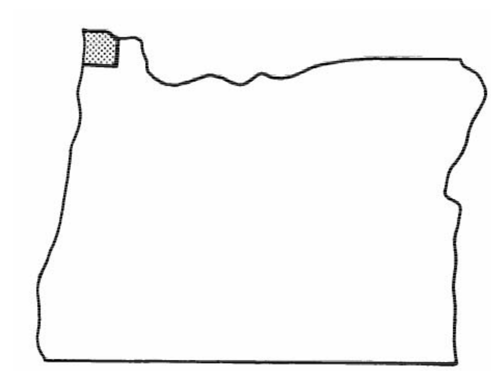
FLOOD INSURANCE STUDY

CLATSOP COUNTY, OREGON AND INCORPORATED AREAS VOLUME 1 OF 2



COMMUNITY NAME	COMMUNITY NUMBER
ASTORIA, CITY OF	410028
CANNON BEACH, CITY OF	410029
CLATSOP COUNTY, UNINCORPORATED AREAS	410027
GEARHART, CITY OF	410030
SEASIDE, CITY OF	410032
WARRENTON, CITY OF	410033

September 17, 2010

Federal Emergency Management Agency

Flood Insurance Study Number
41007CV001A

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.

Selected Flood Insurance Rate Map panels for the community contain information that was previously shown separately on the corresponding Flood Boundary and

Old Zone	New Zone
A1 through A30	AE
V1 through V30	VE
B	X
C	X

Floodway Map panels (e.g., floodways, cross sections).. In addition, former flood hazard zone designations have been changed as follows

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by a 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 report components.

This FIS report was revised on September 17, 2010. Users should refer to Section 10.0, Revisions Descriptions, 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 17, 2010

TABLE OF CONTENTS – VOLUME 1

FIGURES

TABLES

TABLE OF CONTENTS – VOLUME 2

EXHIBITS

PUBLISHED SEPARATELY
Flood Insurance Rate Map Index

FLOOD INSURANCE STUDY
CLATSOP COUNTY, OREGON 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 Clatsop County, including the Cities of Astoria, Cannon Beach, Gearhart, Seaside, and Warrenton; and the unincorporated areas of Clatsop County (referred to collectively herein as Clatsop 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 at 44 CFR, 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.

Please note that the Town of Hammond is no longer an incorporated community. The community has been annexed by the City of Warrenton in or around 1996. All further mention of the Town of Hammond has been removed unless referencing the previous study done for the Town of Hammond.

1.2 Authority and Acknowledgments

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

The hydrologic and hydraulic analyses for this study were performed by CH2M HILL, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. H-3803. It study was completed in May 1977.

The hydrologic and hydraulic analysis for the revised data for the City of Seaside was performed by WEST Consultants, Inc. It was completed in May 2005.

1.3 Coordination

Consultation Coordination Officer's (CCO) meetings may be held for each jurisdiction in this countywide FIS. An initial CCO meeting is held typically with representatives of FEMA, the community, the state, and the study contractor to explain the nature and purpose of a FIS and to identify the streams to be studied by detailed methods. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

The dates of the initial and final CCO meetings held for Clatsop County and the incorporated communities within its boundaries are shown in Table 1, "Initial and Final CCO Meetings."

Table 1. Initial and Final CCO Meetings

Community	Initial CCO Date	Final CCO Date
Astoria, City of	September 1975	April 19, 1977
Cannon Beach, City of	September 1975	April 18, 1977
Clatsop County, Unincorporated Areas	September 4, 1975	April 19, 1977
Gearhart, City of	September 1975	April 21, 1977
Seaside, City of	March 1975	July 13, 1978
Warrenton, City of	September 1975	April 19, 1977

The results of the each community's FIS reports were reviewed at the final CCO meeting. All problems raised at those meetings have been addressed in their respective studies.

Countywide
The results of the study were reviewed at the final Consultation Coordination Officer [CCO] meeting held on November 8, 2007, and attended by representatives of City of Astoria, City of Cannon Beach, City of Seaside, City of Warrenton, Clatsop County, FEMA, Department of Land Conservation and Development and West Consultants. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS report covers the geographic area of Clatsop County, Oregon, including the incorporated communities listed in Section 1.1. The areas studied be detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction.

At the February 1975 meeting, it was agreed that the following areas would be studied in detail:

1. Plympton Creek, from its confluence with the Columbia River to 1 mile upstream.

2. Three miles of shoreline along the Columbia River, from Wauna to the Clatsop-Columbia County line

3. One mile of shoreline along the Columbia River at Bradwood

4. One-half mile of shoreline along the Columbia River at Clifton

5. Three miles of shoreline along the Columbia River at Brownsmead

6. Blind Slough, from its confluence with the Columbia River upstream to Davis Creek

7. Grizzle Slough, entire length

8. Big Creek, from its confluence with the Columbia River to 2 miles upstream

9. Little Creek, from its confluence with the Columbia River to 2 miles upstream

10. Ferris Creek, from its confluence with the Columbia River to 1.5 miles upstream

11. Bear Creek, from its confluence with the Columbia River to 1 mile upstream

12. Little Walluski River, from its confluence with the Walluski River to 1.5 miles upstream

13. Youngs River, from the confluence of the Lewis and Clark River to the confluence of the Klaskanine River, excluding the east shoreline from the corporate limits of Astoria to the confluence of the Walluski River

14. Lewis and Clark River, from the confluence with Youngs River to the confluence with Shweeash Creek

15. The Pacific Ocean coastline, from the corporate limits of Warrenton to the corporate limits of Gearhart

16. Mill Creek and tributaries at Seaside, entire length

17. Neawanna Creek, from its confluence with Neacoxie Creek upstream to the Sunquist Road Bridge, excluding flooded areas within the corporate limits of Seaside and Gearhart

18. The Pacific Ocean coastline, from the corporate limits of Seaside to a point 0.5 mile south

19. Necanicum River, from a point 2 miles downstream from Necanicum Junction to the corporate limits of Seaside

20. The Pacific Ocean coastline, from the corporate limits of Cannon Beach to the Clatsop-Tillamook County line

21. North Fork Nehalem River, from Hamlet to a point 2 miles downstream

22. Nehalem River, from the Clatsop-Columbia County line to a point 1.5 miles downstream from the confluence of Humbug Creek

23. Humbug Creek, from its confluence with the Nehalem River to 2 miles upstream

24. Cow Creek, from its confluence with the Nehalem River to 1 mile upstream

25. Beneke Creek, from its confluence with the Nehalem River to its confluence with Fishhawk Creek, thence upstream on Fishhawk Creek for 0.5 mile

26. Northrup Creek, from its confluence with the Nehalem River to 1 mile upstream

27. Fishhawk Creek from a point 0.25 mile upstream from Clatsop-Columbia County line to a point 0.25 mile downstream from the Fishhawk Lake Dam

Those areas studied by detailed methods were chosen with consideration given to all proposed construction and forecasted development.

The following areas were studied using approximate methods:

1. The shoreline of the Columbia River, from its confluence with Westport Slough to the Clatsop-Columbia County line

2. The north shoreline of Westport Slough, from its confluence with the Columbia River to the Clatsop-Columbia County line

3. The drainage basin at Ivy Station, from the Burlington and Northern Railway to 0.75 mile upstream

4. The John Day River, from 1.75 miles upstream of the U.S. Route 30 bridge to 0.75 mile downstream of the U.S. Route 30 bridge

5. The Walluski River, from its confluence with Youngs River to 3 miles upstream

6. The Klaskanine River, from its confluence with Youngs River to 2.75 miles upstream

7. The Skipanon River, from the Rodney Acres Road bridge to 1 mile upstream

2.2 Community Description

Clatsop County is located on the north coast of Oregon. It is bordered by the Columbia River on the north, the Pacific Ocean on the west, Columbia County on the east, and Tillamook County on the south.

The county has an area of 921 square miles, of which 820 square miles is land and 101 square miles is part of the Columbia River. The county also has 36 miles of shoreline along the Pacific Ocean.

The land area of Clatsop County has varied terrain which is dominated by rugged mountains, with steep, sloping valleys and sharp peaks and ridges. Elevations range from sea level to over 3,000 feet. The entire county is located on the western and northern slopes of the Coast Range Mountains.

Several short streams flow northward into the Columbia River estuary from adjacent uplands, including Plympton Creek, Big Creek, Little Creek, Ferris Creek, and John Day River. The Youngs River, Lewis and

Clark River, Skipanon River, Walluski River, Little Walluski River, and the Klaskanine River also flow north, and enter the Youngs Bay estuary just west of Astoria. The Necanicum River and the Nehalem River flow westward toward the Pacific Ocean from upland areas of the Coast Range Mountains.

The mountainous, upland areas are generally igneous rock, with some sedimentary rock, overlain by a thin soil cover of silt or clay. Generally, streams and rivers flowing through these upland areas are turbulent and fast flowing through channels or steep-walled canyons of igneous rock.

In Clatsop County, much of the Columbia River and Youngs Bay and its tributaries are bordered by low-lying, flat, alluvial clay and silt floodplains. Elevations of these lowlands are at or near sea level and rely on an extensive diking system and tide gates to prevent flooding during high tides.

Another lowland area, the Clatsop Plains, extends along the Pacific coast from the Columbia River south to Seaside. It varies in width from 1 to 2 miles. The alluvial terraces of the east side of the Clatsop Plains are gradually replaced by a series of parallel beach ridges and sand dunes near the Pacific Ocean. Many of the beach ridges and dunes are separated by lakes and swamps.

Due to the moderating influence of the Pacific Ocean, Clatsop County has cool summers and mild winters. Approximately 80 percent of the precipitation occurs during the months of October through March. Precipitation varies from 80 inches at lower elevations to 120 inches in the mountain areas. Average yearly precipitation is 81.03 inches at Astoria and 79.70 inches at Seaside. Average temperature ranges for Astoria vary from a low of 41.0°F to a high of 61.4°F; temperature ranges for Seaside vary from a low of 43.3°F to a high of 60.1°F (Reference 2).

A majority of the county land area is forested. A small percentage of the county is agricultural and residential. Most of the forestland area is privately owned. The dominant forest species is Western hemlock, with Douglas fir and Sitka spruce ranking second and third, respectively (Reference 2).

The estimated population of Clatsop County in 2004 was 36,340 (Reference 1). Most of this population was concentrated in the lowland areas along the Pacific coast and the Columbia River. The larger incorporated communities and their populations include Astoria, 9,660; Seaside, 5,916; Warrenton, 4,205; Cannon Beach, 1,608; and Gearhart, 985 (Reference 1).

Clatsop County and its community's major industries include forestry and wood products, commercial and sport fishing, fish processing, agriculture, waterborne materials transportation, tourism, and recreation.

Development is restricted by the topography, which is quite steep throughout most of the county. Most development has occurred in the lowland farm- and pastureland of the lower river valleys, Youngs Bay, and the Pacific Ocean coastline.

City of Astoria

Astoria is located in northwestern Clatsop County. It is situated on a peninsula formed by the Columbia River and Youngs Bay, approximately 10 miles, by water, from the Pacific Ocean.

The topography of Astoria is quite rugged. It varies from sea level to over 600 feet in elevation. The soil is derived from sedimentary deposits consisting primarily of well-drained silty loam and silty clay, several feet deep. These soils support forest and pasture vegetation. The majority of the open land within the corporate limits is covered with coniferous trees, such as western hemlock and sitka spruce. Some areas support either stands of red alder trees and other hardwoods or grasses and shrubs.

City of Cannon Beach

Cannon Beach is located in the southwestern portion of Clatsop County. The city is located at the mouth of Elk Creek on the Pacific Ocean, approximately 25 miles south of Astoria, and 80 miles northwest of Portland.

The Oregon coast in this area is characterized by rugged terrain, offshore rocks, and sand beaches alternating with headlands of resistant rock. The area is very susceptible to erosion by the wind and ocean waves. A narrow strip of beach sand extends south from Chapman Point for several miles. The beach consists of relatively flat land with little or no vegetation. Typical ocean beach slopes, measured between sea level and an elevation of 25 feet, vary from 10 percent. Offshore slopes average approximately 1 percent.

Cannon Beach is the only developed area in the Elk Creek watershed. Flooding in Cannon Beach is from the Pacific Ocean, which borders the city to the west, and Elk Creek, which drains the northern part of the city.

The entire drainage basin lies within 6 miles of the Pacific Ocean, in Clatsop County, and drains approximately 22 square miles of mountainous land in the Oregon Coast Range. Elk Creek's stream slope is relatively flat in the lowermost 2-mile reach, downstream from the confluence of its north and west forks. The head of tidewater lies near the U.S. Highway 101 bridge, at approximately River Mile 1.0.

The climate of the Elk Creek basin is characterized by wet winters and comparatively dry summers. No rain gages exist in the basin. The nearest recording station is at Seaside, 8 miles north of Cannon Beach, where normal annual precipitation is 80 inches.
Rainfall in the mountains of Elk Creek basin is estimated at 110 inches annually. Approximately 80 percent of that total occurs during the 6-month period of October through March. Snow is not common and seldom remains on the ground longer than a few days.

During the late fall and winter months, the Oregon coast is subject to frequent, intense, flood-producing storms, which usually sweep in from the southwest. Several inches of rain often fall in a 24-hour period. Such storm conditions may occur several times during the winter season in the Elk Creek basin and are often accompanied by high winds. During those storms, winds are generally from the southwest, and gusts up to 100 miles per hour have been experienced.

Elk Creek's flow is directly related to the watershed precipitation pattern, with high flows occurring during the months of October through March, and low flows occurring during July, August, and September. Because of the small drainage area and steep stream gradient, Elk Creek rises quickly following periods of intense precipitation.

Tides at Elk Creek exhibit the diurnal (daily cycle) inequality that is typical of the Pacific Coast of North America. Two unequal tides occur each day, the long runout to low water normally follows higher high water. The mean diurnal range of tide is approximately 6 feet.

<u>City of Gearhart</u>

The City of Gearhart is located on the shoreline of the Pacific Ocean, approximately 73 miles northwest of Portland, Oregon. It is situated on Oregon Coast Highway 101.

The topography in Gearhart is typical of many Oregon coastal communities. The city is situated on a series of stabilized dunes, which parallel the coast. The coastline is characterized by narrow, sandy beaches, with elevations rising from sea level to an average of 25 feet throughout the city. Typical ocean beach slopes, measured between mean sea level and 25 feet above, vary from 5 to 12 percent. Offshore slopes average from 1 to 2 percent. East of Coast Highway 101, elevations range from 25 to 30 feet, with land sloping upward to approximately 250 feet at the foot of the Coast Range.

Soil erosion from wind has been a major problem in Gearhart. The dunes were stabilized in the 1920s and 1930s by a concerted beach grass development program. The program has been effective, but careful maintenance is required to prevent a recurrence of erosion. The grass used for dunes stabilization is of the Holland variety, while the predominant vegetation inland is conifer forest.
The areas subject to coastal flooding in Gearhart are typically developed as single-family residential or condominiums. Inland flood-prone areas include single-family residences, trailer courts, and the airport. Several city streets cross through flood-prone areas.

City of Seaside

The City of Seaside is located on the west-central border of Clatsop County and lies along the Pacific coast on the west slope of the Coast Range.

The Necanicum River drains approximately 68 square miles on the Pacific Ocean side of the northern Coastal Range. It flows 18 miles in a generally northwestern direction to within 0.25 miles of the Pacific Ocean, then flows north for approximately 3 miles, before turning west to empty into the ocean. The lower 3 miles are separated from the ocean by a sandpit, ranging from 0.25 to 0.50 miles in width, forming part of the City of Seaside. There are 1.8 miles of ocean front within Seaside.

In its lower reaches, the Necanicum River is joined by several tributaries. These streams meander through farmlands, then flow through Seaside to the ocean.

Neawanna Creek flows from the east, meanders along the valley floor through Seaside, and joins the Necanicum River in the bay area, approximately 0.5 mile upstream from the Pacific Ocean.

Circle Creek flows from the south, meanders along the Necanicum River valley floor, and joins the Necanicum River at the Seaside Golf Course.

A lowland area of Clatsop County, known as the Clatsop Plains, extends along the Pacific coast from the Columbia River south to Seaside. It varies in width from 1 to 2 miles. The alluvial terraces of the east side of the Clatsop Plains are gradually replaced by a series of parallel beach ridges and sand dunes near the Pacific Ocean (Reference 2).

City of Warrenton

The City of Warrenton is located in Clatsop County, in the extreme northwestern part of Oregon on Youngs Bay, near the mouth of the Columbia River. The Pacific Ocean forms the western corporate limit.

The terrain of Warrenton varies from flat to rolling hills, ranging in elevation from 2 feet to 100 feet. Tide levels in Youngs Bay and the Columbia River occasionally reach from 7 to 8 feet. Much of the soil is alluvial, containing silt, sand, and gravel. These soils have good permeability, but internal drainage is a problem in low areas, especially during periods of extended rainfall. Wet or swampy conditions are common in the low areas, with accumulations of peat-like, organic material. The soil is generally classified as U.S. Soil Conservation Service Class III, but is often too wet to farm efficiently.

Development in Warrenton has been concentrated primarily on the west bank of the Skipanon River. The Skipanon River provides sheltered moorings and easy access to the Columbia River for commercial and private watercraft. Several highways pass through the area, providing important links to the surrounding regions. Additional development occurs along these routes, particularly the Fort Stevens Highway in the vicinity of Alder Creek and the Columbia River. Other areas of development are quite limited. The Clatsop County Airport occupies a substantial portion of the eastern part of the corporate territory.

2.3 Principal Flood Problems

Flooding in Clatsop County occurs principally during the winter months. The most extensive flooding occurs in the low-lying coastal and estuary areas. In these areas, flooding is a result of high spring tides and strong winds from winter storms. Heavy rains with some snowmelt produce the highest runoff flows during the winter months. The storms that produce the storm surges also bring heavy rains; therefore, the high riverflows are held back by tides, producing the greatest flooding at river mouths.

Diked areas bordering the Columbia River and Youngs Bay and its tributaries are often flooded during the winter months. High tides and riverflows close tide gates on dikes, often for extended periods. While tide gates are closed, storm runoff accumulates and floods the flat, low-lying floodplain areas. Extreme high water often overtops or breaches poorly maintained dikes. Occasionally, debris clogs a tide gate and causes some minor flooding.

Flooding on those portions of streams and rivers in the upland areas is much less severe than in the low, flat coastal and estuary areas. In most cases, the extent of flooding is limited by the narrowness of the stream valleys. Many rivers have built up terraces along their banks which constrict all but the most severe floods to the channel.

High amounts of rainfall and the impermeability of underlying strata produces annual runoff in excess of 60 inches over much of the county. Individual drainage basins, however, differ considerably in runoff. Runoff is greater on some basins because there is less forest cover as a result of intensive, clearcut logging or forest fires; steeper valley slopes; or higher elevations along the basins rim, which induce more rainfall. However, things change, and therefore this statement must be taken with a grain of salt.

Flooding in Clatsop County is also caused by log jams and landslides. Log jams usually occur on the smaller streams in upland areas where the stream gradient is steep. However, flooding from log jams is usually not a serious flood problem.

Mudflows and earthflows are common in the county, but the location and frequently of these events are not predictable. These earthen movements are only significant to flooding when they can effectively dam a stream and impound water. Impounded water can cause flooding upstream. Once the slide has been breached by overflow of impounded water, areas downstream can experience a serious flash flood. However, a landslide or earth movement is likely to completely dam only the smaller streams with steep valley side slopes, such as Cow Creek on the Nehalem River. In Clatsop County, this type of stream usually has little population or development near its banks and the hazard of this type of flooding is minimal.

Significant floods that have occurred in Clatsop County in the past were recorded in February 1949, February 1961, January 1964, December 1970, January 1971, January 1972, December 1981, January 1990, and February 1996. The January 1972 flood was close to a 1-percent-annual chance flood frequency throughout much of the County.

On March 27, 1964, a tsunami wave originating in Alaska caused widespread damage in Warrenton, Seaside, and Cannon Beach. The surge of water was so great in the City of Cannon Beach that it swept the 200-foot-long Elk Street Bridge 0.25 mile upstream. Motels along Elk Creek were badly damaged, and much of the business district was flooded. The two business blocks from 1st to 3rd Streets and from Hemlock to Spruce Streets were underwater, as was the area east of U.S. Highway 101. The tsunami caused $41,000 damage to the City of Seaside and $235,000 damage to private property in the Seaside area. Flood elevations in this report do not include the runup from tsunami waves.

In November 2006, the Clatsop County Board of Commissioners declared a countywide state of emergency in response to flooding and other damage caused from storms.

City of Astoria

Historical records and personal interviews indicate that floods have caused very little damage in Astoria. Most of the city is on high ground. See Section 2.4 “Flood Protection Measures” for more information. The area near Cedar and Birch Streets is the only area with significant flood problems. Water from the drainage basin south of Birch Street flows northward toward the Columbia River. The low area between Birch and Cedar Streets traps the water, causing flood hazards.

Flooding sources affecting Astoria are Youngs Bay on the south and west, the Columbia River on the north, and several small streams within the city. Because the city is located near the ocean, flood levels are directly affected by astronomical tides and storm surge. Riverflow and the effects of coastal storms and tides combine to cause flood hazards in the city.

The levees that protect the city from flooding sometimes cause flooding. When water levels are high in either the Columbia River or Youngs Bay, the tide gates in the levees do not open to allow the water which has accumulated behind the levees to escape. If the water levels in either the river or bay remain high for a long period of time, flooding can occur behind the dikes from the accumulation of local runoff. This problem exists in several areas within the city.

City of Cannon Beach

Flooding in Cannon Beach is almost entirely ocean-related. The primary source of flooding is the Pacific Ocean. In addition, Elk Creek is a flood source when higher-than-normal flows in the creek occur in conjunction with very high tides caused by coastal storms. High astronomical tides topped with surges and waves caused by strong winds of winter storms are responsible for coastal flooding. The large waves run up onto ocean beaches to flood shoreline structures. Furthermore, wave setup on top of storm surge and high tide combine in Elk Creek to back up streamflow and cause flooding in lowlands.

The greatest flood of record in Cannon Beach occurred on January 3, 1939, when wind-driven waves caused extensive damage. The 1939 storm constituted a 75-year flood along the coast. On December 2 and 3, 1967, Cannon Beach was battered by unusually destructive storm waves that were measured at the 50-year flood level. The waves were generated by the cumulative effect of prolonged 50-mile per hour south-westerly winds and still-water levels exceeding 7 feet. Cannon Beach was hit by open-coast storm waves of a 10 to 15-year flood magnitude on February 18, 1976. In the last 25 years, flooding was recorded in January 1983 and February 1986.

During the flood of December 2 and 3, 1967, water ponded to an elevation of 11.5 feet, a depth of 2.5 feet above the street surface, at the intersection of 2nd and Hemlock Streets, the center of the city's business district. Approximately 35 stores and business establishments, several public building, the conference complex, and three residential properties were flooded. Water and sanitary facilities were damaged, creating a health hazard. Similar, but less severe, flooding has occurred three other times in the last 20 years.

In 1969 the city built its temporary low levee north of Second Street. Minor flooding of the protected area has occurred. In the winter of 1971, a freshet caused waters in Elk Creek to rise and flow around the downstream end of the city's levee. In January 1972, a high tide aided by wind and wave buildup resulted in the overtopping of that levee in two locations; however, prompt sandbagging by local residents prevented failure of the levee and limited inundation on the landward side to undeveloped low areas.

City of Gearhart

Severe floods are caused by adverse combination of climatic conditions. The freezing level, during the most intense rainstorms, often rises to 10,000 feet or more, causing significant melting of accumulated snow. When the ground is near saturation, the runoff is great and rapid. In addition, onshore winds may raise tides higher than predicted, creating a more severe blocking of the river outlet than usual.

