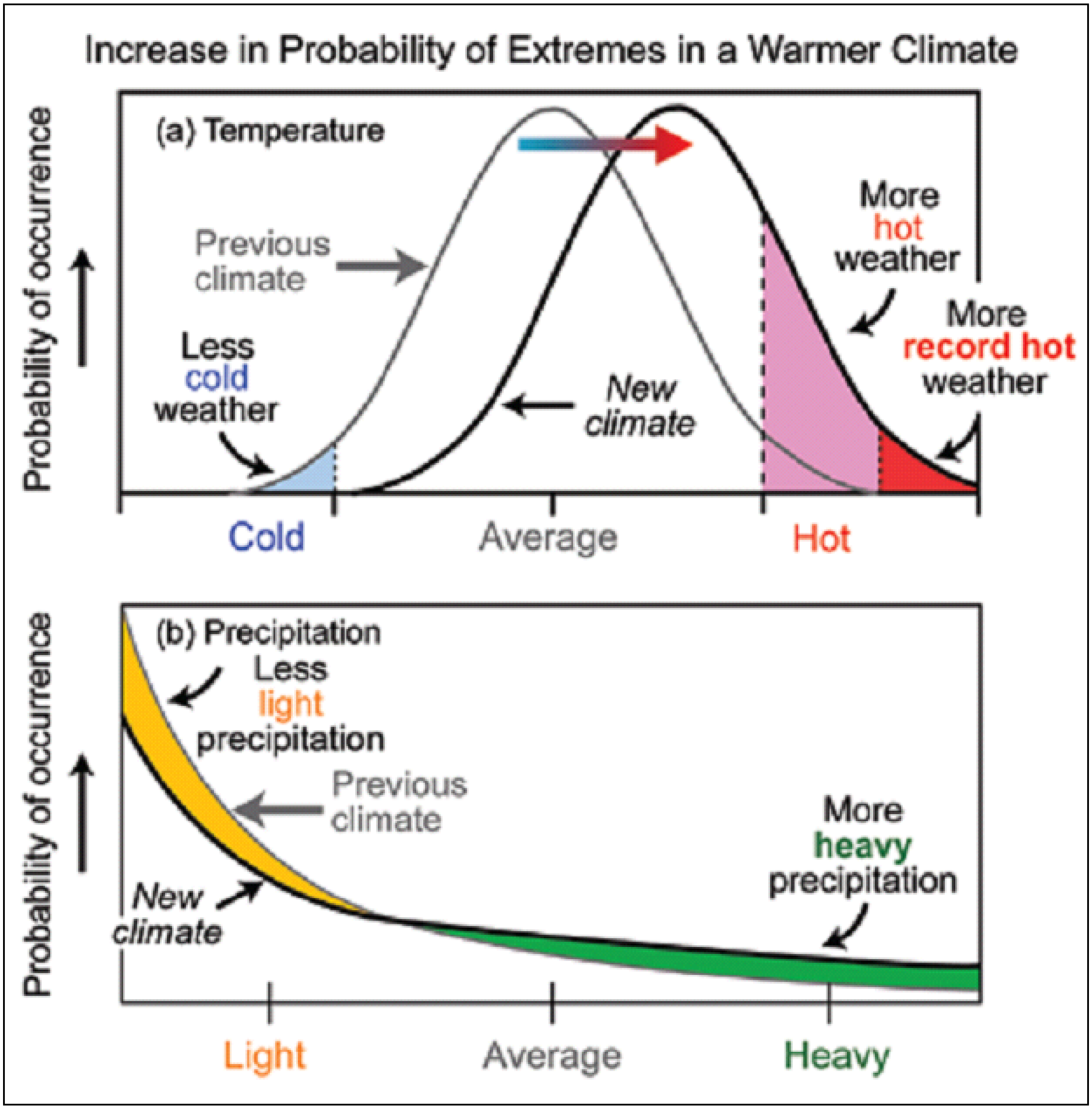


Figure 15-3. Severe Weather Probabilities in Warmer Climates

15.6 EXPOSURE

15.6.1 Population

A lack of data separating severe weather damage from flooding and landslide damage prevented a detailed analysis for exposure and vulnerability. However, it can be assumed that the entire county is exposed to some extent to severe weather events. Certain areas are more exposed due to geographic location and localized weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out, while populations living in low lying areas are at risk for possible flooding. The large amount of coastline in Del Norte County equates to a large population exposed to the danger of coastal storm surges.

15.6.2 Property

According to the Del Norte County Assessor, there are 11,708 buildings within the census tracts that define the planning area. The majority of these buildings are residential use. All of these buildings are considered to be exposed to the severe weather hazard, but structures in poor condition or in particularly vulnerable locations (such as near the coast) may risk the most damage. The frequency and degree of damage will depend on specific locations.

15.6.3 Critical Facilities and Infrastructure

All critical facilities exposed to flooding (see Chapter 13) are also likely exposed to severe weather. Additional facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with severe weather are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Consequently, phone, water and sewer systems may not function. Roads may become impassable due to ice or snow or from a secondary hazard such as landslides.

15.6.4 Environment

Severe storm events can drastically affect the physical environment, changing natural landscapes and affecting property and people. Natural habitats such as streams and trees are exposed to the elements during a severe storm and risk major damage and destruction. Prolonged rains can saturate soils and lead to slope failure. Flooding caused by severe weather can cause stream channel migration. Storm surges can erode beachfront bluffs and redistribute sediment loads. Severe local storms can have significant effects on the environment. Heavy rains cause the ground to become saturated and rivers and streams to rise. This will result in the potential for flooding and landslides. Additionally, snowmelt after snowstorms can cause riverine flooding, which has the potential to damage riparian habitat.

15.7 VULNERABILITY

For the state hazard mitigation plan, factors used to determine which counties are most vulnerable to future non-flood, severe storms are how often severe storm events occur, expressed as a percentage of recurrence per year. Data on the frequency of severe storm events was obtained from the National Oceanic and Atmospheric Administration, whose database covers all severe weather events declared by the National Weather Service (NWS) from 1958 to 2005. The following are general conclusions about Del Norte County's vulnerability to severe weather:

- Counties considered most vulnerable to high winds are those most affected by downed trees and loss of power and those with a high wind recurrence rate of 100 percent, meaning the county experiences at least one damaging high wind event every year. The severe wind event of December 2005 resulted in the loss of power to hundreds of homes in Del Norte County as well as many state and county buildings.
- The NWS defines a winter storm as having significant snowfall, ice, and/or freezing rain. In non-mountainous areas, heavy snowfall is 4 inches or more in a 12-hour period, or 6 or more inches in a 24-hour period; in mountainous areas heavy snowfall is 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period. In Del Norte County, severe winter storms generally consist of rain and wind events, not snow and ice.
- Del Norte County is not considered vulnerable to a tornado event.
- Del Norte County's vulnerability to flooding is covered in the Chapter 13.

15.7.1 Population

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

15.7.2 Property

All property is vulnerable during severe weather events, but structures in poor condition or in particularly vulnerable locations may risk the most damage. Those in higher elevations and on ridges may be more prone to wind damage. Also, those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse.

There are no generally accepted damage function values for estimating damage from severe storm events. For the purposes of this risk assessment, a rough damage function was established by comparing reported damage from the 2005-2006 winter storms to assessed building values. Using this approach, it was estimated that the average damage from this event was 25 percent of the total assessed value for building structures; it is assumed that severe weather will not damage contents, so the loss ratio is applied only to the value of the structure. To estimate vulnerability, this ratio was applied to the building stock for each planning unit, as summarized in Table 15-2.

TABLE 15-2.
ESTIMATED LOSS FOR SEVERE WEATHER EVENTS IN DEL NORTE COUNTY

Planning Unit	Assessed Building Structure Value	Estimated Damage
Crescent City	$253,884,114	$63,471,028
Crescent City UGA	$690,272,370	$172,568,092
Fort Dick	$224,484,966	$56,121,241
Gasquet	$36,038,604	$9,009,651
Hiouchi	$35,436,816	$8,859,204
Klamath	$78,172,494	$19,543,123
Smith River	$115,735,938	$28,933,984
Other County	$19,762,974	$4,940,753
Total	**$1,453,788,276**	**$363,447,076**

These estimates are based on a past occurrence and may be understated or overstated for future events. However, this represents the best available information at this time. As new data and methods become available for evaluating severe weather events, this vulnerability assessment should be updated.

15.7.3 Critical Facilities and Infrastructure

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

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

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting both electricity and communication for households. Loss of electricity and phone connection would result in isolation because some residents will be unable to call for assistance.

15.7.4 Environment

The environment vulnerable to the severe weather hazard is the same as the environment exposed to the hazard.

15.8 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe storms.

15.9 SCENARIO

A worst-case event would involve prolonged high winds during an extremely wet rain/snowstorm accompanied by freezing temperatures, followed by warmer weather and continued rain. Such an event would have both short-term and long-term effects. Initially, schools and roads would be closed due to flooding, downed tree obstructions, and downed power lines. Power outages would be common throughout the county. In more rural areas, some subdivisions in unincorporated areas could experience limited ingress and egress. Later, as the weather warms and rains continue while snow melts, the sudden run-off could produce flooding, overtopped culverts with ponded water on roads, and landslides on steep slopes. Flooding and landslides could further obstruct roads and bridges, further isolating residents.

15.10 ISSUES

In general, every household and resident in the county is likely to be exposed to severe weather, but some are more likely than others to experience isolation as a result. Those residing in higher elevations with limited transportation routes may have the greatest vulnerability to isolation from storms. Another group at risk is the portion of the county population that is over the age of 65.

CHAPTER 16.
TSUNAMI

16.1 TSUNAMI DEFINED

The following definition applies in the discussion of tsunami hazards:

- **Tsunami**—Tsunamis are series of traveling ocean waves of extremely long wavelength usually caused by displacement of the ocean floor and typically generated by seismic or volcanic activity or by underwater landslides.

16.2 GENERAL BACKGROUND

A tsunami consists of a series of high-energy waves that radiate outward like pond ripples from the area in which the generating event occurred. The sequence of tsunami waves arrives at shorelines over an extended period. A tsunami approaching a shore may take three forms:

- Non-breaking waves that act as a rapidly rising tide
- A large, turbulent wall-like wave (bore)
- A series of partially developed waves.

Tsunamis are typically classified as either local or distant. Locally generated tsunamis have minimal warning times and may be accompanied by damage resulting from the triggering earthquake due to ground shaking, surface faulting, liquefaction, or landslides. This leaves few options except to run to high ground. Distant tsunamis may travel for hours before striking a coastline, giving a community a chance to implement evacuation plans.

In the open ocean, a tsunami may be only a few inches or feet high but can travel with speeds approaching 1,000 kilometers (about 600 miles) per hour. As a tsunami enters the shoaling waters near a coastline, its speed diminishes, its wavelength decreases, and its height increases greatly. However, the first wave usually is not the largest. Several larger and more destructive waves often follow the first one. As tsunamis reach the shoreline, they may take the form of a fast-rising tide, a cresting wave, or a bore. The bore phenomenon resembles a step-like change in the water level that advances rapidly (from 10 to 60 miles per hour).

The configuration of the coastline, the shape of the ocean floor, and the characteristics of advancing waves play important roles in the destructiveness of the waves. Offshore canyons can focus tsunami wave energy and islands can filter the energy. The orientation of the coastline determines whether the waves strike head-on or are refracted from other parts of the coastline.

A wave may be small at one point on a coast and much larger at other points. Bays, sounds, inlets, rivers, streams, offshore canyons, islands, and flood control channels may cause various effects that alter the level of damage. It has been estimated, for example, that a tsunami wave entering a southern California flood control channel could reach a mile or more inland, especially if it enters at high tide.

The first visible indication of an approaching tsunami may be recession of water (draw down) caused by the trough preceding the advancing, large inbound wave crest. Rapid draw down can create strong currents in harbor inlets and channels that can severely damage coastal structures due to erosive scour around piers and pilings. As the water's surface drops, piers can be damaged by boats or ships straining at or breaking their mooring lines. The vessels can overturn or sink due to strong currents, collisions with other objects, or impact with the harbor bottom.

Conversely, the first indication of a tsunami may be a rise in water level. The advancing tsunami may initially resemble a strong surge increasing the sea level like the rising tide, but the tsunami surge rises faster and does not stop at the shoreline. Even if the wave height appears to be small, 3 to 6 feet for example, the strength of the accompanying surge can be deadly. Waist-high surges can cause strong currents that float cars, small structures, and other debris. Boats and debris are often carried inland by the surge and left stranded when the water recedes.

At some locations, the advancing turbulent wave front will be the most destructive part of the wave. In other situations, the greatest damage will be caused by the outflow of water back to the sea between crests, sweeping all before it and undermining roads, buildings, bulkheads, and other structures. This outflow action can carry enormous amounts of highly damaging debris with it, resulting in further destruction. Ships and boats, unless moved away from shore, may be dashed against breakwaters, wharves, and other craft, or be washed ashore and left grounded after the withdrawal of the seawater.

16.3 HAZARD PROFILE

16.3.1 Past Events

California is at risk from both local and distant tsunamis. Eighty-two possible or confirmed tsunamis in California have been observed or recorded. Table 16-1 summarizes the major events among these that have affected the northern coastal area of the state. Most of these events were small and detected only by tide gages. Eleven events were large enough to cause damage and four events caused deaths. At least three of these events had direct measurable impacts on Del Norte County. Two tsunami events caused major damage.

- The 1960 Chilean earthquake produced a great tsunami that impacted the entire Pacific basin. Damage was reported in California ports and harbors from San Diego to Crescent City and losses exceeded $1 million.
- The worst event was the 1964 tsunami generated by the magnitude-9.2 Alaska earthquake, which killed 12 in Northern California and caused $10 million in property damage in the Crescent City area. The peak wave height was 21 feet in Crescent City and 29 city blocks were inundated. Wave oscillations in San Francisco Bay lasted more than 12 hours, causing nearly $200,000 in damage to boats and harbor structures.

16.3.2 Location

The earth's surface is made up of crustal plates underlying the continents and ocean basins. These plates may pull apart from, slide past, override, or under-ride ("subduct") one another. Plate boundaries coincide with faults that produce earthquakes as the plates move against one another. These earthquakes may produce displacements of the sea floor that can set the overlying column of water in motion, initiating a tsunami, depending on the magnitude of the earthquake and the type of faulting that occurs. Most tsunamis originate in the Pacific Ocean, where tsunami waves triggered by seismic activity can travel at up to 500 miles per hour, striking distant coastal areas in a matter of hours (see Figure 16-1).

Most recorded tsunamis affecting the Pacific Northwest have originated in the Gulf of Alaska. There is also geological evidence of significant impacts from tsunamis originating along the Cascadia subduction zone, which extends from Cape Mendocino, California to the Queen Charlotte Islands in British Columbia.

TABLE 16-1.
TSUNAMIS THAT HAVE AFFECTED NORTH COAST CALIFORNIA

Date	Origin of Tsunami	Impacted Areas	Run-up (meters)	Observations/comments
3/19/1855	N. California	Humboldt Bay	Observed	Water in the bay agitated for 1 hour
4/6/1943	N. Central Chili	Crescent City	Trace	
4/1/1946	E. Aleutian Islands	Crescent City	1.0	3-foot amplitude and a 12-minute period were recorded for this event.
12/20/1946	Nankaido, Japan	Crescent City	0.2	
3/4/1952	SE Hokkaido, Japan	Crescent City	0.2	
11/4/1952	Kamchatka Peninsula, Russia	Crescent City	1.0	In Crescent City, four boats were overturned and concrete buoys were moved.
3/91957	Central Aleutian Is.	Crescent City	0.7	
5/22/1960	South/Central Chili	Crescent City	1.7	$30,000 in damage. Two ships were destroyed, others were damaged.
10/13/1963	Kuril Islands, Russia	Crescent City	0.5	
3/28/1964	Gulf of Alaska	Crescent City	6.3	Ten people killed, 35 injured, 52 homes and 172 businesses damaged or destroyed. $10 million in damage
		Klamath River		One person killed $4,000 damage to dock and boats at Requa. Damage reported least 2.6 km from mouth of Klamath River.
		Trinidad		Observed run-up was 5.4 meters above mean lower low water.
2/4/1965	W. Aleutian Islands	Crescent City	0.1	
10/17/1966	Peru	Crescent City	0.1	
5/16/1968	Honshu, Japan	Crescent City	0.6	
7/26/1971	New Ireland	Crescent City	<0.1	
10/3/1974	Peru	Crescent City	<0.1	
5/7/1986	W. Aleutian Islands	Crescent City	0.1	
4/25/1992	Cape Mendocino	Humboldt Bay	0.3 Observed	Waves arrived at Humboldt Bay about 20 minutes after ground shaking.
		Clam Beach	0.6	Water level changed several feet
		Crescent City	0.9	Oscillations in harbor, the fourth wave was the highest recorded.
		Trinidad		Cars were struck on the beach.
9/1/1994	Cape Mendocino	Crescent City	0.14	Recorded on Crescent City tide gauge 45 minutes after earthquake.
11/15/2006	Kuril Islands	Crescent City	1.76	Recorded on Marigram
		Arena Cove	1.18	
		Pt. Reyes	0.62	
01/13/2007	Kuril Islands	Crescent City	0.23	Recorded on Marigram
		Arena Cove	0.25	
		Pt. Reyes	0.12	

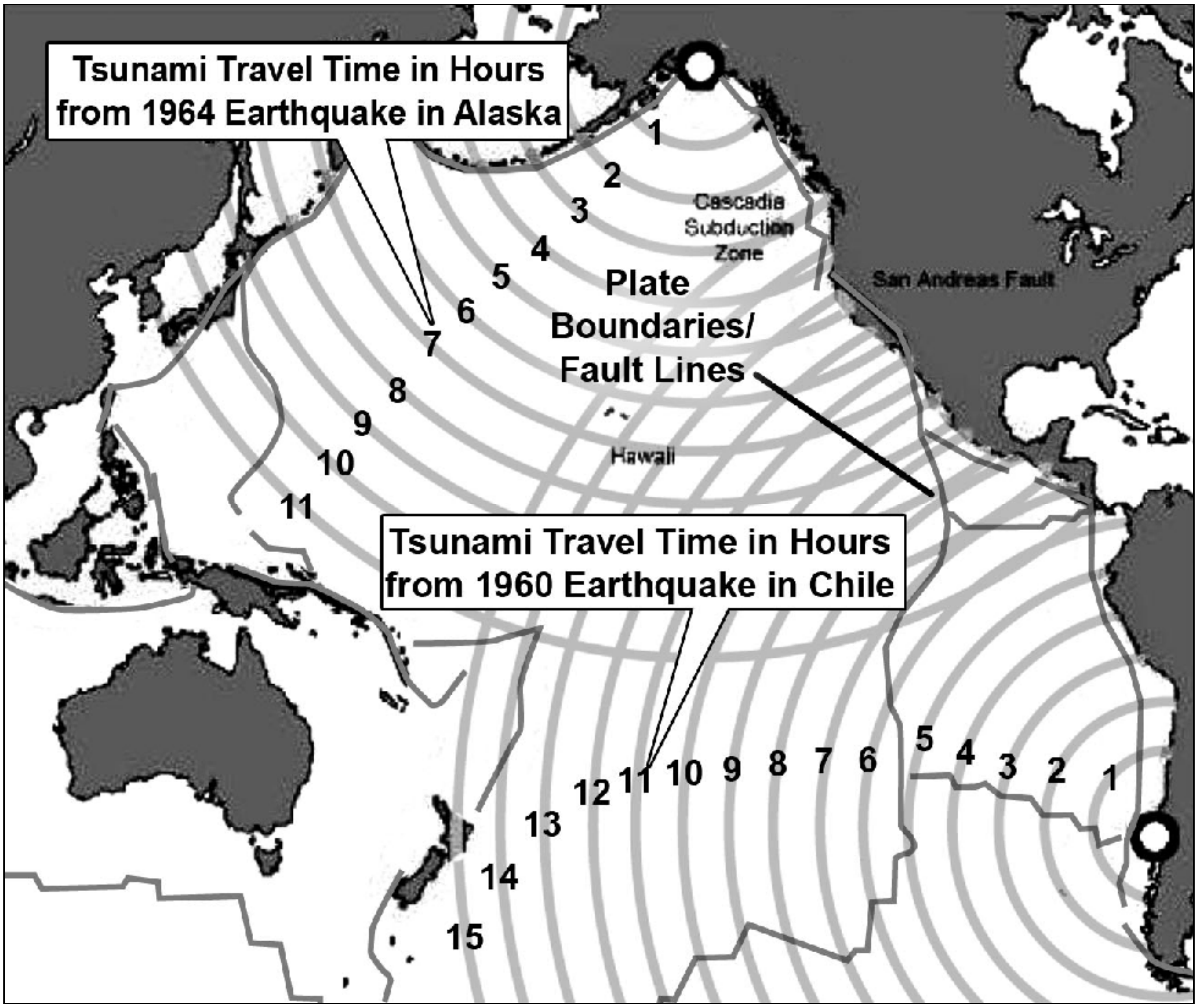


Figure 16-1. Potential Tsunami Travel Times in the Pacific Ocean

Nearly two-thirds of California's tsunami events and all but one damaging event were generated by distant sources. Local tsunamis have the potential to cause locally greater wave heights. The largest historical local-source tsunami on the west coast was caused by the 1927 Point Arguello, California, earthquake (magnitude 7.1), which produced 7-foot waves in the nearby coastal area.

