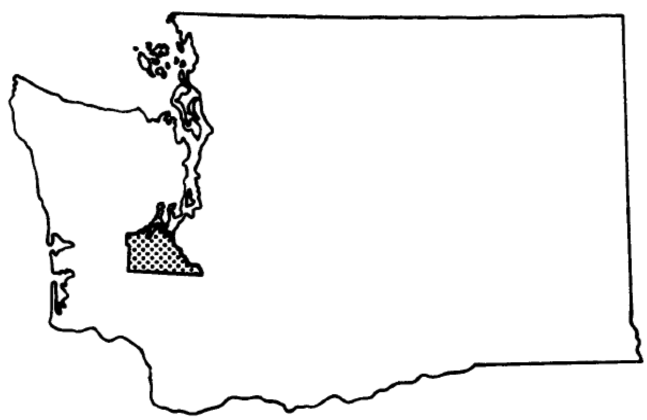
FLOOD INSURANCE STUDY

THURSTON COUNTY, WASHINGTON AND INCORPORATED AREAS

Community Name	Community Number
BUCODA, TOWN OF	530189
LACEY, CITY OF	530190
OLYMPIA, CITY OF	530191
RAINIER, CITY OF	530260
TENINO, CITY OF	530302
THURSTON COUNTY	530188
TUMWATER, CITY OF	530192
YELM, CITY OF	530310



Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
53067CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at any time. In addition, FEMA may revise part of this FIS Report by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult with community officials and check the Community Map Repository to obtain the most current FIS report components.

Selected Flood Insurance Rate Map (FIRM) panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map (FBFM) panels (e.g., floodways and cross sections). In addition, former flood hazard zone designations have been changed as follows:

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

Initial Countywide FIS Effective Date:

TABLE OF CONTENTS Page

TABLE OF CONTENTS - continued

Page

FIGURES

TABLES

EXHIBITS

FLOOD INSURANCE STUDY
THURSTON COUNTY, WASHINGTON AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in, or revises and updates previous FISs/Flood Insurance Rate Maps (FIRMS) for the geographic area of Thurston County, including the Cities of Lacey, Olympia, Rainier, Tenino, Tumwater, Yelm; the Town of Bucoda, and the unincorporated areas of Thurston County (hereinafter referred to collectively as Thurston County). Within Thurston County, the Chehalis Indian Reservation and the Nisqually Indian Reservation are non-participating communities in the NFIP.

This FIS 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 county that will be used to establish actuarial flood insurance rates. This information will also be used by the communities of Thurston County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the 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.

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.

This FIS was prepared to include the incorporated communities within Thurston County into a countywide format. Information on the authority and acknowledgments for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is shown below.

Bucoda, Town of:	The hydrologic and hydraulic analyses for this study were performed by the U.S. Geological Survey, for the Federal Insurance Administration, under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 2. This work, which was completed in August 1979, covered all significant flooding sources affecting the Town of Bucoda.
Lacey, City of:	The hydrologic and hydraulic analyses for this study were performed by the U.S. Geological Survey for the Federal Insurance

Administration, under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 2. This work, which was completed in April 1979, covered all significant flooding sources affecting the City of Lacey.

Olympia, City of:	The hydrologic and hydraulic analyses for this study were performed by the U.S. Geological Survey, for the Federal Emergency Management Agency, under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 2. This work, which was completed in July 1980, covered all significant flooding sources affecting the City of Olympia.
Tenino, City of:	The hydrologic and hydraulic analyses for this study were performed by the U.S. Geological Survey, for the Federal Insurance Administration, under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 2. This work, which was completed in November 1978, covered all significant flooding sources affecting the City of Tenino.
Thurston County, Unincorporated:	The hydrologic and hydraulic analyses for this study were performed by the U.S. Geological Survey, for the Federal Emergency Management Agency, under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 2. This work, which was completed in November 1980, covered all significant flooding sources affecting Thurston County.
Tumwater, City of:	The hydrologic and hydraulic analyses for this study were performed by the U.S. Geological Survey, for the Federal Emergency Management Agency, under Inter-Agency Agreement No. H-9-77, Project Order No. 2. This work, which was completed in March 1979, covered all significant flooding sources affecting Tumwater.
Yelm, City of:	The hydrologic and hydraulic analyses for this study were performed by Northwest Hydraulic Consultants, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-93-C-4152, Task Order Nos. LMMP95-NHC-l and LMMP95-NHC-2. This study was completed in September 1997.