Neacoxie Creek passes through the central city area and drains into the Neawanna Creek-Necanicum River estuary area. The portion of Gearhart lying east of Oregon Coast Highway 101 drains southerly through several small surface drainageways, which combine and empty into Neawanna Creek through several parallel tidal gates. A major source of flooding in the eastern portion of Gearhart is created when the drainageways and/or the tidal gates become obstructed with debris. The estuary becomes a flooding source by backing up higher-than-normal flows from Neacoxie Creek, with very high tides caused by coastal storms and high flow from the Necanicum River. High astronomical tides, topped with surges and waves caused by strong winds of winter storms, results in coastal flooding. The large waves run up the narrow ocean beach to flood coastal properties.

One of the greatest ocean floodings in Oregon history occurred on January 3, 1939, when wind-driven waves caused extensive damage. This event was estimated to be a 75-year flood.

Other floods occurred on December 12, 1969; December 6 and 30, 1970; January 11 and 25, 1971; January 11 and 20, 1972; December 12 and 21, 1972; November 22, 1973; and January 16, 1974. The more significant floods that have occurred in the past would include February 1949, February 1961, January and December 1964, and January 1966. Significant open-coast flooding occurred in 1952, 1960, and 1964.

East of Oregon Coast Highway 101, flood levels rise in combination with the increase in elevation of Neawanna Creek. In the winter of 1969, the floodgates draining the eastern portion of the city under Oregon Coast Highway 101 became obstructed with debris. Flooding between 1 and 5 feet deep occurred extensively on the eastern side of Oregon Coast Highway 101.

City of Seaside

During flood stages, the stream cause severe damage from overbank flooding and streambank erosion. Log jams and deposited debris also cause considerable damage. During high floods, the Necanicum River overflows its banks and flows west into the Circle Creek flood plain. This happens at various locations from above the corporate limits northward to the Seaside Golf Course. From Peterson Point north to the Seaside Golf Course, floodwater from the Necanicum River overflows U.S. Highway 101 and into the Beerman Creek flood plain east of the city. Floodwater from Necanicum River also flows eastward under Dooley Bridge into the Neawanna Creek flood plain.

The more significant floods that have occurred in the past occurred in February 1949, February 1961, January 1964, December 1964, and January 1966. The most severe recorded flood was in February 1949. This flood caused extensive damage. A flood in January 1990 was the highest observed flood in the past 40 years.

Flood damage in tidal and coastal areas is a result of high stillwater levels and wave action. The stillwater level is caused by astronomical tides (caused by gravitational effects of the moon and sun) and storm surges (rise in water levels due to wind stress and low atmospheric pressure). Wave action produces a rise in water level, due to shoreward mass transport of the water, which is called wave runup or setup. In addition, wave runup, after breaking, produces flooding, and the velocity of the wave causes damage above the stillwater level of the flood.

City of Warrenton

Flooding in Warrenton is also caused by the influence of astronomical tides and storm surge on the discharge of area streams. The land within the city is low, and levees have been constructed which prevent flooding from tides or storm surge in the Columbia River and Youngs Bay. However, these levees also cause flooding by trapping local runoff when the Columbia River is high. Flooding along Alder Creek and parts of the Skipanon River is a result of trapped runoff. This flooding is typically shallow, with low velocities and short duration. The Lewis and Clark River causes flood hazards in the east part of Warrenton when the levees along the river are overtopped.

2.4 Flood Protection Measures

Special Flood Hazard Areas (SFHAs) along the Columbia River were previously shown as protected by levees in the USACE Rehabilitation and Inspection Program (RIP). The USACE has placed these levees on an inactive status in the RIP due to maintenance deficiencies. Due to these deficiencies, the levees do not meet the minimum requirements of 44 CFR Section 65.10 and therefore cannot be accredited. For this reason, the landward areas of the levees are identified as SFHA. The base flood elevation of the Columbia River applies to the area landward of the levee as well.

Flood protection measures along Youngs Bay and its tributaries and the Columbia River include an extensive system of dikes and tide gates, most of which were constructed in 1939. Diking districts in the areas studied are as follow:

1. Lewis and Clark River
    a. Clatsop County Diking District No. 11
    b. Clatsop County Diking District No. 8
    c. Clatsop County Diking District No. 5
    d. Clatsop County Diking District No. 2

2. Youngs River
    a. Clatsop County Diking District No. 3
    b. Clatsop County Diking District No. 9

3. Klaskanine River
    a. Clatsop County Diking District No. 9

4. Walluski River & Little Walluski River
    a. Clatsop County Diking District No. 13

5. John Day River
    a. Clatsop County Diking District No. 14

6. Blind Slough, Grizzly Slough, and Columbia River
    a. Clatsop County Diking District No. 1
    b. Clatsop County Diking District No. 4
    c. Clatsop County Diking District No. 7

7. Westport Slough
    a. Clatsop and Columbia County Diking District No. 15

Most of the dikes have received some improvements since they were constructed, such as bank protection, additional tide boxes, and tide box replacements by the U.S. Army Corps of Engineers (USACE). Most are maintained in fair condition by citizen-organized diking districts, which levy taxes to accomplish maintenance. However, a few diking districts have not been maintained adequately and are flooded frequently during winter months. None of these dikes do not meet the minimum requirements of 44 CFR Section 65.10 and therefore cannot be accredited. The landward areas of the levees are identified as SFHA. They do not provide protection from the 1-percent-annual chance flood.

City of Cannon Beach

No Federal or State flood-control works exist in Elk Creek basin.

In the early 1970's, the USACE studied the feasibility of constructing flood-control levees along Elk Creek at Cannon Beach (Reference 3), but the project was not authorized. Other than localized construction of rock, concrete, and wood bulkheads around private property, no construction of open-coast flood protection has been performed in Cannon Beach.

City of Gearhart

A private dike, approximately 700 feet long, was constructed in the 1970's along the right bank of Neacoxie Creek at its mouth. The city also implemented a limited bank stabilization project along the lower portion of the Necanicum River estuary area. No open-coast flood protection measures exist near Gearhart. These levees do not provide protection from the 1-percent-annual chance flood due to requirements of 44 CFR Section 65.10. The landward areas of the dike are identified as SFHA.

City of Seaside

The coastal shoreline of Seaside is protected by a seawall, except for a portion at the south of the city where a rockpile wall has been installed. These protections, along with the extensive beach area built up during the last 75 years and regulations forbidding the removal of sand from the entire beach, will protect most of Seaside from storms smaller than the 1-percent-annual chance frequency. The 1-percent-annual chance flood is not protected by these levees. The landward areas of the seawall are identified as SFHA. No flood plain management measures have been undertaken in the City of Seaside.

City of Warrenton

A levee system protects Warrenton from some water levels in the rivers and Youngs Bay. The system was initially designed and constructed by the USACE around 1940. This levee system has been placed on the inactive status due the failed requirements of 44 CFR Section 65.10. They cannot be accredited; therefore the landward areas of the levee system are identified as SFHA. Shoreline erosion in places has become a matter of concern, but has not yet affected the levee system.

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 is 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 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.

The hydrologic analysis for Clatsop County is broken into four parts: riverine, tidal, coastal, and diked areas.

For riverine flooding sources, peak discharge-frequency curves were developed from stream gage records, where available, using log-Pearson Type III frequency analysis (Reference 4). To obtain flows at the proper locations in the study area, for sites on a gaged stream and not at the gage, the following formula was used

$$Qs = Qg\,(As / Ag)^{a}$$

Qs and Qg are flows at the site and gage, respectively; As and Ag are drainage areas above the site and gage, respectively; and a is a constant developed from flow data measured at gages in the county.

Because Astoria and Warrenton lie near the mouth of the Columbia River, flood levels are strongly influenced by the Pacific Ocean. To accurately predict flood levels, many variables must be considered, including astronomical tide, storm surge, wave setup, local wind, waves, tsunamis, and riverflow.

The following streams did not have available or reliable streamflow data:

1. Lewis and Clark River
2. Little Walluski River
3. Ferris Creek
4. Little Creek
5. Plympton Creek
6. Fishhawk Creek near Birkenfeld
7. Northrup Creek
8. Fishhawk Creek at Jewell
9. Beneke Creek
10. Cow Creek
11. Humbug Creek
12. North Fork Nehalem River
13. Necanicum River

Discharge-frequency relationships for these Clatsop County streams were determined by analyzing several regional frequency methods, including the U.S. Geological Survey regional method (Reference 5), a USACE regional method (Reference 6), U.S. Geological Survey regression equations (Reference 7), an Oregon State Engineers regional method (Reference 8), and regional relations developed by the study contractor.

The following stream gage records were used to develop regional frequency-discharge relationships:

Table 2 – Stream Gage Records

Gage Name	County	Years of Record
Fall Creek Near Clatskanie	Columbia	11
Oak Ranch Creek Near Vernonia	Columbia	10
Little Creek Near Knappa	Clatsop	12
South Fork Necanicum Near Seaside	Clatsop	16
Asbury Creek Near Cannon Beach	Clatsop	26
Fishhawk Creek Near Jewell	Clatsop	7
Youngs River Near Astoria	Clatsop	31
North Fork Kalskanine River near Olney	Clatsop	6
Big Creek Near Knappa	Clatsop	6
Bear Creek Near Svenson	Clatsop	9
Wilson River Near Tillamook	Tillamook	93
Nehalem River Near Foss	Tillamook	68
Trask River Near Foss	Tillamook	35
Nestucca River Near Beaver	Tillamook	27
Siletz River at Siletz	Lincoln	102

At the time these hydrologic investigations took place there were only 3 years of record for Fall Creek and Little Creek, 23 years of record for Asbury Creek, 4 years of record for Fishhawk Creek, 43 years of record for Wilson River, 35 years of record for Nehalem River, 10 years of record for Nestucca River, and 57 years of record for Siletz River.

Discharge-frequency relationships were computed by each method previously listed. Relationships developed by the study contractor specifically for the Clatsop County area were given more weight than others for selecting the final discharge-frequency curve to establish the 10-, 50-, 100-, and 500-year peak flows. Watershed characteristics, such as forest cover, annual precipitation, precipitation intensity (2-year and 24-hour events), temperature index, and soils index, were used to define the frequency relationships for each study area.

Peak floodflows on Alder Creek and the Skipanon River were determined using regional techniques (Reference 9). The triangular hydrograph analysis method (Reference 10) was used to determine peak flows and to construct a typical hydrograph. The peak flows obtained by the two methods compared favorably. The hydrograph provided discharges versus time relationships to allow correlation of floodflows in Alder Creek and the Skipanon River with tide levels of Youngs Bay. Another hydrograph provided discharge versus time relationships to allow correlation of floodflows in Alder Creek with tide levels of the Columbia River.

Hydrology to compute flood hazards for the area east of the Skipanon River (Warrenton Diking District Nos. 2 and 3) was based on the combined probability for peak rainfall and extreme tide elevations. This resulted in the 4-percent-annual chance rainfall being used to compute the 1-percent-annual chance flooding behind the levees.

High and low tide elevations for a typical 7-day tide cycle were developed from tide data recorded by the National Oceanic and Atmospheric Administration on the Columbia River at Astoria, Oregon. Hourly fluctuations were computed using methods outlined by the National Oceanic and Atmospheric Administration (Reference 11). These tidal elevations were used as the downstream boundary control for computing flood levels in Alder Creek.

Peak discharge-drainage area relationships for Clatsop County are shown in Table 3, Summary of Discharges.

Local drainage area contributing to the Necanicum River Overflow was not calculated because overflows from the Necanicum River were determined to be driving the peak flows for large flood events. Consequently, no local flow values were calculated either.

Flood damage in tidal and coastal areas is caused by high stillwater levels and wave action. The stillwater level is a result of astronomical tide (caused by gravitational effects of the sun and moon) and storm surge (rise in water levels due to wind stress and low atmospheric pressure). Wave action also produces a rise in water level due to shoreward mass transport of the water. This is wave setup. Wave runup, after breaking produces flooding, and the energy of the wave produces damage above the stillwater level of the flood.

It was not necessary to collect specific data on astronomical tide, storm surge, or riverflow to establish stillwater levels on the Columbia River. Profiles are available which give elevations for various flood frequencies (Reference 12). These profiles are based on a frequency analysis of measured flood elevations along the Columbia River and, therefore, include the combined effects of each condition affecting stillwater levels.

Most significant flood events due to astronomical tide and storm surge occur during the period from November to March. The astronomical tide height histogram was computed using hourly predicted tides (Reference 13). Predicted tides were calculated from tide tables (Reference 14).

Surface weather maps at 3-hour intervals for the period from 1942 to 1975 (Reference 15) were used to compile statistics on significant storm surge-

Table 3. Summary of Discharges

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CFS) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
BEAR CREEK					
At Columbia River Highway	13.1	848	1,272	1,467	2,022
BEERMAN CREEK					
Upstream End	2.66	1,207	1,634	1,665	1,956
BIG CREEK					
At Old U.S. Highway 30	33.3	2,086	2,646	2,864	3,373
COW CREEK					
At Mouth on Nehalem River	3.9	490	570	610	710
FISHHAWK CREEK AT BIRKENFELD					
At Greasy Spoon Road	22.7	2,250	2,650	2,850	3,300
FISHHAWK CREEK AT JEWELL					
At Mouth on Nehalem River (Beneke Creek)	62.0	5,350	6,350	6,800	7,850
At Mouth on Beneke Creek	36.3	2,450	2,900	3,100	3,550
HUMBUG CREEK					
At Mouth on Nehalem River	29.5	3,900	4,800	5,100	5,900
LEWIS AND CLARK RIVER					
At Mouth on Youngs Bay	62.0	4,480[1]	5,300[1]	5,680[1]	6,550[1]
At Chadwell	49.7	4,448	5,300	5,680	6,550
At Confluence With Stovebolt Creek	44.6	4,080	4,820	5,170	5,960
At Confluence With Shweeash Creek	33.4	3,180	3,760	4,030	4,650
LITTLE CREEK					
At Old U.S. Highway 30	4.5	334	453	503	620
LITTLE WALLUSKI RIVER					
At Walluski Loop Road	2.7	360	430	460	525
At Cross Section E	1.0	150	183	196	224
NEACOXIE CREEK					
At Golf Course Road	3.68	278	382	420	520

[1]Flow is Reduced Due to Restrictions From Dikes and Levees

Table 3. Summary of Discharges

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CFS) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
NEAWANNA CREEK					
Upstram End	0.75	465	630	642	754
NECANICUM RIVER					
Above Upper Neawanna Creek	66.6	13,526	18,307	18,657	21,922
Above Beerman Creek	62.4	12,877	17,428	17,761	20,870
Near Junction of US 101 and US 26	54.9	11,693	15,826	16,128	18,951
Klootchie Creek	48.4	10,900	13,600	14,700	17,300
At Confluence With South Fork Necanicum River	37.2	8,800	11,100	12,100	14,300
At Confluence With North Fork Necanicum River	24.0	6,400	8,000	8,700	10,300
NEHALEM RIVER					
At Confluence With Humbug Creek	538.0	30,000	38,000	42,750	50,150
At Sunset Highway (Jewell Junction)	498.0	26,700	33,800	38,000	44,600
At Nehalem Highway Bridge (River Mile 50.0)	398.0	25,150	31,925	35,850	41,900
At Nehalem Highway Bridge (River Mile 62.0)	363.6	22,500	28,800	32,000	37,600
NORTH FORK NEHALEM RIVER					
At Aldervale (County Road Ridge)	75.1	8,780	12,400	14,100	17,900
At Confluence With Grassy Lake Creek	62.0	7,970	11,700	13,400	17,300
At Hop'n Scotchit Road	16.5	2,596	3,068	3,293	3,798
NORTHRUP CREEK					
At Mouth on Nehalem River	12.6	1,350	1,600	1,700	2,000
PLYMPTON CREEK					
At Mouth on Columbia River	10.0	650	885	980	1200
UPPER NEAWANNA CREEK					
At Confluence with Neawanna Creek	0.75	465	630	642	754

cfs -cubic feet per second

producing events on the northern Oregon coast for the initial flood study in the 1970's. This data were separated into three wind direction classes so that appropriate wave statistics could be combined with storm surge statistics generated with a storm surge model. A description of the storm surge model is given in Section 3.2.

The storm surge frequency distribution for the three wind directions was computed from a population of the highest storm surges for three reaches on the northern Oregon coast in the period from 1942 to 1975 when the initial flood study was done in the 1970's. The three reaches were from Columbia River to Cape Falcon, from Cape Falcon to Cape Lookout, and from Cape Lookout to Depoe Bay. These storm surge heights were computed using weather data obtained from 3-hour interval weather maps.

Wave statistics for wind-generated waves, called sea, were computed using the Sverdrup-Munk-Bretschneider procedure (Reference 16). The frequency distributions of wind waves for the three direction classes were computed from wave heights calculated using pressure gradients taken from the weather maps of significant storm events. Surface winds were computed from a modified version of the geostrophic wind equation. For the same direction class, wind waves of a certain probability were assumed to take place with a storm surge of the same probability because the same meteorological conditions produce both.

Waves produced by storms not directly affecting the coast, called swell, were computed by correlating the sea and swell wave height statistics (Reference 17). The swell statistics were then extended using the wind wave distributions referenced in the preceding paragraphs. This assures that delay and travel of the offshore wind waves (causing swell on the coast) do not significantly distort the shape of these probability distributions.

Most diked areas in Clatsop County are along the Columbia River. Those not on the Columbia River are, however, affected by the water stage in the Columbia River. The tributary watershed of the protected area behind the dike is either the protected area itself or a very small, additional tributary area. Because these areas are small, they tend to make peak flow and runoff volume a function of high-intensity rainfalls.

Analysis of Columbia River time-stage curves, completed in the 1970's, shows that two 5-day periods occur during December and January when the combined river/tide stage remains above an elevation such that diked areas cannot be drained by gravity. Pumping is not available in any of the diking districts. The period of greatest rainfall volumes is also during December and January.

The probability of a maximum annual rainfall event occurring during the two 5-day periods of December and January is approximately 1 in 4. Rainfall probabilities in northwest Oregon indicate that maximum rainfall volume occurs during a 6-hour period. Thus, for the small tributary diked area in Clatsop County, the 1-percent-annual-chance flood will results from the 25-year, 6-hour rainfall. This, of course, assumes that dikes are not overtopped by flows from the stream for which they are providing protection. The above analogy agrees very well with high-water information provided by local residents in all the diking districts of Clatsop County.

Ponding behind the dikes is totally dependent on runoff volume during the 5-day high tide cycle. Runoff of the 6-hour storm over the tributary is easily determined by subtracting infiltration from precipitation.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations shown on the Flood Insurance Rate Map (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.

The hydraulic analysis for Clatsop County is broken into four parts: riverine, estuarine, coastal, and diked areas.

For riverine flooding sources, the USACE HEC-2 step-backwater computer program (Reference 18) was used to determine the water-surface elevations along each stream studied in detail. This program uses the standard step-backwater method of balancing total energy in order to determine water-surface elevations. The program is designed especially for riverine studies and can correctly include special conditions such as levees and bridges.

Cross sections which describe the river geometry were obtained from several sources. For the Nehalem River, a complete computer input file for the HEC-2 program was obtained from the USACE, Portland District (Reference 19). The file contained cross sections obtained from field surveys, along with all other data to compute flood profiles. For the lower 6 miles of the Necanicum River, cross sections were supplied by the U.S. Soil Conservation Service (Reference 20). They also supplied values of Manning's "n". For the upper 4.5 miles of the Lewis and Clark River, cross sections were obtained from the Clatsop-Tillamook Intergovernmental Council (Reference 21). The cross sections were digitized from aerial photographs used to prepare topographic mapping of the Lewis and Clark River at a scale of 1:4,800 (Reference 21). For all the other rivers, cross sections were digitized from aerial photographs taken by the study contractor. The aerial photographs were also used to prepare topographic maps at a scale of 1:4,800, with a contour interval of 5 feet (Reference 22). In areas where tree cover was too dense to see the ground in the aerial photos, the cross sections were field surveyed. In all cases, only the portion of the cross section above water could be measured on aerial photos. All underwater cross sections were obtained by field surveys.

Locations of selected cross section used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the FIRM.

Roughness coefficients (Manning's "n") were estimated by field inspection at each cross section. Values for all stream studied in detail ranged from 0.030 to 0.055 for the channel and from 0.035 to 0.15 for the floodplain.

Starting water-surface elevations for the backwater computations were determined in several ways. On some streams, normal depth was used. For rivers flowing into the Pacific Ocean, the starting elevation was based on the results of the coastal flooding analysis. For rivers flowing into the Columbia River, starting elevations were based on flood elevations determined by the USACE (Reference 23). In all cases, starting elevations were verified with high-water marks from past floods.

The 1955, 1964, 1971, 1972, and 1975 flood records were used to calibrate and develop the HEC-2 computer model.

Flood profiles were drawn to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

The north coastal counties of Oregon experience numerous mud slides that block streamflows for a limited period. When water overtops the mud slide and failure of the temporary impoundment occurs, a large wall of water might result. Because these mud flows are unpredictable, the situation was not evaluated.

Some streams were studied using approximate methods. Approximate flood elevations were determined by analyzing available data from the Oregon Department of Geology and Mineral Industries (Reference 24) and applying engineering judgment. No detailed backwater analysis was performed.

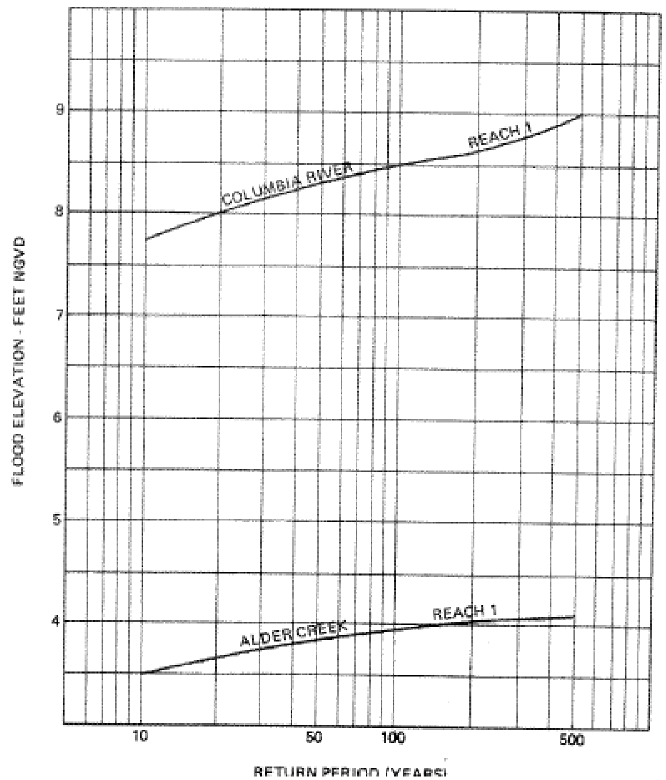
Hydraulic analyses of Youngs River and Lewis and Clark River combined the flooding effects of tides in the lower Columbia River and river discharges. A USACE estuary model was used to study the combined effects (References 25 and 26). The estuary model, ESTURY, is a computer program which solves the one-dimensional flow equations by an explicit, finite-difference method. Data requirements for the estuary model were tidal information for the Columbia River at Astoria, channel cross section characteristics, and riverflow at the upstream end of tidal influence. The time-varying water surface at the mouth of the rivers is a function of astronomical ides, storm surges, and flows in the lower Columbia River. The data for this model boundary condition were obtained from the USACE flood frequency profiles along the Columbia River (Reference 23) and published tide tables (Reference 14). The cross section geometry and flow resistance (Manning's "n") were obtained from a previous study (Reference 27), which used the same estuary model to study environmental impact of tidal hydraulics in Youngs Bay.