Figure 16-2 shows the estimated extent and location of the high and moderate tsunami hazard zones for the planning area. These zones correspond approximately to a 500-year and 100-year event, respectively. This mapping is based on the best available historical and observed data and technical interpretation of tsunami risk for the planning area, not on probabilistic tsunami modeling.

16.3.3 Frequency

The frequency of tsunamis is related to the frequency of the events that cause them, so it is similar to the frequency of seismic or volcanic activities or landslides. Generally four or five tsunamis occur every year in the Pacific Basin, and those that are most damaging are generated in the Pacific waters off South America rather than in the northern Pacific.

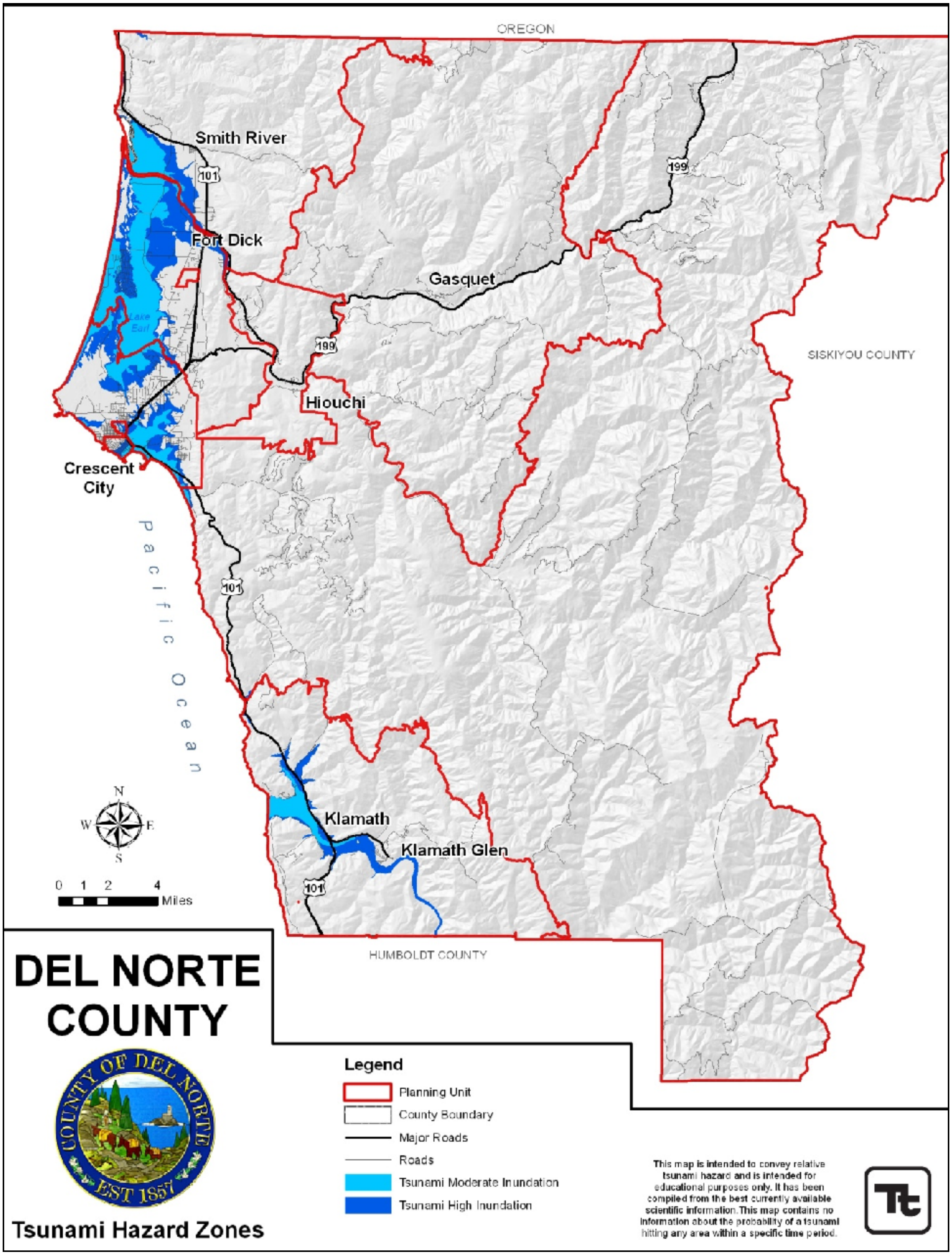


Figure 16-2. Moderate (100 Year) and Highest (500 Year) Tsunami Hazard Zones

The Cascadia subduction zone threatens California, Oregon and Washington with potentially devastating tsunamis that could strike the coast within minutes. There is increasing geological and seismological evidence that earthquakes of magnitude 8 or higher have occurred in this region and that at least one segment of the subduction zone may be approaching the end of a seismic cycle culminating in such an earthquake. The evidence suggests that these earthquakes have generated tsunamis that have caused extensive flooding along the coastlines of California, Oregon and Washington. Tsunami experts estimate that the probability of a Cascadia earthquake is comparable to that of large earthquakes in Southern California (i.e., 35-percent probability of magnitude 8 or higher between 1995 and 2045).

16.3.4 Severity

Tsunamis are a threat to life and property to anyone living near the ocean. From 1950 to 2007, 478 tsunamis have been recorded globally. Fifty-one of these events caused fatalities to over 308,000 coastal residents. The overwhelming majority of these events occurred in the Pacific basin. Recent tsunamis have struck Nicaragua, Indonesia, and Japan, killing several thousand people. Property damage due to these waves was nearly $1 billion. Historically, tsunamis originating in the northern Pacific and along the west coast of South America have caused more damage on the west coast of the United States than tsunamis originating in Japan and the Southwest Pacific.

The Cascadia subduction zone will produce the state’s largest tsunami. The Cascadia subduction zone is similar to the Alaska-Aleutian trench that generated the magnitude 9.2 1964 Alaska earthquake and the Sunda trench in Indonesia that produced the magnitude 9.3 December 2004 Sumatra earthquake. Native American accounts of past Cascadia earthquakes suggest tsunami wave heights on the order of 60 feet, comparable to water levels in Aceh Province Indonesia during the December 2004 tsunami there. Water heights in Japan produced by the 1700 Cascadia earthquake were over 15 feet, comparable to tsunami heights observed on the African coast after the Sumatra earthquake. The Cascadia subduction zone last ruptured on January 26, 1700, creating a tsunami that left markers in the geologic record from Humboldt County to Vancouver Island in Canada and is noted in written records in Japan. At least seven ruptures of the Cascadia subduction zone have been observed in the geologic record.

16.3.5 Warning Time

Typical signs of a tsunami hazard are earthquakes or a sudden and unexpected rise or fall in coastal water levels. The large waves are often preceded by coastal flooding and followed by a quick recession of the water. Tsunamis are difficult to detect in the open ocean, with waves only 1 or 2 feet high. The tsunami’s size and speed, as well as the coastal area’s form and depth, affect the impact of a tsunami; wave heights of 50 feet are not uncommon. In general, scientists believe it requires an earthquake of at least a magnitude 7 to produce a tsunami. Earthquake shock waves close to the epicenter consist of high-frequency vibrations, while those at much greater distances are of lower frequency, which can enhance the rhythmic movement in a body of water. Figure 16-3 shows estimated arrival times for a Pacific tsunami.

The Pacific tsunami warning system evolved from a program initiated in 1946. It is a cooperative effort involving 26 countries along with numerous seismic stations, water level stations and information distribution centers. The National Weather Service operates two regional information distribution centers. One is located in Ewa Beach, Hawaii, and the other is in Palmer, Alaska. The Ewa Beach center also serves as an administrative hub for the Pacific warning system.

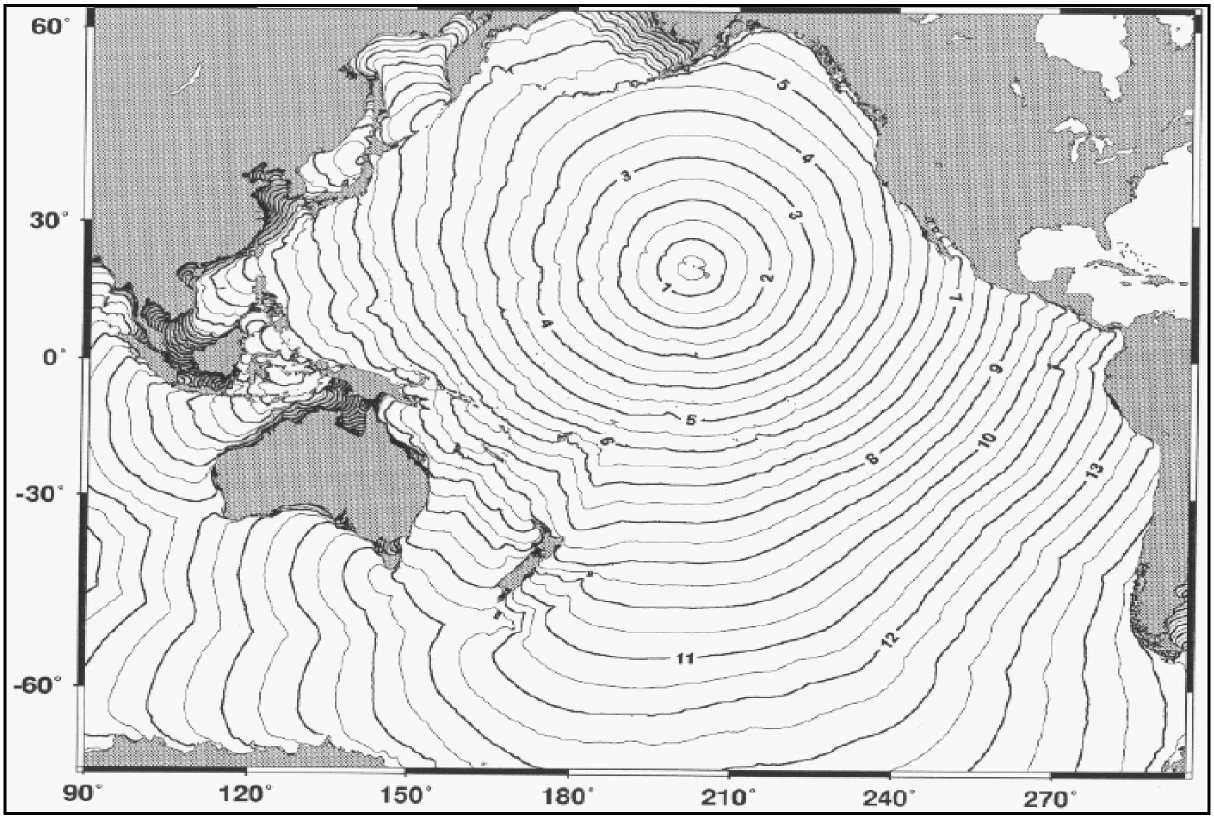


Figure 16-3. Arrival Times of Pacific-Based Tsunami

The warning system only begins to function when a Pacific basin earthquake of magnitude 6.5 or greater triggers an earthquake alarm. When this occurs, the following sequence of actions occurs:

- Data is interpolated to determine epicenter and magnitude of the event.
- If the event is magnitude 7.5 or greater and located at sea, a TSUNAMI WATCH is issued.
- Participating tide stations in the earthquake area are requested to monitor their gages. If unusual tide levels are noted, the tsunami watch is upgraded to a TSUNAMI WARNING.
- Tsunami travel times are calculated, and the warning is transmitted to the disseminating agencies and thus relayed to the public.
- The Ewa Beach center will cancel the watch or warning if reports from the stations indicate that no tsunami was generated or that the tsunami was inconsequential.

This system is not considered to be effective for communities located close to the tsunami because the first wave would arrive before the data were processed and analyzed. In this case, strong ground shaking would provide the first warning of a potential tsunami.

16.4 SECONDARY HAZARDS

Aside from the tremendous hydraulic force of the tsunami waves themselves, floating debris carried by a tsunami can endanger human lives and batter inland structures. Ships moored at piers and in harbors often are swamped and sunk or are left battered and stranded high on the shore. Breakwaters and piers collapse, sometimes because of scouring actions that sweep away their foundation material and sometimes because of the sheer impact of the waves. Railroad yards and oil tanks situated near the waterfront are particularly vulnerable. Oil fires frequently result and are spread by the waves.

Port facilities, naval facilities, fishing fleets and public utilities are often the backbone of the economy of the affected areas, and these are the resources that generally receive the most severe damage. Until debris can be cleared, wharves and piers rebuilt, utilities restored, and fishing fleets reconstituted, communities may find themselves without fuel, food and employment. Wherever water transport is a vital means of supply, disruption of coastal systems caused by tsunamis can have far-reaching economic effects.

16.5 CLIMATE CHANGE IMPACTS

The cumulative impacts of climate change on the frequency and severity of tsunami events could be significant, especially in regions with vulnerable coast line like Del Norte County. Sea-level rise is inevitable in the coming decades and has already been observed. Global sea-level rise will affect all coastal societies, especially small island states and densely populated low-lying coastal areas. *The Scientific Basis* estimates a sea level rise of 0.09 to 0.88 meters from 1990 to 2100. Currently sea level is rising at a rate of about 2.5 mm per year. This rise has two effects on low-lying coastal regions: any structures located below the new level of the sea will be flooded; and the rise in sea level may lead to coastal erosion that can further threaten coastal structures. As a rule-of-thumb, a sandy shoreline retreats about 100 meters for every meter rise in sea level.

16.6 EXPOSURE

The exposure to the tsunami hazard was evaluated in terms of the population and/or property within the area identified as being susceptible to a moderate hazard or high hazard tsunami event.

16.6.1 Population

The population living in tsunami hazard zones was estimated based on the census blocks that intersect with moderate and high tsunami hazard zones. The populations that would be most exposed to this type of hazard are those along beaches, low-lying coastal areas, tidal flats and river deltas that empty into ocean going waters. The methodology used identified census tract groups whose centers are along the coastline of the planning area. HAZUS-MH estimated the number of buildings in each block that are in the tsunami hazard zone, and then estimated the total population by multiplying the average Del Norte County household size of 1.3 persons per household by the number of structures. Using this approach, it is estimated that exposed population is 14,602 in the high tsunami hazard zone (45.9 percent of the county total) and 5,251 in the moderate tsunami hazard zone (17.8 percent of the county total). The high population percentages can be attributed to the high degree of exposure in Crescent City, which is the population center of Del Norte County.

Development of more detailed spatial analysis can assist in identification of the most vulnerable among residents living in the tsunami hazard zone and can be used to focus public education and outreach efforts on these communities.

16.6.2 Property

The value of exposed buildings in the moderate and high tsunami hazard zones in the planning area was generated using HAZUS-MH at the census block level and is summarized in Table 16-2. The estimates include the value of both the buildings and their contents. This methodology estimates that that there is $580.3 million worth of assessed value exposed to the moderate tsunami hazard within the planning area and $1.39 billion of assessed value exposed to the high tsunami hazard within the planning area.

The number and type of structures exposed to the tsunami hazard areas was estimated as summarized in Table 16-3.

TABLE 16-2.
EXPOSED ASSESSED VALUE IN TSUNAMI HAZARD ZONES IN DEL NORTE COUNTY

Planning Unit	Building Exposure Value	Contents Exposure Value	Total Exposure Value	% of Total Assessed Value
Moderate Tsunami Hazard Zone				
Crescent City	$67,691,256	$48,616,744	$116,308,000	26.7
Crescent City UGA	$79,380,144	$57,011,856	$136,392,000	5.5
Fort Dick	$26,052,648	$18,711,352	$44,764,000	11.6
Gasquet	$0.00	$0.00	$0.00	0
Hiouchi	$0.00	$0.00	$0.00	0
Klamath	$13,217,220	$9,492,780	$22,710,000	16.9
Smith River	$15,908,970	$11,426,030	$27,335,000	13.7
Other County	$913,740	$656,260	$1,570,000	.01
Total	**$203,163,978**	**$145,915,022**	**$349,079,000**	**14**
High Tsunami Hazard Zone				
Crescent City	$146,689,608	$105,354,392	$252,044,000	57.8
Crescent City UGA	$202,570,920	$145,489,080	$348,489,080	13.9
Fort Dick	$65,779,386	$47,243,614	$113,023,000	29.3
Gasquet	$0.00	$0.00	$0.00	0
Hiouchi	$0.00	$0.00	$0.00	0
Klamath	$32,697,924	$23,484,076	$56,182,000	41.8
Smith River	$30,854,148	$22,159,852	$53,014,000	26.7
Other County	$1,213,470	$871,530	$2,085,000	0.08
Total	**$479,805,456**	**$344,602,544**	**$824,408,000**	**33**

TABLE 16-3.
STRUCTURES IN TSUNAMI HAZARD ZONES IN DEL NORTE COUNTY

	Moderate Tsunami Hazard Zone			Highest Tsunami Hazard Zone		
Planning Unit	Residential	Other	Total	Residential	Other	Total
Crescent City	269	65	334	837	128	965
Crescent City UGA	960	30	990	2221	58	2279
Fort Dick	298	17	315	753	28	781
Gasquet	0	0	0	0	0	0
Hiouchi	0	0	0	0	0	0
Klamath	220	5	225	587	19	606
Smith River	199	20	219	464	31	495
Other County	44	11	55	73	19	92
Total	**1990**	**148**	**2138**	**4935**	**283**	**5218**

16.6.3 Critical Facilities/Infrastructure

Tables 16-4 and 15 summarize the identified critical facilities in the moderate and high tsunami hazard zones, respectively. There is one identified hazardous material site located in the highest tsunami hazard zone.