No previous FIS report was prepared for the City of Rainier, the Chehalis Indian Reservation, or the Nisqually Indian Reservation.

For this countywide study, all flooding sources studied by detailed methods were redelineated on new topographic data derived from the 2002 Puget Sound LiDAR Consortium (PSLC) Bare Earth LiDAR ASCII Points data, developed by TerraPoint, Inc. The LiDAR data has a Root Mean Square (RMS) vertical accuracy of approximately 30 centimeters.

In addition, the Nisqually River was converted to approximate zone due to the extreme stream channel migration occurring since the original models where developed.

The Deschutes River floodway and floodway data tables were removed, also due to the extreme channel migration within the floodplain.

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, 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 the communities of Thurston County are shown in Table 1, Initial and Final CCO Meetings.

TABLE 1 - INITIAL AND FINAL CCO MEETINGS

Community	Initial CCO Date	Intermediate CCO Date	Final CCO Date
Town of Bucoda	April 29, 1976	*	August 18, 1980
City of Lacey	April 29, 1976	*	July 26, 1979
City of Olympia	April 29, 1976	*	March 31, 1981
City of Tenino	April 29, 1976	*	May 15, 1979
Thurston County	April 29, 1976	May 1980	December 17, 1981
City of Tumwater	April 29, 1976	*	July 13, 1979
City of Yelm	April 30, 1996	*	May 13, 1998

*Data not available

For this revision, the final CCO meeting was held on xx/xx/xxxx with with representatives of FEMA, the study contractor, and representatives from _________

2.0 **AREA STUDIED**

2.1 Scope of Study

This FIS report covers the geographic area of Thurston County, Washington.

Detailed Methods

The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction. Table 2 lists the flooding sources which were studied by detailed methods and redelineated based on updated topography. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

TABLE 2 - STREAMS STUDIED BY DETAILED METHODS

FLOODING SOURCE	STATION START	UPSTREAM LIMIT OF STUDY
Black River	From the western boundary of Thurston County (RM 5.6) upstream	Black Lake
Chehalis River	From the western boundary of Thurston County (RM 52.1) upstream	Southern boundary of Thurston County (RM 60.7)
Deschutes River	Corporate Limits of the City of Tumwater (River Mile (RM) 3.4)	Approximately 7000 feet upstream of the confluence with Thurston Creek (RM 41.6)
Outlet of Black Lake	From Mottman Road Southwest	Black Lake
Percival Creek	Corporate limits of the City of Tumwater at Sapp Road upstream	Trosper Lake
Scatter Creek	From 11,250 downstream of Grand Mound Road crossing at Tenino	Approximately 4,700 feet upstream of the confluence of Scatter Creek Tributary
Scatter Creek Tributary	Confluence with Scatter Creek	State Highway 507
Skookumchuck River	Just upstream Tono-Bucoda Road (Thurston County boundary (RM 5.5)	(River Mile 20.7 (1.2 miles downstream of Skookumchuck Dam)
Woodland Creek	From Pleasant Glade Road NE	Approximately 500 feet downstream of Interstate 5
Yelm Creek	Just upstream Centralia Power Canal Flume	Approximately 2.7 miles upstream Centralia Power Canal Flume

Lakes and bays studied in detail include: Black Lake, Bigelow Lake, Budd Inlet, Capitol Lake, Chambers Lake, Clear Lake, Hicks Lake, Ken Lake, Lake Lawrence, Long Lake, Nisqually Reach, Pattison Lake, Setchfield Lake, Summit Lake, Tempo Lake, and Trosper Lake.

