FLOOD INSURANCE STUDY

DEL NORTE COUNTY, CALIFORNIA
AND INCORPORATED AREAS

Community Name	Community Number
CRESCENT CITY, CITY OF	060039
DEL NORTE COUNTY	
UNINCORPORATED AREAS	065025

PRELIMINARY
September 1, 2015

REVISED:
TBD

Federal Emergency Management Agency
FLOOD INSURANCE STUDY NUMBER
06015CV000C

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

This FIS report was revised on (Insert Date). Users should refer to Section 10.0, Revisions Description, for further information. Section 10.0 is intended to present the most up-to-date information for specific portions of this FIS report. Therefore, users of this FIS report should be aware that the information presented in Section 10.0 supersedes information in Sections 1.0 through 9.0 of this FIS report.

Initial Countywide FIS Effective Date:	September 26, 2008	
Revised Countywide date:	November 26, 2010	First Revision
	<date>	Second Revision

This preliminary FIS report does not include unrevised Floodway Data Tables and unrevised Flood Profiles. These Floodway Data Tables and Flood Profiles will appear in the final FIS report.

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Flood Insurance Rate Map

FLOOD INSURANCE STUDY
DEL NORTE COUNTY, CALIFORNIA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Del Norte County, including the City of Crescent City and the unincorporated areas of Del Norte County (referred to collectively herein as Del Norte County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations, Title 44, Section 60.3.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

For the July 3, 1986, Del Norte County, and September 29, 1986, Crescent City FIS reports, the coastal hazard analyses were performed by Ott Water Engineers, Inc. for FEMA, under Contract No. EMW-83-C-1175. This work was completed in August 1984.

The FIS was revised on September 26, 2008 to incorporate the results of hydrologic and hydraulic analyses of the Smith River Basin in California. Nolte Associates, Inc. completed this work for the Federal Emergency Management Agency (FEMA) under Contract No. EMS-2000-CO-0057 in October 2002. The hydrologic analyses for Smith River Basin were performed by U.S. Army Corps of Engineers (USACE) and are included in the March 2002 report titled "Smith River Basin Del Norte County, California Hydrologic Engineering Report". The hydraulic analyses for this study were performed by Nolte Associates, Inc. Del Norte County served as a Cooperating Technical Partner (CTP) for this study and was responsible for the development of the digital base maps, digital topography, and digital cross sections for the study reaches.

As part of the September 26, 2008 revision, Nolte Associates, Inc. completed approximate studies on several streams. These analyses were completed in November 2004. The FIS was revised on November 26, 2010 to incorporate the hydrologic and hydraulic analyses of the Lower Smith

River basin in Del Norte County, California. Nolte Associates, Inc. completed this work for FEMA under Contract No. EMS-2000-CO-0057 in October 2008. Del Norte County served as a CTP for this study and was responsible for the development of the digital base maps and digital topography for the lower Smith River study reach.

1.3 Coordination

For the 1986 FIS reports for Del Norte County and the City of Crescent City, coastal areas requiring detailed study were identified at initial coordination meetings attended by representatives of FEMA, the study contractor, Del Norte County, and the City of Crescent City on May 24, 25, 27, and 28, 1983.

An information search was conducted to collect all existing information relevant to flooding in the detailed-study area. Engineering firms, residents, and business owners were interviewed near the detailed-study area. The status of shore protection measures and the extent of recent coastal damage were noted.

The USACE office in San Francisco provided tsunami predictions for northern California. Records of observed waves, atmospheric pressures, and winds were obtained from the National Weather Service. The National Ocean Service and the U.S. Geological Survey (USGS) provided tidal records, bathymetric maps, and benchmark locations. Wave data records for State beaches along the northern California coast were obtained through the California Department of Boating and Waterways. Records of major storm events and damage were obtained from records at the local newspaper, the Del Norte *Triplicate*.

The results of the September 26, 2008, revision were reviewed at the final Consultation Coordination Officer (CCO) meeting held on April 24, 2007, and attended by representatives of FEMA, Del Norte County, and the City of Crescent City. All problems raised at that meeting have been addressed in this study.

The results of this Del Norte County November 26, 2010 revision were reviewed at the final Consultation Coordination Officer meeting held on August 17, 2009, and attended by representatives of FEMA Region IX, Del Norte County and the City of Crescent City. All problems raised at that meeting have been addressed in this revision.

For the <date> revision, the initial CCO meeting was held on <date>. Attending the meeting were representatives of <attendees> representatives of FEMA Region IX, BakerAECOM, and the community.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Del Norte County, California, including the incorporated

communities listed in Section 1.1.

Under Contract No. EMW-83-C-1175, flooding from the Pacific Ocean was studied in detail from an area beginning near the southwestern terminus of Third Street in the City of Crescent City, along Front Street to Elk Creek, then approximately 3,000 feet southeast to the tidal flats beyond the eastern corporate limits of Crescent City.

The coastal areas studied by detailed methods in the 1986 FIS reports were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through 1989.

The October 2002 study covers river reaches totaling approximately 24 miles and includes the Smith River and Middle Fork Smith River. The Hiouchi reach of the Smith River extends from approximately 2,000 feet upstream of the U.S. Highway (US) 101 Bridge to approximately 2,500 feet upstream of the confluence of the South Fork Smith River. The Gasquet reach of the Smith River extends from US 199 to approximately 4,000 feet upstream of the convergence of the North and Middle Fork Smith River. For this report, the North Fork Smith River will be treated as a continuation of the Smith River. In addition, a portion of the Middle Fork Smith River was studied in detail from its confluence to approximately 1.9 miles upstream of the confluence with North Fork Smith River.

The approximate study of streams was completed by FEMA in November 2004 and includes the Smith River from approximately 2,600 feet upstream of the confluence of South Fork Smith River to approximately 300 feet downstream of Mary Adams Memorial Bridge; along the South Fork Smith River from approximately 1,100 feet to approximately 23,000 feet upstream of the confluence with Smith River; and from approximately 2,000 feet downstream of the confluence of West Branch Mill Creek and East Branch Mill Creek with Mill Creek to the confluence with the Smith River. This work was performed to remove several of the areas in which flood hazards are undetermined, but possible.

The October 2008 study covers river reaches totaling approximately 10 miles and includes the lower portion of the Smith River from the Pacific Ocean to approximately 2,100 feet upstream of the US 101 Bridge, and Rowdy Creek from its confluence with the Smith River to approximately 1,500 feet upstream of the US 101 Bridge. The detailed study includes riverine and coastal flooding analyses.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon, by FEMA and Del Norte County.

2.2 Community Description

Del Norte County is located on the Pacific Coast in the extreme northwest corner of California. It is bordered by Siskiyou County to the east, Humboldt County to the south, the Pacific Ocean to the west, and the State of Oregon to the north. The total area of the county is 1,229.75 square miles

(sq. mi.). The population of the county in 2000 was 27,507. The only incorporated city in the county is Crescent City, with a population of 4,006 during the 2000 Census (U.S. Department of Commerce, 2000). The Crescent City area is the major trade and population center for the county.

Most of Del Norte County is located within the Six Rivers National Forest and logging is a major industry in the area. Elevations in the county range from sea level at the coast to 6,424 feet at Bear Mountain, along the county's eastern boundary.

Climate in the coastal areas is dominated by the Pacific Ocean. Warm winters, cool summers, small daily and seasonal temperature ranges, and high relative humidity are characteristic of the area. Annual precipitation totals of 30 to 40 inches are characteristic of northern California coastal areas.

2.3 Principal Flood Problems

Flooding along the Pacific coast near Crescent City in Del Norte County is often associated with the simultaneous occurrence of very high tides, large waves, and storm swells during the winter.

As a result, oceanfront development has not been extensive because of the natural instability of the shoreline and the intense winter weather conditions.

Computer analyses conducted by the USACE indicate that critical high-water conditions near Crescent City in Del Norte County are associated with tsunami-generated waves from the Aleutian Trench and are not typical high water events.

Tsunami (sea waves generated from oceanic earthquakes, submarine landslides, and volcanic eruptions) create some of the most destructive natural water waves. As tsunami waves approach shallow coastal waters, wave refraction, shoaling, and bay resonance amplify the wave heights.

The 1964 Alaska tsunami is the most recent major tsunami to affect the United States. During that event, 11 people were killed in Crescent City. Because Crescent City is a timber-based community, related structural damage in the city and county was partly attributed to the logs that were carried by the tsunami. The 1964 tsunami exceeded a 1%-annual-chance (AC) flood event at Crescent City and a 0.2%-AC flood event at some other California coastal sites.

More recently, the city's harbor suffered extensive damage due to tsunamis generated by the March 11, 2011 earthquake originating off Sendai, Japan. Many vessels and docks were destroyed during this event. However, it should be noted that the <date> update to this FIS does not consider tsunamis in the coastal analysis which informs the FIRMs; only coastal storm waves and water levels were assessed. Tsunamis are considered as a separate hazard, with results of modeling and analysis presented in non-regulatory products.

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 create storm surges are also accompanied by heavy rains. In some instances, high tides back up river flow, which

causes flooding at the river mouths.

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

In January 1978, a series of storms emanated from a more southerly direction than normal; consequently, some of the better-protected beaches were also damaged. Jetties and breakwater barriers were overtopped and in some cases undermined. The winter of 1983 brought an extremely unusual series of high tides, storm surges, and storm waves. Record high tides were reported in Del Norte County, with the worst coastal flooding since the 1964 Alaska tsunami (Ott Water Engineers, Inc., 1984). Winter storms in November, 1997 and March, 1999 also produced significant coastal flooding.

The Smith River Basin is fan shaped with a common focal point for the major tributaries, which gives the basin its very sharp reaction to rainfall and runoff. As a result, floods in the basin are normally of short duration, lasting about 2 to 4 days. Floods develop rapidly, with the peak being reached in about 6 to 8 hours after occurrence of the most intense part of the storm. During the 1964 flood of record, the flow at the US 101 bridge increased from 20,000 cubic feet per second (cfs) to a peak of 228,000 cfs in approximately 36 hours and remained above 100,000 cfs for about 30 hours.

Flooding within the lower portion of the Smith River delta, namely below River Mile (RM) 3, occurs almost every year. When discharges of any significant magnitude occur, flooding will generally take place downstream of RM 7. About once every 10 years, floodwaters break over the low divide separating Smith River from the Lake Earl region and flow through Lake Tolowa into the ocean.

Since the beginning of continuous measurements in 1932, the greatest peak discharge at the USGS stream gaging station, “Smith River near Crescent City, CA,” occurred in December 1964. The recorded discharge of 228,000 cfs is believed to have equaled or exceeded the legendary flood of December 1861, making it the largest in about 140 years. During the 3-day period of December 21-23, 1964, the volume of runoff was 615,000 acre-feet, which is equivalent to 18.8 inches of water spread out over the entire basin. During the period of high stages in the delta, floodwaters flowed through the Tolowa Slough into Lake Earl. Lake Earl rose about 5 feet, and waters then flowed through Lake Tolowa, discharging directly into the ocean. Approximately 9,300 acres of pasture and other agricultural lands were flooded in the delta and Lake Earl areas. Total damages in 1964 price levels amounted to an estimated $11 million (U.S. Department of the Army Corps of Engineers, 2002).