TABLE 16-4.
CRITICAL FACILITIES IN THE MODERATE HAZARD TSUNAMI HAZARD ZONE

Jurisdiction	Medical & Health Services	Government Function	Protective Function	Hazardous Materials	Schools	Other	Societal Function	**Total**
Crescent City	0	6	0	0	0	0	0	**6**
Crescent City UGA	0	1	0	0	0	0	0	**1**
Fort Dick	0	0	0	0	0	0	0	**0**
Gasquet	0	0	0	0	0	0	0	**0**
Hiouchi	0	0	0	0	0	0	0	**0**
Klamath	0	0	0	0	0	0	1	**1**
Smith River	0	0	0	0	0	0	0	**0**
Other County	0	0	0	0	0	0	0	**0**
Total	**0**	**7**	**0**	**0**	**0**	**0**	**1**	**8**

TABLE 16-5.
CRITICAL FACILITIES IN THE HIGH HAZARD TSUNAMI HAZARD ZONE

Jurisdiction	Medical & Health Services	Government Function	Protective Function	Hazardous Materials	Schools	Other	Societal Function	**Total**
Crescent City	1	9	4	0	0	2	0	**16**
Crescent City UGA	0	5	1	1	0	1	0	**8**
Fort Dick	0	0	1	0	0	0	0	**1**
Gasquet	0	0	0	0	0	0	0	**0**
Hiouchi	0	0	0	0	0	0	0	**0**
Klamath	0	0	1	0	1	1	2	**5**
Smith River	0	0	0	0	0	0	0	**0**
Other County	0	0	0	0	0	0	0	**0**
Total	**1**	**14**	**7**	**1**	**1**	**13**	**2**	**30**

Roads or railroads that are blocked or damaged can prevent access throughout the county and can isolate residents and emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by tsunami inundation or debris from flood flows also can cause isolation. Water and sewer systems can be flooded or backed up, causing further health problems. Underground utilities can also be damaged during flood events.

Roads

Roads are an important component in the management of tsunami-related emergencies in that they act is the primary resource for evacuation to higher ground before and during the course of a tsunami event. Roads often act as flood control facilities in low depth, low velocity flood events by acting as levees or berms and diverting or containing flood flows. HAZUS-MH indicated that Highways 101 and 199 may be impacted by tsunami events, based on the bridge inventory exposed to the tsunami hazard areas. This list of roads should not be misinterpreted as possible evacuation routes for tsunami events. Evacuation routes are identified in emergency response plans.

Bridges

Bridges exposed to tsunami events can be extremely vulnerable due to forces transmitted by the wave run-up and by the impact of debris carried by the wave action. HAZUS-MH identified nine bridges that would be exposed to a moderate hazard event and an additional 18 bridges that would exposed to a high hazard event.

Water/Sewer/utilities

Water and sewer systems can be affected by the flooding associated with tsunami events. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can also be backed up, causing wastes to spill into homes, neighborhoods, rivers and streams. The forces of tsunami waves can impact above-ground utilities by knocking down power lines and radio/cellular communication towers. Power generation facilities can be severely impacted by both the impact of the wave action and the inundation of floodwaters. HAZUS identified four utilities that would be exposed to a moderate hazard event and an additional 11 utilities that would exposed to a high hazard event.

16.6.4 Environment

All waterways would be exposed to the effects of a tsunami; inundation of water and introduction of foreign debris could be hazardous to the environment. All wildlife inhabiting the area also is exposed.

16.7 VULNERABILITY

16.7.1 Population

The populations most vulnerable to the tsunami hazard are the elderly, disabled and very young who reside near beaches, low-lying coastal areas, tidal flats and river deltas that empty into ocean going waters. In the event of a local tsunami generated in or near the planning area, there would be little warning time, so more of the population would be vulnerable. The degree of vulnerability of the population exposed to the tsunami hazard event is based on a number of factors:

- Is there a warning system?
- What is the lead time of the warning?
- What is the method of warning dissemination?
- Will the people evacuate when warned?

For this assessment, the population vulnerable to possible tsunami inundation is considered to be the same as the exposed population.

16.7.2 Property

All structures along beaches, low lying coastal areas, tidal flats and river deltas would be vulnerable to a tsunami, especially in an event with little or no warning time. The impact of the waves and the scouring associated with debris that may be carried in the water could be damaging to structures in the tsunami's path. Those that would be most vulnerable are those located in the front line of tsunami impact and those that are structurally unsound.

HAZUS-MH generated loss estimates for the moderate and high tsunami hazard areas, as reflected in Table 16-6. It is estimated that there would be up to $127.7 million of loss from a moderate hazard tsunami event in the planning area and $565.9 million of loss from a high hazard tsunami event.

TABLE 16-6.
ESTIMATED LOSS FROM TSUNAMI EVENTS IN DEL NORTE COUNTY

Planning Unit	Building Loss	Contents Loss	Total Loss	% of Total Assessed Value
Moderate Tsunami Hazard Zone				
Crescent City	$10,507,138	$12,025,862	$22,533,000	0.90
Crescent City UGA	$19,134,154	$21,899,846	$41,034,000	3
Fort Dick	$2,321,241	$2,656,759	$4,978,000	1.3
Gasquet	$0	$0	$0	0
Hiouchi	$0	$0	$0	0
Klamath	$434,592	$497,408	$932,000	0.7
Smith River	$2,594,027	$2,968,973	$5,563,000	2.8
Other County	$94,659	$108,341	$203,000	0.01
Total	**$35,085,811**	**$40,157,189**	**$75,243,000**	**3.0**
High Tsunami Hazard Zone				
Crescent City	$56,861,088	$65,079,912	$121,941,000	4.9
Crescent City UGA	$76,109,953	$87,111,047	$163,221,000	12.7
Fort Dick	$14,024,439	$16,051,561	$30,076,000	7.8
Gasquet	$0	$0	$0	0
Hiouchi	$0	$0	$0	0
Klamath	$5,101,788	$5,839,212	$10,941,000	8.1
Smith River	$7,700,478	$8,813,522	$16,514,000	8.3
Other County	$1,136,839	$1,301,160	$2,438,000	0.10
Total	**$160,934,584**	**$184,196,415**	**$345,131,000**	**13.8**

16.7.3 Critical Facilities/Infrastructure

Using damage function curves to estimate the percent of damage to critical buildings and their contents, HAZUS-MH correlates these estimates to estimated functional down-time. Functional down-time is the time it will take to restore a facility to 100 percent of its functionality.

HAZUS estimated that on the average, critical facilities would receive 18 percent damage to structures and 34 percent damage to contents during a moderate tsunami event. The functional down-time to restore these facilities to 100 percent of their functionality would be approximately 480 days. A high hazard tsunami event would cause 100 percent damage to both the buildings and contents of exposed critical facilities. The functional down-time to restore these facilities to 100 percent of their functionality after a highest hazard event was not determined, due to the severity of the estimated damage.

16.7.4 Environment

Environmental impacts would be most significant in areas closest to the point of impact. Local waterways and wildlife would be most vulnerable at these points. Areas near gas stations, industrial areas and Tier II facilities would be most vulnerable due to potential contaminations from hazardous materials. The vulnerability of aquatic habit and associated ecosystems in low-lying areas close to the coastline would be highest. Tsunami waves can carry destructive debris and pollutants that can have devastating impacts on all facets of the environment, as evidenced in the Indian Ocean tsunami of December 2004. Millions of dollars spent on habitat restoration and conservation in the planning area could be wiped out by one significant tsunami. There are currently no tools available to measure these impacts.

Projects that deal solely with environmental restoration or mitigation are not eligible for funding under FEMA hazard mitigation programs, so environmental assessment tools have not been developed to support the programs. However, it is conceivable that the potential financial impact of a tsunami event on the environment could equal or exceed the impact on property. Community planners and emergency managers should take this into account when preparing for the tsunami hazard.

16.8 FUTURE TRENDS IN DEVELOPMENT

It is assumed that development trends in Del Norte County are not such that there is major concern about development in identified tsunami hazard zones. Del Norte County and Crescent City have adopted critical areas and resources lands regulations pursuant to state general planning laws and the California Coastal Act. Maintaining the agricultural heritage of Del Norte County is a high priority for its land use programs and managers. It has been Del Norte County’s policy in the past to not allow for an increase in exposure within its floodplains. The information in this plan provides Del Norte County and its planning partners a tool to ensure that there is no increase in exposure within the tsunami hazard zones of the planning area.

16.9 SCENARIO

The worst-case scenario for the planning area is a local tsunami event triggered by a seismic event along the Cascadia subduction zone. Historical records suggest that tsunami wave heights on the order of 15 to 60 feet could be generated by a Cascadia subduction event. The Del Norte County planning area possesses some geographical features that may help absorb some of the impacts of tsunami events. However, a major tsunami event in the region would have devastating impacts on the people, property and economy of Del Norte County

16.10 ISSUES

The planning team has identified the following issues related to the tsunami hazard for the planning area:

- Hazard Identification: To truly measure and evaluate the probable impacts of tsunamis on planning, new hazard mapping based on probabilistic scenarios likely to occur for Del Norte County needs to be created. The science and technology in this field are emerging. For tsunami hazard mitigation programs to be effective, probabilistic tsunami mapping will need to be a key component.

- Present building codes and guidelines do not adequately address the impacts of tsunamis on structures and current tsunami hazard mapping is not appropriate for code enforcement.
- Organizations in the planning area such as the Redwood Coast Tsunami Work Group and Humboldt State University have done excellent work in implementing and supporting public information and awareness programs. These programs need to be continued, supported and enhanced to promote the concepts of mitigation and preparedness for the impacts of tsunamis and all hazards addressed by this plan.
- As tsunami warning technologies evolve, the tsunami warning capability within the planning area will need to be enhanced to provide the highest degree of warning to planning partners with tsunami risk exposure.
- With the possibility of climate change, the issue of sea level rise may become an important consideration as probable tsunami inundation areas are identified through future studies.
- Special attention will need to be focused on the vulnerable communities in the tsunami zone and on hazard mitigation through public education and outreach.

CHAPTER 17.
WILDLAND FIRE

17.1 WILDLAND FIRE DEFINED

The following definitions apply in the discussion of wildland fire hazards:

- **Wildland Fire**— Wildland fires are fires caused by nature or humans that result in the uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources and manpower, these fires can be difficult to contain and can cause a great deal of destruction.
- **Conflagration**—A conflagration is a fire that grows beyond its original source area to engulf adjoining regions. Wind, extremely dry or hazardous weather conditions, excessive fuel buildup and explosions are usually the factors contributing to a conflagration.
- **Firestorm**—A firestorm is a fire that expands to cover a large area, often more than a square mile. A firestorm usually occurs when many individual fires grow together to make one large conflagration. The involved area becomes so hot that all combustible materials ignite, even if they are not exposed to direct flame. Temperatures may exceed 1000° Celsius as the fire creates its own local weather: superheated air and hot gases of combustion rise upward over the fire zone, drawing surface winds in from all sides, often at velocities approaching 50 miles per hour. Although firestorms seldom spread because of the inward direction of the winds, once started there is no known way of stopping them. Within the area of the fire, lethal concentrations of carbon monoxide are present, which, combined with intense heat, pose a serious life threat to responding fire forces. In exceptionally large events, the rising column of heated air and combustion gases carries enough soot and particulate matter into the upper atmosphere to cause cloud nucleation, creating a locally intense thunderstorm and the hazard of lightning strikes.
- **Interface Area**—An area susceptible to wildland fire where wildland vegetation and urban or suburban development occur together, such as in smaller urban areas and dispersed rural housing in the forested areas of Del Norte County.

The *Del Norte Fire Safe Plan, Community Wildfire Protection Plan,* developed by the Del Norte Fire Safe Council in 2005, and the California Department of Forestry (CDF) *Fire Protection Humboldt – Del Norte Unit 2005 Fire Management Plan* (CDF, 2005) were the sources for much of the content found in this chapter.

17.2 GENERAL BACKGROUND

The total area of Del Norte County is 683,500 acres, of which 192,357 acres are privately owned and 489,697 acres are publicly owned. It is a mountainous region characterized by steep, inaccessible topography with extensive forest resources (primarily redwood and Douglas fir). The wildland fire season in Del Norte County usually begins in early June and ends in mid-October; however, wildland fires have occurred in every month of the year. Drought, light snow pack, and local weather conditions can expand the length of the fire season. The fire season typically is shorter in the western half of the county than in the eastern half for a number of reasons:

- The western half of the county receives more rainfall.
- The west has spring seasons that are wetter and cooler than the east.

- Temperatures in the eastern portion of the county are much higher in the summer.
- Much of the precipitation received in the east is snow that falls during winter.

Wildland fires usually are extinguished while smaller than 1 acre, but they can spread to more than 100,000 acres and may require thousands of firefighters and several months to extinguish. How a fire behaves primarily depends on the following:

- **Fuel**—The fuel hazard ranking indicates the expected behavior of fire in severe weather (when wind speed, humidity, and temperature make conditions favorable for a catastrophic fire). These rankings help CDF and other agencies determine what kind of fire to expect in different areas. Forests in Del Norte Unit are predominantly mixed conifer forest consisting of coast redwood, Douglas fir and spruce, with intermingled hardwoods including madrone and tanoak. (National Fire Danger Rating System Fuel Model G or Fire Behavior Fuel Model 10). The large amount of precipitation the county receives on an annual basis creates a lot of vegetation, which is potential fuel. A key component of this fuel type is the large amount of down and dead woody fuel. This vegetation type consists of the following zones:
  - The coastal strip consists of coast redwood, Douglas fir and spruce. This is a closed-canopy forest with a thick, lush understory of brush. The biomass in this fuel type is equal to or greater than that of a rain forest.
  - The second zone occurs inland where Douglas fir dominates and resides with the hardwoods. This results in a more open canopy with a sparser understory.
- **Weather**—"Fire weather" refers to weather conditions that influence fire ignition, behavior, and suppression, such as temperature, relative humidity, wind speed and direction, precipitation, atmospheric stability, and aloft winds. When the temperature is high, relative humidity is low, wind speed is increasing and coming from the east (offshore flow), and there has been little or no precipitation so vegetation is dry, conditions are very favorable for extensive and severe wildland fires. These conditions occur more frequently inland where temperatures are higher and fog is less prevalent. During the dry summer months, the county's abundant vegetation dries out and becomes hazardous fuel. That fuel combined with a Chinook wind—hot and dry from the Great Basin—can produce extreme fire danger. The coastal area has a fire-weather scenario when prevailing winds from the Gulf of Alaska blow off the ocean.

  Precipitation in Northern California is usually at its lowest from July to September. Thunderstorm activity, which typically begins in June with wet storms, turns dry with little or no precipitation reaching the ground as the season progresses into July and August. Thunderstorms with dry lightning are more prevalent in the eastern portion of the county. July and August are when local winds (slope winds and sea breezes) predominate, with the Pacific jet stream weak and well to the north. By mid or late September, north to northeast winds return to the north half of the planning area, bringing in moist ocean air.
- **Terrain**—Topography affects the amount and moisture of fuel; the ease with which fire spreads (fire spreads more easily uphill than downhill); the impact of weather conditions such as temperature and wind; and potential barriers to fire spread, such as highways and lakes.
- **Time of Day**—A fire's peak burning period generally is between 1 p.m. and 6 p.m.

Fire threat is a rating for estimating the potential for impacts on assets susceptible to fire. Impacts are more likely to occur and/or be of increased severity for higher fire-threat classes. Fire threat is derived from a combination of fire frequency (how often an area burns) and expected fire behavior under severe weather conditions. Fire frequency is derived from 50 years of fire history data. Fire behavior is derived from fuel and terrain data. Figure 17-1 shows the percentage of land area in Del Norte County within each of fire threat categories; there are five categories in all, but none of the area of Del Norte County is in the two lowest-threat categories (nil and low).

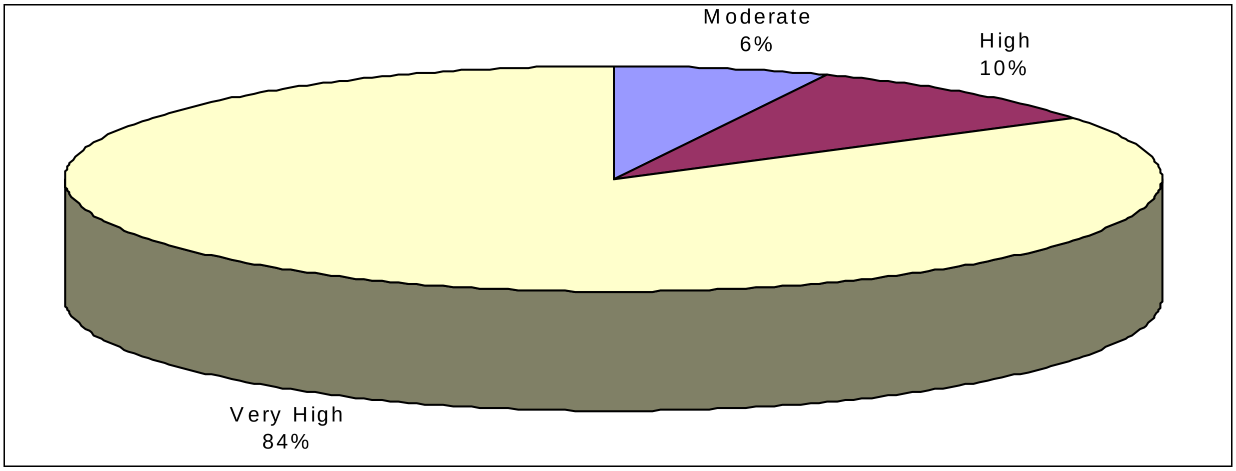


Figure 17-1. Distribution of County Area by Fire Threat Category

17.2.1 Effects of Human Activities

People start most wildland fires. Major causes include arson, recreational fires that get out of control, smoker's carelessness, debris burning, and children playing with fire. From 1992 to 2001, on average, people caused more than 500 wildland fires each year on state-owned or protected lands; this compared to 135 fires caused by lightning strikes. However, wildland fires started by lightning burn more state-protected acreage than any other cause, an average of 10,866 acres annually; human caused fires burn an average of 4,404 state-protected acres each year. The early and late shoulders of the fire season usually are associated with human-caused fires; fires in the peak period of July, August and September are more commonly due to thunderstorms and lightning strikes.

The CDF's Fire and Resource Assessment Program includes an historical record of all wildland fires in Del Norte County. According program statistics, 220 wildland fires burned in Del Norte County between 1901 and 2008. The cause of 171 of these fires is known and recorded, and 49 percent of them were caused by human activities. Lightning accounts for another 30 percent of the county's wildland fires, but human activities often influence the severity and number of fires caused by lightning strikes. Figure 17-2 presents the causes of the county's historical wildland fires.

Before 1875, Native Americans often burned much of what is now Del Norte County. Fire would clear the understory of the forested areas, driving out insects and rodents. Fire also enhanced the grasses and forbs used to weave baskets. During the settlement period (1875-1897), European settlers used fire for enlarging and replenishing pasture/agricultural lands. These fires often escaped their control.