Approximate Methods

Table 3 lists the flooding sources which were studied by approximate methods

TABLE 3 - AREAS STUDIED BY APPROXIMATE METHODS

JURISDICTION	FLOODING SOURCE
Thurston County, Unincorporated Areas	Alder Lake, Bald Hill Lake, Barnes Lake, Beatty Creek, Beaver Creek, Beaver Creek tributaries, Black Lake tributaries, Black River downstream of Black Lake, Black River Tributaries, Blooms Ditch, Blooms Ditch Overflow to Salmon Creek, Chapman Run, Chehalis River areas along detailed study, Chehalis River Overflows, Chehalis River tributary, Coffee Creek, Coffee Creek West Branch, Deep Lake, Dempsey Creek, Deschutes River areas along detailed study, Deschutes River Overflows, Deschutes River tributaries, D'Miller Lake, Dry Creek, Eaton Creek, Eaton Creek Tributary, Edna Creek, Elbow Lake, Eld Inlet, Fry Cove, Gehrke Lake, Goose Pond, Grass Lake Outlet, Green Cove, Henderson Inlet, Henderson Inlet - Chapman Bay, Henderson Inlet - Woodward Bay, Indian Creek, Inmen Lake, Johnson Creek, Kennedy Creek, Lackamas Creek, Lagrande Reservoir, Lake Lawrence Outlet, Lake Lois, Lake Saint Clair, Laramie Creek Tributary, Little Deschutes River, Little Nisqually River, Long Lake Tributary, McAllister Creek, McAllister Creek Tributary, McLane Creek, McIntosh Lake, Medicine Creek, Mima Creek, Munn Lake, Nisqually River, North Hanaford Creek, Offutt Lake, Outlet of Black Lake Drainage Ditch, Outlet of Black Lake Tributary, Outlet of Grass Lake, Oyster Bay, Pattison Lake, Pattison Lake North, Pipeline Creek, Pitman Lake, Powell Creek, Puget Sound, Puget Sound - Big Fishtrap Cove, Reichel Lake, Reichel Lake Outlet, Salmon Creek, Scatter Creek (downstream of Tenino), Scatter Creek Tributaries, Scott Lake, Sheehan Lake, Skookumchuck Reservoir, Skookumchuck River (portions), Southwick Lake, Spurgeon Creek, Spurgeon Creek tributaries, Summit Lake Outlet, Susan Lake, Thompson Creek, Thompson Creek Overflow to Skookumchuck River, Thompson Creek Tributary, Toboton Creek, Totten Inlet, Trails End Lake, Trosper Lake, Waddell Creek, Ward Lake, Woodland Creek downstream of Pleasants Road SE, Woodward Creek, Yelm Creek outside of the Yelm City limits, Yelm Ditch, Young Cove, and numerous isolated ponding areas throughout the county.

JURISDICTION	FLOODING SOURCE
Town of Bucoda	Skookumchuck River - Front Street Overflow, along the Burlington Northern Railroad in the vicinity of Main and Martina Streets
City of Lacey	Woodland Creek, upstream of Interstate Highway 5, and several unnamed ponding areas
City of Olympia	Ellis Creek, Grass Lake, Grass Lake Outlet, Indian Creek, Ken Lake Tributary East, Ken Lake Tributary West, Mission Creek, Outlet of Black Lake, Percival Creek, Percival Cove, Setchfield Lake, Ward Lake, Woodward Creek, and various unnamed ponding areas.
City of Tenino	Scatter Creek Tenino Tributary 1 and Scatter Creek Tenino Tributary 2
City of Tumwater	Barnes Lake, Deschutes River along the edge of the detailed study, Percival Creek, Trosper Lake, and various unnamed ponding areas
City of Yelm	Thompson Creek

This countywide FIS incorporates the determinations of Letter of Map Revisions (LOMRs) issued by FEMA, for the projects listed by community as follows:

LETTERS OF MAP REVISION

Community Name	Case Number	Streams	Date
Thurston County	94-10-058P	Zone A along Scatter Creek	August 31, 1994
Thurston County	94-10-031P	Zone A along Scatter Creek	December 5, 1994
Thurston County	96-10-013P	Unnamed Zone A along Chehalis River	April 24, 1996
Thurston County	97-10-112P	Unnamed Zone A along Chehalis River	January 21, 1997
City of Olympia, City of Tumwater, and Thurston County	03-10-0337P	Capitol Lake, Budd Inlet south of 4th Street	December 26, 2003
City of Olympia	06-10-B326P	Unnamed Zone A	May 31, 2006

One LOMR (89-10-06P) was superseded based on engineering judgment during the floodplain redelineation using updated LiDAR topographic data. Another LOMR (94-10-058P) was superseded due to insufficient information. The Capitol Lake LOMR (03-10-0337P) was incorporated with the associated BFE change from 14' to 15' NAVD, but was redelineated on new LiDAR-derived elevation data.