The second highest recorded peak discharge of 182,000 cfs occurred in January 1972. According to published USGS information, a non-recorded, estimated peak discharge of 166,000 cfs occurred in 1927 (U.S. Department of the Army Corps of Engineers, 2002).

2.4 Flood Protection Measures

The USACE built the Klamath–Glen Levee in 1970, as a mitigation project, following the devastating 1964 flood that destroyed over two hundred homes in the Klamath Glen Community. The levee survived the floods of 1997 and 2006 without overtopping. There was, however, concern expressed that a flooding event of sustained duration might lead to overtopping or failure of the levee. The three diesel pumps used for pumping water out of the protected area can only pump for three days without running out of fuel if the Terwar Bridge on Highway 169 is down.

In accordance with FEMA Procedure Memorandum No. 43, the levee has been provisionally accredited for a period of two years and is shown on Flood Insurance Rate Map (FIRM) Panel 06015C0500F as providing protection from the 1-percent-annual-chance flood event with a provisionally accredited levee (PAL) designation.

To maintain accreditation, the levee owner or community is required to submit documentation necessary to comply with Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10), titled "Mapping of Areas Protected by Levee Systems," by July 23, 2009. Because of the risk of overtopping or failure of the structure, communities should take proper precautions to protect lives and minimize damages in these areas, such as issuing an evacuation plan and encouraging property owners to purchase flood insurance.

Additional information about FEMA Procedure Memorandum No. 43 and PALs may be found at the following web site http://www.fema.gov/plan/prevent/fhm/pl_memo43.shtm.

Residents with coastal properties and the City of Crescent City have implemented flood protection measures to ameliorate the coastal storm and flooding problems.

In Crescent City, two breakwaters were constructed to reduce the effects of swells and waves in the harbor. A landfill was developed as a recreational park along the harbor and has effectively reduced flooding to the southeastern shore of the city. A riprap wall was constructed along the outer perimeter of the park (Ott Water Engineers, 1984).

The Smith River is classified as a National Wild and Scenic River by the National Park Service and is the only major river in California to flow freely for its entire length without a dam (National Park Service, 2002).

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent

chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

Flooding from the Pacific Ocean is caused by either storm surge or tsunami-generated waves (Ott Water Engineers, 1984). In Del Norte County, long-term tide records were used to develop an elevation frequency relationship to formulate the storm-tide elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance recurrence intervals.

The 1- and 0.2-percent-annual-chance data were obtained from USACE tsunami study reports (U.S. Department of the Army Corps of Engineers, 1978; 1974; and 1979). Assuming a log-normal probability relationship for the tsunami data, a log-normal plot was developed using the 1- and 0.2-percent-annual-chance values; the 10- and 2-percent-annual-chance tsunami wave heights were obtained through extrapolation.

A comparison of the storm tide elevation and the tsunami wave height determined the higher value to be used in evaluating the coastal flooding hazard. It was found that storm generated surge dominates the lower frequency flooding, e.g., the 10-percent-annual-chance event.

For the Lower Smith River Basin, peak discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods were determined by use of the USACE Flood Frequency Analysis HEC-FFA computer program. For the Lake Earl and Lake Tolowa basins, peak discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods were determined using the USGS Regional Regression Equations (Nolte, 2008).

Peak discharge-drainage area relationships for Del Norte County are shown in Table 1.

Table 1. Summary of Discharges

Flooding Sources and Location	Peak Discharges (cfs)			
	10%-Annual-Chance	2%-Annual-Chance	1%-Annual-Chance	0.2%-Annual-Chance
Middle Fork Smith River				
Approximately 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)				
Approximately 17,000 feet downstream of US 199 (Hiouchi Bridge)	144,000	198,000	222,000	278,000
Just downstream of confluence of South Fork	134,000	184,000	206,000	258,000

Flooding Sources and Location	Peak Discharges (cfs)			
	10%-Annual-Chance	2%-Annual-Chance	1%-Annual-Chance	0.2%-Annual-Chance
Smith River				
Smith River (Pacific Ocean to US Highway 101)				
Above Peacock Creek	142,000	195,000	218,000	273,000
Rowdy Creek				
Approximately 11,500 feet upstream of confluence with Smith River (Gasquet Reach)	8,800	12,400	13,800	16,500

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

For the 2002 Nolte Associates study, aerial photogrammetry was used to develop topographic maps with 2-foot contour intervals. Channel cross-section information was digitized from photogrammetric data and supplemented with field survey data where needed. Cross sections include surveyed ground points under the water level while contours are used from edge of water. This information was used to develop the hydraulic models for delineation of the 1- and 0.2-percent-annual-chance floodplains and floodway. Hydraulic analyses were performed using the USACE computer program HEC-RAS Version 3.0.1 (U.S. Department of the Army Corps of Engineers, 2001).

Channel roughness coefficients (Manning's "n") used in the hydraulic computations were determined by engineering judgment and field investigation, using the tables in *Open-Channel Hydraulics* (Chow, 1959).

High Water Marks (HWMs) tied to the 1964 historical flood were obtained from the USACE and were used to help calibrate channel roughness coefficients.

Normal depth based on slope-area computations was assumed as the downstream hydraulic control for both the Hiouchi reach and the Gasquet reach of the Smith River. It was assumed that there was no tidal influence on the Hiouchi reach because of the 1-percent-annual-chance water surface elevations (WSELs) being significantly higher than the mean high water (MHW) elevation.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed (Section 4.2), cross section locations are also shown on the FIRM.

The November 2004, approximate study for the Smith River and the South Fork Smith River were performed using FEMA's *Quick-2 V2.0* computer program (FEMA, 1997). Existing discharge values were used, along with interpolated cross sections for each of these two river reaches to obtain the 1-percent-annual-chance WSEL for the approximate study. Delineations for Mill Creek were completed by interpolation of USGS topographic maps to join existing approximate delineations to its confluence with the Smith River.

3.3 Coastal Analyses for the September 26, 2008 Revision to the Countywide FIS

The September 2008 study includes both riverine and coastal flooding analyses for the FIS (Nolte, 2008). The riverine analysis established flood elevations for the lower portion Smith River and Rowdy Creek, and their overflow areas using a 2-dimensional hydrodynamic numerical model, MIKE 21 HD. Various topographic and bathymetric data were used to establish an overall digital elevation model (DEM) for the hydraulic modeling. Grid spacing of 49.2125 ft (15 meter) was determined to be acceptable for use in the entire study area. Hydrographs were used as upstream boundary conditions for the Smith River and Rowdy Creek at the US 101 Bridge, and mean high water (MHW), or 5.84 feet (1.781 meters) NAVD 88 was applied as the downstream coastal boundary condition. The Manning resistance factors used, were M=25 (n=0.04) for overland area, M=32 (n=0.031) for open sea, and M=50 (n=0.02) for riverine area. The hydraulic model was calibrated and refined with the 1964 historical flood and the model results were consistent with the observed high water mark (HWM) elevations.

The coastal flooding analysis follow the methodology outlined in Table D.4.2-2 titled "Open Coast, Dune Backed Beach Example using Parametric DIM Model for Setup/Runup" in Appendix D: FEMA Guidelines & Specifications (FEMA, 2004). The open ocean portion of the coastal study, extending from just south of Lake Earl to a location just north of the Smith River inlet (a stretch of about 10 miles), is subject to very dynamic winter ocean conditions, where large waves and high water levels contribute to high erosion and high wave runup elevations. A combination of hindcast data, 1-D models, and 2-D models are used to quantify erosion volumes and to determine total water levels. A 2-dimensional spectral wave model, MIKE 21 SW FM was used to compute wave transformation due to refraction, shoaling and bottom friction as the waves propagate from the GROW hindcast position to the near shore.

The analysis of coastal hazards and the associated mapping of special flood hazard areas (SFHA) were carried out for thirty-seven of the thirty-eight transects. Transect 1 extends across the Smith River mouth, and is thus covered by the riverine flood analyses. All transects are perpendicular to the shoreline; the distance between consecutive transects (measured along the shoreline) varies between 1,148 ft at the Smith River mouth and the breach at Lake Earl to 1,640 ft elsewhere. Once the hydraulic analyses were completed, flood hazard zones and BFEs were mapped following the procedures set forth in Section D.4.9 of Appendix D: FEMA Guidelines & Specifications (FEMA, 2004).

The coastal analysis indicated the eroded beach profile was either not overtopped by the 1% total water level (TWL), or the overtopping splash zone did not extend beyond the landward limit of the primary frontal dune (PFD) for most transects. In that case, the mapping was limited to a VE zone extending from map datum (0 ft NAVD88) to the landward limit of the PFD. Exceptions to this situation were Transects 25 and 27, for which the overtopping splash zone extends farther landward than the PFD, thus determining the VE/AO boundary, and transects subject to overland wave propagation (transects 2 to 5 and transects 29 to 31).

Due to the complex interaction between riverine and coastal forces, this study includes an analysis of TWL based on the joint probability of both riverine and ocean influences. The joint probability

analysis affected results in the area near the mouth of the Smith River inlet, and the area around Lake Earl when the dune barrier between the lake and the sea is assumed to be breached, which leads to a static BFE of 13 ft (NAVD) for Lakes Earl and Tolowa.

Hydraulic computations for all reaches included modeling bridges. The bridges are extremely elevated and do not impede flood flows, except for the localized bridge pier effects. The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

3.4 Coastal Analyses for the (Insert Date) Revision to the Countywide FIS

Storm surge, swell, and locally generated wind waves were modeled on a regional scale using numerical models to deterministically predict water levels and wave conditions for the Pacific Ocean along the coastline of the study area. These data were then used as inputs to 1-dimensional, transect-based analysis to determine the coastal flooding hazards onshore.

The SHELF model developed by the Scripps Institution of Oceanography was used for the regional surge and wave modeling. The hydrodynamic model included the effects of storm surge, wave effects, and other phenomena such as El Niño and La Niña conditions. The SHELF model produced a hindcast of hourly wave conditions for a 50-year period extending from January 1, 1960, through December 31, 2009. Hourly water levels were obtained from NOAA tide gauges and were paired with the SHELF model waves to analyze the coastal hazards at the shoreline. The frequency and magnitude of storm surge was derived statistically from the 50-year hindcast record.

Tidal elevation data for tide stations along the California coast were obtained from the NOAA National Ocean Service (NOS). However, the existing tide gauge records along the coast provide an incomplete record, both spatially and temporally. The gaps needed to be filled to obtain complete and reasonable and continuous still water levels as inputs for response-based onshore analyses. Temporal gaps in the records were filled using an approach that applied the relationships of observed tidal residuals between neighboring gauges to estimate residual components at stations with missing data. Using these correlations and an understanding of the spatial variability of regional storms, the gaps in gauge records were empirically filled to provide a continuous hourly time series of SWLs for the desired period of record at each tide gauge.