Major land activities during the post-settlement period (1898-1940) were livestock grazing, farming, debarking of the tanoak for tannin production and logging of Douglas fir and coast redwood. Logging was clearly a dominant activity during this time period. Logged areas were burned to assist with the removal of the logs and reduce the logging debris left behind. These fires were left to burn with no real control efforts. The same can be said for the area ranchers who commonly set fire to their land in order to maintain the grazing. This resulted in many, large fires that are documented in area newspapers from 1880 to 1952.

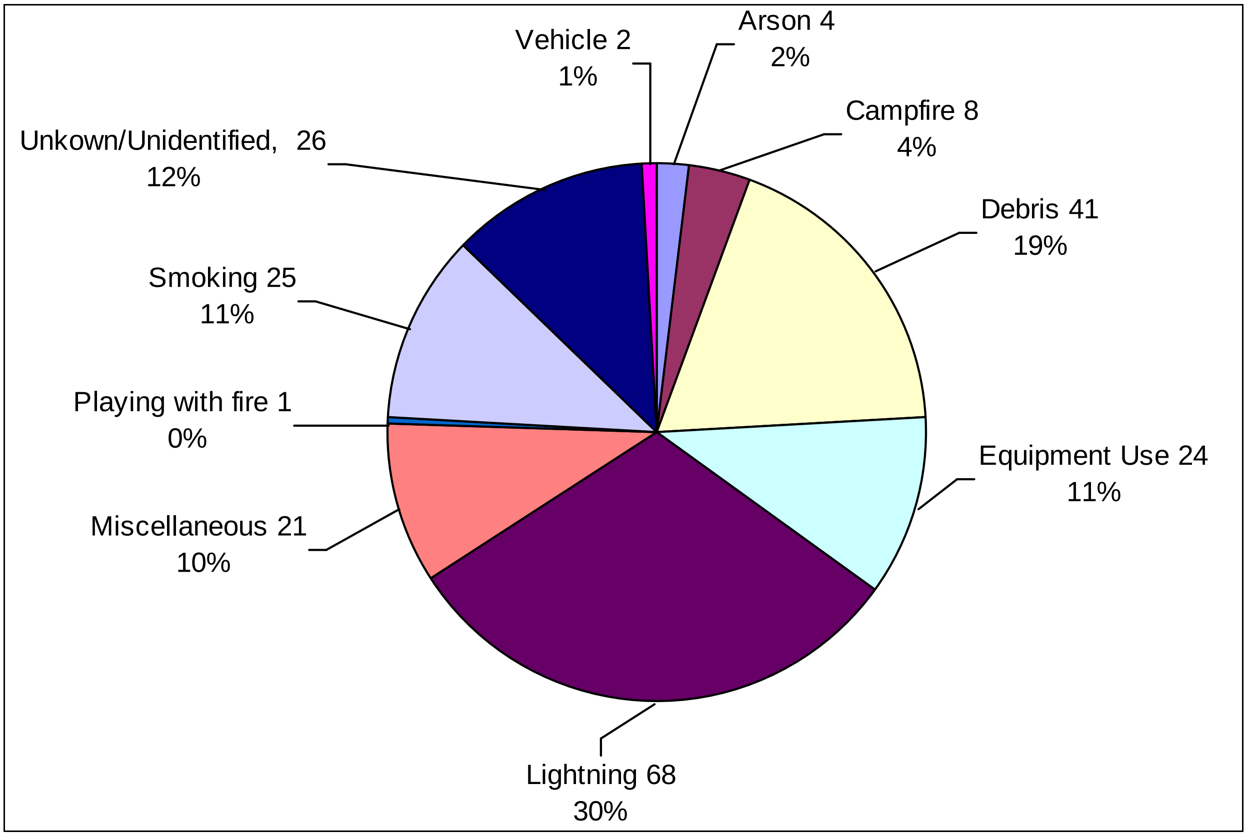


Figure 17-2. Causes of Wildland Fires in Del Norte County (of 220 wildland fires, 1909 – 2008)

The suppression of wildland fires in recent decades has resulted in a buildup of fuel and has increased the potential for large fires, which burn with greater intensity than under natural conditions. These intense fire events generally result in greater resource damage than would result from natural-condition events.

Natural resource lands, primarily forestlands, surround many unincorporated communities in Del Norte County. The areas where communities abut natural resource lands are known as the ***wildland-urban interface***. At the interface, a mix of fuel, weather and topographical conditions create conditions that put a community at risk of wildland fire. A wildland-urban interface is an area of increased human influence and land use conversion. Population and demographic trends, economic and tax issues, and land use planning and policy issues all play a part in influencing the interface. At the interface, public values and perceptions shape the way that natural resources are managed and conserved. An interface can also be defined as a zone where human-made infrastructure is located in, or adjacent to, areas prone to wildland fires. At a community-level perspective, the interface can be defined as the conditions that contribute to a neighborhood or community's vulnerability to a wildland fire.

17.2.2 Communities at Risk

The CDF and the California Fire Alliance prepared a list of California communities at risk from wildland fire (http://www.cafirealliance.org/communities_at_risk.php). The three main factors used to determine wildland fire threat to wildland-urban interface areas of California were:

- **Ranking Fuel Hazards**—Ranking vegetation types by their potential fire behavior during a wildland fire.

- **Assessing the Probability of Fire**—The annual likelihood that a large damaging wildland fire would occur in a particular vegetation type.
- **Defining Areas of Housing Density that Would Create Wildland-Urban Interface Fire Protection Strategy Situations**—Areas of intermingled wildland fuels and urban environments that are in the vicinity of fire threats.

The U.S. Department of Interior also designates communities as at risk from wildland fire. Table 17-1 lists the Del Norte County communities at risk (state and federal), along with each community's hazard level code (the level of hazard ranges from "1" as the lowest to "3" as the highest) and indication of whether there is a threat to federal lands (designated by an "F").

**TABLE 17-1.
DEL NORTE COUNTY COMMUNITIES AT RISK FROM WILDLAND FIRE**

Community	Hazard Level	Federal Threat	Source
Big Flat	2	F	1, 2
Douglas Park	2	F	1, 2
Fort Dick	2	F	2
French Hill	2	F	1, 2
Gasquet	2	F	1, 2
Hiouchi	2	F	1, 2
Klamath	3	F	1, 2
Klamath Glenn	3	F	2
Lado Del Rio	2	F	2
Major Moore's	2	F	1, 2
Patrick Creek	2	F	1, 2
Pioneer Tract	2	F	1, 2
Requa	3	F	2
Rock Creek	2	F	1, 2
Smith River	2	F	2
Yurok Indian Reservation	3	F	2

Sources:
1 = Department of the Interior, Federal Register, 8/17/01
2 = CDF/CA Fire Alliance, 2001

17.2.3 Programs and Agencies Related to Wildland Fire

In Del Norte County, there are nine agencies that provide fire service:

- Five fire protection districts (FPDs), two of which do not levy assessment fees for services (Klamath and Gasquet)
- The Crescent City Fire Department

- The California Department of Forestry and Fire Protection (CDF)
- The U.S. Forest Service's Six Rivers National Forest
- The National Park Service's Redwood National Park.

Each has its own fire service area. Mutual aid agreements are common among neighboring fire organizations to assist one another in responding to fire and other emergencies. Some rural areas of Del Norte County have wildland fire protection even though they are not within any fire response area for structural protection. The U.S. Forest Service provides wildland fire protection on Forest Service lands. CDF provides wildland fire protection on the rest of the lands designated as State Responsibility Area (SRA), unless it is provided by local fire organizations.

Federal Program and Agencies

Federal fire policy is derived principally from three sources: the Federal Wildland Fire Management Policy, the Western Governors Association *Ten-Year Comprehensive Strategy: A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment* (August 2001), and the Healthy Forests Restoration Act (2003). These documents call for a single comprehensive federal fire policy for the Interior and Agriculture Departments (the agencies using federal fire management resources). They mandate community-based collaboration to reduce risks from wildland fire. The 2001 National Fire Plan was developed based on the National Fire Policy. A major aspect of the National Fire Plan is joint risk reduction planning and implementation carried out by federal, state and local agencies and communities.

U.S. Forest Service Six Rivers National Forest

The U.S. Forest Service role in wildland fire management is primarily focused on National Forest lands. However, Forest Service personnel will respond to wildland and structural fires on adjacent lands through mutual aid agreements when crews and equipment are available. Forest Service fire stations are not staffed outside of fire season.

Bureau of Land Management

The U.S. Bureau of Land Management (BLM) funds and coordinates wildland fire management programs and structural fire management and prevention on BLM lands. BLM works closely with the Forest Service and state and local governments to coordinate fire safety activities. The Interagency Fire Coordination Center in Boise, Idaho serves as the center for this effort.

Bureau of Indian Affairs

The U.S. Bureau of Indian Affairs' (BIA's) Fire and Aviation Management National Interagency Fire Center provides wildland fire protection, fire use and hazardous fuels management, and emergency rehabilitation on Indian forest and rangelands held in trust by the United States, based on fire management plans approved by the appropriate Indian Tribe.

National Park Service, Redwood National Park

The National Park Service (NPS) provides wildland and structure fire protection, and conducts wildland fire management within the NPS units. These activities are guided by the National Park Service Fire Management Plan.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service fire management strategy employs prescribed fire to maintain early successional fire-adapted grasslands and other ecological communities throughout the National Wildlife Refuge System.

Federally Recognized Indian Tribe

The Yurok and Hoopa Valley Tribes provide funding, equipment, and facilities for volunteer fire departments that protect their respective reservations. The Hoopa Valley Tribe also operates a wildland fire department that responds to fires on Hoopa Valley Tribal Trust lands and to other wildland fires in Del Norte County, facilitated through the CDF. The Yurok Tribe has staff and resources that provide contract fire protection services through the Bureau of Indian Affairs.

State Program and Agencies

The State Board of Forestry and the CDF have prepared a comprehensive update of the *California Fire Plan* for wildland fire protection. The planning process included defining a level of service measurement; considering assets at risk; incorporating the cooperative interdependent relationships of wildland fire protection providers; providing for public stakeholder involvement; and creating a fiscal framework for policy analysis. The *California Fire Plan's* overall goal is to reduce costs and losses from wildland fire in the state by protecting assets at risk through pre-fire management and by reducing the spread of fire through more successful initial response.

California Fire Safe Council

In 1993, the statewide Fire Safe Council, consisting of private and public membership, was formed to educate and encourage Californians to plan and prepare for wildland fires by reducing the risk of fire to property, communities, and natural/structural resources. In 2002, this group created a nonprofit organization and board of directors, called the California Fire Safe Council (CFSC). The CFSC works with the California Fire Alliance to facilitate the distribution of National Fire Plan grants for wildland fire risk reduction and education (www.grants.firesafecouncil.org). The CFSC also provides assistance to local Fire Safe Councils (FSCs) through its website (www.firesafecouncil.org), the distribution of educational materials, and technical assistance, primarily through regional representatives. More than 130 local FSCs have formed in California to plan, coordinate, and implement fire prevention activities.

California Department of Forestry and Fire Protection, Humboldt/Del Norte Unit

CDF has responsibility for wildland fires in areas of the county that are not under the jurisdiction of the Forest Service or a local fire organization, including lands designated as State Responsibility Areas. CDF also has fire protection responsibilities by contract and mutual aid agreements. For example, CDF provides year-round fire protection under Amador Plan agreements with certain local government agencies (Public Resources Code §4144). Through these agreements, CDF provides local structural and wildland fire protection or dispatch services to a community and maintains a staffing level that otherwise would be available only during the fire season. The local entity pays the additional cost of the service.

California Department of Parks and Recreation (State Parks)

State Parks manages portions of the California coastline including coastal wetlands, estuaries, beaches, and dune systems. The State Parks Resources Management Division has limited wildland fire protection resources available to suppress fires on State Park lands. State Parks does not operate a fire station in Del Norte County and relies on CDF as the primary wildland fire protection resource for the lands under its management. State Parks cooperates with CDF and Redwood National Park on prescribed burns, and can provide limited mutual aid.

California Emergency Management Agency

The California Emergency Management Agency Fire and Rescue Branch administers the California Fire Service and Rescue Emergency Mutual Aid Plan. The agency provides guidance and procedures for agencies developing emergency operations plans, as well as training and technical support, primarily to overall emergency service organizations and urban search and rescue teams.

Technical Support Agencies

There are federal and state agencies that provide technical support to fire agencies/organizations. For example, the U.S. Fire Administration, which is a part of FEMA, provides leadership, advocacy, coordination, and support for fire agencies and organizations. The Office of the State Fire Marshal is a division of CDF and has a wide variety of fire safety and training responsibilities.

17.2.4 Wildland Fire Characteristics of Planning Units

Crescent City and Crescent City UGA Planning Units

Crescent City and its UGA lie on the Pacific Ocean, just south of Point Saint George, and about 20 miles south of the Oregon border.

The wildland-urban interface here is predominantly on the south and eastern edges of the area. To the south, Crescent City butts up against the Del Norte Coast Redwoods State Park and Redwood National Park. To the east, Redwood National Park and Jedediah Smith Redwoods State Park interface with the edge of the suburban development. These interface areas are predominantly redwood forests, of all age classes. The younger forests tend to have high fuel loads and ladder fuel.

Given this area’s location near the coast and the fact that it is an urban area, it does not have a notable wildland fire history. Structural fires are more common.

Fort Dick Planning Unit

The Fort Dick planning unit is between Crescent City to the south, the Pacific to the west, and the Smith River to north and east. Much of the land surrounding this area is agricultural, with many acres in flower bulb production. Lake Earl State Park/Tolowa Dunes is a dominant landscape feature. The Pelican Bay State Prison is located within this planning unit, although legally it is a part of Crescent City. It has 4,200 people on site. Fort Dick was designated as a community at risk from wildland fire by CDF and the California Fire Alliance in 2001.

Redwood School and Fort Dick Bible Academy are the designated evacuation locations for the Fort Dick community; however, both need defensible space. The South Bank Road area has only one way in and out. The road enters the area under Dr. Fine Bridge. If an earthquake were to take this bridge out, the neighborhood would have no evacuation route. Water sources were identified as 12 hydrants on the east side of Highway 101 (Kings Valley Road), two off Arrowhead, and two off Wonder Stump Road. Nearly all water in the area is from wells, with no generator backup. The hydrant system is supported by a 120,000-gallon tank. Six hydrants are projected for Wonder Stump Road at the intersections and at a projected subdivision to the north of Kings Valley Road. There is also a large pond in a field along Kings Valley Road.

Although Fort Dick is along the coast, with primarily urban and agricultural lands, much of its western portion is designated as very high fire threat. This is due to strong coastal winds and the history of fire starts in this area, especially around Lake Earl. The Pacific Shores area is especially susceptible to fire.

Historically the big fires in the Fort Dick area include the mercantile store 30 to 40 years ago, the Alexander Dairy Barn Fire three years ago (started in a burn barrel), a beach fire on Kellogg Beach (400 acres, started by a vehicle), a fire 75 years ago south of the present Pelican Bay State Prison (Skeleton Park), a 1988 fire across the street from the prison (transient-started, 80 acres), and a Simpson land fire 10 to 15 years ago (started by arson).

Gasquet Planning Unit

Gasquet is small community of approximately 500 year-round residents (over 600 summer residents) nestled along the banks of the Middle Fork Smith River and Highway 199, completely surrounded by the Smith River National Recreation Area. This planning unit is 18 miles inland from Highway 101 and the coast. Gasquet was designated as a community at risk by the Department of Interior on August 17, 2001.

The planning unit includes various private parcels along Highway 199 to the Oregon border. Bar-O Boys Ranch is a juvenile facility located at Washington Flat and affiliated with the Del Norte County Unified School District. Approximately 70 boys live here, as well as 10 to 12 permanent staff. The ranch has participated in Del Norte Fire Safe Council fuel reduction projects. Patrick Creek Lodge is a historical building at the mouth of Patrick Creek on the Smith River. Across the highway is a Forest Service campground. There are also a few homes on Siskiyou Fork Road.

The Gasquet planning unit is one of the highest fire threat areas in the county. This interface community is surrounded by National Forest lands, many of which have been previously logged or have increasing numbers of dead trees, both resulting in high fuel loads. In addition, this community is isolated, being situated along winding Highway 199. There are several alternate evacuation routes (Gasquet Mountain Road, French Hill Road, and Jawbone Road). However, all of these roads are narrow and winding, often only one lane and gravel for long stretches. Therefore, they are not conducive to rapid evacuation. The Gasquet community is different from most other Del Norte communities in that it does not have a coastal influence. Temperatures here are on average at least 10 degrees (sometimes 20 to 30 degrees) higher than in Crescent City. In late afternoon, the winds increase blowing up the Smith River.

The Gasquet Community Services District pumps water from the river into a half-million gallon tank with gravity feed. In the past, when power has been out, the fire department has pumped the water, as there may be no generator backup. Del Norte Fire Safe Council has installed twelve 2,500-gallon water tanks in the greater Gasquet area, and another six on the North Fork Loop. In addition, the FSC put in four tanks at the Bar-O Boys Ranch.

Historically, the big fires in the Gasquet area were the Panther Fire (1996), the Biscuit Fire (2002), and the Shelly Fire (2002). This community is getting accustomed to big fires and evacuation. The entire community was evacuated during the Biscuit Fire. Everything north of the Middle Fork Bridge (North Fork Loop and Azalea Lane) was evacuated for the Panther Fire.

Hiouchi Planning Unit

The Hiouchi planning unit is centered on the community of Hiouchi, located on Highway 199 just east of Jedediah Smith Redwoods State and National Park, at an elevation of 163 feet. The planning unit includes the residential areas along North Bank Road (Highway 197), South Bank Road, and Low Divide Road. The planning unit boundary is the park and main stem Smith River on the west, including the private residences along Highway 197. To the north, east, and south the planning unit is bounded by the Smith River National Recreation Area, as well as Redwood National Park to the south. Situated on the Smith River, the area receives canyon winds; the afternoon breeze comes up the river. It is on the edge of the maritime climate, with the fog reaching the nearby redwoods, so it is cooler than Gasquet, a few miles upriver.

The town of Hiouchi straddles Highway 199 and the main stem of the Smith River just west of the confluence of the South and Middle Forks. Hiouchi is experiencing increasing development on both sides of the highway, including Hiouchi mountain on the north, South Fork, Howland Hill, and Douglas Park areas on the south side of the Smith River, and along North Bank Road, which follows the Smith River from Highway 199 to Highway 101. Several of these areas have one-way in and out access and are in densely vegetated or steep terrain. Together, these areas are both a risk and hazard. Hiouchi was designated as a community at risk by the Department of Interior on August 17, 2001.

Water is an issue for many outlying areas of Hiouchi, as only central Hiouchi has a hydrant system. The Del Norte Fire Safe Council installed two 2,500-gallon water tanks on Douglas Park, four tanks on Low Divide and six on upper Ashford Road at Hyatt Heights. Christensen Way, a cul-de-sac at the forks of the Smith River, has a 25,000-gallon swimming pool and a 5,000-gallon pond; there is another swimming pool two houses west on Douglas Park. A residence on North Bank Road has a 25,000-gallon swimming pool. There are four irrigation ponds at the golf course on North Bank Road, with 500,000 gallons of storage. The HRC Community Services District has eight tanks, with 75,000 to 85,000 gallons of storage off Low Divide. Jed Smith Lane subdivision off North Bank Road has its own water system. Redwood National Park created a shaded fuel-break along the eastern edge of its property adjacent to the Hiouchi community. Smith River FPD provides fire and medical emergency response to Hiouchi, from its Station #2 in downtown Hiouchi, and Station #3 on upper Low Divide Road.