Town of Bucoda

Approximate analyses were performed by field survey and engineering judgment. The Skookumchuck River - Front Street Overflow, along the Burlington Northern Railroad in the vicinity of Main and Martina Streets was studied by approximate methods.

City of Lacey

Approximate methods of analyses were used to study those areas having a low development potential or minimal flood hazards. Woodland Creek, upstream of Interstate Highway 5, and several swampy areas were studied by approximate methods.

City of Olympia

Shallow flooding or ponded areas studied by approximate methods were Percival Cove and an area north of Setchfield Lake. Riverine flooding was studied by approximated methods along Percival Creek, from Percival Cove upstream to the corporate limits and from Mottman Road Southwest upstream to the corporate limits; Ellis Creek northeast of East Bay Drive; and Indian Creek, from Interstate Highway 5 upstream to the corporate limits. Additional streams are listed in Table 3.

Approximate methods of analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by the Federal Emergency Management Agency and the City of Olympia.

City of Tumwater

Shallow flooding or ponded areas of Barnes Lake were studied by approximate methods. These included areas west of Tumwater Junior High School; east of Miner Drive Southwest; south of Trosper Road in the vicinity of Schoth Street; south of Hartman Street and north of the Union Pacific Railroad tracks; north of Trosper Road and west of Lake Park Road; at the east end of E Street and east of the union Pacific Railroad; east of M, N, and O Streets; and, north of East T Street.

Two areas of riverine flooding were studied by approximate methods. These include Percival Creek, upstream from U.S. Highway 101 to Mottman Road and from Dacatur Street Southwest to Sapp Road (Thurston County-Tumwater corporate limits); and Deschutes River, from Capitol Lake upstream to the dam at Olympia Brewery.

City of Tenino

Shallow flooding areas studied by approximate methods were; ditch from culvert outfall at schoolyard to Scatter Creek, north of Garfield Avenue, fields north of Sussex Avenue, from Reynolds Street to Olympia-Tenino highway, and a residential area from Olympia-Tenino Highway to Custer Street.

Approximate methods of analyses were used to study those areas having a low development potential or minimal flood hazards.

Thurston County Unincorporated Areas

Some overflow areas of the Black, Chehalis, Deschutes, and Skookumchuck Rivers; Indian, a portion of Woodland, a portion of Percival, Mima, Scatter, Waddell, Dempsey, Johnson, Thompson, Spurgeon, North Hanaford, and Toboton Creeks; the outlets of Grass Lake and Reichel Lake were studied by approximate methods.

Offutt, Barnes, Sheehan, Munn, Susan, and Trails End Lakes; Totten, Eld, and Henderson Inlets; and Puget Sound along the coast of Thurston County were also studied by approximate methods. A complete list of streams studied by approximate methods is listed in Table 3.

City of Yelm

Approximate methods of analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by the Federal Emergency Management Agency, the City of Yelm, and the study contractor. A complete list of streams studied by approximate methods is listed in Table 3.

2.2 Community Description

Thurston County is located in the west-central area of Washington, just south of Budd Inlet –a southern arm of Puget Sound. Thurston County is bordered by Mason County to the northwest, Gray's Harbor County to the immediate west, Lewis County to the south and Pierce County to the east.

Thurston County is comprised of seven incorporated communities (six cities, one town) and the unincorporated areas. According to the 2000 U.S. Census Bureau, the population for Thurston County was 207,355 with land and water area totaling 773.6 square miles (U.S. Census Bureau, 2009).

The climate of Thurston County is marine with an annual precipitation ranging from approximately 40 inches on the eastern lowland prairies to approximately 60 inches in the southeastern and northwestern hills. In the City of Olympia, the average annual precipitation is approximately 51 inches, 42 inches of which fall from October to March. The mean annual temperature in the City of Olympia is 51°F, with monthly mean temperatures ranging from 38°F in January to 64°F in July (U. S. Department of Commerce, 1965). Temperatures as high as 104°F and as low as -8°F have been recorded for Olympia.

The five main river systems in Thurston County are Nisqually, Deschutes, Black, Skookumchuck, and Chehalis Rivers. Black and Skookumchuck Rivers are major tributaries to Chehalis River (FEMA, Thurston County Unincorporated Areas, 1999).