The riverflows at the upstream end of tidal influence were determined in the hydrologic analysis section of this report. The backwater-producing structures in the estuaries are bridges and islands in the channel. These elements were represented in the estuary model by locating cross sections at these elements and restricting the flow area to represent the structures.

Computer water-surface elevations matched high-water marks for past floods. These high-water marks were established from local residents who could identify points of maximum flooding. The combined flooding effects are shown in the Elevation-Frequency curves given in Figure 1.

Table 4, "Elevation Frequency Curve Descriptions", describes each reach from Figure 1 including reach location and 1-percent-annual-chance flood elevations. The reach locations came from their approximate locations on the FIRM.

A limitation of the estuary model is the fixed geometry of the channel, which does not allow an increase in the lateral flow area for higher water surfaces. Hydraulic analyses revealed that no significant increase in overbank flow area occurred in Youngs River nor in the lower portion of the Lewis and Clark River. However, in the reach of the Lewis and Clark River above Chadwell School, the flow area increased when flooding occurred. The USACE's HEC-2 computer program (Reference 18) was used to compute the flood frequency profiles above Chadwell School on the Lewis and Clark River.



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

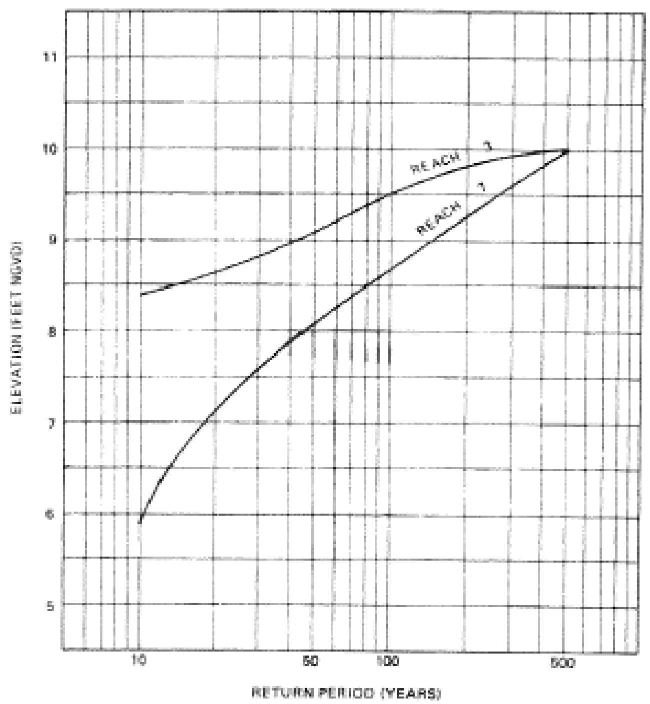
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

COLUMBIA RIVER AND ALDER CREEK



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

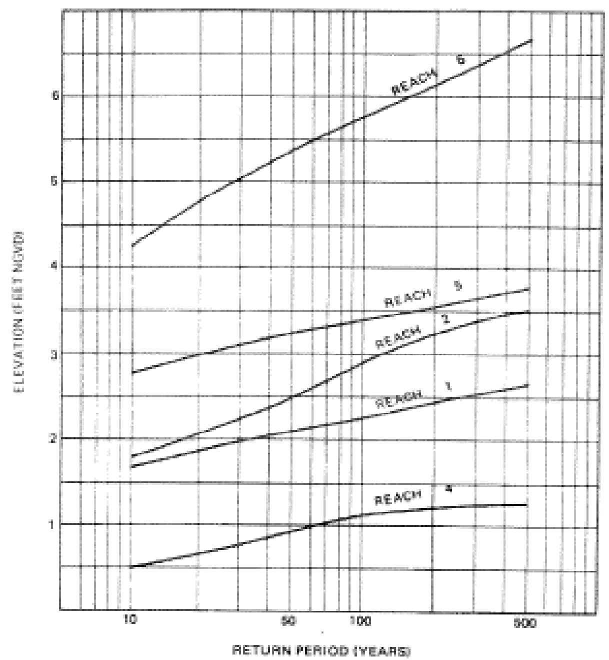
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

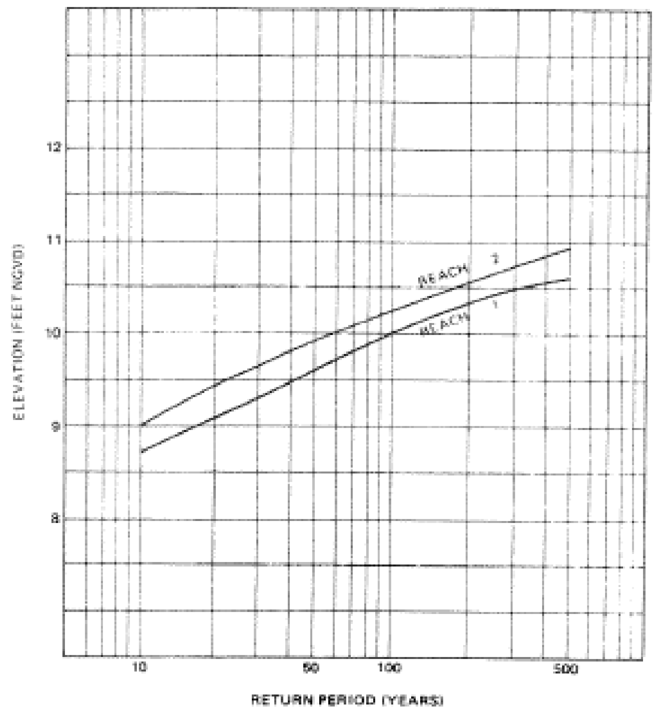
COLUMBIA RIVER AT BLIND SLOUGH



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

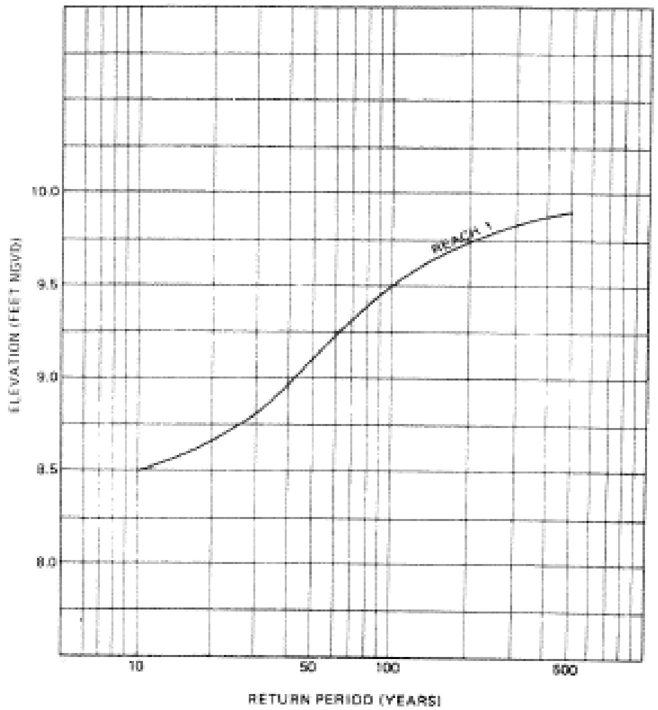
FIGURE 1	FEDERAL EMERGENCY MANAGEMENT AGENCY **CLATSOP COUNTY, OR** AND INCORPORATED AREAS	**ELEVATION FREQUENCY CURVE** **COLUMBIA RIVER AT BLIND SLOUGH**



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

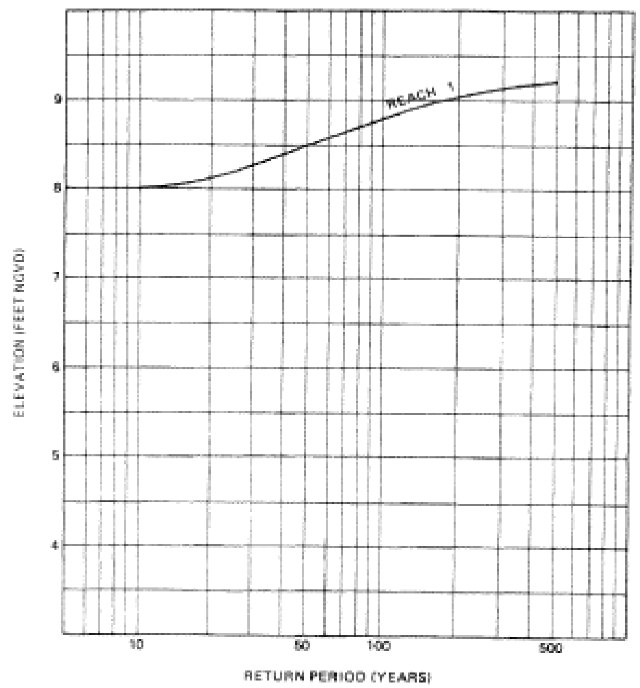
FIGURE 1	FEDERAL EMERGENCY MANAGEMENT AGENCY **CLATSOP COUNTY, OR** AND INCORPORATED AREAS	**ELEVATION FREQUENCY CURVE** **COLUMBIA RIVER AT BRADWOOD CLIFTON**



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1	FEDERAL EMERGENCY MANAGEMENT AGENCY **CLATSOP COUNTY, OR** AND INCORPORATED AREAS	**ELEVATION FREQUENCY CURVE** **COLUMBIA RIVER AT KNAPPA**

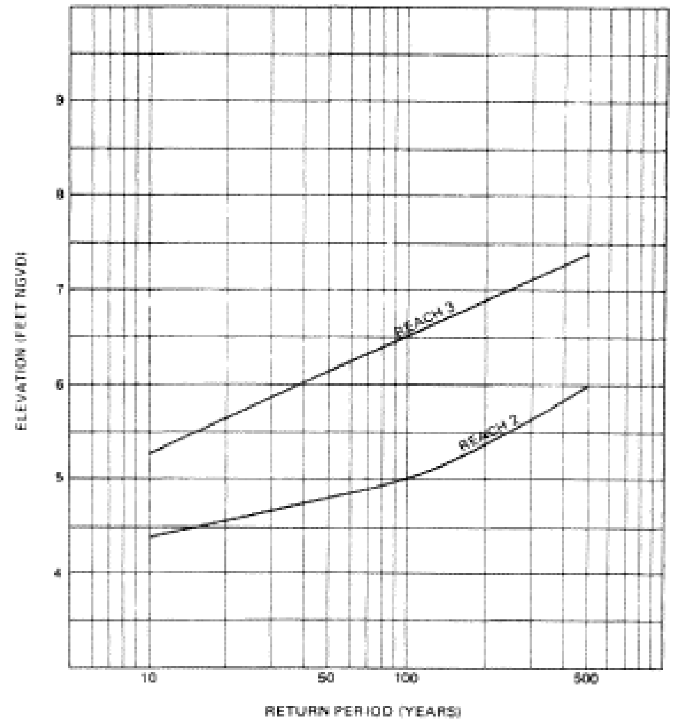


NAVD 88 = NGVD 29 + 3.61 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

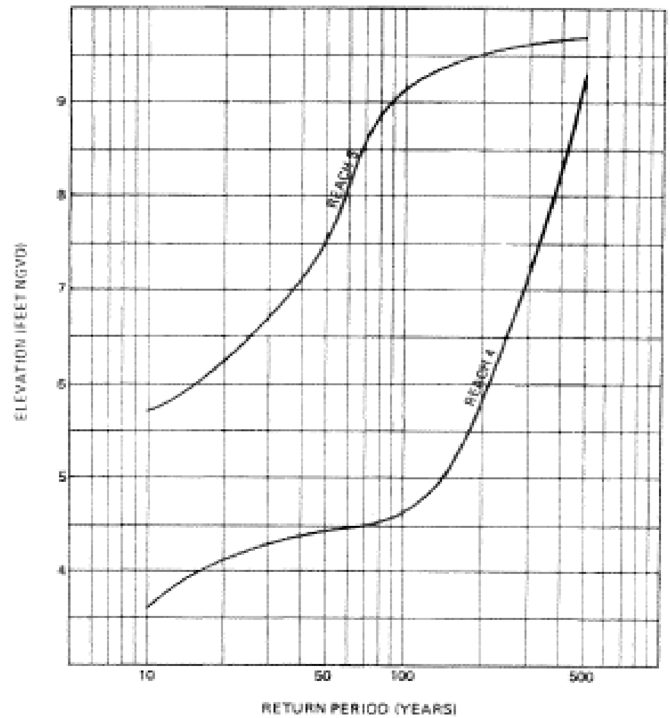
FEDERAL EMERGENCY MANAGEMENT AGENCY **CLATSOP COUNTY, OR** AND INCORPORATED AREAS	**ELEVATION FREQUENCY CURVE**
	COLUMBIA RIVER AT LEWIS AND CLARK RIVER



NAVD 88 = NGVD 29 + 3.61 feet

See Section 2.4 for explanation of levee failure for the Columbia River

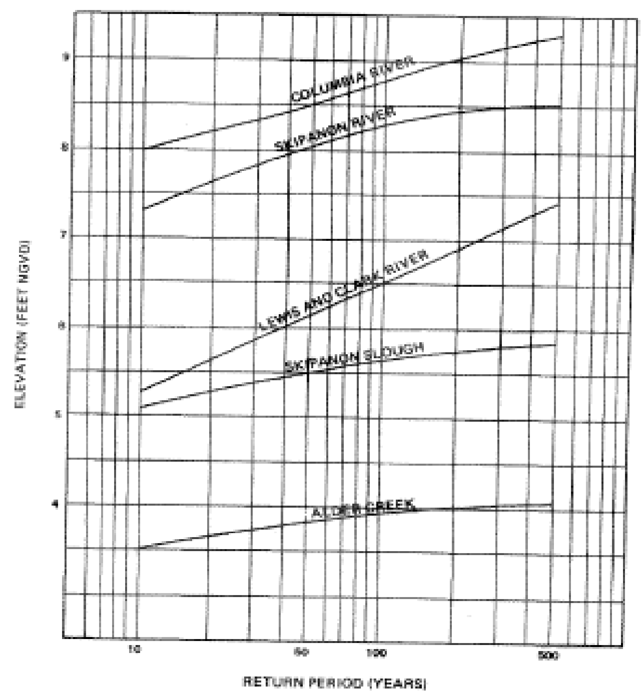
FIGURE 1	FEDERAL EMERGENCY MANAGEMENT AGENCY **CLATSOP COUNTY, OR** AND INCORPORATED AREAS	**ELEVATION FREQUENCY CURVE** **COLUMBIA RIVER AT LEWIS AND CLARK RIVER**



NAVD 88 = NGVD 29 + 3.61 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1	FEDERAL EMERGENCY MANAGEMENT AGENCY **CLATSOP COUNTY, OR** AND INCORPORATED AREAS	**ELEVATION FREQUENCY CURVE** **COLUMBIA RIVER AT LEWIS AND CLARK RIVER**



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

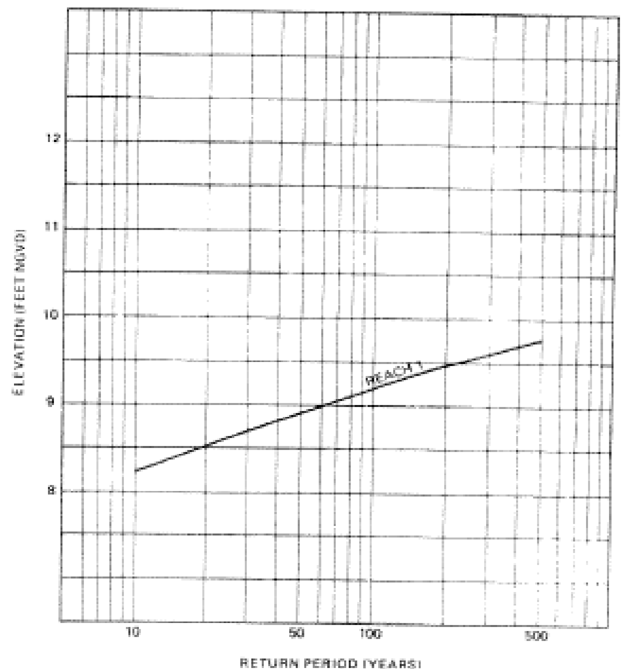
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

COLUMBIA RIVER - SKIPANON RIVER - LEWIS AND CLARK RIVER
SKIPANON SLOUGH - ALDER CREEK



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

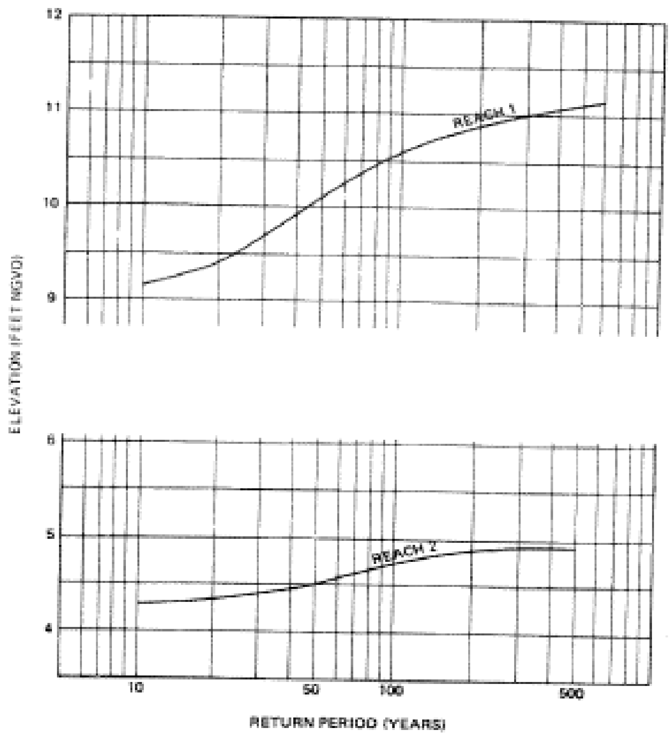
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

COLUMBIA RIVER AT SVENSEN



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

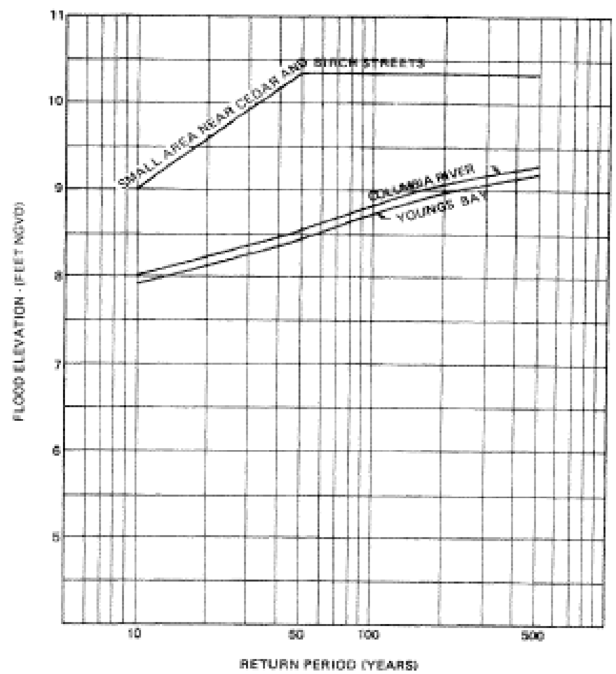
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

COLUMBIA RIVER AT WAUNA-WESTPORT



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

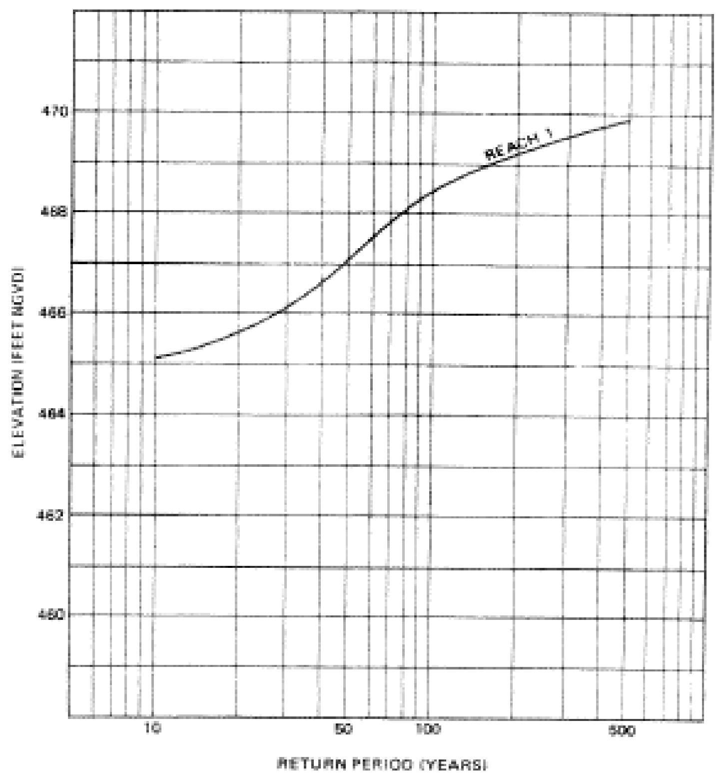
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

COLUMBIA RIVER-YOUNGS BAY-SMALL AREA NEAR CEDAR AND BIRCH STREETS



NAVD 88 = NGVD 29 + 3.5 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

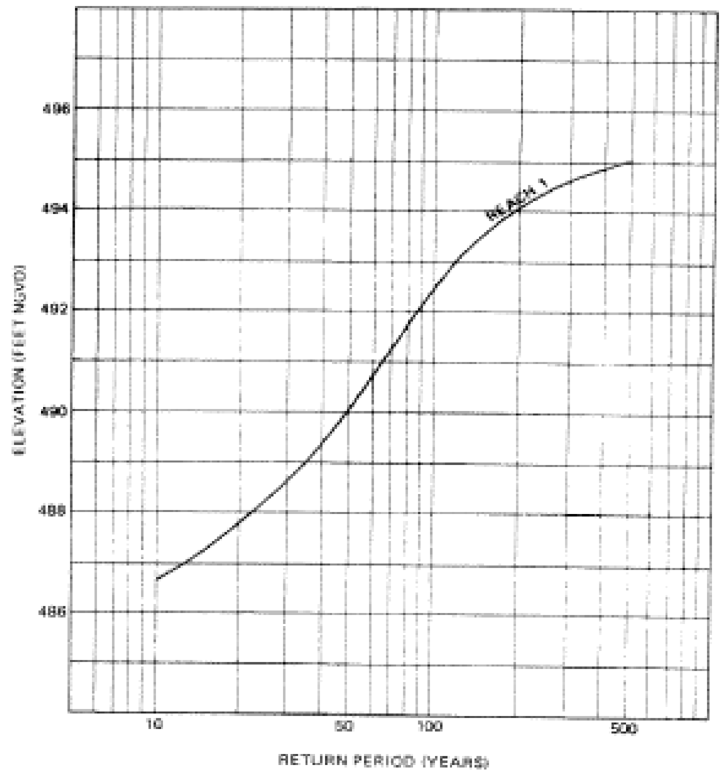
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