Once the hourly SWL hindcast was reconstructed for each tide gauge, each tide gauge was assigned the coastal reach for which it was considered to be most representative of the still water levels. The water level record from the representative tide gauge was used for each one-dimensional transect within the defined reach. The Del Norte County tide gauge assignment for spatial application of still water level hindcast results is presented in Table 2 and shown in Figure 1.

Table 2. Spatial Application of Tide Gauge Analyses Results

Coastal Reach	Tide Gauge Station
Del Norte open coast Oregon border to Patrick's Point (HU)	Crescent City (9419750)

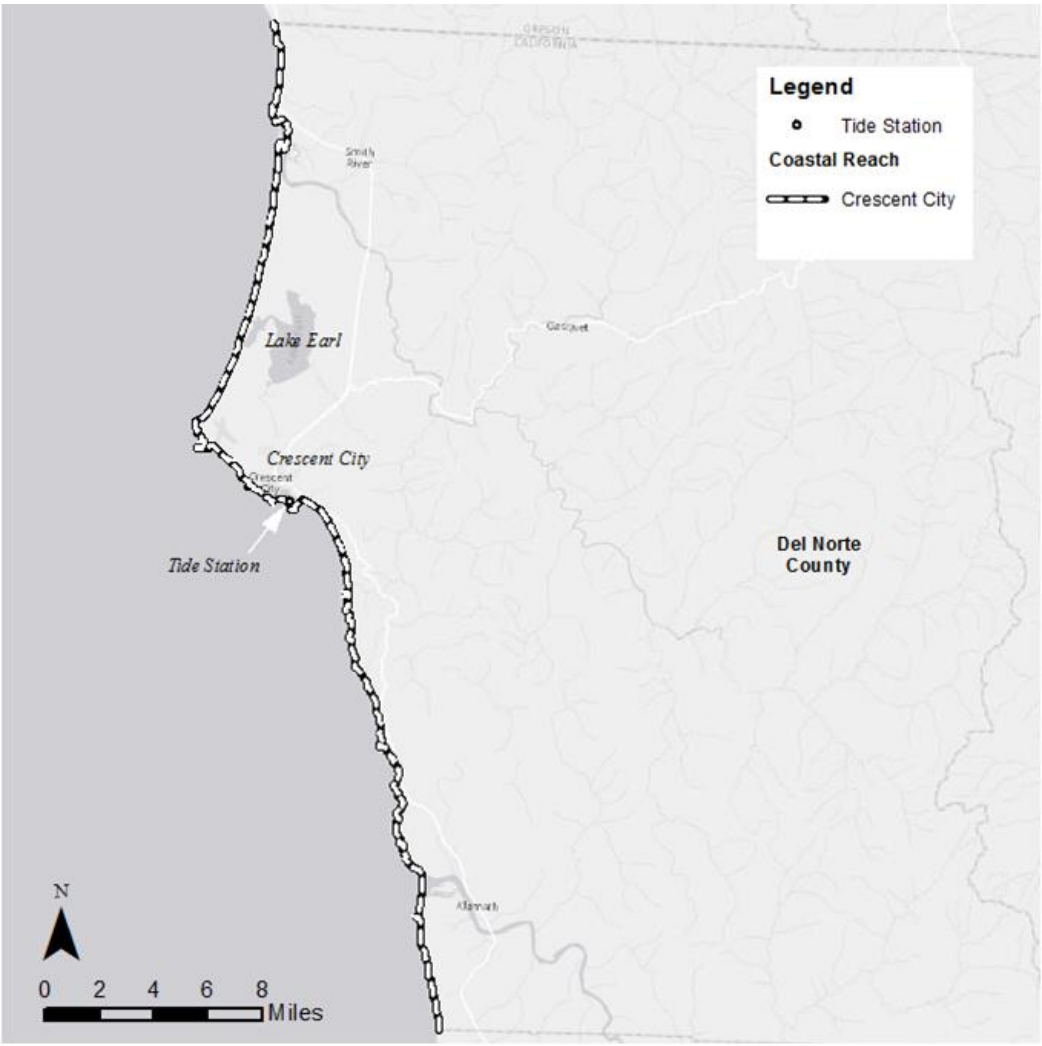


Figure 1. Coastal Reach Assignment for Spatial Application of Tide Gauge Analyses Results

Annual maxima from tide gauges along the California coastline that had sufficient lengths of observed records were used in the determination of statistical SWELs. The regional L-Moments method was employed to conduct the frequency analysis of the tide gauge data. This approach involved fitting various frequency distributions using the method of L-Moments (Hosking, 1996; Hosking and Wallis, 1997) and using statistical tests to determine "homogenous" regions as well as the best frequency distribution to fit the tide gauge data. This approach assumes that the

environmental response variable of interest within a homogenous region is produced by common climatological or meteorological forcing functions, such as El Niños and coastal storms, each having the same regional probability distribution. Results of the SWEL frequency analysis are presented in Table 3 and apply to the reaches described in Table 2 for the open coast. The results from the Crescent City tide station were applied to the entire Del Norte County open coast.

Table 3. Summary of Regional SWELs at Tide Gauges

Tide Gauge	Regional 50-percent (feet, NAVD)	Regional 20-percent (feet, NAVD)	Regional 10-percent (feet, NAVD)	Regional 4-percent (feet, NAVD)	Regional 2-percent (feet, NAVD)	Regional 1-percent (feet, NAVD)	Regional 0.2-percent (feet, NAVD)
Crescent City	8.79	9.20	9.48	9.86	10.16	10.48	11.30

Water level and wave information from the tide gauge analysis and the SHELF model were used as inputs to the 1-dimensional onshore flood hazard analyses. Wave setup, runup, overtopping, event-based erosion, and overland wave propagation were analyzed, where appropriate, at transects placed along the coastline. Transects are shown on the FIRM panels and are depicted in the Transect Location Maps (Figure 2) and described in Table 4. Transect profiles were obtained from LiDAR collected by the Ocean Protection Council and the USGS between 2009 and 2011. Bathymetric data was obtained from NOAA. Various datasets were merged to create a seamless terrain for use in this study.

Wave runup was calculated for transects with steeply sloping ground profiles along the shoreline. Wave runup was calculated using one of three methods, depending upon the dynamic water level relative to the profile and the shoreline slope, m_{TAW}, and calculated iteratively across the surf zone between the stillwater line minus 1.5 times the spectral significant wave height at the toe, H_m0, and the runup limit. As recommended in the Pacific Guidelines, the Direct Integration Method (DIM) was used to calculate runup for transects with natural, gently sloping ($m_{DIM} < 0.125$) profiles. The Technical Advisory Committee for Water Retaining Structures (TAW) method (van der Meer, 2002) was used for shorelines with shore protection structures and steeply sloping ($m_{TAW} \geq 0.125$) natural shorelines where the dynamic water level exceeded the toe of the structure or bluff. If, on these shorelines, the dynamic water level did not reach the toe of the structure or bluff face, the DIM was used for gently sloping profiles while a modified TAW approach was implemented on steeper shorelines. In these modified TAW cases, the Iribarren number, ξ_0, was compared to a critical Iribarren number, ξ_0c, to determine whether to use DIM or the modified TAW approach. The Shore Protection Manual method (USACE, 1984) was used to calculate wave runup on vertical walls. The total runup, including wave setup and incident wave runup, was added to the stillwater level to determine the TWL. Annual TWL maxima were selected from the 50-year hindcast (1960-2009), and the generalized extreme value statistical distribution was employed to calculate the 1-percent-annual-chance TWL at each transect. Results are presented in Table 5. Wave overtopping was evaluated for transects where the runup elevation exceeded the crest of the structure or bluff.

Combined probability analysis of coastal and riverine hazards was not part of the scope of this study. Only the greater hazard is mapped at river confluences. Since many rivers are unstudied and have no BFEs, these remain largely unchanged in the effective mapping. In general, the new coastal stillwater elevations at the upstream extents of coastal influence are lower than those in the effective flood insurance study, creating a gap in the floodplain between the new coastal limit and the effective Zone A riverine limit. In these areas, the boundaries of the effective coastal zone were evaluated using topography, orthophotography, and engineering judgment. The dynamic water level which includes the coastal SWEL and setup components was used where rivers openly flow into the ocean to delineate the tie into the effective mapping. For some areas it was deemed appropriate to extend the effective Zone A downstream to meet the new coastal zones using the effective floodplain boundaries in the area. None of the newly created Zone A areas were considered subject to development pressure. Re-delineation is limited to the coastal tie-ins.

Table 4. Transect Location Descriptions for the Open Pacific Coast Study

Study Area	Transect Number	Location
Pacific Ocean	1	Sandy beach and bluff south of Oregon State border.
Pacific Ocean	2	Rocky beach and bluff at White Rock Resort, CA.
Pacific Ocean	3	Sandy beach and bluff 0.35 south of White Rock Resort, CA.
Pacific Ocean	4	Sandy beach and dunes 0.55 south of White Rock Resort, CA.
Pacific Ocean	5	Sandy beach and bluff just north of Cone Rock.
Pacific Ocean	6	Sandy beach and bluff at Kamph Memorial Park.
Pacific Ocean	7	Sandy beach and bluff just north of Hunter Rock.
Pacific Ocean	8	Sandy beach and bluff just south of Prince Island and north of the Smith River inlet.
Pacific Ocean	9	Sandy beach at north end of spit separating the Smith River and the Pacific Ocean.
Pacific Ocean	10	Sandy beach and dunes about 1.5 miles south of Smith River inlet.

Study Area	Transect Number	Location
Pacific Ocean	11	Sand beach and dunes about 1.4 south of Yontocket.
Pacific Ocean	12	Sandy beach and dunes at Pacific Shores, CA and the north end of Lake Earl.
Pacific Ocean	13	Sandy beach at the south end of Lake Earl.
Pacific Ocean	14	Sand beach and dunes south of Lake Earl in Talawa Dunes State Park.
Pacific Ocean	15	Bluff just north of Point Saint George.
Pacific Ocean	16	Rocky beach and bluff just south of Point Saint George.
Pacific Ocean	17	Sandy beach and dunes about 0.6 miles southeast of Point Saint George.
Pacific Ocean	18	Rip-rap and bluffs on the north edge of Crescent City.
Pacific Ocean	19	Rocky beach and bluff in Crescent City that crosses White Rock.
Pacific Ocean	20	Bluff at Battery Point Island.
Pacific Ocean	21	Rip-rap in Crescent City harbor at trailer park.
Pacific Ocean	22	Rocky beach and bluff about 0.5 miles southeast of Preston Island.
Pacific Ocean	23	Rocky beach and bluff about 0.2 miles northwest of Battery Point Island lighthouse.
Pacific Ocean	24	Middle of jetty at Crescent City harbor just north of Steamboat Rock.
Pacific Ocean	25	Rip-rap in Crescent City harbor at park.
Pacific Ocean	26	Sandy beach and dunes just east of Crescent City harbor.
Pacific Ocean	27	Sandy beach and dunes about 0.8 miles east of the harbor along Crescent City beach.