Historically, the big fires in the Hiouchi community have been the Howard and Biscuit Fires (2002). Some outer Hiouchi residents were evacuated during the Biscuit Fire.

Klamath Planning Unit

The Klamath Fire Planning Compartment is the southernmost area of Del Norte County. The county border here with Humboldt County occurs near the northern end of the Prairie Creek Redwoods State Park. Much of the land along the coast in this planning unit is managed by Redwood National and State Parks. Much of the rest of the planning compartment is private timberland owned by Green Diamond Resource Company (formerly Simpson Timber). There is a thin band of private residential parcels along Highway 101 and along the Klamath River. The Yurok Reservation, which includes one mile on both sides of the river, totals approximately 15,000 acres in Del Norte County (most of the Reservation is in Humboldt County). The Resighini Reservation is on the south side of the Klamath River east of Highway 101, with approximately one dozen homes.

The northern extent of this planning compartment is near the mouth of Wilson Creek and the Del Norte Coast Redwoods State Park and Redwood National Park. This area includes the communities of Klamath and Klamath Glen, with a combined population of approximately 1,200. Much of Klamath Glen was destroyed by the 1964 flood. Shortly after that, a dike was built to better protect the town. On January 4, 2001, Klamath was the first community in Del Norte County to be designated a community at risk by the U.S. Department of Interior.

The town of Klamath has a hydrant system. Klamath Glen is currently finishing the process of installing a hydrant system, including a 200,000-gallon water tank. There are no hydrants in Hunter Creek or Requa. There are 10,000 gallons of water in tanks at the Margaret Keating School that were purchased and installed by the Klamath Fire Protection District. Previously a hydrant system existed on the Resighini Reservation at the casino. However, the casino no longer exists and the hydrants are not used. That reservation uses private residential water.

Historically, the big fires in the Klamath planning compartment were the Blue Creek Fire (1929), unnamed fires in 1956 and 1957, the Blake Fire (1998), and the Hunter Creek Fire (1998). The Blake Fire began on a weeknight in the rain from arson. Because of the steep terrain, helicopters were used to fight the fire, at a total cost of more than $1 million.

Smith River Planning Unit

The Smith River planning unit is centered on the community of Smith River, the northernmost community in coastal Del Norte County, with a population of 2,000. It lies just south of the Oregon border and east of the mouth of the river. The town center is located near Rowdy Creek. On the east, it is bounded by Green Diamond Resource Company lands and on the south by the Smith River. The western edge of Smith River is covered in agricultural land, where flower bulbs are principally grown.

This planning unit is seeing significant development, especially on the hills facing the ocean. Recent subdivisions like Spyglass and Nautical Heights have only one principal access road, winding up the ridge with no alternate access. This is significant, given that the eastern border of these developments is forested, making this a serious interface issue. Smith River was designated as a community at risk from wildland fire by CDF and the California Fire Alliance in 2001.

The town water system has four wells, and 750,000 gallons total water storage (two 250,000-gallon tanks, one 150,000-gallon tank, and several smaller tanks in subdivisions). There are water availability issues along Rose Lane, Knutsen, High Meadow Drive, Rossine, and Oma Lane. Many of these areas are on wells. Nautical Heights has a 100,000-gallon tank. Spyglass has 40,000- and 75,000-gallon tanks. There is a pond at the end of Sun River Road and a 10,000-gallon water tank on the road. Smith River FPD has one station here, one in Hiouchi, and a third near the top of Low Divide Road.

Other County Planning Unit

This planning unit represents the balance of the county and has characteristics reflected in all of the other planning units discussed above.

17.3 HAZARD PROFILE

Fire has been a significant factor in Del Norte County's history. Evidence of this can be seen in the fire scars on ancient redwoods, some dating back more than a thousand years. The county's history and culture, as well as recent developments and growth patterns, all influence how future fire risk can be managed, and future fire services can be provided. Fuel loads have been accumulating to abnormal levels throughout the West due to decades of fire suppression and timber harvesting.

The primary purpose of fire protection is to protect assets valued by a community: life and safety; timber; range; recreation; water and watershed; plants; air quality; cultural and historic resources; unique scenic areas; buildings; and wildlife, plants, and ecosystem health.

Short-term loss caused by a wildland fire can include the destruction of timber, wildlife habitat, scenic vistas and watersheds; the destruction of watersheds also increases the vulnerability to flooding. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Large-scale watershed disturbance such as wildland fire can result in loss of vegetative cover, increased runoff, and severe erosion and sediment production. Large sediment loads in rivers and streams can damage aquatic habitat in riparian areas.

17.3.1 Past Events

In the four years between 1998 and 2001, state and federal agencies responded to more than 250 fires in Del Norte County, not including fires responded to by the county's local fire departments. The largest recent fire was the Biscuit Fire in 2002, which burned in southern Oregon and northern California. It began on July 13, 2002, due to lightning strikes and ended up burning a total of 501,070 acres. This fire caused the evacuation of Gasquet and surrounding communities. Its heavy smoke contributed to health problems for residents within a 100-mile radius. The Biscuit Fire was the region's largest and most devastating wildland fire over the last 125 years. Its boundaries stretched from 10 miles east of the coastal community of Brookings, Oregon; south to the communities of Hiouchi and Gasquet; east to the Illinois Valley in southern Oregon; and north to within a few miles of the Rogue River in Oregon. The fire became one of the most difficult fires to contain in recent history.

17.3.2 Location

Figure 17-3 shows the location and size of historical fires in the county between 1901 and 2009. The majority of wildland fires have been located in the north-central and southeastern portions of the county, with a few smaller fires occurring in the central portion of the county. Of the 220 fires between 1901 and 2009, the average area burned was 2,996 acres per fire including the Biscuit Fire. Without the Biscuit Fire being considered, the average fire size was still over 700 acres per fire.

Figure 17-4 shows the fire threat designation for all of Del Norte County. As this map shows, 84 percent of the county is in areas of very high fire threat, 10 percent is in areas of high fire threat, and 6 percent is in areas of moderate fire threat. No areas in Del Norte County are classified as low-risk or no risk.

17.3.3 Frequency

Many studies have been conducted on the fire frequency of the coast redwood. Estimates suggest a 50 to 100-year fire cycle for the redwoods in Del Norte County, and 12 to 50 years in Humboldt County (CDF, 2005). Figure 17-5 charts the 220 major fires in the county each year from 1901 to 2009. The average is 2.1 fires per year and the range is 0 to 17 fires per year. The number of annual fires in the county was higher in the period before 1961, with an average of 2.3 fires per year. Since 1961, the average has been 1.8 fires per year, with the exception of three years that exceeded 6 fires per year.

Fire season in Del Norte County begins in June, peaks in August and September, and typically ends by mid-October. As Figure 17-6 shows, over 80 percent of wildland fires in the county's history ignited between July and October.

17.3.4 Severity

According to CDF's Fire and Resource Assessment Program, wildland fires in Del Norte County between 1901 and 2009 ranged from 2 acres to more than 500,000 acres. Figure 17-7 displays the severity (defined by total area burned) of Del Norte County's historical wildland fires.

All recorded Del Norte County fires larger than 100 acres are displayed in Table 17-2, along with the responding agency, the alarm date, and the cause of the fire. Due to steep terrain, inaccessibility, late notification or a combination of these, 13 fires have reached significant size (up to 3,000 acres).

17.3.5 Warning Time

Most wildland fires occur without warning, though fire-management agencies are able to analyze many factors to predict the likelihood of fire. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm. Summer and fall holiday weekends with heavy camping and extended dry periods are secondary indicators of short-term risk. Dry seasons and droughts are factors that greatly increase likelihood. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

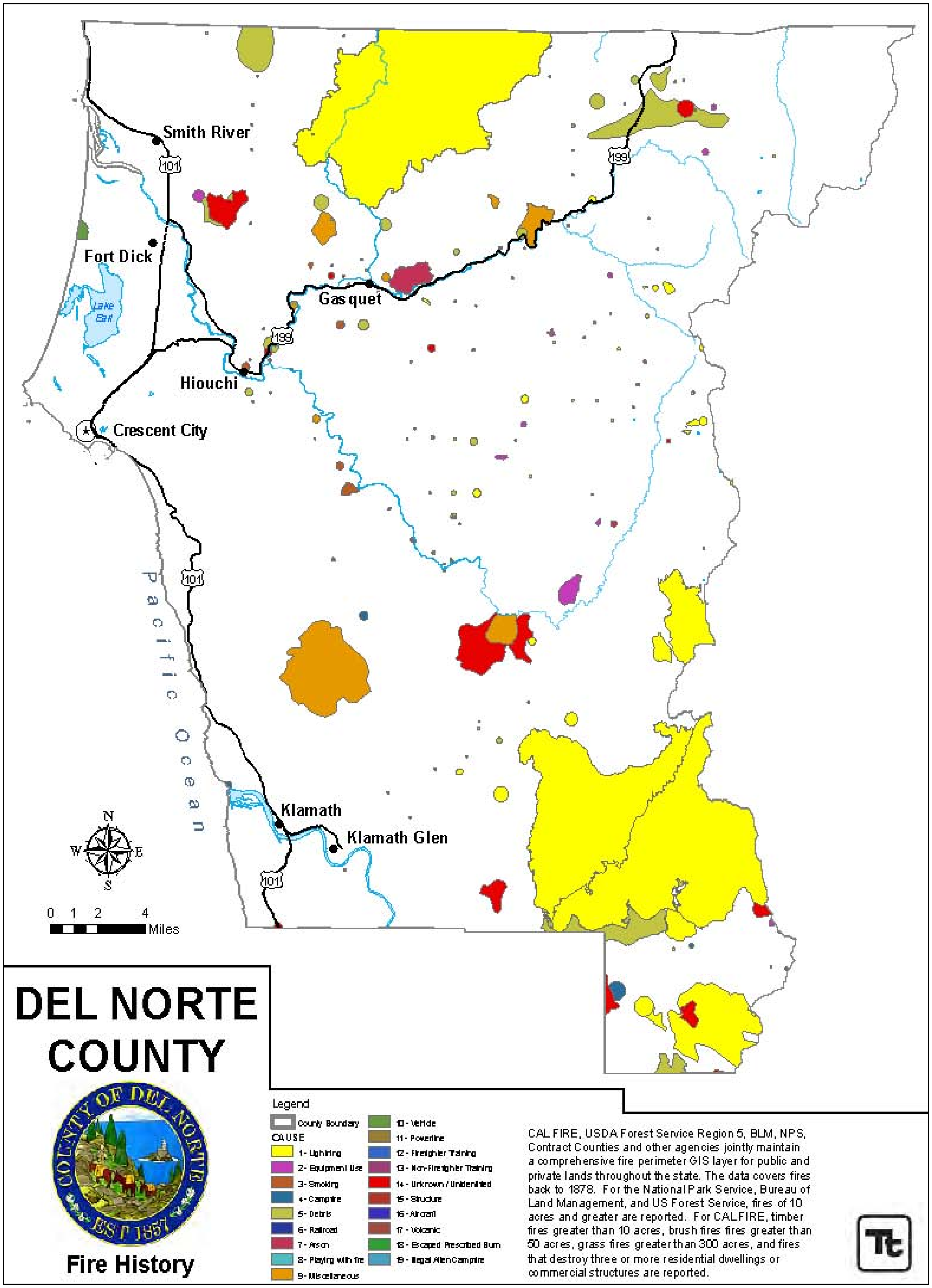


Figure 17-3. Extent and Location of Del Norte County Wildland Fires, 1901 – 2009

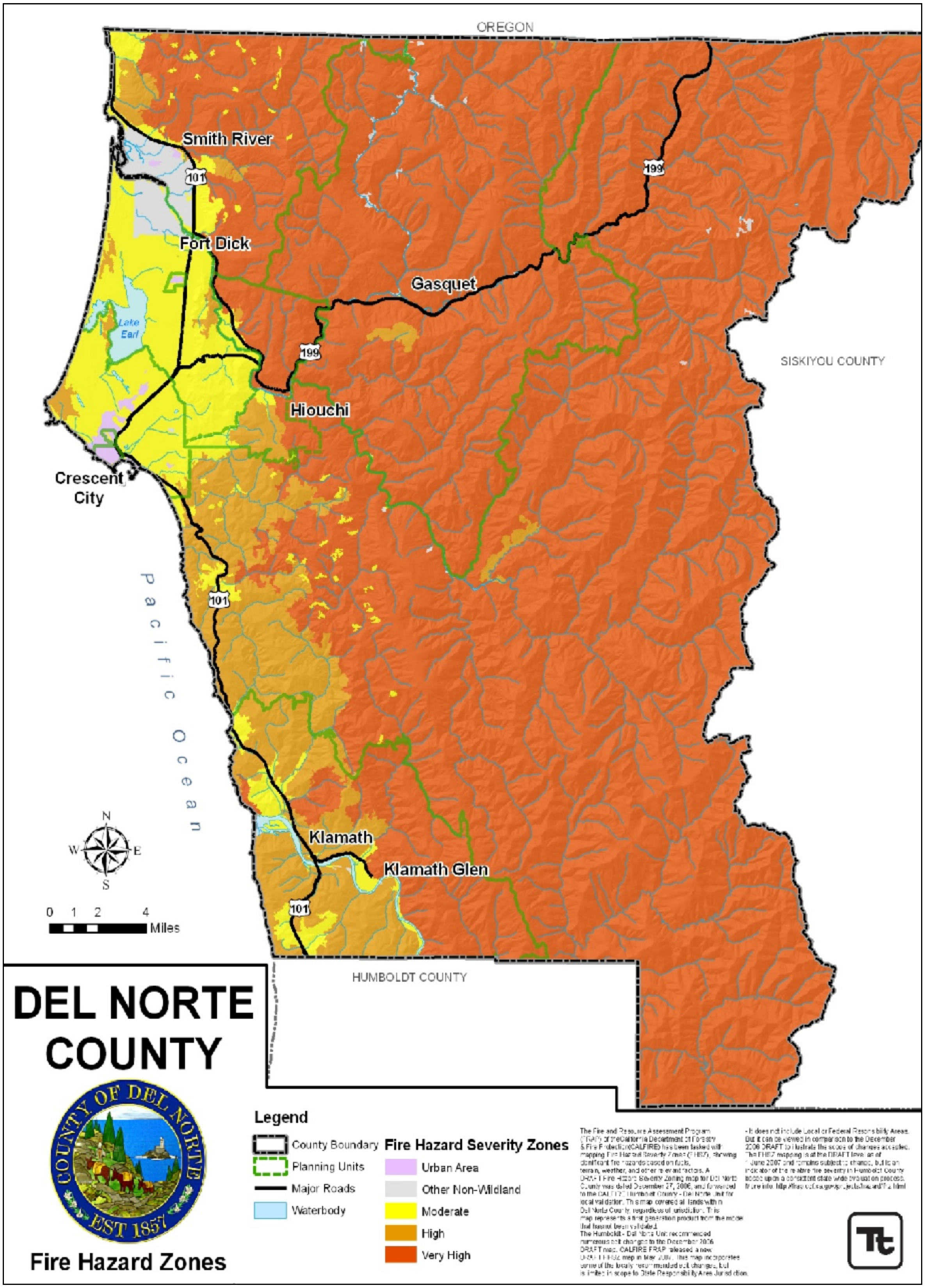


Figure 17-4. Fire Hazard Zones in Del Norte County

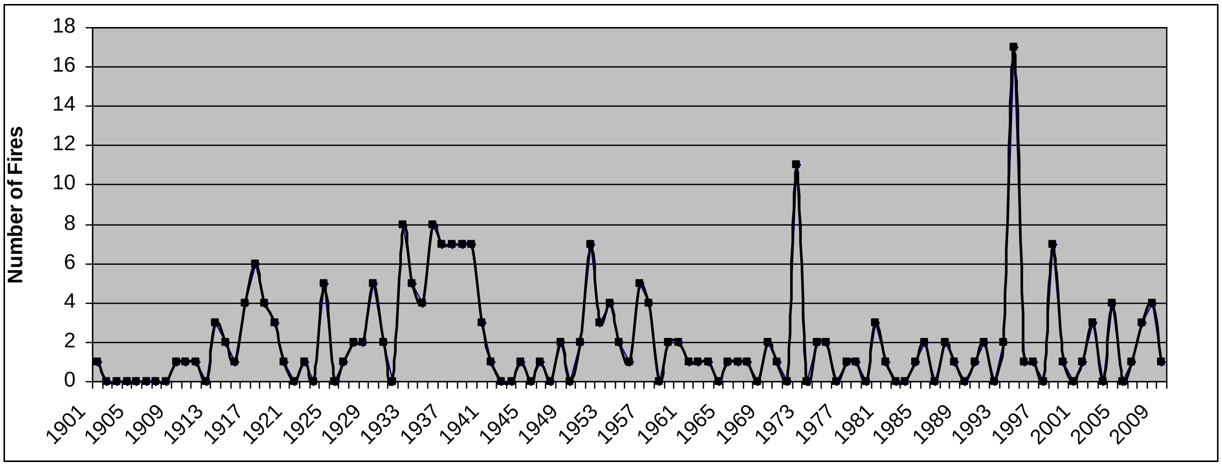


Figure 17-5. Annual Frequency of Fires in Del Norte County, 1901 – 2009

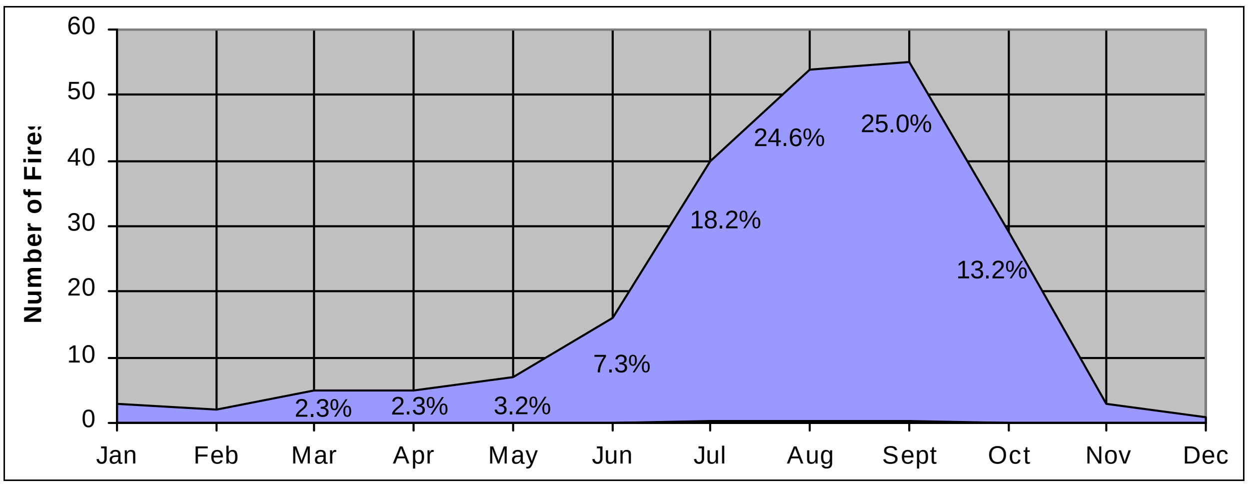


Figure 17-6. Months in which Del Norte County Wildland Fires Ignite, 1901 – 2009

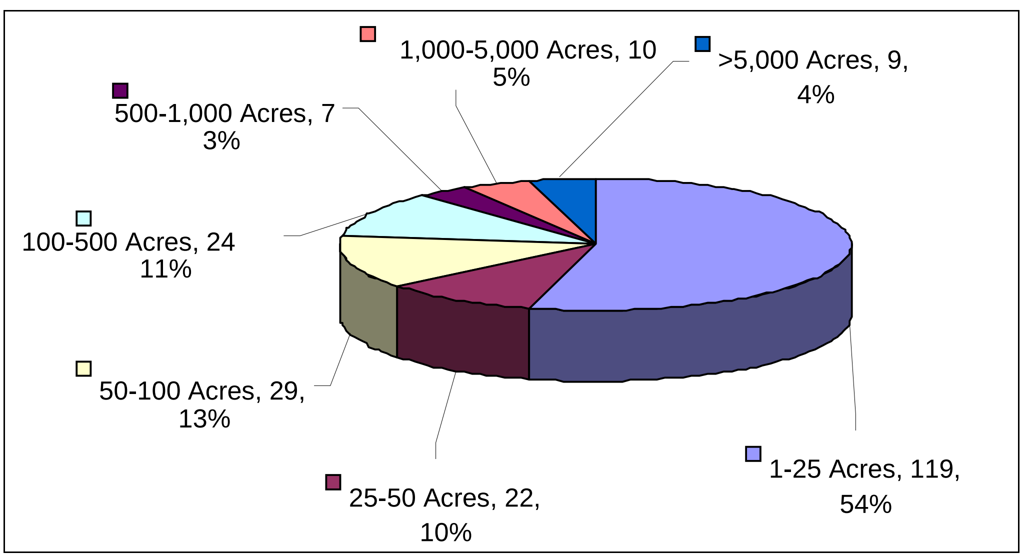


Figure 17-7 Severity (area burned) of Del Norte County Wildland Fires, 1901 – 2009