NEHALEM RIVER AT FISHHAWK CREEK



NAVD 88 = NGVD 29 + 3.5 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

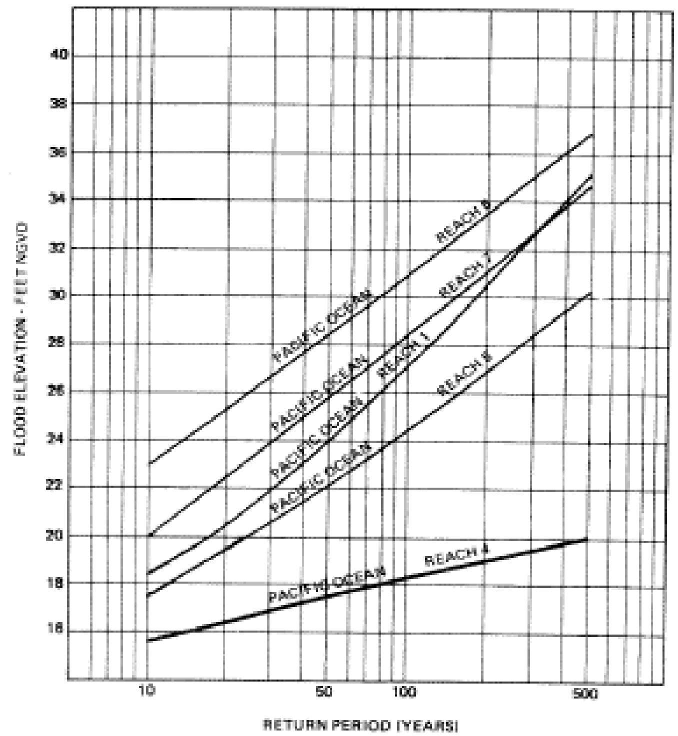
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

NEHALEM RIVER AT NORTHRUP CREEK



NAVD 88 = NGVD 29 + 3.54 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

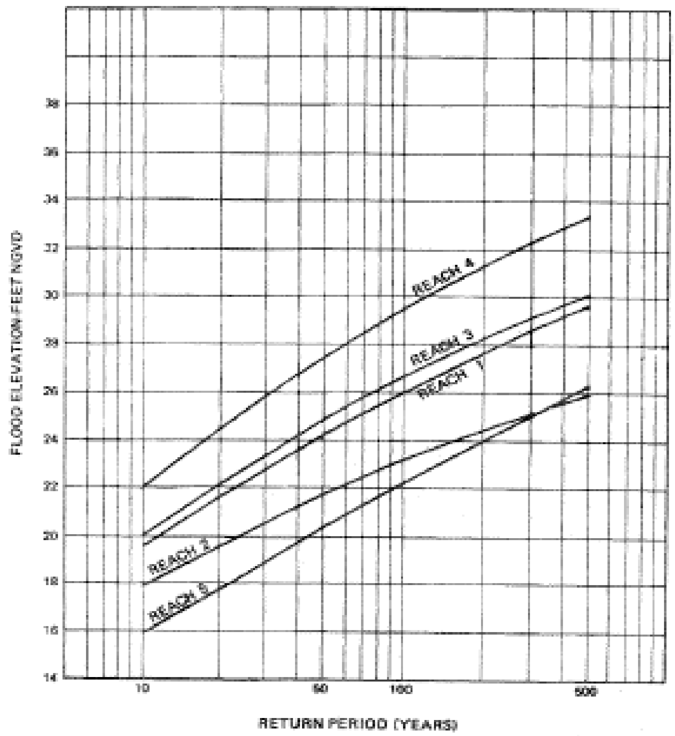
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

PACIFIC OCEAN



NAVD 88 = NGVD 29 + 3.59 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

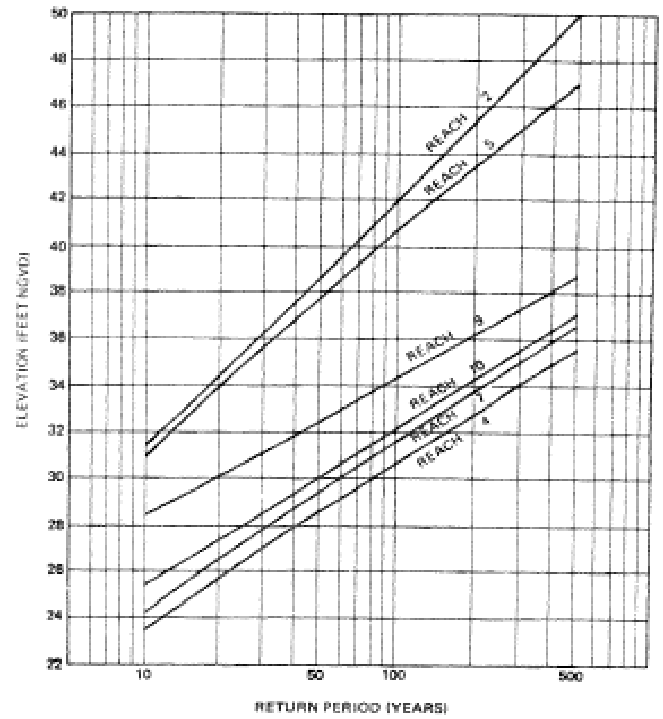
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

PACIFIC OCEAN



NAVD 88 = NGVD 29 + 3.53 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

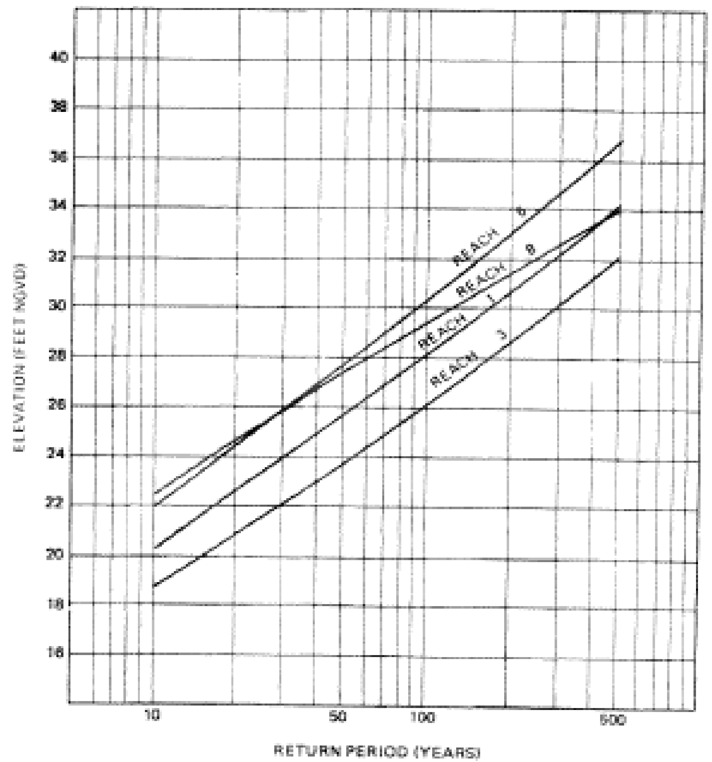
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

PACIFIC OCEAN AT ARCH CAPE



NAVD 88 = NGVD 29 + 3.53 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

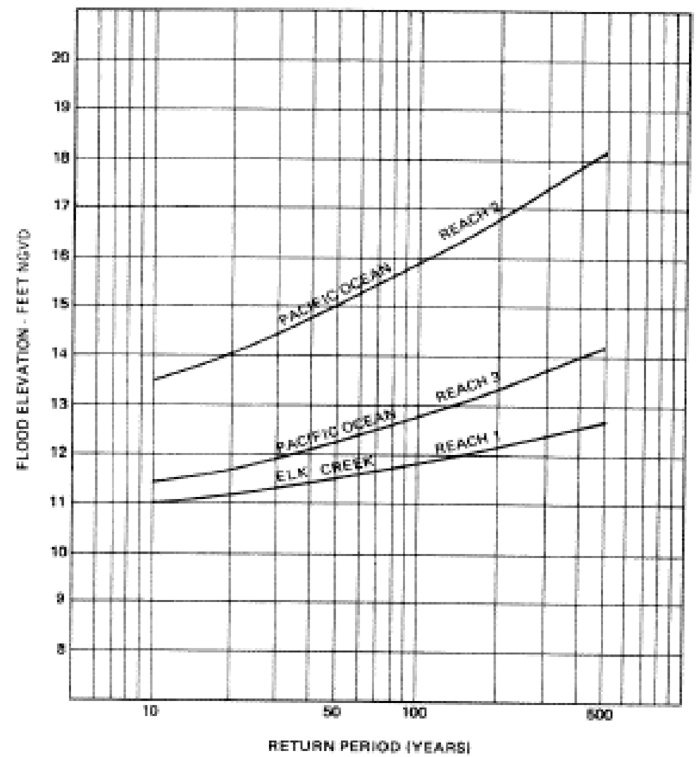
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

PACIFIC OCEAN AT ARCH CAPE



NAVD 88 = NGVD 29 + 3.54 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

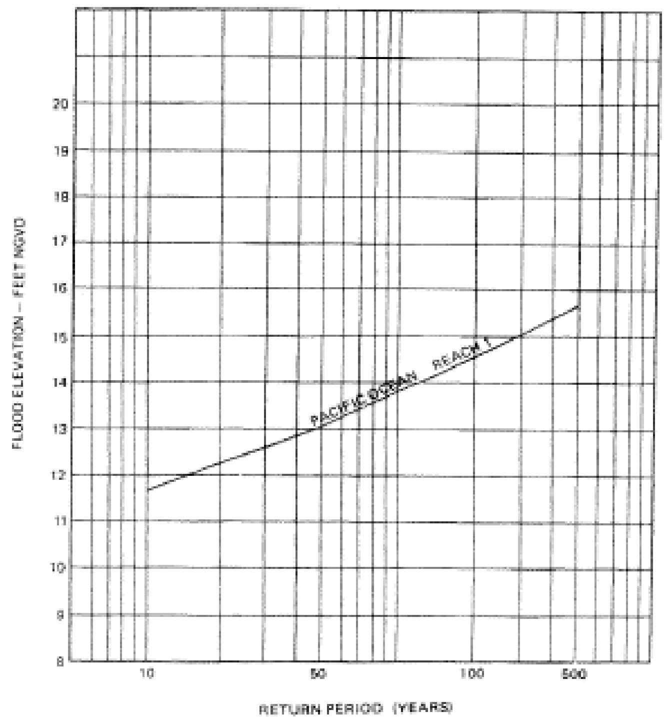
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

PACIFIC OCEAN AND ELK CREEK



NAVD 88 = NGVD 29 + 3.59 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

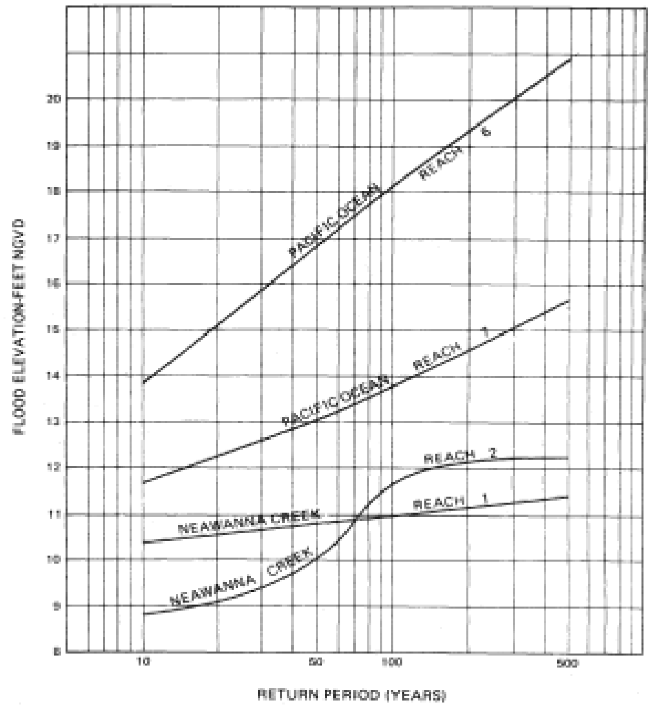
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

PACIFIC OCEAN AT GEARHART



NAVD 88 = NGVD 29 + 3.59 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

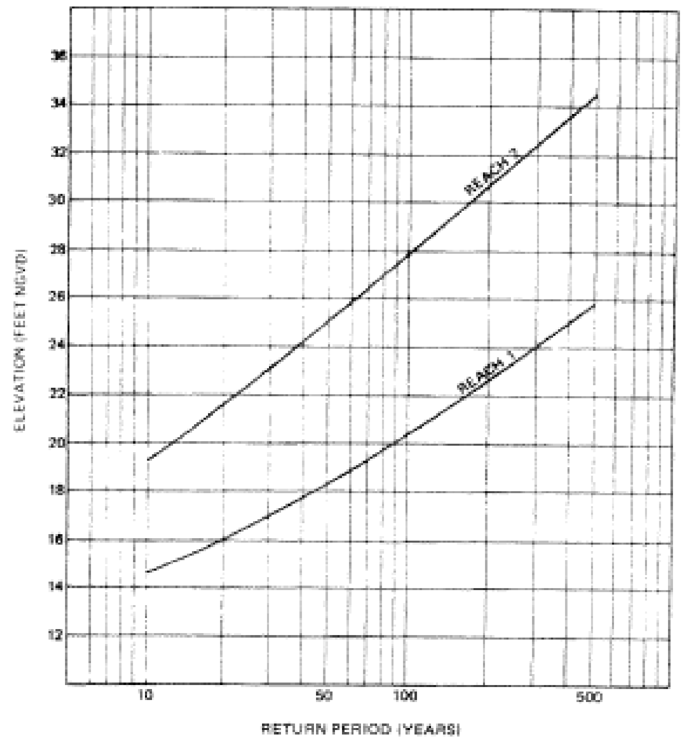
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

PACIFIC OCEAN-NEAWANNA CREEK



NAVD 88 = NGVD 29 + 3.59 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

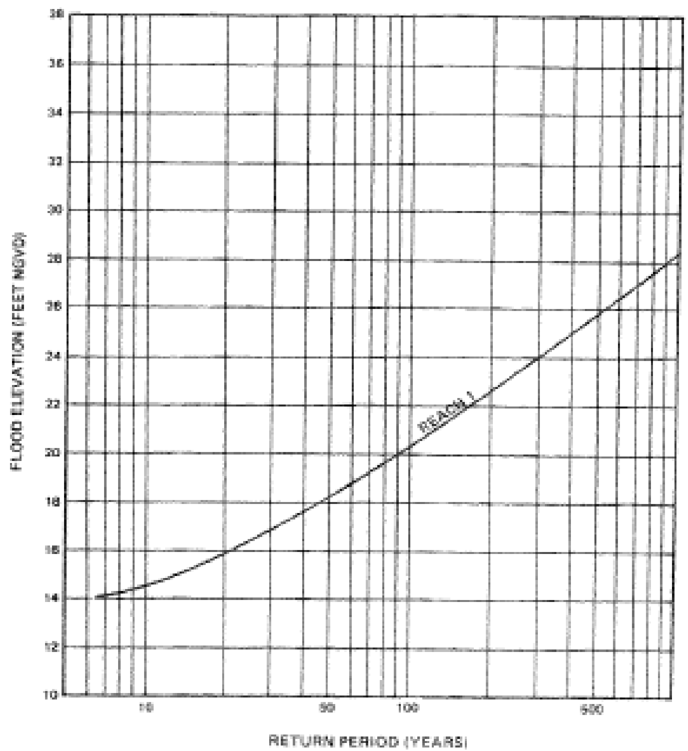
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

PACIFIC OCEAN AT SEASIDE



NAVD 88 = NGVD 29 + 3.59 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

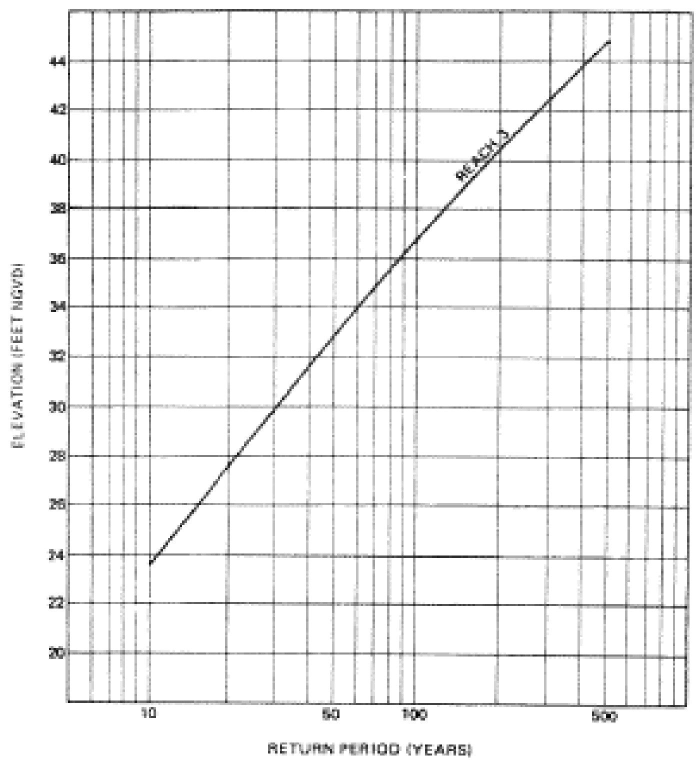
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

PACIFIC OCEAN AT SEASIDE



NAVD 88 = NGVD 29 + 3.59 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

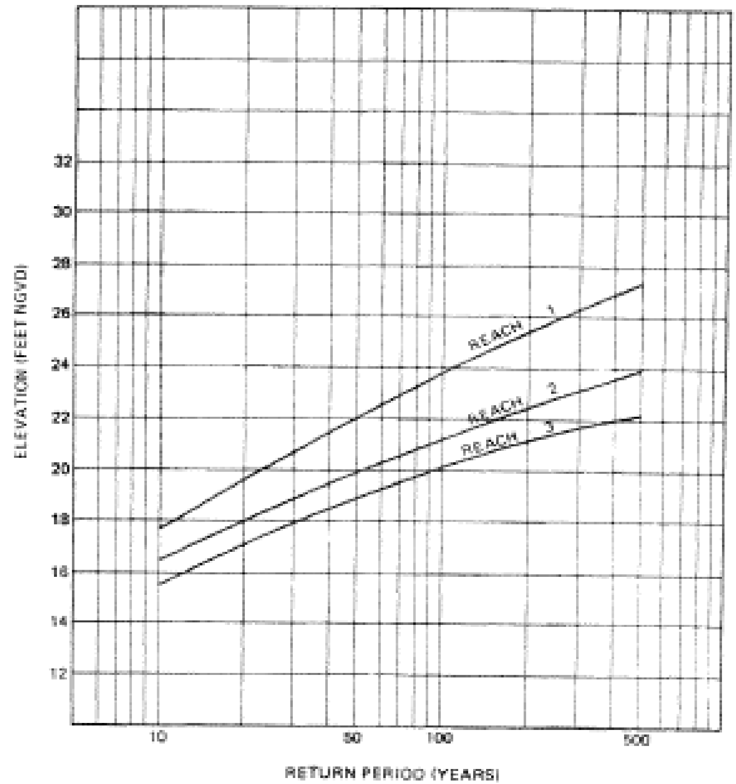
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

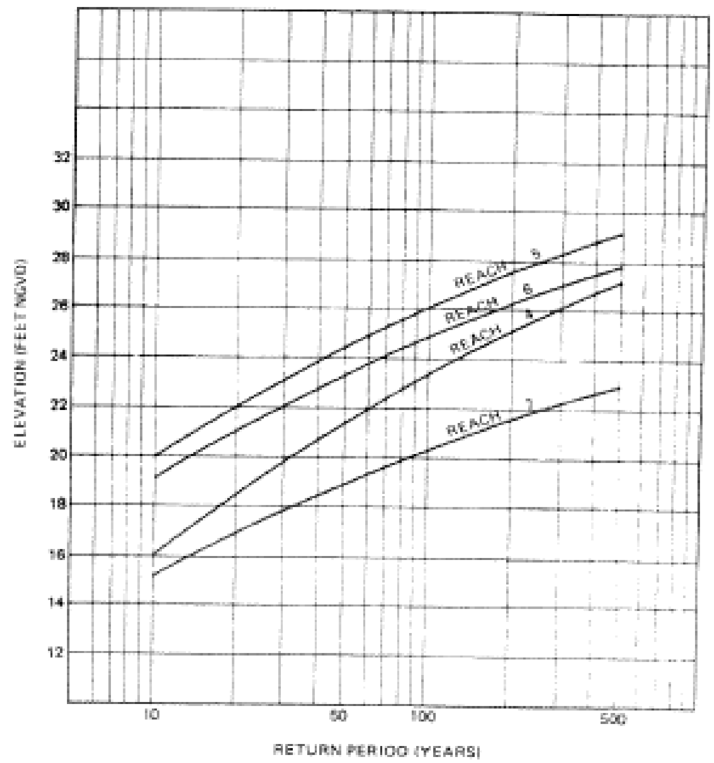
PACIFIC OCEAN AT SEASIDE



NAVD 88 = NGVD 29 + 3.60 feet

See Section 2.4 for explanation of levee failure for the Columbia River

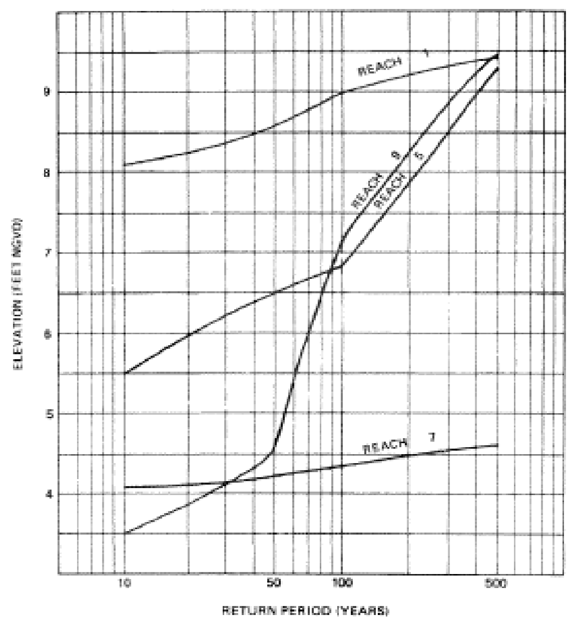
FIGURE 1	FEDERAL EMERGENCY MANAGEMENT AGENCY **CLATSOP COUNTY, OR** AND INCORPORATED AREAS	**ELEVATION FREQUENCY CURVE** **PACIFIC OCEAN AT SUNSET BEACH**



NAVD 88 = NGVD 29 + 3.60 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1	FEDERAL EMERGENCY MANAGEMENT AGENCY **CLATSOP COUNTY, OR** AND INCORPORATED AREAS	**ELEVATION FREQUENCY CURVE** **PACIFIC OCEAN AT SUNSET BEACH**



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

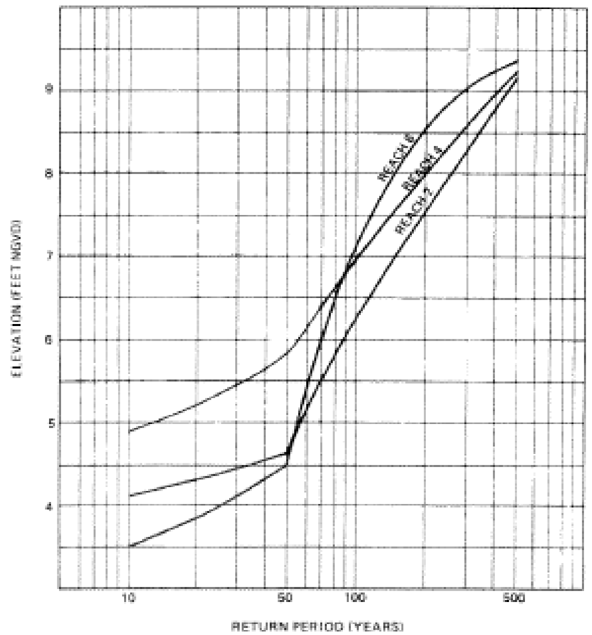
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