Study Area	Transect Number	Location
Pacific Ocean	28	Sandy beach and bluffs about 2.3 miles southeast of harbor along Crescent City beach.
Pacific Ocean	29	Sandy beach and bluffs about 2.8 miles southeast of harbor along Crescent City beach.
Pacific Ocean	30	Sandy beach and bluffs at north end of Redwood National and State Parks.
Pacific Ocean	31	Bluffs just south of Sister Rocks.
Pacific Ocean	32	Bluffs about 1.6 miles south of Sister Rocks.
Pacific Ocean	33	Bluffs about 2.5 miles south of Sister Rocks.
Pacific Ocean	34	Bluff at north end of False Klamath Cove.
Pacific Ocean	35	Revetment in False Klamath Cove.
Pacific Ocean	36	Sandy beach and dunes in False Klamath Cove at Lagoon Pond outlet.
Pacific Ocean	37	Bluff about 0.4 miles south of False Klamath Rock.
Pacific Ocean	38	Bluff just south of Hidden Beach.
Pacific Ocean	39	Bluff about 2.2 miles north of Klamath River outlet.
Pacific Ocean	40	Bluff just north of Klamath River outlet.
Pacific Ocean	41	Sandy beach at Klamath River outlet.
Pacific Ocean	42	Bluff about 0.2 miles south of White Rock.
Pacific Ocean	43	Bluff about 1.6 miles north of Humboldt County line.
Pacific Ocean	44	Sandy beach and bluff just north of Humboldt County line.

Table 5. Open Pacific Coast Transect Data and TWLs

Transect	X, Y Coordinates (Feet, NAD83 HARN)		Total Water Level (feet NAVD 88)[1]				Zone	BFE
	X	Y	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance		
1	399597.72	4650091.09	15.5	16.9	17.5	18.9	VE	18
2	399715.85	4649299.43	17.2	19.0	19.7	21.5	VE	20
3	399983.70	4648813.64	16.5	17.8	18.3	19.4	VE	18
4	400036.92	4648529.25	16.5	17.8	18.3	19.3	VE	18
5	399997.89	4647721.04	16.5	17.4	17.7	18.2	VE	18
6	399933.44	4646676.05	16.3	17.4	17.7	18.5	VE	18
7	399812.06	4645827.33	16.2	17.4	17.9	18.9	VE	18
8	399686.03	4644674.10	16.2	17.5	18.1	19.3	VE	18
9	399793.03	4644460.05	15.9	17.3	17.9	19.1	VE	18
10	399999.87	4642161.41	16.3	17.6	18.1	19.3	VE	18
11	399675.46	4638193.07	16.6	17.9	18.4	19.5	VE	18
12	398880.82	4634297.22	16.8	18.0	18.5*	19.5	VE	18
13	398096.43	4631404.61	17.1	18.6	19.2	20.6	VE	19
14	397277.14	4629171.14	16.8	18.2	18.8	19.9	VE	19
15	396063.85	4626992.14	17.2	20.5	22.2	27.1	VE	22
16	395753.03	4625694.52	19.2	21.7	22.9	25.8	VE	23
17	397599.33	4624266.92	19.0	22.4	24.1	28.4	VE	24
18	398145.86	4623694.70	19.7	24.9	27.7	35.8	VE	28
19	398758.95	4623020.59	17.5	19.8	20.8	23.2	VE	21
20	399832.82	4622015.02	17.3	18.6	19.0	19.9	VE	19
21	400999.68	4622443.84	17.6	19.0	19.6	20.7	VE	20
22	399557.98	4622451.28	38.1	42.6	44.5*	48.5	VE	44
23	399700.23	4622225.74	52.2	54.1	54.6	55.3	VE	55
24	400205.80	4621532.70	12.3	13.0	13.3	13.8	VE	13
25	401340.67	4621121.28	19.1	19.4	19.5	19.6	VE	20
26	402096.20	4621747.24	18.6	22.8	24.8	30.0	VE	25
27	402921.28	4621596.16	20.3	25.7	28.2	35.0	VE	28
28	404130.93	4619750.84	18.1	23.1	26.0	35.0	VE	26
29	404516.17	4618798.94	20.6	28.3	32.8	47.4	VE	33
30	404727.37	4617451.79	17.1	19.4	20.4	23.0	VE	20
31	405394.11	4612290.70	21.4	28.5	32.6	45.8	VE	33
32	406625.32	4610171.69	18.7	21.9	23.5*	27.7	VE	23
33	406925.05	4608634.65	17.8	18.9	19.3	20.1	VE	19

Transect	X, Y Coordinates (Feet, NAD83 HARN)		Total Water Level (feet NAVD 88)[1]				Zone	BFE
	X	Y	10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance		
34	407502.92	4607132.06	22.6	27.4	29.6	35.5	VE	30
35	408120.88	4605835.12	34.4	38.6	40.3	44.0	VE	40
36	407994.13	4605559.71	19.2	22.6	24.3	29.2	VE	24
37	407968.48	4604947.32	17.8	19.5	20.2	22.0	VE	20
38	408240.62	4604005.61	24.4	28.3	29.9	33.3	VE	30
39	408077.60	4602478.72	20.5	21.5	21.8	22.4	VE	22
40	409347.54	4600336.74	19.9	23.0	24.4	27.7	VE	24
41	409685.35	4599166.77	17.5	19.1	19.8	21.6	VE	20
42	409631.16	4596233.38	22.7	25.2	26.1	27.9	VE	26
43	410398.18	4593465.31	17.3	18.0	18.3	18.7	VE	18
44	410812.79	4591000.56	16.9	18.0	18.3	19.0	VE	18

[1]North American Vertical Datum of 1988

*Value has been rounded to the nearest tenth of a foot – precision of results to the hundredths of a foot resulted in rounding the BFE on the FIRM down to the nearest whole foot.

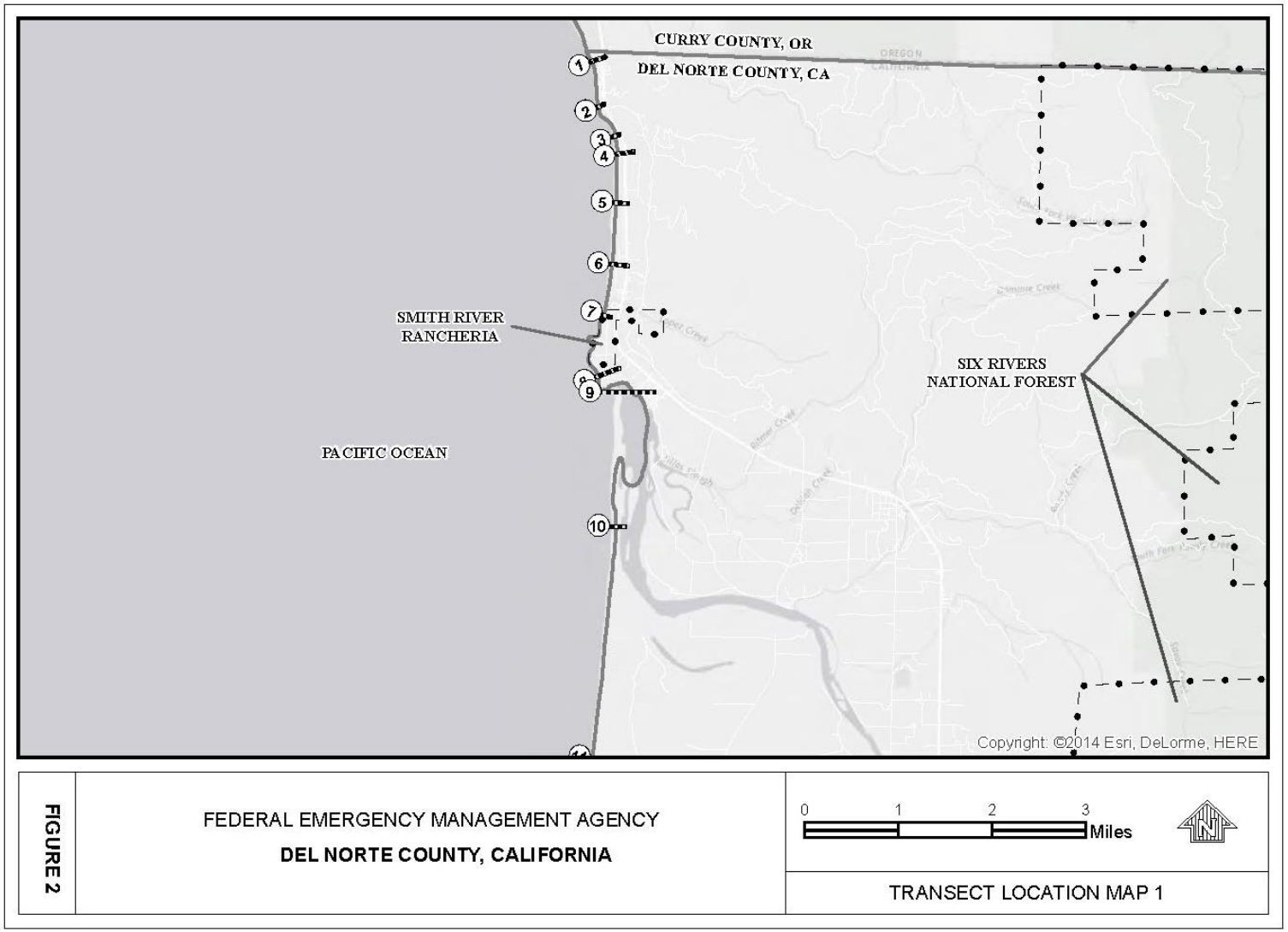
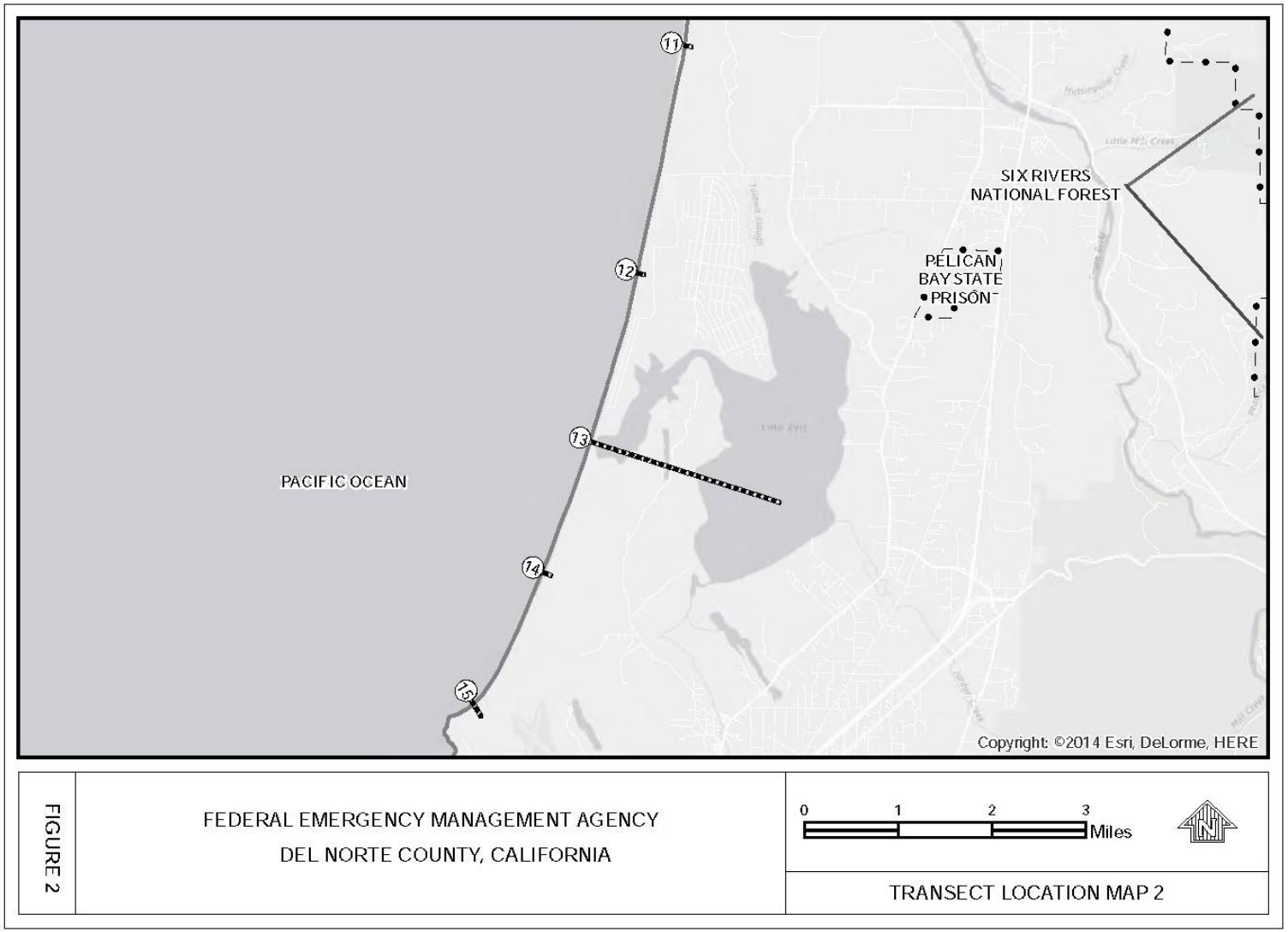