TABLE 17-2.
DEL NORTE COUNTY FIRES >100 ACRES (1901 TO 2009)

Fire Name	Agency	Alarm Date	Cause	Area Burned (acres)
Nickowitz	USF	12/24/1901	Lightning	1,004
Bluff Creek	USF	7/24/1910	Campfire	298
Unnamed	USF	8/22/1911	Unknown Unidentified	258
Unnamed	USF	9/7/1915	Debris	1,643
Unnamed	USF	8/24/1917	Debris	199
Serpentine Camp	USF	9/3/1917	Debris	996
Unnamed	USF	9/29/1917	Debris	2,970
Unnamed	USF	1/1/1918	Unknown Unidentified	5,469
Camp Creek	USF	6/12/1918	Lightning	3,565
Stone Creek	USF	6/18/1918	Debris	119
Myrtle Creek	USF	6/26/1918	Debris	1,050
Hardscabble	USF	8/18/1920	Debris	199
Doctor Rock	USF	9/8/1922	Debris	558
C&O Lbr. Co.	USF	8/15/1924	Equipment Use	119
Summit Valley	USF	9/1/1924	Lightning	149
Bluff Creek #1	USF	9/5/1924	Lightning	261
Bluff Creek #2	USF	9/12/1924	Debris	1,227
Bluff Creek	USF	7/29/1927	Lightning	5,656
French Hill	USF	9/1/1929	Debris	228
Blue Creek #2	USF	9/15/1929	Debris	6,112
Blue Creek #4	USF	11/25/1929	Debris	3,769
Unnamed	USF	9/8/1932	Debris	288
Unnamed	USF	9/29/1939	Lightning	199
Rock Creek	USF	7/3/1950	Smoking	153
Pappas	CDF	7/29/1950	Unknown Unidentified	1,034
Lems Summit	CDF	9/16/1951	Unknown Unidentified	3,368
Flint Valley	USF	9/17/1951	Lightning	325
Notice Creek	USF	9/17/1951	Lightning	318
Gasquet Mtn.	USF	9/19/1957	Miscellaneous	562
Sugar	USF	9/12/1967	Equipment Use	477
Panther	USF	7/1/1972	Miscellaneous	209
Patricks	USF	10/5/1980	Debris	104
Klamath	CDF	9/11/1988	Miscellaneous	6,158
Kevin	USF	7/21/1994	Lightning	206

TABLE 17-2 (continued). DEL NORTE COUNTY FIRES >100 ACRES (1901 TO 2009)

Fire Name	Agency	Alarm Date	Cause	Area Burned (acres)
Panther	USF	9/26/1996	Arson	943
Buck	USF	9/13/1998	Miscellaneous	841
Unnamed	USF	10/1/1998	Unknown Unidentified	6,284
Unnamed	USF	10/1/1998	Unknown Unidentified	318
Unnamed	USF	10/1/1998	Unknown Unidentified	496
Unnamed	USF	10/1/1998	Unknown Unidentified	3,617
Unnamed	USF	10/1/1998	Unknown Unidentified	956
Unnamed	USF	10/10/1998	Unknown Unidentified	441
Bottom	USF	9/15/2001	Lightning	101
Kellogg	CDF	4/28/2002	Vehicle	174
Biscuit	USF	7/13/2002	Lightning	501,082
Shelly	USF	7/28/2002	Miscellaneous	843
Buck	USF	7/24/2006	Lightning	422
Mill	USF	6/20/2008	Lightning	6,5882
Blue 2	USF	6/21/2008	Lightning	1,7552
Blue Creek #3	USF	11/24/2009	Debris	6,705

17.4 SECONDARY HAZARDS

Wildland fires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses by reducing harvestable timber and more indirect economic losses in reduced tourism. Wildland fires cause the contamination of reservoirs, destroy transmission lines and contribute to flooding. Landslides can be a significant secondary hazard of wildland fires. Wildland fires strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildland fire. The following additional secondary effects are possible; rehabilitation efforts after a fire occurs can reduce but cannot eliminate them:

- **Air Quality**—Air pollution from wildland fires can affect visibility, human health, materials, vegetation, pollution rights and greenhouse gas accumulation. Quantifying impacts is difficult because there is insufficient data on the quantities of pollutants emitted during wildland fires. Models of pollutant dispersion, though increasingly sophisticated, still leave much to be desired, particularly when trying to apply them to specific events rather than to longer-term emissions. Moreover, models estimating the impacts of pollutant levels on human health have generally been geared toward examining chronic pollution levels, not episodic events such as wildland fires.

  Future wildland fires are predicted and levels of air pollutants can be managed before the fire occurs. The estimated annual wildland fire air pollutant emissions are 600,000 tons from CDF and U.S. Forest Service fires. This does not include Bureau of Land Management, Bureau of Indian Affairs, National Park Service or wildland fires inside city limits. The 600,000-ton estimate is based on a 10-year average of acreage burned by vegetation type annually.

- **Damaged Fisheries**—Critical trout fisheries throughout the West and salmon and steelhead fisheries in the Pacific Northwest can suffer from increased water temperatures, sedimentation, and changes in water quality and chemistry.
- **Flooding**—Most wildland fires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This results in increased runoff generated by storm events, increasing the chance of flooding.
- **Soil Erosion**—The protective covering provided by foliage and dead organic matter is removed, leaving soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitat.
- **Spread of Invasive Plant Species**—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- **Disease and Insect Infestations**—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- **Destroyed Endangered Species Habitat**—Catastrophic fires can have devastating consequences for endangered species. For instance, the Biscuit Fire destroyed 125,000 to 150,000 acres of spotted owl habitat.
- **Soil Sterilization**—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

17.5 CLIMATE CHANGE IMPACTS

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

Historically, drought patterns in the West are related to large-scale climate patterns in the Pacific and Atlantic oceans. In the Pacific, the El Niño–Southern Oscillation varies on a 5- to 7-year cycle. The Pacific Decadal Oscillation (PDO) varies on a 20- to 30-year cycle and the Atlantic Multidecadal Oscillation (AMO) varies on a 65- to 80-year cycle. As these large-scale ocean climate patterns vary in relation to each other, drought conditions shift from region to region in the United States. El Niño years bring drier conditions to the Pacific Northwest and more fires. The 1930s Dust Bowl occurred when both the PDO and AMO were in their warm phases.

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

17.6 EXPOSURE

17.6.1 Population

A geographic analysis of demographics was performed using GIS data and mapping. Population figures (in census blocks) were cross-referenced with the map displaying degree of wildland fire threat (Figure 17-4). The results of this analysis are displayed in Table 17-3.

TABLE 17-3.
DEL NORTE COUNTY POPULATION AT RISK FROM WILDLAND FIRE

Fire Threat	Exposed Population	% of County Total
Moderate	21,476	72.8
High	4,100	13.9
Very High	3,924	13.3
Total County	**29,500**	**100**

17.6.2 Property

Property damage from wildland fires can be severe and can significantly alter entire communities. Table 17-4 displays the number of homes exposed to the three levels of fire threat in Del Norte County. Table 17-5 shows the value of property in the county within each fire-threat area, based on Del Norte County Census Assessor values as of March 1, 2009.

Table 17-6 shows the existing land use of all parcels in the county as they fall within each level of wildland fire threat. This assessment shows that of the parcels that fall within high or very high risk of wildland fire, 98.2 percent are under state or federal jurisdiction or are reserved for timber production. The majority of the developed or developable parcels are in the moderate risk areas.

17.6.3 Critical Facilities and Infrastructure

Tables 17-7 and 17-8 identify critical facilities in the county exposed to the wildland fire hazard; 47 percent are within areas of high and very high risk from wildland fire.

TABLE 17-4.
DEL NORTE COUNTY HOUSES AT RISK FROM WILDLAND FIRE

Fire Threat	Exposed Houses	% of County Total
Moderate	7,055	72.8
High	1,346	13.9
Very High	1,289	13.3
Total County	**9,690**	**100**

TABLE 17-5.
VALUE OF PROPERTY IN EACH WILDLAND FIRE THREAT AREA IN DEL NORTE COUNTY

	Property Value Exposed			% of Total Assessed Value		
Planning Unit	Moderate Fire Threat	High Fire Threat	Very High Fire Threat	Moderate Fire Threat	High Fire Threat	Very High Fire Threat
Crescent City	$436,227,000	$0	$0	17.5%	0%	0%
Crescent City UGA	$1,052,013,045	$134,021,955	$0	42.1%	5.37%	0%
Fort Dick	$336,698,000	$49,015,000	$0	13.5%	1.96%	0%
Gasquet	$0	$0	$61,922,000	0%	0%	2.48%
Hiouchi	$18,734,385	$11,952,314	$29,585,479	0.75%	0.48%	1.18%
Klamath	$57,017,566	$58,401,032	$18,898,402	2.28%	2.34%	0.76%
Smith River	$116,093,884	$48,422,167	$34,342,949	4.65%	1.94%	1.37%
Other County	$427,858	$2,781,078	$31,363,886	0.02%	0.11%	1.21%
Total	**$2,017,211,738**	**$304,593,546**	**$176,112,716**	**80.80%**	**12.20%**	**7.00%**

TABLE 17-6.
DEL NORTE COUNTY LAND USE AND WILDLAND FIRE RISK (SEE FIGURE 17-4)

	Moderate Risk		High Risk		Very High Risk	
Land Use	Area (acres)	% of Total in Risk Level	Area (acres)	% of Total in Risk Level	Area (acres)	% of Total in Risk Level
Public Facility	523.63	1.34%	91.95	0.15%	99.41	0.02%
Rural Residential (1 du/3 ac)	1201.41	3.07%	1.00	0.00%	80.48	0.02%
Rural Residential (1 du/1 ac)	1387.49	3.54%	181.11	0.30%	773.19	0.15%
Rural Residential (1 du/2 ac)	1277.10	3.26%	307.48	0.51%	228.82	0.04%
Rural Residential (1 du/5 ac)	426.77	1.09%	136.40	0.23%	548.42	0.10%
Timberland	7068.86	18.04%	33719.62	56.36%	69992.66	13.30%
Agricultural General 20	1280.42	3.27%	323.58	0.54%	131.54	0.02%
Agricultural General 5	1519.43	3.88%	73.09	0.12%	119.17	0.02%
Agricultural Prime	2690.26	6.87%	33.14	0.06%	28.33	0.01%
Resource Conservation Area	7360.82	18.79%	862.22	1.44%	138.85	0.03%
State/Federal Lands	10775.01	27.51%	22400.71	37.44%	453420.26	86.17%
Visitor-Serving Commercial	675.43	1.72%	461.89	0.77%	95.70	0.02%
General Commercial	129.57	0.33%	88.11	0.15%	31.30	0.01%
General Industrial	100.50	0.26%	166.91	0.28%	53.84	0.01%
Light Industrial	0.18	0.00%	27.83	0.05%	24.10	0.00%
Golf	88.16	0.23%	78.01	0.13%	17.90	0.00%
Pacific shoreline	889.92	2.27%	151.62	0.25%	0	0.00%

TABLE 17-6 (continued).
DEL NORTE COUNTY LAND USE AND WILDLAND FIRE RISK (SEE FIGURE 17-4)

Land Use	Moderate Risk		High Risk		Very High Risk	
	Area (acres)	% of Total in Risk Level	Area (acres)	% of Total in Risk Level	Area (acres)	% of Total in Risk Level
Riparian Corridor	1175.50	3.00%	312.24	0.52%	249.72	0.05%
Rural Mobile Home Park	11.10	0.03%	0	0.00%	0	0.00%
Rural Neighborhood	199.83	0.51%	32.47	0.05%	101.30	0.02%
Urban Residential	0.05	0.00%	19.61	0.03%	0	0.00%
Tribal	163.93	0.42%	303.53	0.51%	59.82	0.01%
Vacant/Unzoned parcels	99.34	0.25%	51.02	0.09%	0	0.00%
Multi-Family Residential	0.00	0.00%	4.38	0.01%	2.99	0.00%
Total	**39,045**	**100%**	**59,828**	**100%**	**526,198**	**100%**

TABLE 17-7.
NUMBER OF CRITICAL FACILITIES BY WILDLAND FIRE THREAT CATEGORY

Facility Type	Moderate	High	Very High	**Total**
Medical and Health Services	4	0	0	4
Government Function	20	0	1	21
Protective Function	8	2	1	11
Schools	10	0	2	12
Societal Function	20	2	1	23
Hazmat	2	0	0	2
Other Critical Function	3	2	1	6
Total	**67**	**6**	**6**	**79**

TABLE 17-8.
CRITICAL INFRASTRUCTURE BY WILDLAND FIRE THREAT CATEGORY

Facility Type	Moderate	High	Very High	**Total**
Water Supply	0	0	0	0
Water Storage	11	2	2	15
Wastewater	3	3	0	6
Power	7	1	0	8
Fuel storage	3	0	0	3
Communications	16	4	0	20
Bridges	23	8	32	63
Other Critical Infrastructure	0	0	0	0
Total	**63**	**18**	**34**	**115**

17.6.4 Environment

Natural Resources

Natural resources are highly valued by residents of Del Norte County for their contribution to the local quality of life, and as an economic development asset that attracts tourist-related expenditures. Fire can destroy natural assets that are highly valued by the community.

Air Quality

Smoke generated by wildland fire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides) and toxics (formaldehyde, benzene). Emissions from wildland fires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildland fire include difficulty in breathing, odor, and reduction in visibility.

Del Norte County is prone to temperature inversions, which occur when a layer of warm air traps cool air near the surface and creates a lid that inhibits the vertical dispersion of smoke and other pollutants. The Megram Fire (Big Bar Complex Fire) burned 135,000 acres between late August and early November 1999 in eastern Humboldt and Trinity Counties, and resulted in the first air quality related state of emergency in California history. Smoke from the fire was trapped by an inversion layer between late September and early October, causing officials to close schools and encourage residents to leave the area. Those who remained in the affected area were encouraged to remain indoors.

Agricultural and Timber Resources

Agricultural resources include rangelands, timberlands, cultivated farmlands and dairy lands. Agricultural lands are an important element of the Del Norte County identity and economy. Although fire has been used as a tool in rangeland and timber management, wildland fire can have disastrous consequences on such resources, removing them from production and necessitating lengthy restoration programs.

Cultural Resources

Culturally sensitive areas exist on both public and private lands. While some locations are publicly identified, others are held as confidential information by local Native American organizations. Many cultural sites are at risk of incidents of wildland fire. Fire can destroy artifacts and structures. However, a light fire can clean an area of litter and ground fuel, exposing new cultural sites and artifacts without causing much damage. The discovery of new cultural sites can be a benefit to archeologists and Native American groups, but can also present problems of looting and vandalism.

17.7 VULNERABILITY

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildland fire hazard. There is currently no validated damage function available to support wildland fire mitigation planning. Except as discussed in this section, vulnerable populations, property, infrastructure and environment are assumed to be the same as described in the section on exposure.

All residents of the county are vulnerable to wildland fire to some degree, but particular segments are more vulnerable than others. Some land uses are more vulnerable to wildland fire, such as single-family rural residential, while others are less vulnerable, such as agricultural land, gravel mining, and cemeteries. Critical facilities that are of wood frame construction are especially vulnerable during wildland fire events.

In the event of wildland fire, there would likely be little damage to the majority of infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk from wildland fire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access throughout the county and can isolate residents and emergency service providers needing to get to vulnerable populations or to make repairs. Wildland fire typically does not have a major direct impact on bridges. However, wildland fires can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

The potential for large wildland fires in Del Norte County is normally small. Improved fire spotting techniques, better equipment, and trained personnel are major factors, as are the county's wet climate and normally low fire fuel conditions. The wet climate and the infrequent occurrence of strong, dry winds prevent potential fuel from reaching a combustible state. Unlike Southern California's trees, known for their production of an oily, combustible sap and their susceptibility to dry conditions, Del Norte County's forests retain moisture and are resistant to an abnormal dry spell. The potential for a disastrous wildland fire is much lower in Coastal Northern California than in other parts of the state.

17.8 FUTURE TRENDS

It is assumed that development trends in Del Norte County are not such that there is major concern about development in identified wildland fire hazard zones. The County and Crescent City have adopted General Plans with associated safety elements pursuant to state laws. Maintaining the abundance of natural resources within Del Norte County is a high priority for its land use programs and managers. To meet the intent of California State mandates, Crescent City, Del Norte County and all of the planning partners are committed to assuring that future growth and development in the planning area take the wildland fire hazard into account.

17.9 SCENARIO

With increased interface development, a wildland fire in Del Norte County has the potential to cause even greater damage than the Biscuit Fire. A major conflagration might begin with a wet spring, adding to the fuels that are already present on the forest floor. Flashy fuels would build throughout the spring. A dry summer could follow the wet spring, exacerbated by winds. The summer would see the onset of insect infestation. Holidays inevitably bring many hikers and campers to the area. Careless campfires, a tossed lit cigarette, or a sudden lighting storm would trigger a multitude of small isolated fires.

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

The worst-case scenario in Del Norte County would probably coincide with an active fire season in the entire American west, spreading resources thin. Firefighting teams, exhausted or committed to fighting conflagrations in other areas, may be unavailable to assist the County. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be extremely useful in the urban interface areas, they have limited wildland fire capabilities or experience, and they would have a difficult time responding to the ignition zones. Additionally, starting with the 2003 fire season, air tanker support has been cut by one-third. Even though the existence and spread of the fire would be well known, it may not be possible to respond to it adequately. Thus an initially manageable fire could become significant before meaningful resources are dispatched.