YOUNGS RIVER



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

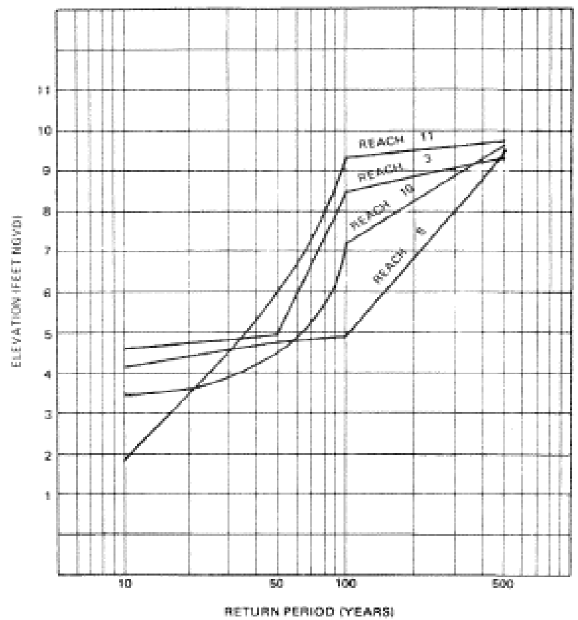
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

YOUNGS RIVER



NAVD 88 = NGVD 29 + 3.32 feet

See Section 2.4 for explanation of levee failure for the Columbia River

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY CURVE

YOUNGS RIVER

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
COLUMBIA RIVER AND ALDER CREEK						
Alder Creek Reach 1	Alder Creek	0204, 0208,0212,0216	Begins at the railroad crossing Alder Creek extending upstream approximately 10,000 feet	7	7.3	12
Columbia River Reach 1	Columbia River	0204, 0208, 0216	From approximately Lake Drive along the left bank of the Columbia River to intersection of Warrenton Drive, 7th Avenue, and pacific Drive	12	11.8	12
COLUMBIA RIVER AT BLIND SLOUGH						
Reach 1	Columbia River	285	Enclosed by the railroad on the east side and the Columbia River's levee on the left bank	6	5.6	13
Reach 2	Columbia River	285	Located along Saspal Slough's left bank levee, north to the railroad, and east to Blind Slough's left bank	6	6.1	13
Reach 3	Columbia River	0280, 0285,295	Located along the main channel of the Blind Slough	13	12.8	13
Reach 4	Columbia River	285	Bounded by the Borowsmead Dike Road, Railroad, Pentilla Road, and the levee along Blind Sough's right bank	5	4.5	13
Reach 5	Columbia River	0280, 0285	Located between Ziak-gnat Creek Road and the levee located along Blind Slough's left bank	7	6.7	13
Reach 6	Columbia River	285	Located approximately 1000 feet north of the Aldrich Point Road and Sylvandale Lane	9	9.1	13
Reach 7	Columbia River	285	Located east of the Barendse Road and Ziak-gnat Creek Road intersection extending south from the Blind Slough left bank	12	12.0	13

1 Digital Flood Insurance Rate Map
2 Rounded to nearest foot
3 - Base Flood Elevation based Flood frequncy Curves on Columbia River
4 - Base Flood Elevation based on levee failure scenario on Columbia River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

COLUMBIA RIVER AND ALDER CREEK - COLUMBIA RIVER AT BLIND SLOUGH

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
COLUMBIA RIVER AT BRADWOOD CLIFTON						
Reach 1	Columbia River	0305	Located along the left bank of the Columbia River approximately 580 feet west-northwest of the Clifton Road and Railroad intersection	13	13.3	14
Reach 2	Columbia River	0305, 0310	Located near the confluence of the Columbia River and Hunt Creek along the left bank of the Columbia River	14	13.6	14
COLUMBIA RIVER AT KNAPPA						
Reach 1	Columbia River	0290	Located at the confluence of Big Creek, Little Creek, and the Columbia River	13	12.8	13

1 Digital Flood Insurance Rate Map
2 Rounded to nearest foot
3 - Base Flood Elevation based Flood frequncy Curves on Columbia River
4 - Base Flood Elevation based on levee failure scenario on Columbia River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

COLUMBIA RIVER AT BRADWOOD CLIFTON - COLUMBIA RIVER AT KNAPPA

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
COLUMBIA RIVER AT LEWIS AND CLARK RIVER						
Reach 1	Columbia River	219	Begins at Highway 101 and extends southwest along Fort Clatsop Road	12	12.1	12
Reach 2	Columbia River	212	Extends from the Lewis and Clark River and Columbia River Confluence upstream between the right side of the Lewis and Clark River and Lewis and Clark Road	8	8.3	12
Reach 3	Columbia River	0219,0236,0240, 0357, 0380	Begins at Highway 101 and extends south to Lewis and Clark Road	10	9.8	12
Reach 4	Columbia River	380	Extends from the Lewis and Clark Road, downstream to Searls Lane. Follows along the right bank of the Lewis and	8	8.0	12
Reach 5	Columbia River	380	Located along the right bank of the Lewis and Clark River, 2800 feet west-southwest from Huckleberry Lane and Logan Road intersection	13	12.5	13

1 Digital Flood Insurance Rate Map
2 Rounded to nearest foot
3 - Base Flood Elevation based Flood frequncy Curves on Columbia River
4 - Base Flood Elevation based on levee failure scenario on Columbia River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

COLUMBIA RIVER AT LEWIS AND CLARK RIVER

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
COLUMBIA RIVER	Columbia River	0228,0229, 0233,0234	Located along the left bank of the Columbia River within the corporate limits of the City of Warrenton	12	12.1	12
SKIPONAN RIVER	Skiponan River	0216,0218	Begins at 7th Street extending upstream to the southern corporate limits of the City of Warrenton	12	11.6	12
LEWIS AND CLARK RIVER	Columbia River	0219,0236,0240, 0357,0380	Begins at Highway 101 and extends south to Lewis and Clark Road	8	9.8	12
SPOKANAN SLOUGH	Spokanan Slough	0216,0218	Begins at Harbor Street extending upstream the entire length of Skipanon Slough	9	8.9	12
ALDER CREEK	Alder Creek	0204,0208, 0212,0216	Begins at the railroad crossing Alder Creek extending upstream approximately 10,000 feet	7	7.3	12

1 Digital Flood Insurance Rate Map
2 Rounded to nearest foot
3 - Base Flood Elevation based Flood frequncy Curves on Columbia River
4 - Base Flood Elevation based on levee failure scenario on Columbia River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

COLUMBIA RIVER - SKIPONAN RIVER - LEWIS AND CLARK SKIPONAN SLOUGH - ALDER CREEK

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
COLUMBIA RIVER AT SVENSON						
Reach 1	Columbia River	270	Located along Hillcrest Creek	13	13.3	12
COLUMBIA RIVER AT WAUNA - WESTPORT						
Reach 1	Columbia River	320	Extends from the eastern Clatsop County boundary downstream along the left bank of the Columbia River approximately 31,000 feet	14	14.0	14
Reach 2	Columbia River	340	Extends from south of Highway 30 north to the levee along the left bank of the Westport Slough to the eastern edge of Clatsop County	8	8.1	14

1 Digital Flood Insurance Rate Map
2 Rounded to nearest foot
3 - Base Flood Elevation based Flood frequncy Curves on Columbia River
4 - Base Flood Elevation based on levee failure scenario on Columbia River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

COLUMBIA RIVER AT SVENSON - COLUMBIA RIVER AT WAUNA - WESTPORT

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
COLUMBIA RIVER - YOUNGS BAY - SMALL AREA NEAR NEAR CEDAR AND BIRCH STREETS						
CEDAR AND BIRCH STREETS	Columbia River	0233, 0234	Small area near Cedar and Birch streets	14	13.7	12
COLUMBIA RIVER	Columbia River	0228,0229, 0233,0234	Begins near Portway Street and extends east along the left bank to the eastern edge of the City of Astoria corporate limits	12	12.1	12
YOUNGS BAY	Youngs Bay	0236	Begins near Portway Street and extends approximately 15600 feet upstream along the right bank of Youngs River	12	12.0	12

1 Digital Flood Insurance Rate Map
2 Rounded to nearest foot
3 - Base Flood Elevation based Flood frequncy Curves on Columbia River
4 - Base Flood Elevation based on levee failure scenario on Columbia River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

COLUMBIA RIVER - YOUNGS BAY - SMALL AREA NEAR CEDAR AND BIRCH STREETS

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
NEHALEM RIVER AT FISHHAWK CREEK						
Reach 1	Fishhawk Creek at Jewell	615	Exists at confluence of Fishhawk Creek and Nehalem River at Jewell	472	471.8	472
NEHALEM RIVER AT NORTHRUP CREEK						
Reach 1	Northrup Creek	610	Extends from approximately 1400 feet northwest of Cow Ridge Road and Northrup Creek Road intersection upstream to the limit of detailed study	496	496.0	496

1 Digital Flood Insurance Rate Map
2 Rounded to nearest foot
3 - Base Flood Elevation based Flood frequncy Curves on Nehalem River
4 - Base Flood Elevation based on DFIRM

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

NEHALEM RIVER AT FISHHAWK CREEK - NEHALEM RIVER AT NORTHRUP CREEK

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
PACIFIC OCEAN Reach 1	Pacific Ocean	0368	Reach not available in City of Gearhart effective FIS (1999)	10	12.3	12
Reach 1	Pacific Ocean	0514	Extends from the North Fork Ecola Creek centerline, north to W 7th Street	10	9.6	12
Reach 2	Pacific Ocean	0368	Reach not available in City of Gearhart effective FIS (1999)	12	11.8	12
Reach 3	Pacific Ocean	0368	Reach not available in City of Gearhart effective FIS (1999)	10	10.3	12
Reach 4	Pacific Ocean	0368	Reach not available in City of Gearhart effective FIS (1999)	10	10.1	12
Reach 4	Pacific Ocean	0514	Extends approximately 890 feet downstream of Elm Avenue 1650 feet. Extends from the left bank near N Spruce Street to the North Fork Ecola Creek's stream centerline.	10	10.4	12
Reach 5	Pacific Ocean	0368	Reach not available in City of Gearhart effective FIS (1999)	8	7.7	12
Reach 5	Pacific Ocean	0514, 0652	Extends from the mouth of North Fork Ecola Creek south approximately 8500 feet and varies from approximately 50 - 100 feet inland	8	8.2	12
Reach 6	Pacific Ocean	0652	Exists from approximately 120 feet north of Delta Street south to 50 feet south of Coos Street	11	10.5	12
Reach 7	Pacific Ocean	0652	Exists from approximately 50 feet south of Coos Street to approximately 500 feet southwest of Maher Street	11	10.6	12

1. Digital Flood Insurance Rate Map
2. Rounded to nearest foot

3 - Base Flood Elevation based Flood frequncy Curves on Pacific Ocean
4 - Base Flood Elevation based on DFIRM

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

PACIFIC OCEAN

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
PACIFIC OCEAN AT ARCH CAPE						
Reach 1	Pacific Ocean	0652	Extends from 1500 feet northwest of Ruby Lane & US 101 intersection, north 2600 feet.	32	31.6	32
Reach 2	Pacific Ocean	0652	Extends from 200 feet southwest of Ruby Lane & US 101 intersection, north 1600 feet.	46	45.5	46
Reach 3	Pacific Ocean	0652, 0655	Extends from Picture Windows Lane, north 2700 feet.	30	29.7	30
Reach 4	Pacific Ocean	0655	Extends from Picture Windows Lane, north 3300 feet.	34	34.2	35
Reach 5	Pacific Ocean	0655	Extends from 510 feet northwest of Beach Access Road, north 560 feet.	44	44.3	45
Reach 6	Pacific Ocean	0655	Extends from 510 feet northwest of Beach Access Road, south 3950 feet.	Varies See Map	Varies See Map	Varies See Map
Reach 7	Pacific Ocean	0655, 0665	Extends from East Ocean Lane north-northeast 3700 feet.	Varies See Map	Varies See Map	Varies See Map
Reach 8	Pacific Ocean	0665	Extends from approximately 300 feet southwest of East Shingle Mill Lane north-northwest to East Ocean Lane.	Varies See Map	Varies See Map	Varies See Map
Reach 9	Pacific Ocean	0665	Extends from 5100 feet north of the southwest corner of Clatsop County, north 1900 feet.	38	37.9	38
Reach 10	Pacific Ocean	0665	Extends north from the southwest corner of Clatsop County, 5100 feet.	36	35.6	36

1. Digital Flood Insurance Rate Map
2. Rounded to nearest foot

3 - Base Flood Elevation based Flood frequncy Curves on Pacific Ocean at Arch Cape
4 - Base Flood Elevation based on DFIRM

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

PACIFIC OCEAN AT ARCH CAPE

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
PACIFIC OCEAN AND ELK CREEK						
Elk Creek Reach 1	Elk Creek (North Fork Ecola Creek)	0514	Extends from approximately 180 feet west of N Larch Street east to the corporate limits	15	15.3	16
Pacific Ocean Reach 2	Pacific Ocean	0514	Extends approximately 890 feet downstream of Elm Avenue to 1890 feet. Extends from the left bank near Beaver Street to near Larch Street on the right bank.	Varies See Map	Varies See Map	Varies See Map
Pacific Ocean Reach 3	Pacific Ocean	0514	Begins at Elm Avenue to approximately 630 feet downstream. From approximately 70 feet south of the left bank of North Fork Ecola Creek to 5th Street.	Varies See Map	Varies See Map	Varies See Map

1 Digital Flood Insurance Rate Map
2 Rounded to nearest foot
3 - Base Flood Elevation based Flood frequncy Curves on Pacific Ocean
4 - Base Flood Elevation based on DFIRM

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY
CLATSOP COUNTY, OR
AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

PACIFIC OCEAN AND ELK CREEK

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
PACIFIC OCEAN AT GEARHART						
Reach 1	Pacific Ocean	0368	Reach not available in City of Gearhart effective FIS (1999)	18	18.1	18
PACIFIC OCEAN-NEAWANNA CREEK						
Neawanna Creek Reach 1	Neawanna Creek	0368	Reach not available in City of Gearhart effective FIS (1999)	Varies See Map	Varies See Map	Varies See Map
Neawanna Creek Reach 2	Neawanna Creek	0368	Reach not available in City of Gearhart effective FIS (1999)	Varies See Map	Varies See Map	Varies See Map
Pacific Ocean Reach 6	Pacific Ocean	0368	Reach not available in City of Gearhart effective FIS (1999)	Varies See Map	Varies See Map	Varies See Map
Pacific Ocean Reach 7	Pacific Ocean	0368	Reach not available in City of Gearhart effective FIS (1999)	Varies See Map	Varies See Map	Varies See Map

1 Digital Flood Insurance Rate Map
2 Rounded to nearest foot

3 - Base Flood Elevation based Flood frequncy Curves on Pacific Ocean and Neawanna Creek
4 - Base Flood Elevation based on DFIRM

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

PACIFIC OCEAN AT GEARHART - PACIFIC OCEAN-NEAWANNA CREEK

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
PACIFIC OCEAN AT SEASIDE						
Reach 1	Pacific Ocean	0368, 0502, 0506	Extends from the mouth of the North Fork Ecola Creek south along the coast to approximately 400 feet north-northwest of Edgewood Street, Ocean Vista Drive and Beach Drive.	24	24.1	24
Reach 2	Pacific Beach	0502, 0506	Extends from approximately 400 feet north-northwest of the Edgewood Street, Ocean Vista Drive, Beach Drive intersection and follows along the coast south to approximately 400 feet north-northwest of Sunset and Greenway Drive intersection.	Varies See Map	Varies See Map	Varies See Map
Reach 3	Pacific Beach	0502	Extends from approximately 400 feet north-northwest of the Edgewood Street, Ocean Vista Drive, Beach Drive intersection and follows along the coast south to approximately 400 feet north-northwest of Sunset and Greenway Drive intersection, along the coast 1600 feet.	40	40.4	41

1. Digital Flood Insurance Rate Map
2. Rounded to nearest foot
3 - Base Flood Elevation based Flood frequncy Curves on Pacific Ocean at Seaside
4 - Base Flood Elevation based on DFIRM

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

PACIFIC OCEAN AT SEASIDE

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
PACIFIC OCEAN AT SUNSET BEACH						
Reach 1	Pacific Ocean	214,	Extends from Delaura Beach Lane south-southeast along the coast 7700 feet	27	27.4	28
Reach 2	Pacific Ocean	0214,0352	Extends from 7700 feet south of Delaura Beach Lane south-southeast along the coast 10500 feet	25	24.7	25
Reach 3	Pacific Ocean	0352,0355,0360	Begins 1480 feet northwest of Sunset Beach Lane and extends south-southeast along the coast 8000 feet	24	23.8	24
Reach 4	Pacific Ocean	0355, 0360	Begins 1500 feet northwest of Horizon Lane and extends south-southeast along the coast 4700 feet	27	26.9	27
Reach 5	Pacific Ocean	0360,0366	Begins 860 feet southwest of High Surf Lane and extends south-southeast along the coast 5100 feet	30	29.7	30
Reach 6	Pacific Ocean	0366	Extends from approximately 370 feet north of 13th Street to 2100 feet north-northwest of Unnamed Street	29	28.6	29
Reach 7	Pacific Ocean	0366,0368	Extends north from approximately 80 feet north of 10th Street to approximately 370 feet north of 13th Street	24	24.1	24

1. Digital Flood Insurance Rate Map
2. Rounded to nearest foot

3 - Base Flood Elevation based Flood frequncy Curves on Pacific Ocean at Sunset Beach
4 - Base Flood Elevation based on DFIRM

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

PACIFIC OCEAN AT SUNSET BEACH

Elevation Frequency Curve	Flooding Source	Panel[1]	Location Description	Still Water Elevation (NAVD FT)[2]	Base Flood Elevation (NAVD FT)[3]	Based On DFIRM (NAVD FT)[4]
YOUNGS RIVER						
Reach 1	Youngs River	0237,0240,0241, 0245,0380,0385	Begins at Highway 101 and extends upstream approximately 40,000 feet	10	12.3	12
Reach 2	Youngs River	0237,0240,0380	Extends from the confluence of Binder Slough and Youngs River along the landward side of the levee located on the left bank of Youngs River	10	9.6	12
Reach 3	Youngs River	0241	Located 1000 feet southeast of the intersection State Highway 202 and Williamsport Road	12	11.8	12
Reach 4	Youngs River	0240, 0241,0245	Located west of approximately 2000 feet of Farm Lane	10	10.3	12
Reach 5	Youngs River	0245	Located approximately 300 feet northeast of the Ordway Lane and State Highway 202 intersection	10	10.1	12
Reach 6	Youngs River	0237,0240,0241, 0245, 0380,0385	Reach not available in Clatsop County Unincorporated Area in effective FIS (1999)	10	10.4	12
Reach 7	Youngs River	0385	Located on Haven Island in Youngs River	8	7.7	12
Reach 8	Youngs River	0385	Located 1500 feet west of Walluski Loop	8	8.2	12
Reach 9	Youngs River	0237, 0240, 0241, 0245, 0380, 0385	Reach not available in Clatsop County Unincorporated Area in effective FIS (1999)	11	10.5	12
Reach 10	Youngs River	0240,0245,0380, 0385	Extends from Binder Slough Lane south along the left bank of Youngs River to approximately 1700 feet south-southwest of the confluence of Cooperage Slough and Youngs River	11	10.6	12
Reach 11	Youngs River	0385	Located approximately 1000 feet northwest of the confluence of Youngs River and Klaskanine River	13	12.7	12

1. Digital Flood Insurance Rate Map
2. Rounded to nearest foot

3 - Base Flood Elevation based Flood frequncy Curves on Youngs River
4 - Base Flood Elevation based on levee failure scenario on Columbia River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

ELEVATION FREQUENCY REACH DESCRIPTIONS

YOUNGS RIVER

For the ocean coastline of Clatsop County, the stillwater level was calculated by combing the astronomical tide height and storm surge height. The storm surge height was completed using a computer program, called COAST. This program was constructed by rewriting the National Weather Service program, SPLASH Part 2 (Reference 28), to accommodate Pacific Northwest coast storm types. Input for this program is the offshore water depths at each point in a two-dimensional grid. One side of the grid coincides with the coast. Atmospheric pressure and pressure gradient field must also be specified in the grid area. Other parameter values for the program were obtained from a report by Jelesnianski (Reference 29) and through trial-and-error calibration to match observed winds and high-water marks from past storms.

Pressure field from representative surge-producing storms of the last 32 years were input to the computer model, COAST, for calculation of storm surge water levels on the northwest Oregon coast. Height-frequency relationships for three storm wind directions classes were calculated.

The astronomical tide and storm surge were combined by superimposing hourly values of storm surge and astronomical tide throughout the period of October 15 through March 15.
An examination of observed surges from tide gage records indicated that the average time-height distribution of the various recurrence interval storm surges could be approximated as a triangle. The surge was first assumed to take place from October to March. The hourly surge heights and the maximum value was retained in the computer memory. The surge distribution was advanced 1 hour and the process repeated through the October-to-March period. This procedure is similar to that employed to combine tsunamis and astronomical tides (References 30 and 31). A cumulative histogram of the resulting heights was made and the fraction of occurrence was multiplied by the surge probability. This was done for four surge heights and the resulting curves were plotted on probability paper. An enveloping curve was drawn to give the stillwater probability curve. This procedure was repeated for the three wind directions in each of the three reaches. The three direction curves were combined to give the stillwater level the three surge reaches.

Data of wave heights, periods, and directions for the various recurrence intervals were used to synthesize waves which were tracked from the deepwater locations (Reference 17) to shore using a wave refraction and shoaling program called WAVES2. This program was a modified version of a program called WAVES (Reference 32). The required data for this program were ocean bottom topography and wave height, period, direction, and starting location.

Once a wave reached the shoreline, calculations specified in the USACE Shore Protection Manual (Reference 16) were used to compute wave setup and wave runup. The effective beach slope values employed in the runup computations were obtained by matching surge and wave hindcasts to open-coast high-water marks. The appropriate values of wave setup and wave runup for certain recurrence intervals to obtain open-coast elevation-frequency curves.

The wave runup for swell was also computed and combined with the astronomical tide. This was done by adding an astronomical tide height value to the wave runup. The probability of this total elevation was obtained by multiplying the probability of tide height occurrence from the cumulative tide histogram by the probability of the wave runup occurrence. This was done for several tide height and runup values, and the points were plotted on probability paper. The resulting swell-tide curves were combined with the sea-surge-tide curves to obtain the final open-coast flood elevation-frequency curves. This procedure for combining the effects of sea and swell was done for several beach slopes. The difference between the total combined frequency curve and the sea-surge-tide frequency curve correlated quite well with effective beach slope. This correlation was employed to compute the total open-coast frequency once the sea-surge-tide curves were calculated.

To determine flood elevations for areas enclosed by dikes, an elevation-storage capacity curve was developed. Applying the storm runoff volume to the curve gave the flood elevation. If the dike was overtopped by water from the river for a given return frequency flood, the river elevation was the flood elevation used.

Results of the hydrologic/hydraulic analysis to determine various return frequency flood elevations agree quite well with observed flood elevations.