Figure 2. Transect Location Maps for Open Pacific Coast study area



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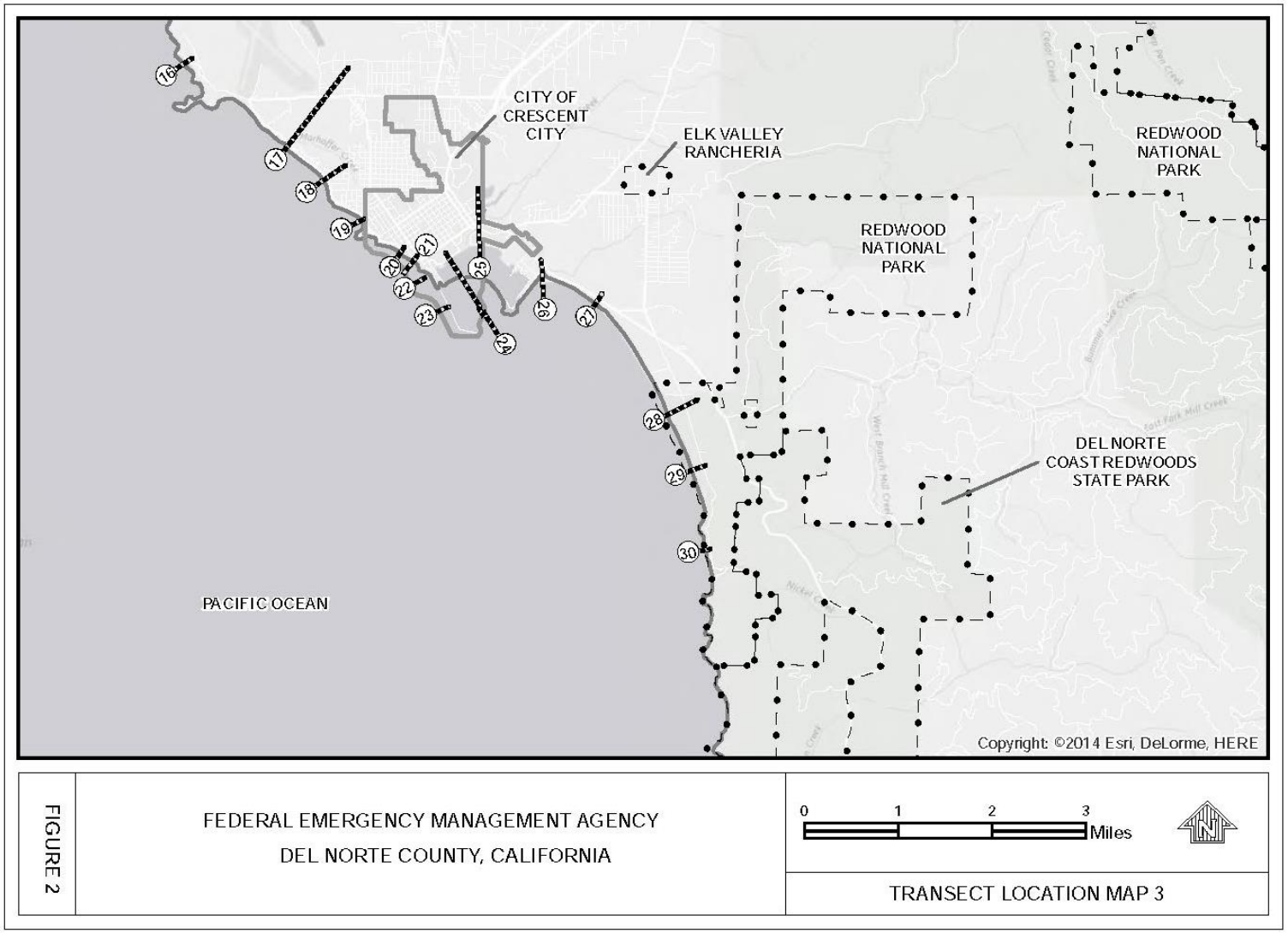

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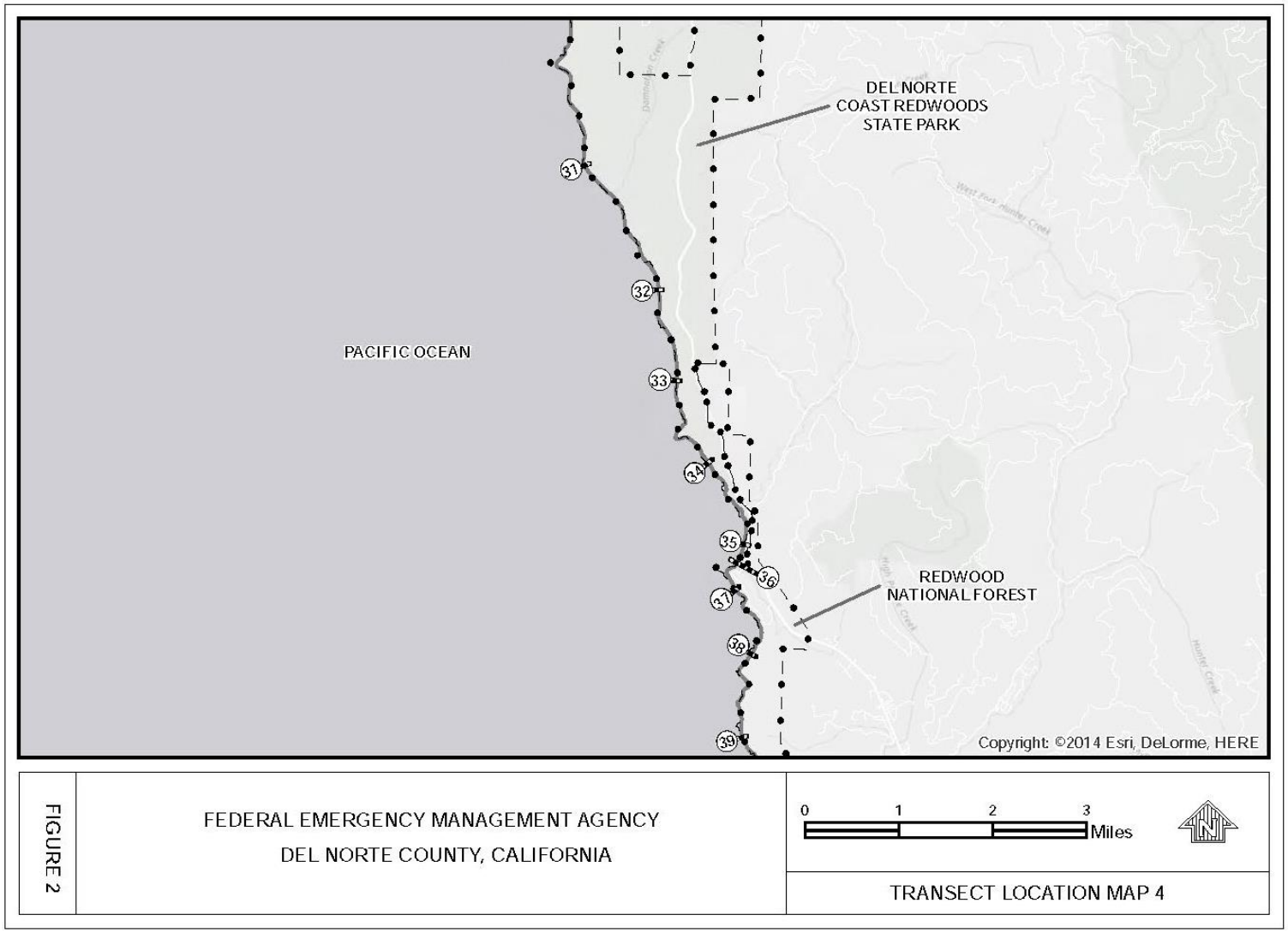