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing the floodplains of the county and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, discharges could easily double. Floods previously would have been expected every 50 years may occur every couple of years. With the streambeds unable to carry this increased discharge because of increased sediment, the floodplains and floodplain elevations would increase. All of these conditions could be intensified due to the impacts of climate change

17.10 ISSUES

The planning team has identified the following issues related to the wildland fire hazard for the planning area:

- Isolation of neighborhoods and communities. Several vulnerable and isolated populations are in areas of high and very high risk for wildland fire.
- Public education and outreach to people living in the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Conflagration of wooden homes and essential buildings such as fire stations; and isolation due to road and bridge blockage.
- A large number of critical facilities are wood-frame structures in areas of high and very high risk from wildland fire.
- Large clusters of structures are wood-frame structures in areas of high and very high risk from wildland fire.
- Much of the planning area’s building stock is of wood-frame construction.
- Wildland fires could cause landslides as a secondary natural hazard.
- A high number of critical/essential facilities in the planning area are at risk and could have a significant amount of functional downtime post event. This creates not only a need for mitigation but also a need for continuity of operations planning to develop procedures for providing services without access to essential facilities.

CHAPTER 18.
PLANNING AREA RISK RANKING

18.1 HAZARD RISK RATING

A risk ranking of the hazards described in this risk assessment determined the probability of occurrence for each hazard and the impact that each would have. Quantitative ranking of risk creates a consistent platform that can be justified for all the partners in this planning effort. Regional consistency is a primary objective for multi-jurisdictional planning. Quantifiable results that have been generated using substantiated data can better justify initiatives and their priorities. The risk ranking described in this chapter is for the entire planning area. Each planning partner ranked risks specific to its jurisdiction using this same methodology, and the results are in the jurisdictional annexes included in Volume 2 of this plan.

18.2 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard event is generally based on past events that have occurred in the area and forecasts for the future. Probability factors used to determine the risk rating of each hazard are assigned based on frequency of occurrence:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor = 2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor = 1)

Table 1-1 lists the probability of occurrence for each hazard assessed in this plan.

TABLE 18-1.
HAZARD PROBABILITY OF OCCURRENCE

Hazard Event	Probability	Probability Factor
Dam Failure	Low	1
Earthquake	High	3
Flood	High	3
Landslide	High	3
Severe Weather	High	3
Tsunami	High	3
Wildland Fire	High	3

18.3 IMPACT

The impact of each hazard was divided into three categories: impacts on people, property or the economy. Numerical impact factors for no, low, medium or high impact were assigned as follows:

- **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. Impact factors were assigned as follows:

  - High Impact—50% or more of the population is exposed to a hazard (Impact Factor = 3)
  - Medium Impact—25% to 49% of the population is exposed to a hazard (Impact Factor = 2)
  - Low Impact—25% or less of the population is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the population is exposed to a hazard (Impact Factor = 0)

- **Property**—Values were assigned based on the percentage of the total ***property value exposed*** to the hazard event.
  - High Impact—30% or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
  - Medium Impact—15% to 29% of the total assessed property value is exposed to a hazard (Impact Factor = 2)
  - Low Impact—14% or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the total assessed property value is exposed to a hazard (Impact Factor = 0)
- **Economy**—Values were assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total assessed value of property in the county. It should be noted that for some of the hazards such as wildland fire, landslide and severe weather, vulnerability was considered to be the same as exposure due to the lack of loss estimation tools specific to those hazards. Loss estimates separate from the exposure estimates were generated for the earthquake, flood and tsunami hazards using the HAZUS-MH loss estimation tool.
  - High Impact—Estimated loss from the hazard is 20% or more of the total assessed property value (Impact Factor = 3)
  - Medium Impact—Estimated loss from the hazard is 10% to 19% of the total assessed property value (Impact Factor = 2)
  - Low Impact—Estimated loss from the hazard is 8% or less of the total assessed property value (Impact Factor = 1)
  - No impact—No loss is estimated from the hazard (Impact Factor = 0)

The impact of each hazard category were also assigned a weighting factor: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the economy was given a weighting factor of 1. Tables 18-2, 18-3 and 18-4 summarize the impacts for each hazard.

18.4 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property and the economy. The results are summarized in Table 18-5. Based on these ratings, a hazard ranking and a priority of high, medium or low was assigned to each hazard, as summarized in Table 18-6.

TABLE 18-2.
HAZARD IMPACT ON PEOPLE

Hazard Event	Impact	Impact Factor	Multiplied by Weighting Factor of 3
Dam Failure	Low	1	3
Earthquake	High	3	9
Flood	Low	1	3
Landslide	Low	1	3
Severe Weather	High	3	9
Tsunami	High	3	9
Wildland Fire	Medium	2	6

TABLE 18-3.
HAZARD IMPACT ON PROPERTY

Hazard Event	Impact	Impact Factor	Multiplied by Weighting Factor of 2
Dam Failure	Low	1	2
Earthquake	High	3	6
Flood	Medium	2	4
Landslide	Low	1	2
Severe Weather	High	3	6
Tsunami	High	3	6
Wildland Fire	Medium	2	4

TABLE 18-4.
HAZARD IMPACT ON THE ECONOMY

Hazard Event	Impact	Impact Factor	Multiplied by Weighting Factor of 1
Dam Failure	Low	1	1
Earthquake	High	3	3
Flood	Low	1	1
Landslide	Low	1	1
Severe Weather	High	3	3
Tsunami	Medium	2	2
Wildland Fire	Medium	2	2

TABLE 18-5.
HAZARD RISK RATING

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Dam Failure	1	3+2+1=6	6
Earthquake	3	9+6+3=18	54
Flood	3	3+4+1=8	24
Landslide	3	3+2+1=6	18
Severe Weather	3	9+6+3=18	54
Tsunami	3	9+6+2=17	51
Wildland Fire	3	6+4+2=12	36

TABLE 18-6.
HAZARD RISK RANKING

Hazard Ranking	Hazard Event	Priority
1	Earthquake	High
1	Severe Weather	High
2	Tsunami	High
3	Wildland Fire	High
4	Flood	Medium
5	Landslide	Medium
6	Dam Failure	Low

PART 4—MITIGATION STRATEGY

CHAPTER 19.
REVIEW OF MITIGATION ALTERNATIVES

The planning team generated a comprehensive list of hazard mitigation alternatives that meet the following objectives:

- Use information obtained from the public involvement strategy.
- Use information provided in the risk assessment.
- Seek alternatives consistent with the goals and objectives for the Crescent City/Del Norte County Hazard Mitigation Plan.
- Create catalogs of mitigation alternatives to be used as a tool by planning partners in selection of mitigation strategies.

19.1 "STRENGTHS, WEAKNESSES, OPPORTUNITIES, AND OBSTACLES" SESSIONS

On March 2, 2009, a workshop was held with the Steering Committee and members of the Planning Partnership. The purpose of this session was to review information garnered from the risk assessment and the public involvement strategy to identify "strengths, weaknesses, opportunities and obstacles" (SWOO) associated with hazard mitigation in Del Norte County. This was accomplished through a facilitated brainstorming session on risks, vulnerabilities, and capabilities. Information shared during this session was used to prepare catalogs of mitigation alternatives for the planning partners to use in preparing their individual jurisdictional annexes. Many of the strategies identified in the catalogs could be applied to multiple hazards.

19.2 CATALOGS OF MITIGATION ALTERNATIVES

The catalogs of mitigation alternatives created for this plan list initiatives that could manipulate the hazard, reduce exposure to the hazard, reduce vulnerability to the hazard, or increase the ability to respond to or be prepared for a hazard. The alternatives are categorized by responsibility for implementation (in other words, who would most likely implement the initiative: public sector, private sector business, or government). These catalogs represent the comprehensive range of alternatives available for consideration by each planning partner.

The catalogs are not meant to be exhaustive or site-specific but rather to inspire thought and provide each planning partner a baseline of initiatives backed by a planning process, consistent with the goals and objectives of the planning area, and within the capabilities of each planning partner. The planning partners were not bound to these alternatives in preparing their annexes for this hazard plan. Initiatives from the catalogs that were not selected by the planning partners in their jurisdictional annexes were rejected based on the following:

- Initiative is currently outside the scope of capabilities (funding)
- The jurisdiction is not vulnerable to the hazard
- Initiative is already being implemented.

19.2.1 Mitigation Alternatives Catalog—Dam Failure

Table 19-1 is the catalog of mitigation alternatives for the dam failure hazard.

TABLE 19-1.
CATALOG OF RISK REDUCTION MEASURES—DAM FAILURE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• None	1. Remove dams 2. Remove levees 3. Harden dams	1. Remove dams 2. Remove levees 3. Harden dams
Reduce Exposure		
• Relocate out of dam failure inundation areas.	• Replace earthen dams with hardened structures	1. Replace earthen dams with hardened structures 2. Relocate critical facilities out of dam failure inundation areas. 3. Consider open space land use in designated dam failure inundation areas.
Reduce Vulnerability		
• Elevate home to appropriate levels.	• Flood-proof facilities within dam failure inundation areas	1. Adopt higher regulatory floodplain standards in mapped dam failure inundation areas. 2. Retrofit critical facilities within dam failure inundation areas.
Increase Preparation or Response Capability		
1. Learn about risk reduction for the dam failure hazard. 2. Learn the evacuation routes for a dam failure event. 3. Educate yourself on early warning systems and the dissemination of warnings.	1. Educate employees on the probable impacts of a dam failure. 2. Develop a Continuity of Operations Plan.	1. Map dam failure inundation areas. 2. Enhance emergency operations plan to include a dam failure component. 3. Institute monthly communications checks with dam operators. 4. Inform the public on risk reduction techniques 5. Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas. 6. Consider the probable impacts of climate in assessing the risk associated with the dam failure hazard. 7. Establish early warning capability downstream of listed high hazard dams. 8. Consider the residual risk associated with protection provided by dams in future land use decisions.

19.2.2 Mitigation Alternatives Catalog—Earthquake

Table 19-2 is the catalog of mitigation alternatives for the earthquake hazard.

TABLE 19-2.
CATALOG OF RISK REDUCTION MEASURES—EARTHQUAKE

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• None	• None	• None
Reduce Exposure		
• Locate outside of hazard area (off soft soils)	• Locate or relocate mission-critical functions outside hazard area where possible	• Locate critical facilities or functions outside hazard area where possible
Reduce Vulnerability		
1. Retrofit structure (anchor house structure to foundation 2. Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) 3. Build to higher design	1. Build redundancy for critical functions and facilities 2. Retrofit critical buildings and areas housing mission-critical functions	1. Harden infrastructure 2. Provide redundancy for critical functions 3. Higher regulatory standards 4. Adopt the IBC once ratified by the State as the State Building Code.
Increase Preparation or Response Capability		
1. Practice “drop, cover, and hold” 2. Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event 3. Keep cash reserves for reconstruction 4. Become informed on the hazard and risk reduction alternatives available. 5. Develop a post-disaster action plan for your household	1. Adopt higher standard for new construction; consider “performance-based design” when building new structures 2. Keep cash reserves for reconstruction 3. Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. 4. Develop a Continuity of Operations Plan	1. Provide better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas (e.g., tax incentives, information) 4. Include retrofitting and replacement of critical system elements in capital improvement plan 5. Develop strategy to take advantage of post-disaster opportunities 6. Warehouse critical infrastructure components such as pipe, power line, and road repair materials 7. Develop and adopt a Continuity of Operations Plan 8. Initiate triggers guiding improvements (such as <50% substantial damage or improvements) 9. Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. 10. Develop a post-disaster action plan that includes grant funding and debris removal components.

19.2.3 Mitigation Alternatives Catalog—Flood

Table 19-3 is the catalog of mitigation alternatives for the flood hazard.

**TABLE 19-3.
CATALOG OF RISK REDUCTION MEASURES—FLOOD**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
1. Clear stormwater drains and culverts 2. Institute low-impact development techniques on property	1. Clear stormwater drains and culverts 2. Institute low-impact development techniques on property	1. Drainage system maintenance 2. Institute low-impact development techniques on property 3. Dredging, levee construction, and providing regional retention areas 4. Structural flood control, levees, channelization, or revetments. 5. Stormwater management regulations and master planning 6. Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff
Reduce Exposure		
1. Locate outside of hazard area 2. Elevate utilities above base flood elevation (BFE) 3. Institute low impact development techniques on property	1. Locate business critical facilities or functions outside hazard area 2. Institute low impact development techniques on property	1. Locate or relocate critical facilities outside of hazard area 2. Acquire or relocate identified repetitive loss properties 3. Promote open space uses in identified high hazard areas via techniques such as: public utility districts (PUDs), easements, setbacks, greenways, sensitive area tracks. 4. Adopt land development criteria such as PUDs, density transfers, clustering 5. Institute low impact development techniques on property 6. Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff
Reduce Vulnerability		
1. Retrofit structures (elevate structures above BFE) 2. Elevate items within house above BFE 3. Build new homes above BFE 4. Flood-proof existing structures	1. Build redundancy for critical functions or retrofit critical buildings 2. Provide flood-proofing measures when new critical infrastructure must be located in floodplains	1. Harden infrastructure, bridge replacement program 2. Provide redundancy for critical functions and infrastructure 3 Adopt appropriate regulatory standards, such as: increased freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions. 4. Stormwater management regulations and master planning. 5. Adopt “no-adverse impact” floodplain management policies that strive to not increase the flood risk on downstream communities.

**TABLE 19-3 (continued).
CATALOG OF RISK REDUCTION MEASURES—FLOOD**

Personal Scale	Corporate Scale	Government Scale
Increase Preparation or Response Capability		
1. Buy flood insurance 2. Develop household mitigation plan, such as retrofit savings, communication capability with outside, 72 hr self-sufficiency during and after an event	1. Keep cash reserves for reconstruction 2. Support and implement hazard disclosure for the sale/re-sale of property in identified risk zones. 3. Solicit ‘cost-sharing” through partnerships with private sector stake holders on projects with multiple benefits.	1. Produce better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) 4. Incorporate retrofitting or replacement of critical system elements in capital improvement plan 5. Develop strategy to take advantage of post-disaster opportunities 6. Warehouse critical infrastructure components 7. Develop and adopt a Continuity of Operations Plan 8. Consider participation in the Community Rating System 9. Maintain existing data and gather new data needed to define risks and vulnerability 10. Train emergency responders 11. Create a building and elevation inventory of structures in the floodplain 12. Develop and implement a public information strategy 13. Charge a hazard mitigation fee 14. Integrate floodplain management policies into other planning mechanisms within the planning area. 15. Consider the probable impacts of climate change on the risk associated with the flood hazard 16. Consider the residual risk associated with structural flood control in future land use decisions 17. Enforce National Flood Insurance Program

19.2.4 Mitigation Alternatives Catalog—Landslide

Table 19-4 is the catalog of mitigation alternatives for the landslide hazard.

**TABLE 19-4.
CATALOG OF RISK REDUCTION MEASURES—LANDSLIDE**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope 3. Minimize vegetation removal and the addition of impervious surfaces.	1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope	1. Stabilize slope (dewater, armor toe) 2. Reduce weight on top of slope
Reduce Exposure		
• Locate structures outside of hazard area (off unstable land and away from slide-run out area)	• Locate structures outside of hazard area (off unstable land and away from slide-run out area)	1. Acquire properties located in high risk landslide areas. 2. Adopt land use policies that prohibit the placement of habitable structures in high risk landslide areas.
Reduce Vulnerability		
• Retrofit home.	• Retrofit at-risk facilities.	1. Adopt higher regulatory standards for new development within unstable slope areas. 2. Armor/retrofit critical infrastructure from the impact of landslides.
Increase Preparation or Response Capability		
1. Institute warning system, and develop evacuation plan 2. Keep cash reserves for reconstruction 3. Educate yourself on risk reduction techniques for landslide hazards.	1. Institute warning system, and develop evacuation plan 2. Keep cash reserves for reconstruction 3. Develop a Continuity of Operations Plan 4. Educate employees on the potential exposure to landslide hazards and emergency response protocol.	1. Produce better hazard maps 2. Provide technical information and guidance 3. Enact tools to help manage development in hazard areas: better land controls, tax incentives, information 4. Develop strategy to take advantage of post-disaster opportunities 5. Warehouse critical infrastructure components 6. Develop and adopt a Continuity of Operations Plan 7. Educate the public on the landslide hazard and appropriate risk reduction alternatives.

19.2.5 Mitigation Alternatives Catalog—Severe Weather

Table 19-5 is the catalog of mitigation alternatives for the severe weather hazard.

TABLE 19-5.
CATALOG OF RISK REDUCTION MEASURES—SEVERE WEATHER

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
None	None	None
Reduce Exposure		
None	None	None
Reduce Vulnerability		
1. Insulate house 2. Provide redundant heat and power 3. Insulate structure 4. Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program)	1. Relocate critical infrastructure (such as power lines) underground 2. Reinforce or relocate critical infrastructure such as power lines to meet performance expectations 3. Install tree wire	1. Harden infrastructure such as locating utilities underground 2. Trim trees back from power lines 3. Designate snow routes and strengthen critical road sections and bridges
Increase Preparation or Response Capability		
1. Trim or remove trees that could affect power lines 2. Promote 72-hour self-sufficiency 3. Obtain a NOAA weather radio. 4. Obtain an emergency generator.	1. Trim or remove trees that could affect power lines 2. Create redundancy 3. Equip facilities with a NOAA weather radio 4. Equip vital facilities with emergency power sources.	1. Support programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. 2. Establish and enforce building codes that require all roofs to withstand snow loads 3. Increase communication alternatives 4. Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. 5. Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines 6. Provide NOAA weather radios to the public

19.2.6 Mitigation Alternatives Catalog—Tsunami

Table 19-6 is the catalog of mitigation alternatives for the tsunami hazard.

TABLE 19-6.
CATALOG OF RISK REDUCTION MEASURES—TSUNAMI

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• None	• None	• Build wave abatement structures (e.g. the "Jacks" looking structure designed by the Japanese)
Reduce Exposure		
• Locate outside of hazard area	• Locate structure or mission critical functions outside of hazard area whenever possible.	1. Locate structure or functions outside of hazard area whenever possible. 2. Harden infrastructure for tsunami impacts. 3. Relocate identified critical facilities located in tsunami high hazard areas.
Reduce Vulnerability		
• Apply personal property mitigation techniques to your home such as anchoring your foundation and foundation openings to allow flow though.	• Mitigate personal property for the impacts of tsunami	1. Adopt higher regulatory standards that will provide higher levels of protection to structures built in a tsunami inundation area. 2. Utilize tsunami mapping once available, to guide development away from high risk areas through land use planning.
Increase Preparation or Response Capability		
1. Develop and practice a household evacuation plan. 2. Support/participate in the Redwood Coast Tsunami Working Group. 3. Educate yourself on the risk exposure from the tsunami hazard and ways to minimize that risk.	1. Develop and practice a corporate evacuation plan. 2. Support/participate in the Redwood Coast Tsunami Working Group. 3. Educate employees on the risk exposure from the tsunami hazard and ways to minimize that risk.	1. Create a probabilistic tsunami map for Del Norte County. 2. Provide incentives to guide development away from hazard areas. 3. Develop a tsunami warning and response system. 4. Provide residents with tsunami inundation maps 5. Join NOAA's Tsunami Ready program 6. Develop and communicate evacuation routes 7. Enhance the public information program to include risk reduction options for the tsunami hazard

19.2.7 Mitigation Alternatives Catalog—Wildland Fire

Table 19-7 is the catalog of mitigation alternatives for the wildland fire hazard.