Most diking, or drainage, districts do not properly maintain their dikes. The evaluation herein provides only a hydraulic analysis of a dike’s ability to retard floodwaters. Analysis of the dike’s structural capacity to resist flooding was not done. Several diking districts offer very little protection from riverine flooding because of poor maintenance.

In low areas behind the dune line which are drained by a channel to the ocean, flood elevations were determined from data and methods described in a USACE report (Reference 33). These areas were designated as sheet flow areas. For low areas not connected by drainage channels with the ocean, the flood elevations were determined from estimates of freshwater inflow from rain and streams and ocean water inflow through breaches in the dune lines.

Flood elevations in Elk Creek were based upon the elevation-frequency curve presented by the USACE in the Elk Creek Detailed Project Report (Reference 3). The curve at the mouth of Elk Creek was adjusted to account for the backwater effects upstream of the mouth.

The Alder Creek basin drains into a low-lying area that is separated from the Columbia River by a levee. Flow in the creek must pass through tide gates into the river. When high-water levels occur in the Columbia River, the tide gate closes, and flow in Alder Creek is stored behind the levee. There is no pump system to pump the water over the levee. Flood levels on Alder Creek are controlled by the length of time the tide gates are closed, the hydraulic characteristics of the tide gate, and the volume of water that flows into Alder Creek. This levee does not meet the minimum requirements of 44 CFR Section 65.10 and therefore is not accredited. The landward areas of the levees are identified as SFHA.

The Skipanon River has the same hydraulic configuration above the tide gates and experiences the same type of flood problems as Alder Creek.

Graphic comparison of flow volumes, storage area water-surface elevation, and Columbia River tide level was performed for several timing combinations of peak flow and maximum tide. The analyses covered the periods when the tide was higher than the tide gate, causing the storage area to fill, and also periods when the tide was low and the tide gate allowed discharge to the river. Hydraulic characteristics of the tide gate were included in the analyses. Iterations were performed until a good estimate of maximum water-surface elevation for the storage area was obtained.

It was determined that the 1-percent-annual chance flood from the Pacific Ocean would cause shallow flooding of a 1.0-foot depth at various locations throughout the City of Seaside. In other areas in the city, the 0.2-percent-annual chance flood from the Pacific Ocean would cause shallow flooding of less than 1.0 foot.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

3.3 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 used 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 now prepared using NAVD as the referenced vertical datum.

To accurately convert flood elevations for the following streams and rivers from the current NGVD29 datum to the newer NAVD88 datum, the following procedure was implemented. Locations at the upstream and downstream ends of each flooding source, as well as at an intermediate location between these two end points, were evaluated using the COE CORPSCON (Reference 34) vertical datum conversion software. At each of the three points CORPSCON calculated the difference between the NGVD29 and NAVD88 elevations. These three conversion factors were averaged to develop an average conversion factor for each flooding source. The final NAVD88 elevations reported herein were computed by adding the calculated average conversion factor to the existing NGVD29 data. Table 5 shows the conversion factor for each stream in detail.

Table 5. Datum Conversion Factors

Stream Name	Conversion from NGVD29 to NAVD88 (ft)			
	Minimum Conversion	Maximum Conversion	Average Conversion	Maximum Offset
Bear Creek	3.39	3.4	3.4	0.01
Beerman Creek	3.4	3.44	3.42	0.02
Big Creek	3.4	3.44	3.42	0.02
Cow Creek	3.5	3.5	3.51	0.01
Fishhawk Creek at Birkenfeld	3.49	3.51	3.5	0.01
Fishhawk Creek at Jewell	3.53	3.53	3.53	0
Humbug Creek	3.49	3.5	3.49	0.01
Lewis and Clark River	3.59	3.62	3.61	0.02
Little Creek	3.4	3.43	3.42	0.02
Little Walluski River	3.45	3.47	3.46	0.01
Neacoxie Creek	3.6	3.6	3.6	0
Neawanna Creek	3.6	3.6	3.6	0

[1]Used to convert elevation data from NGVD29 to NAVD88

Flood elevations shown in this FIS reports and on the FIRM are referenced to NAVD. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the NGVD and NAVD, visit the National

Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242
(301) 713-4172 (fax)

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 FIRM for this community. Interested individuals may contact FEMA to access these data.

To obtain current elevation, description and/or location information for benchmarks shown on this map, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their website at www.ngs.noaa.gov.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report 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- and 0.2-percent-annual-chance floodplains; and a 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, and Floodway Data tables. Users should reference the data presented in the FIS report 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 flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:4,800, with a contour interval of 5 feet (References 21, 22, and 35). The boundaries were also interpolated using topographic maps at a scale of 1:1,200, with a contour interval of 2 feet (Reference 36) for the Cities of Cannon Beach, Gearhart, Seaside, and Warrenton.

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, AH, AO, V, 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 so 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.

Approximate 1-percent-annual-chance floodplain boundaries in some portions of the original studies for Clatsop County and the Cities of Astoria and Warrenton and the former Town of Hammond were taken directly from the FIRM panels (References 37, 38, 39, and 40) for the respective communities.

4.2 Floodways

Encroachment on floodplain, 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 base 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 segment 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 section (see Table 6, 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 water-surface elevation (WSEL) of the base 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 2.

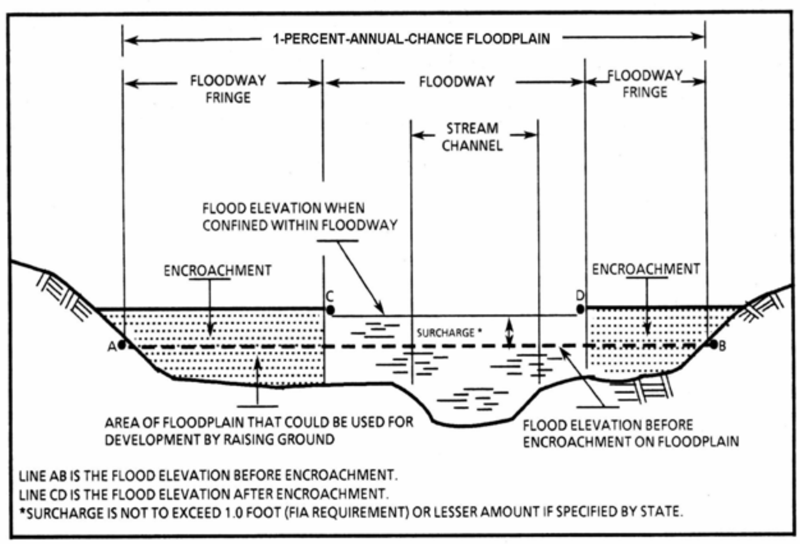


Figure 2. Floodway Schematic

Floodways for Cow Creek and Plympton Creek were not completed, as the floodway would correspond to the 1-percent-annual-chance flood boundary. The floodways shown on Little Walluski River and Bear Creek, downstream of cross section A in both cases, were determined through extrapolation based on engineering judgment. Floodways were not computed for coastal and tidal flooding areas, as the concept of a floodway does not apply in these areas.

A floodway is generally not appropriate in areas such as those that may be inundated by tidewaters from an estuary. The flooding of Neacoxie Creek results from high levels of the Pacific Ocean rather than from high

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
BEAR CREEK								
A	3,350	39	158	9.3	15.7	15.7	15.7	0.0
B	4,210	36	178	8.2	23.1	23.1	23.7	0.6
C	4,340	45	192	7.6	25.4	25.4	26.1	0.7
D	4,910	45	335	4.4	28.3	28.3	29.3	1.0
E	5,390	31	127	11.6	36.1	36.1	37.1	1.0

[1]Feet above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

BEAR CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
BEERMAN CREEK								
A	32	0	NA	NA	19.2	18.9	19.9	1.0
B	808	673[2]	NA	4.3[3]	21.4	21.4	21.5	0.1
C	1,644	428	608	2.7	28.6	28.6	29.4	0.8
D	1,758	21	131	6.1	33.6	33.6	33.6	0.0
E	2,652	63	274	6.0	42.9	42.9	43.8	0.9
F	3,440	61	262	6.2	56.6	56.6	57.5	0.9
G	4,369	48	219	7.4	74.5	74.5	74.7	0.2
H	4,939	92	218	7.5	83.3	83.3	83.7	0.4
I	5,413	128	322	5.1	94.4	94.4	95.4	1.0
J	5,610	82	229	7.1	97.5	97.5	98.1	0.6
K	5,983	58	209	7.8	105.1	105.1	105.5	0.4
L	6,195	90	210	7.8	110.9	110.9	111.1	0.2
M	6,407	67	221	7.4	113.2	113.2	113.8	0.6
N	6,830	88	384	4.2	118.9	118.9	118.9	0.0

[1]Feet above confluence with Necanicum River

[2]Floodway widths reflect flows along Beerman Creek as well as areas that convey flow to/from adjacent reaches

[3]Floodway velocities reflect flows along Beerman Creek and do not reflect overflows to/from adjacent reaches

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

BEERMAN CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
BIG CREEK								
A	4,110	83	509	2.2	12.8	12.8	12.8	0.0
B	4,860	25	97	11.3	13.2	13.2	13.3	0.1
C	5,530	123	459	2.5	15.3	15.3	16.3	1.0
D	6,380	56	219	8.9	19.2	19.2	19.6	0.4
E	6,910	73	286	10.0	25.0	25.0	25.4	0.4
F	8,060	56	307	9.3	33.8	33.8	33.8	0.0
G	8,230	68	457	6.3	34.9	34.9	34.9	0.0
H	9,530	282	651	4.4	42.3	42.3	42.3	0.0

[1]Feet above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

BIG CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
COW CREEK								
A	300	284	NA	NA	436.3	436.3	NA	NA
B	1,300	110	NA	NA	445.5	445.5	NA	NA
C	3,370	116	NA	NA	481.0	481.0	NA	NA
D	3,480	118	NA	NA	485.0	485.0	NA	NA
E	3,605	123	NA	NA	486.8	486.8	NA	NA
F	4,875	114	NA	NA	507.0	507.0	NA	NA
G	5,590	121	NA	NA	524.0	524.0	NA	NA
H	5,730	115	NA	NA	526.0	526.0	NA	NA
I	5,850	127	NA	NA	528.0	528.0	NA	NA
J	6,440	127	NA	NA	540.0	540.0	NA	NA

[1]Feet above confluence with Nehalem River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

COW CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
FISHHAWK CREEK AT BIRKENFELD								
A	2,700[2]	33	351	8.1	520.5	520.5	521.5	1.0
B	3,100[2]	95	602	4.7	522.1	522.1	523.0	0.9
C	4,015[2]	37	487	5.8	526.4	526.4	527.1	0.7
D	7,095[2]	57	374	7.6	528.7	528.7	529.7	1.0
E	7,755[2]	59	563	5.0	531.7	531.7	532.0	0.3
F	8,805[2]	31	289	8.5	532.3	532.3	532.9	0.6
G	9,065[2]	46	402	6.0	533.7	533.7	533.9	0.2
H	10,715[2]	24	164	14.9	535.5	535.5	536.4	0.9
FISHHAWK CREEK AT JEWELL								
A	350	772	8,331	0.8	472.4	472.4	473.4	1.0
B	1,590	922	6,201	1.1	472.4	472.4	473.4	1.0
C	2,410	94	1,492	4.6	472.4	472.4	473.4	1.0
D	3,330	99	973	3.2	472.4	472.4	473.4	1.0
E	4,290	44	407	7.6	473.0	473.0	473.9	0.9
F	5,450	44	353	8.8	475.4	475.4	476.4	1.0
HUMBUG CREEK								
A	875	74	1,346	3.8	384.5	384.5	385.5	1.0
B	3,915	77	487	10.5	392.0	392.0	392.9	0.9
C	5,565	65	650	7.9	400.8	400.8	401.3	0.5
D	6,775	95	825	6.2	403.7	403.7	404.5	0.8
E	7,965	95	854	6.0	406.3	406.3	407.0	0.7
F	9,905	29	389	13.1	412.7	412.7	413.6	0.9
G	11,530	265	2,025	2.5	417.8	417.8	418.8	1.0
H	13,130	410	2,499	2.0	424.4	424.4	425.4	1.0
I	14,525	56	414	12.3	427.2	427.2	427.2	0.0

[1]Feet above confluence with Nehalem River

[2]Feet above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

FISHHAWK CREEK (AT BIRKENFELD) - FISHAWK CREEK (AT JEWELL) - HUMBUG CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
LEWIS AND CLARK RIVER								
A	26,080	314	3,265	1.7	12.4	12.4	12.4	0.0
B	27,480	209	2,967	1.9	12.5	12.5	12.5	0.0
C	28,500	180	1,267	4.5	12.6	12.6	12.6	0.0
D	30,320	140	1,831	3.1	12.8	12.8	13.8	1.0
E	32,500	534	4,580	1.2	13.2	13.2	14.2	1.0
F	37,040	160	1,737	3.3	14.0	14.0	14.9	0.9
G	38,490	248	1,336	3.9	14.5	14.5	15.4	0.9
H	39,610	128	2,272	2.3	14.9	14.9	15.9	1.0
I	40,080	82	1,151	4.5	15.0	15.0	16.0	1.0
J	41,400	222	1,103	4.7	15.8	15.8	16.8	1.0
K	41,640	218	1,093	4.7	16.1	16.1	17.1	1.0
L	43,980	137	1,290	4.0	17.5	17.5	18.5	1.0
M	46,040	150	970	5.3	18.7	18.7	19.7	1.0
N	47,260	93	940	5.5	19.7	19.7	20.7	1.0
O	48,780	139	1,492	3.5	23.8	23.8	24.8	1.0
P	51,300	145	1,131	4.6	28.0	28.0	29.0	1.0
Q	52,850	150	1,039	5.0	30.7	30.7	31.2	0.5
R	53,910	122	883	4.6	32.8	32.8	33.2	0.4
S	54,970	69	620	6.5	34.8	34.8	35.5	0.7
T	55,310	69	640	6.3	35.6	35.6	36.2	0.6
U[2]	57,310	76	402	10.0	41.9	41.9	42.3	0.4
V	58,560	144	769	5.2	48.3	48.3	48.6	0.3
W	60,210	96	618	6.5	52.0	52.0	52.5	0.5
X	61,260	130	520	7.8	57.0	57.0	57.1	0.1
Y	62,460	156	631	6.4	62.8	62.8	62.8	0.0
Z	63,770	45	320	12.6	70.2	70.2	70.4	0.2
AA	65,195	198	778	5.2	80.8	80.8	80.9	0.1
AB	66,775	89	408	9.9	88.6	88.6	88.6	0.0

[1]Feet above mouth

[2]Crosses stream twice

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

LEWIS AND CLARK RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
LITTLE CREEK								
A	4,260	25	120	5.6	12.8	12.8	12.8	0.0
B	5,000	25	129	5.2	14.5	14.5	15.0	0.5
C	5,540	13	78	8.6	16.0	16.0	16.6	0.6
D	5,790	128	506	1.0	18.9	18.9	19.9	1.0
E	6,920	29	61	8.2	22.6	22.6	22.6	0.0
F	7,850	26	77	6.5	35.9	35.9	36.1	0.2
G	8,190	66	403	1.2	41.8	41.8	41.8	0.0
H	9,060	30	61	8.2	46.4	46.4	46.4	0.0
LITTLE WALLUSKI RIVER								
A	4,650	66	598	0.8	12.3	9.5[2]	10.5[2]	1.0
B	5,600	12	95	4.8	12.3	9.5[2]	10.4[2]	0.9
C	5,890	26	218	2.1	12.3	11.0[2]	11.3[2]	0.3
D	6,460	12	94	3.1	12.3	11.0[2]	11.4[2]	0.4
E	8,420	9	26	7.5	13.5	13.5	14.4	0.9

[1]Feet above mouth

[2]Elevation without consideration of backwater effect from the Columbia River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

LITTLE CREEK - LITTLE WALLUSKI RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY[2] (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NEAWANNA CREEK								
A	6,850	1,088	11,599	1.6	14.6	13.4	14.4	1.0
B	7,595	195	3,230	4.2	14.6	13.6	14.6	1.0
C	8,450	326	7,647	3.4	14.6	14.0	15.0	1.0
D	9,330	1,173	6,866	1.0	14.6	14.4	15.3	0.9
E	10,496	454	3,452	2.1	14.6	14.5	15.4	0.9
F	10,849	279	1,669	4.3	14.7	14.7	15.7	1.0
G	11,770	539	4,255	1.7	15.2	15.2	16.1	0.9
H	12,711	554	3,946	1.8	15.4	15.4	16.3	0.9
I	13,622	763	5,614	1.3	15.6	15.6	16.6	1.0
J	14,723	831	6,426	1.1	15.8	15.8	16.8	1.0
K	15,312	606	4,804	1.5	15.8	15.8	16.8	1.0
L	15,634	634	3,041	2.4	15.9	15.9	16.9	1.0
M	16,289	1,370	10,402	0.7	16.2	16.2	17.2	1.0
N	16,969	958	7,976	0.9	16.2	16.2	17.2	1.0
O	17,715	1,416	11,418	0.6	16.3	16.3	17.3	1.0
P	18,981	1,181	7,919	0.9	16.6	16.6	17.6	1.0
Q	19,339	824	9,558	1.4	18.9	18.9	19.4	0.5

[1]Feet above confluence at Necanicum River

[2]Minimum regulatory elevation equal to the 100-year tidal elevation of 14.6 feet

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

NEAWANNA CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY[2] (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NECANICUM RIVER								
A	2,890	222	2,577	4.5	14.4	11.0	12.0	1.0
B	3,475	223	2,644	4.4	14.4	11.5	12.3	0.8
C	3,662	288	3,212	3.6	14.4	11.7	12.5	0.8
D	4,672	309	3,334	3.5	14.4	12.2	12.8	0.6
E	5,549	290	3,430	3.4	14.4	12.5	13.1	0.6
F	6,103	180	2,495	4.6	14.4	12.7	13.2	0.5
G	6,611	125	2,292	5.1	14.4	13.1	13.5	0.4
H	6,998	157	2,526	4.6	14.4	13.5	13.8	0.3
I	7,638	253	3,177	3.6	14.4	13.9	14.1	0.2
J	8,062	215	2,806	4.1	14.4	14.0	14.2	0.2
K	9,200	494	5,064	2.3	14.5	14.5	14.7	0.2
L	9,917	238	1,991	5.8	14.5	14.5	14.7	0.2
M	10,941	255	2,318	5.0	15.6	15.6	15.6	0.0
N	11,895	175	2,329	5.0	16.9	16.9	17.7	0.8
O	12,920	674	3,668	3.2	17.7	17.7	18.4	0.7
P	13,460	1,171	6,779	1.7	18.2	18.2	18.8	0.6
Q	14,497	1,835	11,351	1.0	18.6	18.6	19.1	0.5
R	15,832	2,470	16,182	0.7	18.8	18.8	19.3	0.5
S	16,735	3,018	18,943	0.6	18.9	18.9	19.3	0.4
T	18,196	2,654	16,858	1.2	19.2	19.2	19.6	0.4
U	19,562	2,990	19,769	1.0	19.4	19.4	19.8	0.4
V	20,267	2,347[3]	NA	1.1[4]	19.5	19.5	19.9	0.4
W	21,126	2,307[3]	NA	1.2[4]	19.7	19.7	20.2	0.5
X	21,998	2,580[3]	NA	1.8[4]	20.1	20.1	20.5	0.4
Y	23,191	2,446[3]	NA	1.9[4]	20.7	20.7	20.9	0.2
Z	24,123	1,419[3]	NA	3.8[4]	22.0	22.0	22.0	0.0

[1]Feet above confluence with Neawanna Creek

[2]Minimum regulatory elevation equal to the 100-year tidal elevation of 14.4 feet

[3]Floodway widths reflect flows along the Necanicum River as well as areas that convey flow to/from adjacent reaches

[4]Floodway velocities reflect flows along Necanicum River and do not reflect overflows to/from adjacent reaches

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

NECANICUM RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NECANICUM RIVER								
AA	25,337	1,228	3,235	5.0	24.7	24.7	24.8	0.1
AB	26,037	1,323	4,423	3.7	27.2	27.2	27.4	0.2
AC	26,981	1,087	4,154	3.9	28.9	28.9	29.1	0.2
AD	27,473	905	4,153	4.2	30.1	30.1	30.2	0.1
AE	27,956	158	1,181	9.3	31.5	31.5	31.5	0.0
AF	28,756	292	1,429	7.7	34.3	34.3	34.8	0.5
AG	29,430	141	1,253	8.7	36.4	36.4	36.9	0.5
AH	30,491	583	3,507	3.1	39.3	39.3	40.0	0.7
AI	31,408	425	2,603	4.2	40.4	40.4	40.8	0.4
AJ	32,136	511	2,472	5.1	41.9	41.9	42.1	0.2
AK	33,125	1,236	5,750	2.4	43.8	43.8	43.9	0.1
AL	33,869	1,442[2]	NA	3.4[3]	44.6	44.6	44.6	0.0
AM	34,400	1,365[2]	NA	4.1[3]	45.5	45.5	45.6	0.1
AN	35,059	1,204[2]	NA	4.7[3]	47.3	47.3	47.4	0.1
AO	35,268	970	3,162	5.1	48.3	48.3	48.4	0.1
AP	35,983	1,207	5,321	3.1	50.1	50.1	50.2	0.1
AQ	36,187	916	4,380	3.7	51.7	51.7	51.8	0.1
AR	37,800	1,005	3,474	4.6	55.6	55.6	56.5	0.9
AS	38,592	663	2,967	5.4	58.2	58.2	59.0	0.8
AT	39,431	465	2,231	7.2	61.9	61.9	62.6	0.7
AU	41,117	579	3,259	4.9	67.1	67.1	67.9	0.8
AV	43,178	780	4,899	3.1	74.5	74.5	75.4	0.9
AW	44,328	165	1,054	14.4	78.0	78.0	78.0	0.0
AX	45,328	1,088	5,964	2.6	81.5	81.5	82.4	0.9
AY	45,548	641	3,182	4.8	81.6	81.6	82.4	0.8
AZ	46,708	175	1,074	14.2	84.8	84.8	84.9	0.1

[1]Feet above confluence with Neawanna Creek

[2]Floodway widths reflect flows along the Necanicum River as well as areas that convey flow to/from adjacent reaches

[3]Floodway velocities reflect flows along Necanicum River and do not reflect overflows to/from adjacent reaches

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

NECANICUM RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NECANICUM RIVER								
BA	47,668	300	2,200	6.9	90.1	90.1	91.1	1.0
BB	47,858	445	3,849	4.0	95.5	95.5	95.5	0.0
BC	49,258	622	3,604	4.2	96.3	96.3	96.3	0.0
BD	49,708	305	1,738	8.5	96.9	96.9	96.9	0.0
BE	50,868	456	1,519	9.7	101.8	101.8	101.8	0.0
BF	52,548	375	1,497	9.8	109.8	109.8	110.7	0.9
BG	53,828	170	1,371	9.7	115.3	115.3	116.3	1.0
BH	55,198	190	1,317	10.1	120.9	120.9	121.1	0.2
BI	56,838	158	1,180	11.3	127.6	127.6	128.1	0.5
BJ	58,198	263	1,850	7.2	134.3	134.3	135.3	1.0
BK	59,398	700	2,997	4.4	139.7	139.7	139.8	0.1
BL	60,838	459	2,345	5.7	146.7	146.7	147.6	0.9
BM	61,568	175	1,079	12.3	151.6	151.6	152.0	0.4
BN	61,798	294	1,655	8.0	156.7	156.7	156.7	0.0
BO	62,758	980	5,490	2.4	161.3	161.3	162.1	0.8
BP	63,588	317	1,656	8.0	163.1	163.1	163.5	0.4
BQ	63,998	289	1,522	8.7	166.8	166.8	167.1	0.3
BR	64,098	650	3,450	3.9	167.6	167.6	168.6	1.0
BS	64,208	350	1,911	7.0	168.7	168.7	169.2	0.5
BT	64,508	613	5,259	2.5	171.4	171.4	172.4	1.0
BU	65,268	164	1,239	9.8	173.0	173.0	173.3	0.3
BV	65,768	358	2,300	5.3	178.2	178.2	179.2	1.0
BW	66,848	575	3,050	3.1	183.2	183.2	183.7	0.5
BX	67,038	375	1,914	5.0	183.6	183.6	184.2	0.6
BY	68,098	164	1,169	8.2	190.1	190.1	190.9	0.8
BZ	68,748	260	1,693	5.7	194.4	194.4	195.0	0.6