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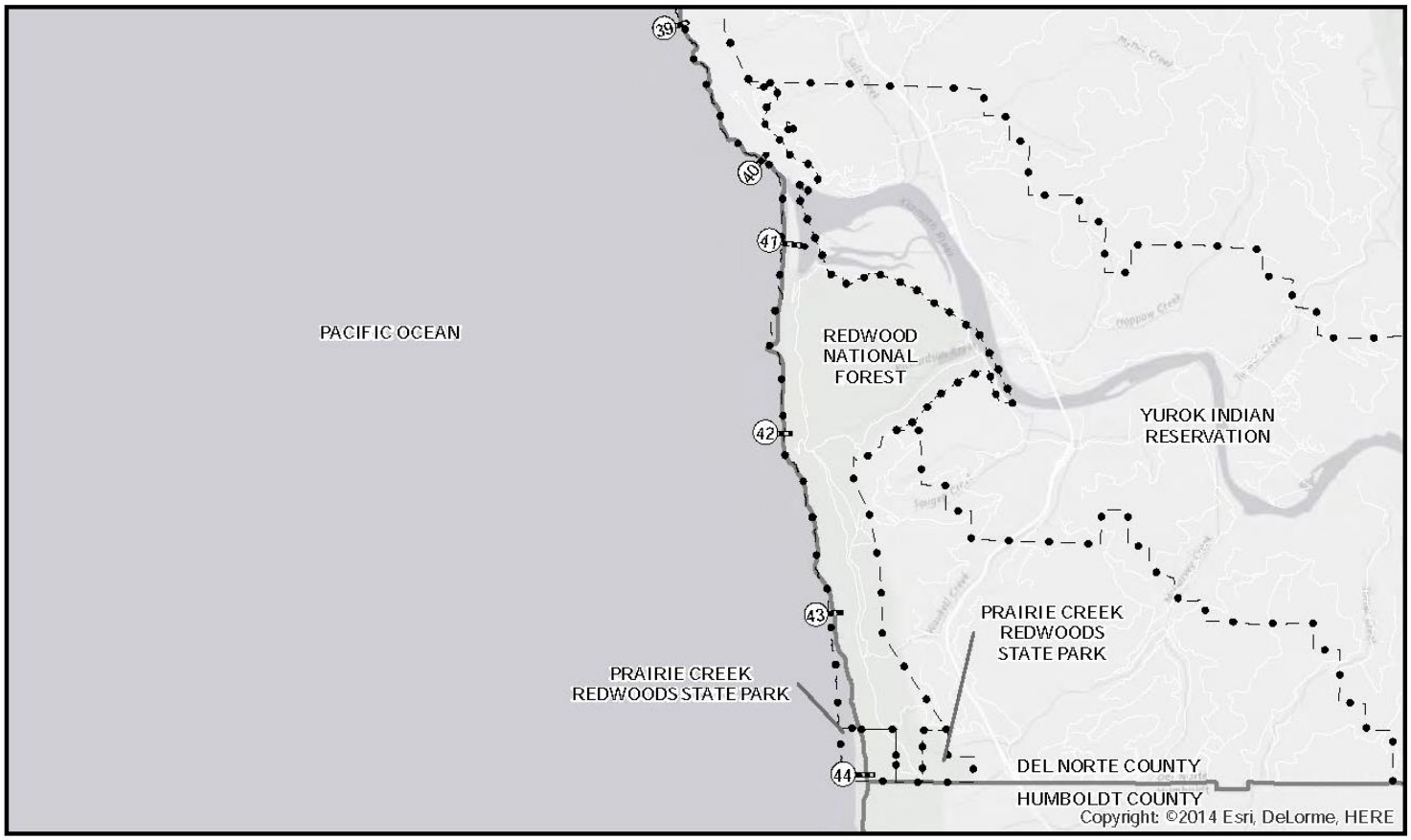

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
DEL NORTE COUNTY, CALIFORNIA

0 1 2 3 Miles

TRANSECT LOCATION MAP 5

Figure 2. Transect Location Maps for Open Pacific Coast study area

3.5 Levee Hazard Analysis

Some flood hazard information presented in prior FIRMs and in prior FIS reports for Del Norte County and its incorporated communities was based on flood protection provided by levees. Based on the information available and the mapping standards of NFIP at the time that the prior FISs and FIRMs were prepared, FEMA accredited the levees as providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year. For FEMA to continue to accredit the identified levees with providing protection from the base flood, the levees must meet the criteria of 44 CFR 65.10.

On August 22, 2005, FEMA issued *Procedure Memorandum No. 34 - Interim Guidance for Studies Including Levees*. The purpose of the memorandum was to help clarify the responsibility of community officials or other parties seeking recognition of a levee by providing information identified during a study/mapping project. Often, documentation regarding levee design, accreditation, and the impacts on flood hazard mapping is outdated or missing altogether. To remedy this, *Procedure Memorandum No. 34* provides interim guidance on procedures to minimize delays in near-term studies/mapping projects, to help our mapping partners properly assess how to handle levee mapping issues.

While documentation of compliance with 44 CFR 65.10 is being compiled, the release of more up-to-date FIRM panels for other parts of a community or county may be delayed. To minimize the impact of the levee recognition and certification process, FEMA issued *Procedure Memorandum No. 43 - Guidelines for Identifying Provisionally Accredited Levees* on March 16, 2007. These guidelines will allow issuance of preliminary and effective versions of FIRMs while the levee owners or communities are compiling the full documentation required to show compliance with 44 CFR 65.10. The guidelines also explain that preliminary FIRMs can be issued while providing the communities and levee owners with a specified timeframe to correct any maintenance deficiencies associated with a levee and to show compliance with 44 CFR 65.10.

FEMA contacted the communities within Del Norte County to obtain data required under 44 CFR 65.10 to continue to show the levees as providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year.

FEMA understood that it may take time to acquire and/or assemble the documentation necessary to fully comply with 44 CFR 65.10. Therefore, FEMA put forth a process to provide the communities with additional time to submit all the necessary documentation. For a community to avail itself of the additional time, it had to sign an agreement with FEMA. Levees for which such agreements were signed are shown on the final effective FIRM as providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year and labeled as a Provisionally Accredited Levee (PAL). Communities have two years from the date of FEMA's initial coordination to submit to FEMA final accreditation data for all PALs. Following receipt of final accreditation data, FEMA will revise the FIS and FIRM as warranted.

FEMA coordinated with USACE, the local communities, and other organizations to compile a list

of levees that exist within Del Norte County. Table 6, "List of Levees Requiring Flood Hazard Revisions" lists all levees shown on the FIRM, to include PALs, for which corresponding flood hazard revisions were made.

Approximate analyses of "behind levee" flooding were conducted for all the levees in Table 6 to indicate the extent of the "behind levee" floodplains. The methodology used in these analyses is discussed below.

The approximate levee analysis was conducted using information from existing hydraulic models (where applicable) and USGS topographic maps.

Base flood elevations and topographic information (where available) were used to estimate an approximate without levee 1-percent-annual-chance floodplain and by tracing along the contour line representing the base flood elevation. If base flood elevations were not available they were estimated from effective FIRM maps and available information. Topographic features such as highways, railroads, and high ground were used to refine approximate floodplain boundary limits.

Table 6. List of Levees Requiring Flood Hazard Revisions

Community	Flood Source	Levee Inventory ID	Coordinate Latitude/Longitude	FIRM Panel
Del Norte County Unincorporated Areas	Klamath River	1901027001	-123.991941, 41.518436 -123.983320, 41.510189	06015C0500F

3.6 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD). With the completion of the North American Vertical Datum of 1988 (NAVD), many FIS reports and FIRMs are being prepared using NAVD as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD. Structure and ground elevations in the county must, therefore, be referenced to NAVD. It is important to note that adjacent counties may be referenced to NGVD. This may result in differences in BFEs across the corporate limits between the communities.

For more information on NAVD, see the FEMA publication entitled *Converting the National Flood Insurance Program to the North American Vertical Datum of 1988* (FEMA, 1992), or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Rockville, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and the FIRM for this community. Interested individuals may contact FEMA to access these data.

The conversion factor for each stream studied by detailed methods is shown below in Table 7, Datum Conversion Factors.

Table 7. Datum Conversion Factors

Location	Elevation in feet NAVD above NGVD
Smith River Hiouchi Reach	+3.4
Smith River US 101 to Pacific	+3.4
Smith River Gasquet Reach Middle Fork	+3.4
Smith River	+3.4

Location	Elevation in feet NAVD above NGVD
Pacific Ocean at Crescent City	+3.4

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations; delineations of the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains, and the 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section.

For the detailed flooding for the Smith River and its tributaries, between cross sections the boundaries were interpolated using topographic maps at a scale of 1” = 500’, with a contour interval of 2 feet (FEMA, 1983).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM. On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, and VE), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM.

Other non-revised approximate 1-percent-annual-chance floodplain boundaries in the study area

were taken directly from the 1982 and 1986 FIRMs for the City of Crescent City and the 1983 and 1986 FIRMs for Del Norte County (FEMA, 1982; 1982; 1986a; and 1986b).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed for certain stream segments on the basis of equal-conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (see Table 8, Floodway Data). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the WSEL of the 1-percent-annual-chance flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 3.