Nisqually River meanders along Thurston County's eastern boundary with Pierce County. Deschutes River flows northwesterly for approximately 41 miles within Thurston County towards its mouth at Capitol Lake in Olympia. Black River is a slow, meandering stream that extends from Black Lake south for approximately 19 miles in Thurston County. Skookumchuck River extends for approximately 24.7 miles in south central Thurston County and has a wide flood plain from the county line upstream for 15 miles. Chehalis River extends for only 8.6 miles in Thurston County, but has an extensive flood plain, covering at least 12 square miles (Thurston Regional Planning Council, 1975).

2.3 Principal Flood Problems

Flooding in Thurston County has been a result of heavy rainfall, sometimes augmented with runoff contributions from snowmelt. Flooding generally occurs during the winter months, November through February, when storms bring intense precipitation. The major flood problems are those of inundation and damage to private property from out-of-bank floodwaters.

The history of flooding in Lacey indicates that flooding occurs along Woodland Creek, in local depressions and marshes, and along the lakes.

For the City of Olympia, rain coupled with storm-driven high tide has caused inundation and property damage. The business and industrial areas around Budd Inlet and Capitol Lake suffer the most damage, with additional impacts from the overflow of Outlet of Black Lake and Ken, Setchfield, and Chambers Lakes. A historical high tide (approximately 100-year recurrence interval) occurred on December 15, 1977, when many businesses along Budd Inlet and Capitol Lake were inundated.

Flood damage on Nisqually River in the unincorporated portions of Thurston County is generally limited to an area near McKenna in Pierce County. A discharge flow of approximately 18,000 cubic feet per second (cfs) at McKenna is associated with zero-flood damage on Nisqually River (Pacific Northwest River Basins Commission, 1970). This flow has been exceeded six times during the period of record (1947-78) at the U.S. Geological Survey gaging station on Nisqually River below Powell Creek near McKenna (No. 12088400), at RM 31.6. The three most severe floods occurred in December 1975 (30,700 cfs), January 1965 (25,700 cfs), and January 1974 (23,200 cfs) (U.S. Department of the Interior, -1971, 1971-74, 1975-1978). The December 1933 flood, estimated at 42,000 cfs, inundated most of the delta (Pacific Northwest River Basins Commission, 1971).

Near the mouth of Deschutes River, a discharge of 3,600 cfs is considered to represent zero-damage flow (Pacific Northwest River Basins Commission, 1970). This flow has been exceeded at least 31 times between 1945 and 2007. On January 15, 1974, a flood with a recurrence interval of approximately 100 years occurred on the Deschutes River. The Tumwater Valley Golf Course was inundated, and the Olympia Brewing Company incurred some property damage during this flood. The most severe floods, as recorded at the gaging station on Deschutes River near Rainier (No. 12079000), at RM 25.9, are

9,600 cfs in January 1990, 7,850 cfs in February 1996, and 7,780 cfs in January 1974 (U.S. Department of the Interior, prior to 1971, 1971-74, 1975-1978).

No extensive records are available describing historic flooding on Black River. However, it is known that, during periods of flooding, Black River is inundated by floodwaters of Chehalis River as far as 5 miles upstream of the Thurston County limits (Thurston Regional Planning Council, 1975).

The three most severe floods on Skookumchuck River occurred in February 1996 (9,020 cfs), January 1990 (7,800 cfs), and December 1953 (6,710 cfs), as recorded by the gaging station below Bloody Run Creek (No. 12026150) (U.S. Department of the Interior, -1971, 1971-74, 1975-1978).

In December 2007, almost the entire Chehalis River flood plain was inundated by the largest flow (79,100 cfs) in 80 years (1928-2007) of record at the gaging station near Grand Mound (No. 12027500). The second and third most severe floods on the Chehalis River occurred in February 1996 (74,800 cfs), and January 1990 (68,700 cfs).

On February 8, 1996, an intense rainstorm occurred in Thurston County following several months of above-average precipitation. Eight inches of rain were recorded at the nearby Olympia Airport gage for the period from February 5-8, 1996. Observed rainfall at the Olympia gage for the period from November 1995 through January 1996 was approximately 40 percent higher than normal. Freezing temperatures and some snow accumulation were observed in the basin from late January through approximately February 4. This combination of meteorological inputs resulted in high flows and significant flooding along portions of Yelm Creek within the City of Yelm City limits.
Much of the floodplain along Yelm Creek was inundated, with large ponding areas upstream of several road crossings. Of the five roads crossed by Yelm Creek in the study reach, four were overtopped during the February 1996 event, including Crystal Springs Road, First Street, 103rd Avenue, and Bald Hills Road.