[1]Feet above confluence with Neawanna Creek

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

NECANICUM RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NECANICUM RIVER								
CA	69,618	142	925	10.4	200.1	200.1	200.4	0.3
CB	69,918	380	2,035	4.7	202.9	202.9	203.3	0.4
CC	70,403	173	1,011	9.5	205.1	205.1	206.1	1.0
CD	71,063	583	3,451	2.8	208.9	208.9	209.9	1.0
CE	71,573	165	767	12.5	214.0	214.0	214.1	0.1
CF	72,413	358	2,268	4.2	221.5	221.5	222.0	0.5
CG	73,443	541	1,466	6.5	225.3	225.3	225.3	0.0
CH	73,843	188	834	10.4	230.9	230.9	231.7	0.8
CI	74,373	341	1,980	4.4	235.4	235.4	236.4	1.0
CJ	74,623	230	972	9.0	236.5	236.5	237.5	1.0
CK	75,793	116	654	13.3	246.2	246.2	246.9	0.7
CL	76,413	460	2,300	3.8	251.8	251.8	252.8	1.0
CM	76,613	114	718	12.1	253.6	253.6	253.7	0.1
CN	76,913	670	3,919	2.2	257.5	257.5	258.5	1.0
CO	77,193	274	862	10.1	258.3	258.3	258.7	0.4
CP	77,748	595	2,190	4.0	264.2	264.2	265.2	1.0
CQ	78,588	99	565	12.4	266.8	266.8	267.1	0.3
CR	79,368	92	516	13.6	272.1	272.1	272.1	0.0
CS	80,728	145	846	8.3	285.3	285.3	285.5	0.2
CT	81,288	224	945	7.4	289.2	289.2	289.9	0.7
CU	82,208	330	1,655	4.3	295.9	295.9	296.9	1.0
CV	82,788	109	623	11.3	298.7	298.7	299.1	0.4
CW	83,748	68	461	14.5	309.3	309.3	309.3	0.0

[1]Feet above confluence with Neawanna Creek

TABLE 6	FEDERAL EMERGENCY MANAGEMENT AGENCY **CLATSOP COUNTY, OR** **AND INCORPORATED AREAS**	**FLOODWAY DATA** **NECANICUM RIVER**

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NECANICUM RIVER OVERFLOW								
A	28,023	257	1,229	4.2	31.5	31.3	31.4	0.1
B	28,203	258	953	5.4	31.5	31.4	31.6	0.2
C	28,710	256	810	6.4	32.6	32.6	32.9	0.3
D	29,494	627	2,728	1.9	34.3	34.3	34.6	0.3
E	30,110	456	1,454	3.6	34.9	34.9	35.2	0.3
F	31,065	764[2]	NA	2.7[3]	37.1	37.1	38.0	0.9
G	31,586	773[2]	NA	0.9[3]	37.8	37.8	38.6	0.8

[1]Feet above confluence with Necanicum River

[2]Floodway widths reflect flows along the Necanicum River Overflow as well as areas that convey flow to/from adjacent reaches

[3]Floodway velocities reflect flows along Necanicum River Overflow and do not reflect overflows to/from adjacent reaches

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

NECANICUM RIVER OVERFLOW

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NEHALEM RIVER								
A	175,375	183	3,595	11.9	367.9	367.9	368.9	1.0
B	179,875	179	3,515	12.2	376.6	376.6	377.0	0.4
C	182,075	295	5,959	7.2	383.3	383.3	384.0	0.7
D	184,275	396	5,711	6.9	385.1	385.1	385.8	0.7
E	186,225	182	3,960	10.9	386.6	386.6	387.3	0.7
F	188,425	194	2,902	13.5	390.1	390.1	391.0	0.9
G	190,825	1,250	6,796	5.8	398.4	398.4	398.9	0.5
H	191,725	168	2,865	13.7	400.0	400.0	400.5	0.5
I	192,825	409	5,242	8.5	404.2	404.2	405.0	0.8
J	194,050	232	7,184	5.4	405.8	405.8	406.5	0.7
K	195,250	488	6,678	5.7	406.2	406.2	406.9	0.7
L	196,050	100	2,517	15.1	407.0	407.0	407.5	0.5
M	198,250	269	5,138	7.4	415.2	415.2	416.0	0.8
N	199,650	202	3,505	10.8	418.2	418.2	419.2	1.0
O	201,470	178	3,566	10.7	421.3	421.3	421.7	0.4
P	203,810	396	4,731	8.0	424.4	424.4	424.7	0.3
Q	205,810	485	6,354	6.0	426.6	426.6	427.2	0.6
R	207,470	156	4,319	8.8	427.7	427.7	428.5	0.8
S	210,070	218	4,977	7.6	430.2	430.2	430.9	0.7
T	211,670	399	5,302	7.2	432.1	432.1	432.6	0.5
U	213,150	451	7,645	5.0	433.4	433.4	434.0	0.6
V	215,750	392	7,273	5.2	434.6	434.6	435.3	0.7
W	217,970	865	11,087	3.4	436.0	436.0	436.7	0.7
X	220,570	640	6,625	5.6	437.5	437.5	438.2	0.7
Y	221,493	306	5,925	6.3	438.6	438.6	439.4	0.8
Z	223,173	271	4,405	8.5	439.9	439.9	440.5	0.6

[1]Feet above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

NEHALEM RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NEHALEM RIVER								
AA	224,233	360	5,420	6.9	441.1	441.1	441.8	0.7
AB	225,833	355	5,797	6.4	442.2	442.2	443.0	0.8
AC	227,433	263	4,552	8.2	443.8	443.8	444.4	0.6
AD	228,413	220	3,772	9.9	445.3	445.3	445.8	0.5
AE	229,393	256	4,088	9.1	445.8	445.8	446.7	0.9
AF	231,043	257	3,596	10.4	452.2	452.2	452.5	0.3
AG	232,943	196	3,264	11.4	457.5	457.5	457.5	0.0
AH	235,343	205	3,604	10.3	462.3	462.3	462.3	0.0
AI	237,343	155	3,254	11.4	464.4	464.4	464.4	0.0
AJ	240,143	155	3,482	10.7	467.5	467.5	467.5	0.0
AK	241,943	192	4,922	7.5	469.3	469.3	469.4	0.1
AL	244,043	719	6,140	6.0	470.4	470.4	470.4	0.0
AM	245,523	636	6,596	5.6	471.3	471.3	471.5	0.2
AN	248,163	291	6,152	6.0	472.4	472.4	472.8	0.4
AO	249,833	186	4,621	7.8	473.1	473.1	473.4	0.3
AP	251,023	217	4,789	7.5	473.9	473.9	474.2	0.3
AQ	252,443	173	5,358	6.7	475.1	475.1	475.1	0.0
AR	254,643	285	7,860	4.6	476.3	476.3	476.4	0.1
AS	256,903	246	5,740	6.3	476.9	476.9	477.0	0.1
AT	258,983	209	5,475	6.6	478.2	478.2	478.2	0.0
AU	261,503	168	4,983	7.2	479.6	479.6	479.6	0.0
AV	263,793	271	5,766	6.2	481.4	481.4	482.0	0.6
AW	265,043	228	4,932	7.3	482.2	482.2	482.8	0.6
AX	267,643	212	6,242	5.7	484.3	484.3	484.6	0.3
AY	270,243	212	6,686	5.4	485.3	485.3	485.7	0.4
AZ	272,143	169	4,825	7.4	486.0	486.0	486.4	0.4

[1]Feet above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

NEHALEM RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NEHALEM RIVER								
BA	274,743	230	6,011	6.0	488.0	488.0	488.5	0.5
BB	276,863	251	6,425	5.5	489.1	489.1	489.5	0.4
BC	279,263	260	6,017	5.9	490.1	490.1	490.5	0.4
BD	281,403	223	6,529	5.0	491.0	491.0	491.3	0.3
BE	283,603	290	5,661	6.3	491.9	491.9	492.2	0.3
BF	284,783	389	7,228	4.9	492.8	492.8	493.1	0.3
BG	285,373	301	7,434	4.8	493.2	493.2	493.8	0.6
BH	286,973	222	5,873	6.0	493.8	493.8	494.3	0.5
BI	288,373	521	7,243	4.9	494.7	494.7	495.2	0.5
BJ	290,443	647	8,846	3.9	495.7	495.7	496.2	0.5
BK	293,643	230	6,560	5.3	496.9	496.9	497.5	0.6
BL	295,183	479	8,141	4.2	497.5	497.5	498.0	0.5
BM	296,783	747	11,775	2.9	498.3	498.3	498.9	0.6
BN	299,583	563	10,454	3.3	499.2	499.2	499.8	0.6
BO	301,533	1,242	12,269	2.8	499.8	499.8	500.5	0.7
BP	303,833	581	10,990	3.1	500.6	500.6	501.3	0.7
BQ	305,558	320	7,302	4.7	501.1	501.1	501.7	0.6
BR	307,583	366	8,981	3.8	501.8	501.8	502.5	0.7
BS	309,423	718	10,064	3.4	502.4	502.4	503.0	0.6
BT	311,263	422	8,612	3.9	503.1	503.1	503.8	0.7
BU	314,163	524	8,031	4.2	504.0	504.0	504.7	0.7
BV	317,763	449	8,089	4.2	505.7	505.7	506.4	0.7
BW	319,823	287	7,019	4.8	506.6	506.6	507.3	0.7
BX	322,483	393	9,599	3.3	507.6	507.6	508.3	0.7
BY	323,893	397	8,466	3.8	507.8	507.8	508.5	0.7
BZ	326,433	284	6,240	5.1	508.9	508.9	509.6	0.7

[1]Feet above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

NEHALEM RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NEHALEM RIVER								
CA	327,028	245	6,170	5.2	509.2	509.2	510.0	0.8
CB	328,641	728	8,754	3.7	510.1	510.1	510.8	0.7
CC	330,311	695	9,889	3.2	510.8	510.8	511.5	0.7
NORTHRUP CREEK								
A	1,025[2]	959	8,341	0.2	496.3	496.3	497.3	1.0
B	1,635[2]	471	5,041	0.3	496.3	496.3	497.3	1.0
C	1,835[2]	389	4,489	1.4	496.3	496.3	497.3	1.0
D	3,815[2]	748	4,148	0.4	496.3	496.3	497.3	1.0
E	5,295[2]	129	1,574	1.1	496.3	496.3	497.3	1.0
F	7,145[2]	165	1,339	1.3	496.3	496.3	497.3	1.0
G	9,395[2]	32	139	11.9	502.1	502.1	502.1	0.0

[1]Feet above mouth

[2]Feet above confluence with Nehalem River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

NEHALEM RIVER - NORTHRUP CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NORTH FORK NEHALEM RIVER								
A	27,560	185	1,962	7.0	27.0	27.0	27.3	0.3
B	28,335	165	2,008	6.9	28.8	28.8	29.0	0.2
C	29,875	178	1,941	7.1	31.2	31.2	31.5	0.3
D	30,555	175	1,727	8.0	32.4	32.4	32.7	0.3
E	31,595	134	1,579	8.7	34.8	34.8	35.3	0.5
F	32,275	189	1,335	10.0	37.2	37.2	37.8	0.6
G	32,589	200	1,145	11.7	39.2	39.2	39.7	0.5
H	32,795	129	1,628	8.2	41.6	41.6	42.1	0.5
I	33,975	200	2,551	5.2	44.0	44.0	44.6	0.6

[1]Feet above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

NORTH FORK NEHALEM RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NORTH FORK NEHALEM RIVER AT HAMLET								
A	95,080	60	369	8.9	471.8	471.8	471.8	0.0
B	95,580	74	384	8.6	477.3	477.3	477.3	0.0
C	96,210	70	285	11.6	486.6	486.6	486.6	0.0
D	97,400	58	333	9.9	500.7	500.7	501.3	0.6
E	97,930	108	668	4.9	503.7	503.7	504.4	0.7
F	98,820	74	367	9.0	506.9	506.9	506.9	0.0
G	99,210	157	775	4.3	509.0	509.0	509.5	0.5
H	99,430	160	785	4.2	509.9	509.9	510.3	0.4
I	99,880	407	1,199	2.8	510.8	510.8	511.7	0.9
J	100,390	566	3,363	0.9	511.2	511.2	512.2	1.0
K	101,220	68	265	11.3	516.0	516.0	516.0	0.0
L	101,400	68	380	7.9	518.0	518.0	518.5	0.5
M	102,100	238	808	3.7	520.4	520.4	520.9	0.5
N	102,350	124	414	7.2	525.7	525.7	526.1	0.4
O	103,550	65	400	7.5	530.2	530.2	531.0	0.8
P	104,090	74	317	9.4	532.6	532.6	532.8	0.2
Q	104,700	106	517	5.2	536.7	536.7	537.4	0.7
R	104,850	49	405	6.7	538.1	538.1	538.6	0.5
S	104,980	50	428	6.3	538.9	538.9	539.6	0.7
T	105,565	84	674	4.0	540.6	540.6	541.6	1.0
U	106,215	210	584	4.6	543.3	543.3	543.4	0.1

[1]Feet above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

NORTH FORK NEHALEM RIVER AT HAMLET

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
PLYMPTON CREEK								
A	800	108	NA	NA	14.3	14.3	NA	NA
B	1,320	110	NA	NA	18.3	18.3	NA	NA
C	1,708	84	NA	NA	21.5	21.5	NA	NA
D	2,495	73	NA	NA	35.0	35.0	NA	NA

[1]Feet above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

PLYMPTON CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY[2] (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
UPPER NEAWANNA CREEK								
A	0	182	296	2.2	16.2	11.9	12.9	1.0
B	681	94	172	3.7	16.6	16.6	17.5	0.9
C	834	117	262	2.5	19.1	19.1	20.0	0.9
D	1,709	38	145	4.4	31.6	31.6	32.1	0.5

[1]Feet above confluence with Neawanna Creek

[2]Minimum regulatory elevation equal to the 100-year tidal elevation of 16.2 feet

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

UPPER NEAWANNA CREEK

streamflow. During 1-percent-annual-chance flood events, tidal gates are shut at the mouth of Neacoxie Creek to hold back tidal floodwaters. This action results in a storage effect on Neacoxie Creek for which a floodway is not applicable; thus, no floodway was computed for Neacoxie Creek.

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 follow:

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 report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base (1-percent-annual-chance) Flood Elevations (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 report by detailed methods. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to areas of 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. 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 rate zone that corresponds to areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses 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 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 square miles (sq. mi.), and areas protected from the base 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 floodplain that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.
Table 7 – Community Map History Table

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 areas of Clatsop County. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the county identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community are presented in Table 7, “Community Map History.”

7.0 OTHER STUDIES

The USACE developed flood profiles for the Columbia River (Reference 23). The USACE has also published a detailed Flood Plain Information report for the

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Astoria, City of	June 28, 1974	N/A	August 1, 1978	-
Cannon Beach, City of	June 21, 1974	N/A	September 1, 1978	-
Clatsop County, Unincorporated Areas	December 20, 1974	NA	July 3, 1978	June 16, 1999
Gearhart, City of	December 7, 1973	December 19, 1975	May 15, 1978	January 3, 1983 June 16, 1999
Seaside, City of	December 7, 1973	April 23, 1976	September 5, 1979	October 27, 1981
Warrengton, City of	June 28, 1974	NA	May 15, 1978	-

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLATSOP COUNTY, OR

AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

Nehalem River (Reference 19). The U.S. Soil Conservation Service has published a Flood Hazard Study for the Necanicum River from its mouth to River Mile 12 (Reference 20). This Flood Insurance Study agrees with the above-mentioned studies.

This FIS report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the NFIP.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study an be obtained by contacting Federal Insurance and Mitigation Division, FEMA Region X, Federal Regional Center, 130 228th Street, SW, Bothell, Washington 98021-9726.

9.0 BIBLIOGRAPHY AND REFERENCES

1. E-Podunk web site, Clatsop County, OR County Profile, http://www.epodunk.com, 2006

2. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Clatsop County, Oregon, CH2M HILL, Inc., January 1978

3. U.S. Department of the Army, Corps of Engineers, Portland District, Elk Creek at Cannon Beach, Clatsop County, Oregon, Draft Detailed Project Report, Portland, Oregon, November 1974

4. U.S. Water Resources Council, “A Uniform Technique for Determining Flood Flow Frequencies,” Bulletin 17, March 1976

5. U.S. Department of the Interior, Geological Survey, Magnitude and Frequency of Floods in the United States, Pacific Slope Basins in Oregon and Lower Columbia Basin, 1964

6. U.S. Department of the Army, Corps of Engineers, Portland District, Report No. 2, Procedure for Determination of Maximum Annual Flood Peak and Volume Frequencies for Portland District, Portland, Oregon, February 1969

7. U.S. Department of the Interior, Geological Survey, Evaluation of the Streamflow-Data Program in Oregon, David Lystrom, Portland, Oregon, 1970.

8. Oregon State Engineer, Watershed Planning Division, Regionalized Flood Frequency Data for Oregon, C. L. Wheeler, 1968

9. U.S. Department of the Interior, Geological Survey, Water Supply Paper 1689, Magnitude and Frequency of Floods in the United States, Part 14, Pacific Slope Basins in Oregon and Lower Columbia River Basin, Washington, D.C., 1964

10. U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, Washington, D.C., 1973

11. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, West Coast, North and South America, Including the Hawaiian Islands, Rockville, Maryland, 1955 through 1975

12. U.S. Department of the Army, Corps of Engineers, Portland District, Drawing No. CL-03-133/1, Flood Frequency Profiles (Fall and Winter Freshets) Columbia River, Portland, Oregon, March 1972

13. University of California, College of Engineering, Hydraulic Engineering Laboratory, Technical Report HEL 16-6, Empirical Probability Distributions for Astronomical Water Height, R. D. Borcherdt and L. E. Borgman, Berkeley, California, July 1970

14. U.S. Department of Agriculture, Soil Conservation Service, Technical Release EWP No. 6, Tides and Tidal Drainage in the Northeastern States, Upper Darby, Pennsylvania, January 1963

15. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, North American Surface Charts, National Climatic Center, Asheville, North Carolina

16. U.S. Department of the Army, Coastal Engineering Research Center, Shore Protection Manual, Vols. I, II, III, 1973

17. National Marine Consultants, Inc., Wave Statistics for Three Deep Water Stations Along the Oregon-Washington Coast, prepared for U.S. Army Corps of Engineers, Seattle and Portland Districts, Santa Barbara, California, May 1961

18. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, October 1973

19. U.S. Department of the Army, Portland District, Flood Plain Information, Nehalem River in Vicinity of Jewell, Oregon, Portland, Oregon, February 1976

20. U.S. Department of Agriculture, Soil Conservation Service, Flood Hazard Analysis, Necanicum River, Clatsop County, Oregon, Portland Oregon, March 1976

21. Clatsop-Tillamook Intergovernmental Council, Topographic Maps, Scale 1:4,800, Contour Interval 5 feet: Lewis and Clark River, Clatsop County, Oregon, Spencer B. Gross and David C. Smith, Cannon Beach, Oregon, January 1973

22. CH2M HILL, Inc., Topographic Maps, Scale 1:4,800, Contour Interval 5 feet: Flood Insurance Studies, Clatsop County, Oregon, P9482.A0, Portland, Oregon, 1975

23. U.S. Department of the Army, Corps of Engineers, Portland District, Columbia River Flood Frequency Profiles, Portland, Oregon, December 1971, Revised March 1972

24. Oregon Department of Geology and Mineral Industries, Environmental Geology of the Coastal Region of Tillamook and Clatsop Counties, Oregon, Portland, Oregon, July 1972

25. U.S. Department of the Army, Corps of Engineers, Technical Bulletin No. 16, The Computation of Tides and Currents in Estuaries and Canals, Vicksburg, Mississippi, D. R. F. Harleman and C. H. Lee, September 1969

26. U.S. Department of the Army, Technical Bulletin No. 16A, The Computation of Tides and Currents in Estuaries and Canals, Appendix A: A User's Manual, D. R. F. Harleman and M. L. Thatcher, Vicksburg, Mississippi, June 1973

27. Oregon State University Ocean Engineering Programs, Physical Characteristics of the Youngs Bay Estuarine Environs – Final Report, prepared for ALUMAX Pacific Aluminum Corporation, Corvallis, Oregon, May 1975

28. U.S. Department of Commerce, National Weather Service, COM-75-10181, SPLASH Programs' User's Guide, C. P. Jelesnianski, et. Al., Springfield, Virginia, November 1974

29. Jelesnianski, C. P., "Numerical Computations of Storm Surges with Bottom Stress," Monthly Weather Review, November 1967, vol. 95, no. 11, pp. 740-756

30. U.S. Department of the Army, Corps of Engineers, Waterways Experiment Station, Hydraulics Laboratory, Technical Report H-75-17, Type 16 Flood Insurance Study: Tsunami Predictions for Monterey and San Francisco Bays and Puget Sound, A. W. Garcia and J. R. Houston, Vicksburg, Mississippi, November 1975

31. University of California, College of Engineering, Hydraulic Engineering Laboratory, Technical Report HEL 16-8, Frequencies of Cress Heights for Random Combination of Astronomical Tides and Tsunamis Recorded at Crescent City, California, C. Petrauskas and L. E. Borgman, Berkeley, California, March 1971

32. Stanford University, Department of Civil Engineering, Technical Report No. 80, Some Applications of a Digital Computer to Hydraulic Engineering Problems, R. S. Dobson, Palo Alto, California, June 1976

33. U.S. Department of the Army, Corps of Engineers, Preliminary Report of Devils Lake, Lincoln City, Oregon, Portland, Oregon

34. U.S. Army Corps of Engineers, Engineer Research and Development Center, CORPSCON-Coordinate Conversion Software, Version 5.11, www.erdc.usace.army.mil, October 1978

35. CH2M HILL, Inc., Photo Contour Map, Clatsop County, Oregon, North Coast Area P81830, Scale 1:4,800, Portland, Oregon, December 1973

36. CH2M HILL, Inc., Photo Contour Map, Scale 1:1,200 , Contour Interval 2 Feet: Clatsop County, Oregon (December 1973)

37. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Rate Map, Clatsop County, Unincorporated Areas, Iowa, July 1978

38. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Rate Map, City of Astoria, Clatsop County, August 1978

39. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Rate Map, City of Warrenton, Clatsop County, May 1978

40. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Rate Map, Town of Hammond, Clatsop County, April 1978

41. Federal Highway Administration, Culvert Analysis Program HY-8, Version 4.1, November 1992

42. Clatsop County, Oregon, Flood Insurance Workmap, Limited Map Maintenance Program, Neacoxie, Scale 1:1,200, Contour Interval 2 feet, June 1992

43. U.S. Army Corps of Engineers, *HEC-RAS River Analysis System User's Manual, Version 3.1*. CPD-68 and CPD-69. Hydrologic Engineering Center, Davis, CA, November 2002.