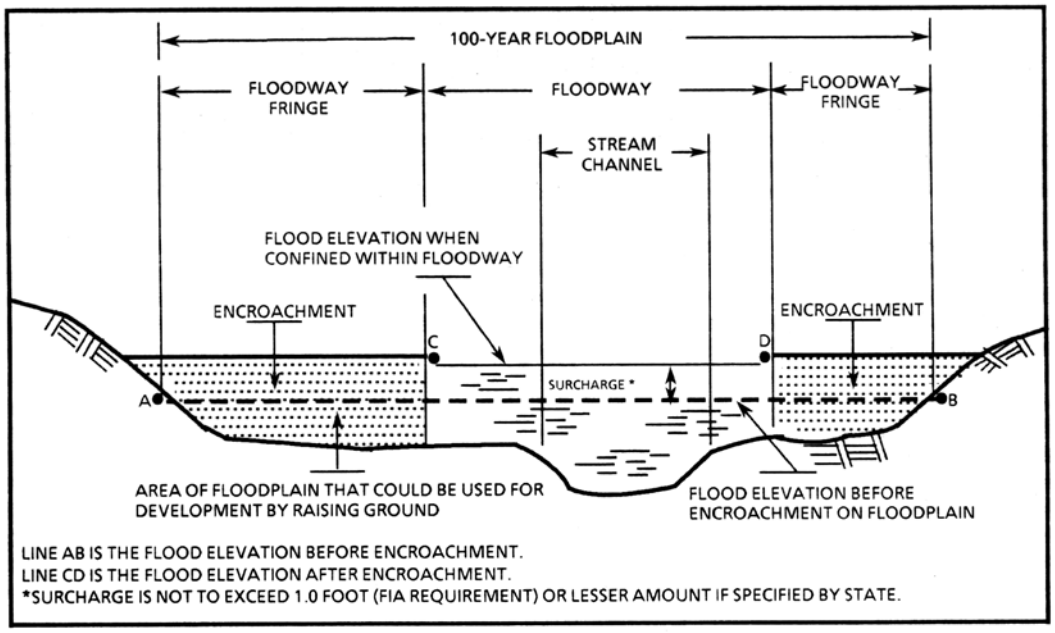

Figure 3. Floodway Schematic

Table 8. Floodway Data

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD 88)	WITHOUT FLOODWAY (FEET (NAVD 88))	WITH FLOODWAY (FEET (NAVD 88))	INCREASE
SMITH RIVER (HIOUCHI REACH)								
A	2,100	4,059	46,459	4.8	46.6	46.6	46.6	0.0
B	3,219	3,336	42,503	5.2	47.0	47.0	47.0	0.0
C	4,777	2,416	27,748	8.0	47.5	47.5	47.5	0.0
D	5,958	1,586	16,236	13.7	48.1	48.1	48.1	0.0
E	6,814	1,834	23,055	9.6	51.7	51.7	51.7	0.0
F	8,094	2,130	18,462	12.0	53.4	53.4	53.4	0.0
G	9,130	1,930	18,394	12.1	55.1	55.1	55.1	0.0
H	10,133	1,713	18,824	11.8	56.9	56.9	56.9	0.0
I	11,155	1,108	18,805	11.8	59.5	59.5	59.5	0.0
J	12,230	1,030	15,079	14.7	60.9	60.9	60.9	0.0
K	13,621	950	17,381	12.8	64.3	64.3	64.3	0.0
L	14,605	1,620	20,147	11.0	66.3	66.3	66.3	0.0
M	15,958	1,624	28,491	7.8	68.7	68.7	68.7	0.0
N	17,107	1,066	17,237	12.9	68.5	68.5	68.5	0.0
O	18,526	1,525	39,847	5.6	74.4	74.4	74.4	0.0
P	19,825	2,515	55,493	4.0	75.2	75.2	75.2	0.0
Q	21,258	1,780	23,614	9.4	75.3	75.3	75.3	0.0
R	22,746	1,547	29,594	7.4	77.8	77.8	77.8	0.0
S	24,186	2,037	22,908	9.5	79.1	79.1	79.1	0.0
T	25,630	1,655	19,301	11.3	81.0	81.0	81.0	0.0
U	27,176	1,095	17,752	12.3	83.9	83.9	83.9	0.0
V	28,676	3,415	57,209	4.1	88.2	88.2	88.2	0.0
W	29,981	2,751	31,884	6.8	88.8	88.8	88.8	0.0
X	31,285	2,399	34,439	6.3	90.8	90.8	90.8	0.0
Y	32,780	1,381	18,900	11.5	91.3	91.3	91.3	0.0
Z	34,287	942	20,223	10.8	94.5	94.5	94.5	0.0

[1] Feet above US 101

FEDERAL EMERGENCY MANAGEMENT AGENCY
DEL NORTE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

SMITH RIVER (HIOUCHI REACH)

Table 8. Floodway Data

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD 88)	WITHOUT FLOODWAY (FEET (NAVD 88))	WITH FLOODWAY (FEET (NAVD 88))	INCREASE
SMITH RIVER (HIOUCHI REACH)								
AA	35,249	1,124	21,957	11.6	96.6	96.6	96.6	0.0
AB	36,214	776	17,306	12.6	98.3	98.3	98.3	0.0
AC	37,159	825	19,016	11.5	100.2	100.2	100.2	0.0
AD	37,933	616	14,089	15.5	100.3	100.3	100.3	0.0
AE	39,024	438	13,417	16.2	103.4	103.4	103.4	0.0
AF	39,577	375	10,827	20.1	104.1	104.1	104.1	0.0
AG	40,940	728	16,736	13.0	110.4	110.4	110.4	0.0
AH	42,234	681	17,826	12.2	112.7	112.7	112.7	0.0
AI	43,687	568	15,685	13.9	114.8	114.8	114.8	0.0
AJ	45,190	718	17,051	12.8	117.4	117.4	117.4	0.0
AK	47,021	1,067	19,620	11.1	120.3	120.3	120.3	0.0
AL	48,589	535	14,341	15.2	121.5	121.5	121.5	0.0
AM	50,096	483	13,637	16.0	125.4	125.4	125.4	0.0
AN	51,722	699	19,678	11.1	130.1	130.1	130.1	0.0
AO	53,274	658	17,685	12.3	132.3	132.3	132.3	0.0
AP	54,774	424	11,214	19.4	133.3	133.3	133.3	0.0
AQ	56,205	408	11,381	18.1	137.8	137.8	137.8	0.0
AR	57,848	306	11,957	8.8	149.8	149.8	149.8	0.0
AS	58,909	302	9,199	11.4	150.6	150.6	150.6	0.0
AT	59,917	386	11,467	9.1	152.2	152.2	152.2	0.0

[1] Feet above US 101

FEDERAL EMERGENCY MANAGEMENT AGENCY
DEL NORTE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

SMITH RIVER (HIOUCHI REACH)

Table 8. Floodway Data

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD 88)	WITHOUT FLOODWAY (FEET (NAVD 88))	WITH FLOODWAY (FEET (NAVD 88))	INCREASE
MIDDLE FORK SMITH RIVER								
A	628	144	3,236	10.7	364.4	364.4	364.4	0.0
B	1,210	123	2,456	14.0	366.0	366.0	366.0	0.0
C	1,709	152	2,955	11.7	368.7	368.7	368.7	0.0
D	2,207	162	3,077	11.2	370.0	370.0	370.1	0.1
E	2,748	215	3,165	10.9	371.5	371.5	371.5	0.0
F	3,269	214	2,759	12.5	373.0	373.0	373.0	0.0
G	4,315	211	2,221	15.5	378.7	378.7	378.7	0.0
H	5,268	206	2,356	14.6	389.6	389.6	389.6	0.0
I	6,247	437	4,538	7.6	397.6	397.6	397.6	0.0
J	7,342	313	3,121	11.1	406.2	406.2	406.2	0.0
K	8,125	272	2,138	16.1	412.0	412.0	412.0	0.0
L	8,879	380	2,558	13.5	419.8	419.8	419.8	0.0
M	9,400	420	2,668	12.9	424.4	424.4	424.4	0.0
N	10,221	250	2,848	12.1	431.7	431.7	431.7	0.0

[1] Feet above confluence with Smith River.

FEDERAL EMERGENCY MANAGEMENT AGENCY
DEL NORTE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

MIDDLE FORK SMITH RIVER

Table 8. Floodway Data

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD 88)	WITHOUT FLOODWAY (FEET (NAVD 88))	WITH FLOODWAY (FEET (NAVD 88))	INCREASE
SMITH RIVER (GASQUET REACH)								
A	-276	264	6,434	16.3	303.5	303.5	303.9	0.4
B	592	648	8,971	11.7	314.8	314.8	314.8	0.0
C	1,272	560	6,756	15.5	315.7	315.7	315.7	0.0
D	2,243	543	12,366	8.5	320.9	320.9	320.9	0.0
E	3,073	293	6,431	16.3	320.9	320.9	320.9	0.0
F	3,960	560	6,926	15.2	324.7	324.7	324.7	0.0
G	4,884	1,070	13,397	7.8	330.1	330.1	330.1	0.0
H	5,586	834	12,520	8.4	330.8	330.8	330.8	0.0
I	6,149	470	6,848	15.3	330.8	330.8	330.8	0.0
J	6,680	458	7,093	14.8	332.9	332.9	332.9	0.0
K	7,265	312	6,652	15.8	335.3	335.3	335.4	0.1
L	8,194	325	6,624	15.9	339.7	339.7	339.7	0.0
M	9,179	278	6,783	15.5	344.2	344.2	344.3	0.1
N	10,173	209	6,310	16.6	348.0	348.0	348.2	0.2
O	10,939	429	8,829	11.9	352.7	352.7	353.0	0.3
P	11,634	599	10,924	9.6	354.8	354.8	355.1	0.3
Q	12,699	469	8,052	13.0	357.9	357.9	358.0	0.1
R	13,488	265	6,415	16.4	360.2	360.2	360.3	0.1
NORTH FORK SMITH RIVER								
S	14,106	209	4,793	13.4	364.1	364.1	364.1	0.0
T	14,972	248	5,745	11.2	367.4	367.4	367.4	0.0
U	15,511	278	5,317	12.1	368.7	368.7	368.7	0.0
V	15,983	233	3,979	16.1	369.7	369.7	369.7	0.0
W	16,525	175	3,594	17.9	373.2	373.2	373.2	0.0
X	17,474	198	3,961	16.2	379.3	379.3	379.3	0.0

[1] Feet above Mary Adams Memorial Bridge.

FEDERAL EMERGENCY MANAGEMENT AGENCY
DEL NORTE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

SMITH RIVER (GASQUET REACH) - NORTH FORK SMITH RIVER

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. The depth should be averaged along the cross section and then along the direction of flow to determine the extent of the zone. Average depths derived from the detailed hydraulic analyses are shown within this zone.

Zone V

Zone V is the flood insurance risk zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no BFEs are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of

1-percent-annual-chance flooding where the contributing drainage area is less than 1 sq. mi., and areas protected from the 1-percent-annual-chance flood by levees. No BFEs or depths are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, and shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The countywide FIRM presents flooding information for the entire geographic area of Del Norte County. Previously, FIRMs were prepared for Crescent City and the unincorporated areas of the County identified as flood-prone. Historical data relating to the maps prepared for each community are presented in Table 10, Community Map History.

7.0 OTHER STUDIES

FIRMs for Crescent City and Del Norte County were published on November 23, 1982, and January 24, 1983, respectively. The 1986 FIS reports for Crescent City and Del Norte County updated the coastal-study area with a more detailed analysis (FEMA, 1982; 1982; 1986a; and 1986b).

This FIS updates one reach of the Smith River and a portion of Rowdy Creek with detailed analysis and, therefore, supersedes or is compatible with all previous studies published on flooding areas studied in this report and should be considered authoritative for the purposes of the NFIP.

DHI analyzed coastal flood hazards between the mouth of the Smith River and the southern end of Lake Earl using the methods outlined in the Final Draft *Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States* (FEMA, 2005). Stillwater elevations were obtained from the Crescent City tide gauge. A two-dimensional spectral wave

model was used to model the wave transformation from offshore deepwater wave input points obtained from Oceanweather, Inc.'s (OWI) Global Reanalysis of Ocean Waves (GROW) model over a period of 34 years. Refraction, shoaling, dissipation, wave growth, nonlinear wave-wave interaction, wave-current interaction, and the effects of bottom friction were accounted for in the model. The 20 storm events exhibiting the largest wave heights and periods were selected per year over the period from 1970 through 2003 for each transect for use in the model. Onshore analyses, including setup, runup, erosion, and overland wave propagation, were conducted as appropriate along one-dimensional transects located with consideration to the physical characteristics along the shoreline. Combined probability analysis of coastal and riverine flooding influences was also conducted in Lake Earl and the Smith River for this study.