**TABLE 19-7.
CATALOG OF RISK REDUCTION MEASURES—WILDLAND FIRE**

Personal Scale	Corporate Scale	Government Scale
Manipulate Hazard		
• Clear potential fuels on property such as dry overgrown underbrush and diseased trees	• Clear potential fuels on property such as dry underbrush and diseased trees	1. Clear potential fuels on property such as dry underbrush and diseased trees 2. Implement best management practices on public lands.
Reduce Exposure		
1. Create and maintain defensible space around structures 2. Locate outside of hazard area 3. Mow regularly	1. Create and maintain defensible space around structures and infrastructure 2. Locate outside of hazard area	1. Create and maintain defensible space around structures and infrastructure 2. Locate outside of hazard area 3. Enhance building code to include use of fire resistant materials in high hazard area.
Reduce Vulnerability		
1. Create and maintain defensible space around structures and provide water on site 2. Use fire-retardant building materials 3. Create defensible spaces around home	1. Create and maintain defensible space around structures and infrastructure and provide water on site 2. Use fire-retardant building materials	1. Create and maintain defensible space around structures and infrastructure 2. Use fire-retardant building materials 3. Consider higher regulatory standards (such as Class A roofing) 4. Establish biomass reclamation initiatives
Increase Preparation or Response Capability		
1. Employ Firewise techniques to safeguard home 2. Identify alternative water supplies for fire fighting 3. Install/replace roofing material with non-combustible roofing materials.	1. Support Firewise community initiatives. 2. Create /establish stored water supplies to be utilized for fire fighting.	1. More public outreach and education efforts, including an active Firewise program 2. Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas 3. Identify fire response and alternative evacuation routes 4. Seek alternative water supplies 5. Become a Firewise community 6. Use academia to study impacts/solutions to wildland fire risk 7. Establish/maintain mutual aid agreements between fire service agencies. 8. Create/implement fire plans 9. Consider the probable impacts of climate change on the risk associated with the wild fire hazard on future land use decisions

CHAPTER 20.
AREA-WIDE MITIGATION INITIATIVES

20.1 SELECTED COUNTY-WIDE MITIGATION INITIATIVES

The Planning Partnership and Steering Committee determined that some mitigation initiatives in the catalog could be implemented countywide to provide hazard mitigation benefits throughout the planning area. Table 20-1 lists the countywide initiatives to be implemented under this plan, the lead agency for each, and the proposed timeline. The parameters for the timeline are as follows:

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

20.2 COUNTY-WIDE ACTION PLAN PRIORITIZATION

Table 20-2 lists the priority of each countywide initiative, using the same parameters used by each of the planning partners in selecting their initiatives. A qualitative benefit-cost review was performed for each of these initiatives. The priorities are defined as follows:

- **High Priority**—A project that meets multiple objectives (i.e., multiple hazards), has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for the Hazard Mitigation Grant Program (HMGP) or Pre-Disaster Mitigation Grant Program (PDM). High priority projects can be completed in the short term (1 to 5 years).
- **Medium Priority**—A project that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but project is grant eligible under HMGP, PDM or other grant programs. Project can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured.
- **Low Priority**—A project that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for HMGP or PDM grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority projects may be eligible for other sources of grant funding from other programs.

TABLE 20-1.
ACTION PLAN—COUNTYWIDE MITIGATION INITIATIVES

Mitigation Initiative	Hazards Addressed	Administrating Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-1. To the extent possible based on available resources, provide coordination and technical assistance in the application for grant funding that includes assistance in cost vs. benefit analysis for grant eligible projects	All	County OES and Crescent City jointly	Existing programs for the two lead agencies Grant funding	Short-term, Ongoing	4, 8
CW-2: Encourage the development and implementation of a county-wide hazard mitigation public-information strategy that meets the needs of all planning partners.	All	County OES and Crescent City jointly, with participation of all planning partners	Cost sharing from the Partnership General Fund Allocations Cost sharing with Stakeholders	Short-Term, Depends on Funding	5, 8, 9
CW-3: Coordinate updates to land use and building regulations as they pertain to reducing the impacts of natural hazards, to seek a regulatory cohesiveness within the planning area. This can be accomplished via a commitment from all planning partners to involve each other in their adoption processes, by seeking input and comment during the course of regulatory updates or general planning.	All	Governing body of each eligible planning partner.	General funds	Short-Term, Ongoing	1, 5, 7, 8
CW-4: Sponsor and maintain a natural hazards informational website to include the following types of information: • Hazard-specific information such as GIS layers, private property mitigation alternatives, important facts on risk and vulnerability • Pre- and post-disaster information such as notices of grant funding availability • CRS creditable information • Links to Coalition Partners' pages, FEMA, Red Cross, NOAA, USGS and the National Weather Service. • Information such as progress reports, mitigation success stories, update strategies, Steering Committee meetings.	All	County OES and Crescent City jointly	County General Fund through existing programs Grant Funding	Short-Term, Ongoing	5, 8
CW-5: The Steering Committee will remain as a viable body over time to monitor progress of the plan, provide technical assistance to planning partners and oversee the update of the plan according to schedule. This body will continue to operate under the ground rules established at its inception.	All	County OES and Crescent City jointly	Funded through existing, on-going programs	Short-term	All
CW-6: Amend or enhance the Crescent City/Del Norte County Hazard Mitigation Plan on an "as needed" basis to seek compliance with state or federal mandates (i.e., CA. Assembly Bill # 2140) as guidance for compliance with these programs become available.	All	County OES and Crescent City jointly Each planning partner	Ongoing programs. Grant funding depending on the mandate.	Long-term Ongoing	All

TABLE 20-1.
ACTION PLAN—COUNTYWIDE MITIGATION INITIATIVES

Mitigation Initiative	Hazards Addressed	Administrating Agency	Possible Funding Sources or Resources	Time Line[a]	Objectives
CW-7: All planning partners that fully participated in this planning effort will formally adopt this plan once pre-adoption approval has been granted by CalEMA and FEMA Region IX. Additionally, each planning partner will adhere to the plan maintenance protocol identified chapter 7 of the plan.	All	County OES	To be funded under existing programs for all planning partners	Short-term	All

a. Short term = 1 to 5 years; Long Term= 5 years or greater

TABLE 20-2.
PRIORITIZATION OF PLANNING-AREA-WIDE MITIGATION INITIATIVES

Initiative #	# of Objectives Met	Benefits	Costs	Do Benefits equal or exceed Costs?	Is project Grant eligible?	Can Project be funded under existing programs/ budgets?	Priority (High, Med., Low)
CW-1	2	Medium	Low	Yes	Yes	Yes	High
CW-2	3	Low	Low	Yes	Yes	Yes	High
CW-3	4	Low	Low	Yes	No	Yes	High
CW-4	2	Medium	Medium	Yes	Yes	No	Medium
CW-5	10	Low	Low	Yes	No	Yes	High
CW-6	12	Low	Low	Yes	No	Yes	High
CW-7	12	Medium	Low	Yes	No	Yes	High

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Crescent City/Del Norte County

Hazard Mitigation Plan

Volume 1: Planning-Area-Wide Elements

APPENDIX A.
ACRONYMS AND DEFINITIONS

July 2010

APPENDIX A.
ACRONYMS AND DEFINITIONS

ACRONYMS

Acronym	Definition	Acronym	Definition
AMO	Atlantic Multidecadal Oscillation	GIS	Geographic Information System
BFE	Base Flood Elevation	HAZUS	Hazards, United States
BLM	Bureau of Land Management	HAZUS-MH	Hazards U.S. Multi-Hazard
BSC	Building Standards Code	HMGP	Hazard Mitigation Grant Program
CCA	California Coastal Act	IBC	International Building Code
CCR	California Code of Regulations	LCP	Local Coastal Program
CDF	California Department of Forestry	MM	Modified Mercalli Scale
CEDS	Comprehensive Economic Development Strategy	NEHRP	National Earthquake Hazards Reduction Program
CFR	Code of Federal Regulations	NFIP	National Flood Insurance Program
cfs	Cubic Feet per Second	NOAA	National Oceanic and Atmospheric Administration
CFSC	California Fire Safe Council	NWS	National Weather Service
CRS	Community Rating System	OES	Office of Emergency Services (Del Norte County)
DFIRM	Digital Flood Insurance Rate Map	PDM	Pre-Disaster Mitigation Grant Program
DMA	Disaster Mitigation Act	PDO	Pacific Decadal Oscillation
DWR	Department of Water Resources	PGA	Peak Ground Acceleration
ESA	Endangered Species Act	PUD	Public Utility District
FEMA	Federal Emergency Management Agency	SEMS	Standardized Emergency Management System
FIRM	Flood Insurance Rate Map	SHELDUS	Special Hazard Events and Losses Database for the United States
FIS	Flood Insurance Study	SWOO	Strengths, Weaknesses, Obstacles, Opportunities
FPD	Fire Protection District	UGA	Urban Growth Area
FSC	Fire Safe Council	USGS	U.S. Geological Survey

DEFINITIONS

100-Year Flood: The term “100-year flood” can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1 percent chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1 percent annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).

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-percent chance of being equaled or exceeded in any given year, also known as the “100-year” or “1-percent chance” flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community’s current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency’s mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community’s actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: A critical facility is defined as a local (non-State or Federal) facility in either the public or private sector that are critical to the health and welfare of the population and that are especially important following hazard events. Critical facilities include, but are not limited to:

- Structures or facilities that produce, use , or store highly volatile, flammable, explosive , toxic and/or water-reactive materials;
- Hospitals, nursing homes, and housing facilities likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a natural hazard event;
- Mass gathering facilities that may be utilized as evacuation shelters;

- Infrastructure such as roads, bridges, airports that provide sources for evacuation before, during and after natural hazard events;
- Police stations, fire stations, government facilities, vehicle equipment and storage facilities, and emergency operation centers that are needed for response activities before, during and after a natural hazard event;
- Public and private utility facilities that are vital to maintaining and restoring normal services to damaged areas before, during and after natural hazard events.

Crustal Earthquake: Crustal quakes occur at a depth of 5 to 10 miles beneath the earth's surface and are associated with fault movement within a surface plate.

Cubic Feet per Second (cfs): A cubic foot can be visualized as a box measuring 1 by 1 by 1 foot. The U.S. Geological Services (USGS) defines a cfs as "the flow rate or discharge equal to one cubic foot of water per second or about 7.5 gallons per second." One CFS is equivalent to approximately 450 gallons per minute. The rate of flow of a creek, river, or flood is measured by quantity over time and is often referred to as "discharge," or the rate at which a volume of water passes a given point in a given amount of time. Discharge and river flow are often measured in terms of cfs.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris: Debris refers to the scattered remains of assets broken or destroyed during the occurrence of a hazard. Debris caused by wind or water hazards can cause additional damage to other assets.

Disaster Mitigation Act of 2000 (DMA); The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. The DMA established a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP).

Drainage Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Duration: For the purposes of this plan, duration is defined as the length of time that a hazard occurs. For example, the duration of a tornado can be minutes, but release of a chemical warfare agent such as mustard gas can persist for hours or weeks if unremediated.

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.

Federal Emergency Management Agency (FEMA): FEMA is an independent agency (now part of the Department of Homeland Security) created in 1978 to provide a single point of accountability for all federal activities related to disaster mitigation and emergency preparedness, response, and recovery.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate.

Flooding: Flooding is a general and temporary condition of rising and overflowing water resulting in partial or complete inundation of normally dry land areas. Floods result from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation of runoff of surface water from any source, and (3) mudflows or the sudden collapse of shoreline land.

Flood Elevation: Flood elevation is the height of water surface above an established datum (for example, the National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or mean sea level).

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 one-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 BFE.

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.

General Plan: California state law requires that every county and city prepare and adopt a comprehensive long-range plan to serve as a guide for community development. The plan must consist of an integrated and internally consistent set of goals, policies, and implementation measures. In addition, the plan must focus on issues of the greatest concern to the community and be written in a clear and concise manner. City actions, such as those relating to land-use allocation, annexations, zoning, subdivision and design review, redevelopment, and capital improvements, must be consistent with such a plan.

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 the hazard mitigation plan, once implemented, should be measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Gravity Dam: Typically a solid concrete dam across a river whose stability is secured by making it of such a size and shape that it will resist overturning, sliding and crushing at the toe. The dam will not overturn provided that the moment caused by the water pressure is smaller than the moment caused by the weight of the dam. This is the case if the resultant force of water pressure and weight falls within the base of the dam. For this type of dam, impervious foundations with high bearing strength are essential.

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. Natural hazards include floods, winds, and earthquakes. Man-made hazards include acts of terrorism and hazardous material spills.

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.

Hazard Mitigation Plan: A hazard mitigation plan is a collaborative document that identifies hazards that could affect a community, assesses vulnerability to hazards, and represents consensus decisions reached on how to minimize or eliminate the effects of hazards.

Hazardous Material: A hazardous material is a substance or combination of substances that (1) can cause or contribute to an increase in mortality or serious irreversible or incapacitating reversible illnesses, or (2) pose a present or potential hazard to human life, property, or the environment. Hazardous materials could cause these effects because of their quantity, concentration, or physical, chemical, or infectious characteristics.

Hazardous Material Incident: This type of incident involves the accidental or intentional release of hazardous materials to the environment. Such incidents typically occur as fixed facility incidents or transportation incidents. It is possible to identify and prepare for a fixed facility incident because federal and state laws require facilities to notify state and local authorities about hazardous materials used or produced at the facility. Transportation incidents are more difficult to prepare for because there is little (if any) notice about the materials involved.

Hazards U.S. Multi-Hazard (HAZUS-MH) Loss Estimation Program: HAZUS-MH is a GIS-based program used to support the development of risk assessments as required under the DMA. The HAZUS-MH software program assesses risk in a quantitative manner to estimate damage and losses associated with natural hazards. HAZUS-MH is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. HAZUS-MH has also been used to assess vulnerability (exposure) for other hazards facing Roseville.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Levee: A human-made structure, usually an earthen embankment built to contain, control or divert the flow of water to protect people and property behind the levee from being flooded.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity. For the purposes of this plan, a local government is also considered a stakeholder in this process.

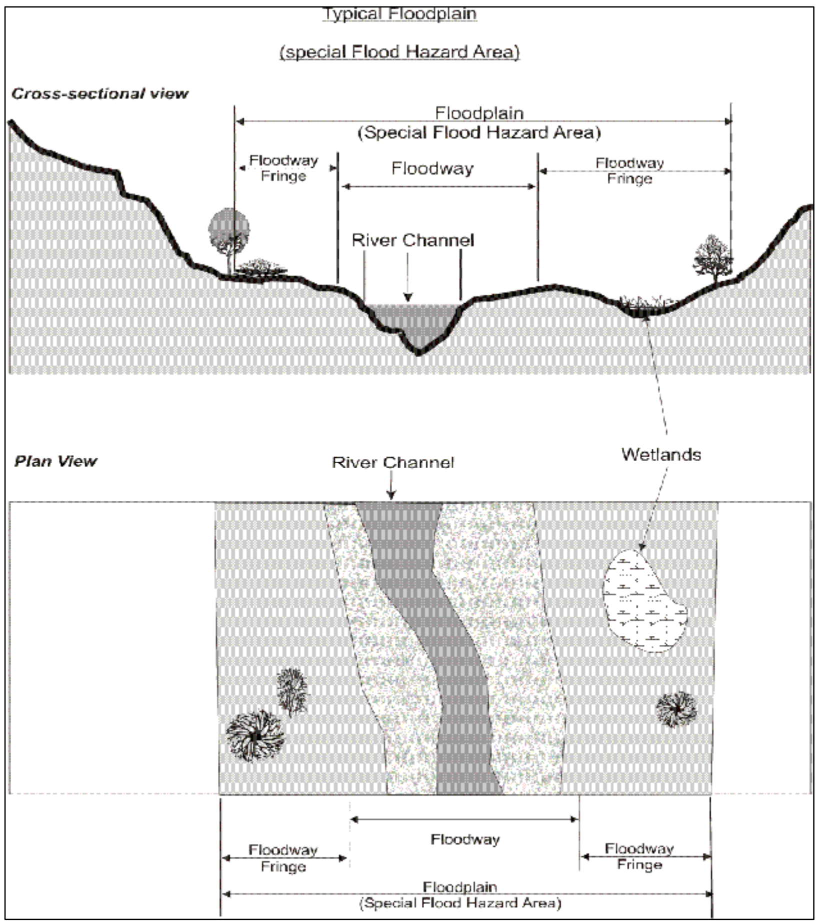
Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, mudflows, debris flows, and sinkholes.

Mitigation: A preventative 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.

National Flood Insurance Program (NFIP): In 1968, Congress created the NFIP in response to the rising cost of taxpayer-funded disaster relief for flood victims and the increasing amount of damage caused by floods. The Mitigation Division is the FEMA section that manages the NFIP and oversees the floodplain management and mapping components of the program. Nearly 20,000 communities across the United States and its territories participate in NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. FEMA contracted the U.S. Army Corps of Engineers to map the floodplains, floodways, and floodway fringes. The figure at right depicts the relationship between these three designations.



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.

Operational Area: An intermediate level of the state emergency services organization, consisting of a county and all political subdivisions within the county area. Political subdivisions include cities, a city and county, counties, districts, or other local governmental agency, or public agency authorized by law.

The geographical area covered by this hazard mitigation plan. The operational area is all of Del Norte County, and is also referred to as the planning area.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Planning Area: The geographical area covered in a hazard mitigation plan. For this plan, the planning area is all of Del Norte County, and is also referred to as the operational area.

Pre- and Post-FIRM Rates: These categories of rates are published in the NFIP manual and apply to buildings in a community qualifying for the regular flood program. Post-FIRM rates are used for buildings whose construction started after December 31, 1974, or after the community's initial FIRM was published, whichever is later. Post-FIRM rates are lower than pre-FIRM rates.

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.

Recovery: Recovery refers to actions taken by an individual or community after a catastrophic event to restore order and community lifelines.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any change(s) of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates for the planning area are based on the methodology that was used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Riverine: Riverine refers to anything of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Sinkhole: A collapse depression in the ground with no visible outlet. Its drainage is subterranean, its size typically measured in meters or tens of meters, and it is commonly vertical-sided or funnel-shaped.

Slab: This refers to one or more layers of snow in which the grains are bonded together. A slab initially fails over a large area instead of at a single point.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The special flood hazard area is mapped as a Zone A in riverine situations and zone V in coastal situations. The special flood hazard area may or may not encompass all of a community's flood problems

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.

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. For the purposes of this plan, all partners are considered stakeholders in this process.

Steering Committee: The steering committee is the body that oversaw all phases of the hazard mitigation plan's development. The members of this committee included planning partners, citizens, and other stakeholders from within the planning area.

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 percent. For this study, steep slope is defined as slopes greater than 33 percent.

Subduction Zone Earthquake: This type of quake occurs along two converging plates, attached to one another along their interface. When the interface between these two plates slips, a sudden, dramatic release of energy results, propagated along the entire fault line.

Sustainable Hazard Mitigation: This concept includes the sound management of natural resources, local economic and social resiliency, and the recognition that hazards and mitigation must be understood in the largest possible social and economic context.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

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.

Wild and Scenic River: A federal designation that is intended to protect the natural character of rivers and their habitat without adversely affecting surrounding property.

Wildland Fire: This term refers to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildland fire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildland fires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

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APPENDIX B.
PUBLIC INVOLVEMENT QUESTIONNAIRE RESULTS

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APPENDIX C. RESOLUTIONS

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