44. FEMA, *Letter to Mayor Monaghan, City of Seaside, from Fred Sharrocks, Acting Director Hazard Mapping Division,* dated April 14th, 2003, Federal Insurance and Mitigation Administration.

45. Bard, G, C. R. Goodwin, and C. F. Glanzman, "Tidal Choking," Journal of Hydraulic Research, vol. 9, no. 3, 1970

46. Bascom, W., Waves and Beaches, Garden City, New York: Doubleday and Company, Inc., 1964

47. Battjes, J. A., "Run-up Distributions of Waves Breaking on Slopes," Journal of the Waterways Harbors and Coastal Engineering Division, vol. 97, no. WW1, American Society of Civil Engineers, New York, New York, February 1971

48. Bowditch, N., "Tides," American Practical Navigator, Chapter XVIII, Washington, D.C., 1943

49. Brands, D., Datums Along the Columbia River, Personal Communication, U.S. Department of the Army, Corps of Engineers, Portland, Oregon, December 30, 1975

50. Caldwell, J. M., "New Developments in the Field of Tidal Hydraulics," American Society of Civil Engineers, Hydraulic Division, Proceedings, Vol. 95, No. HY1, January 1969

51. Calny, E. P., The Tides – Pulse of the Earth, 1968
52. Clatsop County, Oregon, Flood Insurance Work Map, Limited Map Maintenance Program, Neacoxie Creek, Scale 1:1,200, Contour Interval 2 feet, June 1992

53. Cronkers, J. J., "Tidal Computations in Rivers, Coastal Areas and Seas," American Society of Civil Engineers, Hydraulics Division, Proceedings, Vol. 95, No. HY1, January 1969

54. Cronkers, J. J., Tidal Computations in Rivers and Coastal Waters, Amsterdam: N. Holland Publishing Co., 1964

55. Falvey, H. T., "Prediction of Wind Wave Heights," Journal of the Waterways, Harbors, and Coastal Engineering Division, Volume 100, No. WW1, American Society of Civil Engineers, New York, New York, February 1974

56. Federal Emergency Management Agency, Flood Insurance Study, City of Gearhart, Oregon, November 1977

57. Federal Emergency Management Agency, Flood Insurance Study, Clatsop County, Oregon, January 1978, revised September 1987

58. Heaps, N. S., "Storm Surges," Oceanography and Marine Biology: An Annual Review, Volume 5, 1967

59. Komar, P. D., "Storm Surges," Oceanography and Marine Biology: An Annual Review, vol. 5, Harold Barnes (Ed.), London, 1967

60. Marinos, G., and J. W. Woodward, "Estimation of Hurricane Surge Hydrographs," Journal of the Waterways and Harbors Division, Volume 94, No. WW2, American Society of Civil Engineers, New York, New York, May 1968

61. National Engineering Science Company, Contract NONR-4177(00), A Bibliography on Storm Surges and Related Subjects, C. L. Bretscneider and G. S. Pick, McLean, Virginia, August 1, 1966

62. National Engineering Science Company, Contract NONR-4177(00), Engineering Aspects of Hurricane Surge, C. L. Bretschneider, McLean, Virginia

63. Oregon Department of Geology and Mineral Industries, Environmental Geology of the Coastal Region of Tillamook and Clatsop Counties, Oregon, Portland, Oregon, July 1972

64. Oregon State University, Civil Engineering Department, Bulletin No. 45, Tidal Study of Three Oregon Estuaries, C. R. Goodwin, E. W. Emmett, and B. Glenne, Corvallis, Oregon, May 1970

65. Oregon State University, Sea Grant College Program, Description and Information Sources for Oregon Estuaries, K. L. Percy, et. al., Corvallis, Oregon, May 1974

66. Oregon State Water Resources Board, North Coast Basin, Salem, Oregon, June 1961

67. Oregon State Water Resources Board, and U.S. Department of Agriculture, North Coast Drainage Basin, June 1966

68. Pacific Northwest River Basins Commission, Meteorology Committee, Vancouver, Washington, Climatological Handbook, Columbia Basin States, Precipitation, Volume 2, 1969

69. Shougard, O., I. G. Jonsson, and G. A. Bertelsen, “Computation of Wave Heights Due to Refraction and Friction,” Journal of the Waterways and Harbor Division, Volume 101, No. WW1, Presented to American Society of Civil Engineers, New York, New York, February 1975

70. Skovgaard, O., I. G. Jonsson, and J. A. Bertelsen, “Computation of Wave Heights Due to Refraction and Friction,” Journal of the Waterways and Harbors Division, February 1975, vol. 101, no. WWi, American Society of Civil Engineers, New York

71. Thom, H. C. S., “Extreme Wave Heights Distributions Over Oceans,” Journal of the Waterways Harbors and Coastal Engineering Division, Volume 99, No. WW3, American Society of Civil Engineers, New York, New York, August 1973

72. University of Oregon, Department of Geology, Eugene, Oregon, Final Report, Contract NONR-2771(04), Project 388-062, Some Recent Physical Changes of the Oregon Coast, S. N. Dicken, November 15, 1961

73. U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, 1972

74. U.S. Department of Agriculture, Soil Conservation Service, Soil Survey, Astoria Area, Oregon, E. F. Torgerson, James McWilliams, Carl J. McMurphy, June 1949

75. U.S. Department of Commerce, Weather Bureau, Technical Memorandum WR-51, Western Region Sea State and Surf Forecaster’s Manual, G. D. Shields, Salt Lake City, Utah, July 1970

76. U.S. Department of Commerce, Coast and Geodetic Survey, Special Publication 135, Tidal Datum Planes, U.S. Government Printing Office, Washington, D.C., 1951

77. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Technical Report No. 64 Variability of Tidal Datums and Accuracy in Determining Datums from Short Series of Observations, R. L. Swanson, Rockville, Maryland, October 1974

78. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Nautical Chart Catalog 2, United States Pacific Coast Including Hawaii, Guam, and Samoa Islands, Rockville, Maryland

79. U.S. Department of Commerce, Tidal Bench Mark Data, Rockville, Maryland

80. U.S. Department of Commerce, Tides Branch, Tide Records, Rockville, Maryland

81. U.S. Department of Commerce, Systems Development Office, Technical Memorandum NWS TDL-46, SPLASH (Special Program to List Emplitudes of Surges from Hurricanes), Landfall Storms, C. P. Jelesnianski, Silver Spring, Maryland, April 1972

82. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Systems Development Office, Technical Memorandum NWS TDL-52, SPLASH, Part Two, General Track and Variant Storm Conditions, March 1974

83. U.S. Department of Commerce, Environmental Science Services Administration, ESSA Technical Memorandum WBTM HYDO 11, Joint Probability Method of Tide Frequency Analysis Applied to Atlantic City and Long Beach Island, New Jersey, V. A. Myers, Silver Spring, Maryland, April 1970

84. U.S. Department of the Army, Corps of Engineers, North Pacific Division, National Shoreline Study, Inventory Report, Columbia-North Pacific Region, Washington and Oregon, Portland, Oregon, August 1971

85. U.S. Department of the Army, Corps of Engineers, Portland District, River and Harbor and Flood Control, Project and Index Maps, Portland, Oregon, 1975

86. U.S. Department of the Army, Corps of Engineers, Committee on Tidal Hydraulics, Technical Bulletin No. 14, Tidal Flow in Entrances Water Level Fluctuations of Basins in Communication with Seas, G. H. Keulegan, Vicksburg, Mississippi, June 1967

87. U.S. Department of the Army, Corps of Engineers, Committee on Tidal Hydraulics, Inventory Report, National Shoreline Study, Columbia-North Pacific Region, Washington and Oregon, North Pacific Division, Portland, Oregon, August 1971

88. U.S. Department of the Army, Office of the Chiefs of Engineers, Beach Erosion Board, Technical Memorandum No. 35, Analysis of Moving Fetches for Wave Forecasting, Vicksburg, Mississippi, 1953

89. U.S. Department of the Interior, Coast and Geodetic Survey, Special Publication 135, Tidal Datum Planes, U.S. Government Printing Office, Washington, D.C., 1951

90. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Map, Scale 1:24,000, Contour Interval 10 feet: Gearhart Oregon (1949); Olney, Oregon (1949); Tillamook Head, Oregon (1949); Warrenton, Oregon (1953)

91. U.S. Department of the Interior, Geological Survey, 15-Minute Series Topographic Maps, Scale 1:62,500, Contour Interval 20 feet: Cannon Beach, Oregon (1955); Saddle Mountain, Oregon (1955)

92. U.S. Department of the Interior, Geological Survey, Crest-Stage Gaging Station in Oregon, A Compilation of Peak Data Collected from October 1952 to September 1974, John Friday, Portland, Oregon

93. U.S. Department of the Interior, Geological Survey, Open-File Report 74-3336, Magnitude and Frequency of Floods in Washington, J. E. Cummans, M. R. Collins, and E. G. Nassar, Tacoma, Washington, 1975

94. U.S. Department of the Interior, Geological Survey, Water Resources Data for Oregon – Part I, Surface Water Records, 1960 to 1974

95. U.S. Department of the Interior, Geological Survey, Water Supply Paper No. 1318, Compilation of Records of Surface Waters of the United States Through September 1950

96. U.S. Department of the Interior, Geological Survey, Water Supply Paper No. 1738, Compilation of Records of Surface Water of the United States, October 1950 to September 1960

97. U.S. Department of the Interior, Geological Survey, Water Supply Paper No. 1849, Roughness Characteristics of Natural Channels, 1967

98. Weggell, J. R., "Maximum Breaker Height," Journal of Waterways, Harbors, and Coastal Engineering Division, November 1972, vol. 98, no. WW4, American Society of Civil Engineers, New York

10.0 REVISION DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the Flood Insurance Studies for each community was printed in the 1970's. Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To assure that any user is aware of all revisions, it is advisable to contact the community repository of flood hazard data located at the Department of Land and Water Resources, 201 South Jackson Street, Suite 600, Seattle, Washington 981-3855.

10.1 First Revision

This study was revised on September 30, 1987, to change the Zone A designation of the Walluski River to a Zone A2 designation with an elevation of 12.5 feet NAVD. This elevation is a result of backwater from the Columbia River.

The Zone A2 designation on the Walluski River extends from its confluence with the Youngs River upstream to the limit of study on the Walluski River. The 12.5-foot backwater elevation on the Walluski River does not affect water-surface elevations on the Little Walluski River because of a tide gate located on Walluski Loop Road at the confluence of the Walluski and Little Walluski Rivers.

10.2 Second Revision

This study was revised on June 16, 1999, to incorporate the effects of new hydrologic and hydraulic analyses prepared by the USACE, Portland District, for FEMA, under Interagency Agreement No. EMW-89-E-2994, Project Order No. 9. The study was completed in January 1995 and contains a detailed hydraulic analysis of Neacoxie Creek from approximately 1,200 feet downstream of Gearhart Loop Road (formerly called Golf Course Road) to approximately 800 feet upstream of Surf Pines Road, a 1.8 mile-long reach.

Neacoxie Creek is bordered on both sides by sand dunes that vary from about 10 to 60 feet in height above the creek channel bottom. The crest of these sand dunes forms the east and west watershed boundaries of the creek. Surface runoff from the watershed is unlikely because the infiltration rate of sand is greater than the rainfall rate of the most intense storms, and water temporarily stored in the sand dunes is constantly draining at a relatively high rate to Neacoxie Creek, thus ensuring there is sufficient volume of void space available to temporarily store rainfall from even the larger storm events.

Thus, it is concluded that overland runoff does not contribute to the flood flows in Neacoxie Creek and that virtually all discharge along the study reach of Neacoxie Creek is due to sub-surface flow.

Because there are no stream-gage data available for Neacoxie Creek, the best source of information for determining reasonable flood flows is the local residents. They report that, in 30 years, water levels have not come close to reaching the top of Gearhart Loop Road. This time period includes the 1964 floods, which varied throughout Western Oregon from approximately the 2- to 1-percent-chance-exceedence flood; the January 1972 flood, which was close to a 1-percent-chance-exceedence flood throughout much of Clatsop County; and the March 27, 1964, tsunami wave that originated in Alaska and caused widespread damage along the coast in the area of Gearhart.

The Federal Highway Administration's (FHWA's) culvert analysis program HY-8 (Reference 41) was used to determine the discharge that would just overtop Gearhart Loop Road given a tail-water elevation equal to the 1-percent-chance-exceedence flood elevation at a location just below the downstream limit of study. The flow rate obtained was set equal to the 1-percent-chance-exceedence flood. The water flowing from the dunes into the creek is a function of the height of the water table in the dunes, which is directly proportional to the amount of rainfall and starting elevation of the water table. The attenuating effect of the sand dunes produces relatively small differences between the peaks of flood of different percent-chance exceedence.

The following are the results of the analysis to determine reasonable flow rates at Gearhart Loop Road. The same flood rates were used at Surf Pines Road.

Table 8- Discharge - Frequency

Percent-Chance Exceedance	Discharge (cfs)
50 - (2-year flood)	61
10 - (10-year flood)	88
2 - (50-year flood)	110
1- (100-year flood)	120
0.2 - (500-year flood)	138

There are two culverts located at Gearhart Loop Road. The FHWA culvert analysis program HY-8 was used to determine the effect of including the culverts in the hydraulic analysis. The results indicated that inclusion of the two culverts in the analysis, even when assumed completely open, has a negligible effect on the water-surface elevation upstream of Gearhart Loop Road.

The flow rates were used in the HY-8 program to determine the water level on the upstream side of Gearhart Loop Road associated with each percent-chance-exceedence flood. The high tail water on culverts at Gearhart Loop Road in combination with a low channel gradient results in virtually a level pool upstream until the next constriction is encountered at the Surf Pines Road culvert. At Surf Pines Road, elevations just upstream of the road were also obtained with the use of the HY-8 program in the same manner used at Gearhart Loop Road. Tail-water elevations were set equal to the water-surface elevations above Gearhart Loop Road.

The Gearhart Loop Road culverts also have a negligible effect on the upstream water-surface elevations due to the high tail water restricting flow through the culverts and their limited capacity when compared to the predicted peak-flow rates. When upstream water-surface elevations are greater than the road surface, weir discharge over the road increases very rapidly with increases in upstream water-surface elevation, whereas culvert discharge increases only marginally. Similar results occur at Surf Pines Road, although the leveling off of the water-surface-elevation increase occurs at lower discharges because weir flow commences at a lower discharge due to the fact that there is only one 3-foot-diameter culvert at Surf Pines Road, as opposed to two at Gearhart Loop Road.

Table 9 - Water Surface Elevations

Percent-Chance Exceedance	Gearhart Loop Road to Surf Pines Road	Above Surf Pines Road
50 - (2-year flood)	13.7	19.4
10 - (10-year flood)	15	19.6
2 - (50-year flood)	16.6	19.7
1 - (100-year flood)	16.9	19.7
0.2 - (500-year flood)	16.9	19.7

The 1- and 0.2-percent-annual-chance floodplain boundaries were delineated using topographic maps prepared by the USACE, Portland District (Reference 42).

As agreed upon by the community and FEMA, no floodway is shown along this 1.8-mile study reach of Neacoxie Creek.

10.3 Third Revision

The purpose of this revision is to incorporate the results of an analysis of hydrologic and hydraulic studies in the City of Seaside and the unincorporated areas of Clatsop County. For flood insurance purposes, refer to the separately published FIRM.

The hydrologic and hydraulic analyses were performed by WEST, Consultants, Inc., for FEMA under Contract No. EMA-2001-CO-0068. This work was completed in June 2007.

The following streams were studied by detailed methods in this revised study:

Necanicum River:	From just below the 12th Avenue Bridge to approximately 6,500 feet upstream of U.S. Highway 101. Approximate reach length of 7.0 miles.
Necanicum River Overflow	From just below Rippet Road upstream approximately 5,000 feet to its divergence from the Necanicum River. Approximate reach length of 0.9 mile.
Neawanna Creek	From its mouth to approximately 2,500 feet upstream of Avenue S Bridge. Approximate reach length of 3.4 miles.
Upper Neawanna Creek	From its confluence with Neawanna Creek upstream approximately 4,000 feet to the confluence with Neawanna Creek. Approximate reach length of 0.8 mile.
Beerman Creek	From its mouth to the end of the County Road. Approximate reach length of 1.1 miles.

WEST used the effective hydrology for this restudy, based on work conducted by FEMA and Michael Baker, Inc. These relationships are shown below:

0.2%-annual-chance-flow = 940 $A^{0.75}$
1%-annual-chance-flow = 800 $A^{0.75}$
2%-annual-chance-flow = 785 $A^{0.75}$
10%-annual-chance-flow = 580 $A^{0.75}$
50%-annual-chance-flow = 400 $A^{0.75}$

where A = drainage area in square miles.

Flows specified in the HEC-RAS model are shown in Table 3, Summary of Discharges. Optimized split flow computations in the HEC-RAS program determined the discharge to Upper Neawanna Creek.

The local drainage area contributing to the Necanicum River Overflow was not calculated because overflows from the Necanicum River were determined to be driving the peak flows for large flood events. Consequently, no local flow values were calculated either.

HEC-2 was originally used to study these reaches. They were later imported into HEC-RAS (Version 3.1.2). The imported HEC-RAS data was checked against the original HEC-2 files.

As a secondary check of the validity of the importing, flows in these four reaches were simulated using the imported HEC-2 boundary condition data (stage, normal depth, and flow). However, in the HEC-2 data files, the distance from bridges to the upstream cross-sections, was set equal to zero, and this distance must be greater than zero in HEC-RAS – a criteria specified in the coding of the program. WEST therefore specified a distance of 0.1 feet to the upstream cross-section at each bridge, and correspondingly decreased the bridge width by this amount.

Other geometric changes made in the HEC-RAS model were setting the cross-section expansion/contraction values to match those in the HEC-2 model, they were not imported correctly into HEC-RAS, and setting the "conveyance calculation" method to "Between every coordinate point (HEC-2 Style)". The reaches were left independent of one another (i.e., no junction were added at this point) as it was structured in the HEC-2 data files. Knowing that computational differences should be expected between HEC-2 and HEC-RAS, relatively small differences between the computed water surface elevations of the two programs would help to verify that the data was imported correctly. The computed differences between the two programs was relatively small, with a combined average difference for all four reaches of 0.1 feet, and ranging from -0.5 feet to +0.3 feet.

WEST added additional cross-sections from the TIN data at the upstream end of the Upper Neawanna Creek to better define the flow connection with the Necanicum River. The two tributaries, Neawanna Creek (the upper section) and Beerman Creek, were not connected to the main system because the drainage areas for these tributaries are roughly 1% and 4%, respectively, when compared to the upstream drainage area of the main stem and assuming non-coincident peaks. The upper section of the HEC-2

Necanicum River geometry was divided into the main stem ("Reach 5" in HEC-RAS) and an overflow channel ("Overflow" reach in HEC-RAS) towards the west. Reach lengths were set for the overflow channel and Manning's "n" values based on the left overbank values. Five separate HEC-RAS "lateral structures" were defined using the TIN data to hydraulically connect the mainstem Necanicum River to the west overflow channel, and also added a downstream junction at the confluence of the two reaches.

Critical depths resulted in the model, especially in Beerman Creek, after importing the HEC-2 cross-sections. Many attempts were made to remove these critical depths including interpolating cross-sections, raising the Manning's "n" using the Jarrett equation for high gradient stream (Reference 43), and modifying ineffective flow areas, however, removing critical depth was not possible in all locations.

WEST used the effective hydrology (Section 3.1) for all upstream boundary conditions. The downstream boundary condition was set for the Neawanna Creek (upper reach) and Beerman Creek equal to normal depth based on the downstream channel slope from the effective FIS (Reference 2) following FEMA guidelines and specifications.

The water surface quickly converges to a similar water surface elevation and therefore it is assumed that any error in the estimation of these cross-section data would not propagate much beyond the stationing where the flood surge elevation will supersede the computed hydraulic modeling base flood elevations (BFE's). Therefore the flood surge elevation will typically dictate the BFE's in the area where changes to the new geometry will have an effect on the hydraulic model.

Eight calibration points were provided for an event that occurred on January 9, 1990. The 1990 event ranged from a 6.67- to 2-percent-annual chance event across Northwestern Oregon. It is approximately a 4-percent-annual-chance event at Seaside (Reference 44). WEST approximated the 4-percent-annual-chance flow from the regression equations and the graphic representation of these equations in the effective FIS (Reference 2). As part of the calibration WEST also raised the Necanicum "n" value to 0.035 from 0.03 for RS 10802 and cross-sections downstream to the ocean boundary, and the Neawanna "n" values from 0.035 to 0.03 for RS 111415 and cross-sections downstream to the ocean boundary. Weir coefficients were also set during the calibration.

The floodways were developed separately for the Necanicum/Neawanna system, Necanicum Creek (upper reach), and Beerman Creek. The "known" water surface at the downstream end of each of these was set equal to one foot above the value computed for the base case. For the

Necanicum River and Neawanna Creek these were set at the downstream limits of the study area, RS 1979 and RS 102953, respectively. For Beerman Creek this was set downstream of the culvert at the downstream end. Encroachment stationing was set equal to the effective study where data were available and as made possible by the hydraulic simulation. Floodway Data tables are shown in Table 6.

Countywide Update

The countywide update was performed by Black & Veatch, Inc. for FEMA contract No. HSFEHQ-04-D-0025, Task Order HSFE10-05-J-0001.

This update combined the flood Insurance Rate Maps (FIRMs) and Flood Insurance Study (FIS) reports for Clatsop County and Incorporated communities into countywide format. Under the countywide format, FIRM panels have been produced using single layout format for the entire area within the county instead of separate layout formats for each community. The single layout format facilitates the matching of adjacent panels and depicts the flood hazard area within the entire panel border, even areas beyond a community's corporate boundary line. In addition, under the county wide format this single FIS provides all associated information data for the entire county area.

As a part of this revision, the format of the map panels has changed. Previously, flood hazard information was shown on both FIRMs and Flood Boundary and Floodway Maps (FBFMs). In the new format, all the base flood elevations, zone designations, cross sections, and flood plain and floodway boundary delineations are shown on the FIRMs; the FBFM has been eliminated. Some of the flood insurance zone designations were changed to reflect the new format. Areas previously shown as numbered A were revised to zone AE. Areas previously shown as zone B were revised to zone X (shaded). Areas previously shown as zone C were revised to zone X (unshaded). In addition, all flood insurance zone data tables were removed from FIS report and all zone designations and reach determinations were removed from flood profiles.

All flood elevations shown in this FIS report and the FIRM panels were converted from NGVD 29 to NAVD 88. The conversion factor for all flooding sources is given in Table 5.

Flood plain boundaries for most of the flooding sources were digitized from the effective FIRM and the Floodway panels. Aerial photography and USGS topographic maps were used to adjust floodplain and floodway boundaries where appropriate.

As a countywide update for Clatsop County, floodplain boundaries of Rock creek and Nehalem River were revised using new detailed studies and topographic mapping with a contour interval of two feet.

The levees along the Columbia river do not meet FEMA 65.10 stipulated minimum requirements. In the countywide mapping update, flood plain of the Columbia River is expanded as if no levees were existed. However no new hydraulic studies were conducted to determine the water elevation for without levee scenario for Columbia river. With the consultation FEMA RPO, more conservative, effective riverward BFEs were extended on to both sides of the river across the flood plain. The BFEs and still water elevations shown in Table 4 are based on the assumption that levees providing protection for 1% flood discharge. The last column in table 4 shows the Base Flood Elevations based on the DFIRM. Hence, the readers are advised to refer DFIRM for most current update on BFEs.