A probabilistic tsunami hazard assessment pilot study was conducted in Crescent City to provide estimates of the maximum tsunami amplitudes and inundation limits for the 100-year and 500-year recurrence intervals (1- and 0.2-percent-annual probabilities of exceedance) resulting from both near-field and far-field seismic sources. Simulations of tsunami inundation are conducted with the GeoClaw model for tsunamis generated in the near-field on the Cascadia Subduction Zone and in the far-field on the Alaska-Aleutian, Japan, Kamchatka and Chile Subduction Zones. The results of these multiple scenarios are post-processed to provide non-regulatory probabilistic maps to assist communities in developing building standards in these hazard areas and emergency management planning and response throughout the community. Tsunamis were not considered in the analysis which informed the regulatory FIRMs.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Federal Emergency Management Agency, Region IX, Federal Insurance and Mitigation Division, 1111 Broadway, Suite 1200, Oakland, California 94607-4052.

For previous versions of the FIRM Index, the Map Repository information was included on the FIRM Index itself. The map repositories are listed in Table 9 in the FIS.

Table 9. Map Repositories

Community	Address	City	State	Zip Code
Crescent City, City of	Public Works Department 377 J Street	Crescent City	CA	95531
Del Norte County	Community Development Department 981 H Street, Suite 110	Crescent City	CA	95331

Table 10. Community Map History

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Crescent City, City of	May 3, 1974	December 13, 1974 September 26, 1978	November 23, 1982	September 29, 1986
Del Norte County Unincorporated Areas	December 27, 1974	April 4, 1978	January 24, 1983	July 3, 1986 Date TBD

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DEL NORTE COUNTY, CA

AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

9.0 BIBLIOGRAPHY AND REFERENCES

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10.0 REVISION DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the original Flood Insurance Study was printed. Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To ensure that any user is aware of all revisions, it is advisable to contact the community repository of flood hazard data.

10.1 First Revision (September 26, 2008)

The FIS was revised on September 26, 2008 to incorporate the results of hydrologic and hydraulic analyses of the Smith River Basin in California. Nolte Associates, Inc. completed this work for the Federal Emergency Management Agency (FEMA) under Contract No. EMS-2000-CO-0057 in October 2002. The hydrologic analyses for Smith River Basin were performed by U.S. Army Corps of Engineers (USACE) and are included in the March 2002 report titled "Smith River Basin Del Norte County, California Hydrologic Engineering Report". The hydraulic analyses for this study were performed by Nolte Associates, Inc. Del Norte County served as a Cooperating Technical Partner (CTP) for this study and was responsible for the development of the digital base maps, digital topography, and digital cross sections for the study reaches.

10.2 Second Revision (November 26, 2010)

As part of the September 26, 2008 revision, Nolte Associates, Inc. completed approximate studies on several streams. These analyses were completed in November 2004. The FIS was revised on November 26, 2010 to incorporate the hydrologic and hydraulic analyses of the Lower Smith River basin in Del Norte County, California. Nolte Associates, Inc. completed this work for FEMA under Contract No. EMS-2000-CO-0057 in October 2008. Del Norte County served as a CTP for this study and was responsible for the development of the digital base maps and digital topography for the lower Smith River study reach.

The hydrologic analyses for Smith River Basin were performed by U.S. Army Corps of Engineers (USACE) and are included in the March 2002 report titled "Smith River Basin Del Norte County, California Hydrologic Engineering Report". Hydrologic analyses for the Lake Earl and Lake Tolowa were performed by Nolte Associates, Inc. and are summarized in the report titled "Del Norte County, California Flood Insurance Study Hydrologic Analyses". The coastal and riverine hydraulic analyses for this study were performed by the Danish Hydraulic Institute (DHI). All the hydrologic and hydraulic analyses and technical support documents are included in the report titled "Del Norte County Lower Smith River FIS" (Nolte, 2008).

Base map information shown on the Flood Insurance Rate Maps (FIRMs) was provided in digital format by the USDA National Agriculture Imagery Program (NAIP), dated 2005 and by Nolte Associates, Inc., aerial photos dated February 12, 2001 and later. Non revised floodplains were

reviewed for accuracy in relation to this new base and re-fit where appropriate. When redelineations of the floodplain boundaries occurred within studied areas, in order to maintain compliance with FEMA Procedural Memorandum 36, the profiles baselines were not altered from their original positions in order to maintain consistency between FIRM panels, profiles, and floodway data tables.

The projection used in the preparation of the November 26, 2010 revision was Universal Transverse Mercator (UTM) zone 10. The horizontal datum was NAD83, GRS 1980 spheroid. Differences in datum, spheroid, project or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

10.3 Third Revision (Insert Date)

This revision was initiated as a Physical Map Revision (PMR) submitted to FEMA by BakerAECOM for FEMA under Contract No. HSFEHQ-09-D-0368 Task Order No. HSFE09-10-J-0002. The study was completed in <date>.

The California Coastal Analysis Mapping Program – Open Pacific Coast Study was documented in four Intermediate Data Submittal (IDS) reports. IDS #1 – Scoping and Data Review described the study area, data sources, methodology for analysis, field reconnaissance investigations, and transect layout map (BakerAECOM, 2012). IDS #2 – Offshore Water Levels and Waves described the primary analyses of water level and wave conditions to be applied during the detailed analysis in the nearshore hydraulics phase (BakerAECOM, 2013). IDS #3 – Nearshore Hydraulics documented the one-dimensional transect-based analyses conducted to develop the base flood conditions at the shoreline that informed the mapping (BakerAECOM, 2014). IDS #4 – Hazard Mapping described the use of the coastal analysis results to identify, interpret, and delineate flood hazard zones on work maps (BakerAECOM, 2015). Analyses and mapping were conducted in accordance with the Final Draft *Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States*; any deviations from this guidance obtained approval by the FEMA Study Manager prior to implementation.

See Figure 2 for updated Transect Location Maps for the Open Pacific Coast. See Table 5 for the updated Transect Data Table for the Open Pacific Coast and Table 4 for the updated Transect Locations.

This revision involved updating the coastal mapping along the open Pacific coastline of Del Norte County, California. The PMR study area impacts the following 22 printed PMR panels: 0030, 0029, 0037, 0040, 0039, 0201, 0202, 0203, 0211, 0195, 0213, 0214, 0218, 0327, 0331, 0330, 0335, 0340, 0345, 0375, 0475, and 0575.

For this PMR, new flood zones were developed and mapped for the updated open Pacific coast of Del Norte County coastal hazard analysis. Detailed flood hazard boundaries along these shorelines were mapped using LiDAR data collected by the California Ocean Protection Council

and the USGS from 2009-2011.

Areas inundated by still water flooding with minimal wave hazard effects were mapped as Zone AE and the flood hazard boundary was located at the point where the ground elevation equaled the SWEL. In areas subject to wave runup, the flood hazard boundary was located on the face of the slope of the feature analyzed.

At some locations, the calculated TWL did not extend across the beach to the bluffs. Based on a review of historical photographs, field reconnaissance observations, and wrack lines visible in aerial imagery (BakerAECOM, 2012), the SFHA was extended to the base of the bluffs at these locations to accurately reflect the flood hazards. This occurred in the reaches represented by Transects 1 and 7.

In instances where overtopping occurred, the boundary was located at the inland extent of overtopping. The BFE in these areas was rounded to the nearest whole-foot, though the boundary is mapped using precision to the tenth of a foot. If the overtopping zone was too narrow to be mapped as an independent zone due to map scale limitations, this zone was merged with the Zone AE or Zone VE area mapped at the shoreline based on the runup analyses, and that zone was extended by the width of the overtopping zone. Overtopping was mapped at Transects 17, 23, 25, 26, 27, 28, 35, and 36.

At Transect 23, overtopping occurs at a jetty that separates the open water from the Crescent City harbor. Overtopping calculations were performed to calculate wave transmission across the jetty into the harbor. The offshore area designated Zone VE 55 was cropped along the harborside edge of the wall on top of the jetty. The area inside the harbor designated Zone VE 13 reflects the wave and flood hazards at the shoreline within the harbor and was quantified based on the wave transmission and diffraction over and around the jetties.

Transects along which the crests of the controlling features were inundated by the DWL were considered individually to accurately and realistically map the extent of inundation over the feature. Crests of the features at Transect 28 were overtopped by the DWL. The mapping decisions for these transects were largely determined by the backshore features and the effective mapping for tie-ins.

- Transect 28, along Crescent City Beach, is inundated during the 1-percent-annual-chance storm event. The intact and final eroded profiles were combined to map this area. The area designated Zone VE 26 from the intact scenario was terminated at the dune crest, and the areas inland of the crest were mapped according to the final eroded scenario as Zone AE to the DWL, with an 18-foot BFE. Areas inland of the crest above the DWL, in the pre-eroded scenario that the terrain represents, were mapped as Zone AO with a depth of 2 feet. The 2-foot depth is the elevation difference between the final eroded crest elevation (16 feet) and the DWL of the final eroded scenario (18 feet).

- At Transect 36, in which the area designated Zone VE 24 is controlled by overtopping, a low-lying area inland of the overtopping extent is hydraulically connected about 300 feet

south of Transect 36. Since the lagoon area is exposed to coastal flood hazards adjacent to Transect 36, the entire lagoon area and the spit were included as Zone VE 24 and mapped to the DWL of 21 feet. As a result, Transect 36 was not mapped according to the overtopping results.

In September 2008, DHI completed a detailed hydraulic analysis of the Lower Smith River and the surrounding area for the FEMA Flood Insurance Study update for Del Norte County, California. The DHI study area covers Transects 9 through 13 of the OPC study. Since the DHI study is more detailed and includes a combined coastal and riverine analysis of the Smith River and Lake Earl, those results superseded the OPC study results at Transects 9 and 13, where inlets are present. The OPC results for Transects 10 through 12 were left intact, however. They were used in the OPC mapping for Del Norte County instead of the DHI results, since those transects are only influenced by coastal flooding (not riverine).

The previous study delineated the flood zone limits for Crescent City using the 1964 tsunami inundation as its boundary. Because tsunamis are considered separately from coastal storm events as studied in the OPC Study, the VE zone on the effective mapping was replaced by the OPC study results. After removing this coastal VE zone, however, a portion of the city that is at risk of riverine flooding from Elk Creek needed to be included in the riverine flood zone. The floodplain for Elk Creek, an unstudied river, is designated Zone A. To reflect the risks of the river, the Zone A boundary was extended into the superseded effective Zone VE area and redelineated using best engineering judgment.

PFDs were identified according to the definition provided in 44 CFR 59.1. Multiple profiles, spaced approximately 200 feet apart alongshore, were analyzed to identify the heel of the PFD between analysis transects. These points were then plotted onto the base map and used in conjunction with an assessment of the surrounding terrain and aerial imagery to delineate the landward extents of the PFDs shown on the draft flood hazard maps. The most landward result of the wave effects along a transect were applied as the BFE for the entire VE Zone associated with the PFD. Therefore, a BFE may not match the topographic contour to which its inland extent is mapped.

PFDs were mapped at the following locations:

- Approximately 100 linear feet at the California-Oregon border.
- Approximately 50,800 linear feet, including Transects 10 through 12, near the Smith River.
- Approximately 19,300 linear feet at Transect 14 near Lake Earl.
- Approximately 2,600 linear feet at Transect 17 at Pebble Beach, Crescent City.