A slightly smaller flood event occurred from December 31, 1996, through January 2, 1997. Again, a moderately intense rainfall event occurred following an extended period of above-average precipitation. Just prior to this flood, significant snowfall accumulations were present over the entire Yelm Creek basin. The combination of high groundwater, rainfall runoff, and snowmelt caused high flows and significant flooding on Yelm Creek. It took several months for the water to recede, which indicates that the flooding was closely linked to high groundwater levels in the basin. Flooding throughout much of Thurston County was more severe for the December 1996 through January 1997 flood than for any event in recent history, although the February 1996 event was larger on Yelm Creek.

Prior to these two events, significant flooding occurred on Yelm Creek most recently in January 1990. Reports provided by the City of Yelm (Puget Land Consultants, 1994) indicate that the January 1990 flood overtopped at least one road in the study reach (103rd Avenue).

2.4 Flood Protection Measures

There are no physical flood protection measures in the Cities of Lacey, Olympia, and Yelm; and City of Tenino.

The Skookumchuck Dam, completed in 1971, is located on Skookumchuck River approximately 8 miles upstream of Bucoda and has a capacity of 42,000 acre-feet. Its major function is water supply for the Centralia Steam-Electric Project and provides little protection from large floods.

Two reservoirs with a combined storage capacity of 234,700 acre-feet (Alder Reservoir, 232,000 acre-feet, and LaGrande Reservoir, 2,700 acre-feet) are located in the Nisqually River basin. Firm flood-control storage is not provided by either reservoir, although the operation at Alder can be adjusted when a flood is expected to provide for 10,000 to 15,000 acre-feet of storage. This can reduce flood peaks on Nisqually River by an estimated 3000 to 5000 cfs (Pacific Northwest River Basins Commission, 1970).

Several levees have been constructed on Nisqually, Chehalis, Deschutes, and Skookumchuck Rivers, but none are adequate to protect against the 100-year flood and are not shown on the maps.

Flood protective works consist of a levee and fill on the right bank of the Deschutes River at the Olympia Brewing Company, and stream revetments at several bridges. These structures were topped by the 1974 flood and offer little protection from floods greater than or equal to the 100-year event. The Olympia Brewing Company Dam, located in the City of Tumwater, has no effect on flooding.

Limited regulation of flood plain development is provided by the Shoreline Master program of Thurston County and the Washington State Department of Ecology.

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-, 2-, 1-, 0.2 percent 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.

For each community within Thurston County that had a previous printed FIS report, the unrevised hydrologic analysis described in those reports have been compiled and are summarized below by city or town.

Pre-countywide Analyses

In the Town of Bucoda, the peak discharge-frequency relationship for Skookumchuck River was computed from regression equations that relate peak discharge-frequency data to drainage area and mean annual precipitation. Fifty-one continuous-record stream-gaging stations, with 6 to 47 years of peak-discharge records, and 14 peak-stage partial-record stations, with 7 to 26 years of peak-discharge records, located mostly in Thurston and Pierce Counties, were used as the source of peak-discharge and drainage area data (U.S. Department of Interior, 1971, 1971-1974, 1975-1977). Precipitation data for each drainage basin were based on information from the U.S. Weather Bureau (U.S. Department of Commerce, 1965). Values of the 10-, 2-, 1-, 0.2 percent peak discharges were obtained for the regression equations from a log-Pearson Type III distribution of annual peak discharges at each station in accordance with guidelines set forth in U.S. Water Resources Council Bulletin 17 (U.S. Water Resources Council, 1976).

The possibility of using previously developed regional peak discharge-frequency relationships (U.S. Department of the Interior, 1964, 1975) was investigated before developing the regression equations used in this study. However, these relationships were not used because additional peak-discharge data have since become available, the log-Pearson Type III method of analysis has since been improved and standardized, and relationships for a smaller region were needed to more accurately reflect localized flood flow conditions.

In the City of Lacey, the regional relationships in existing publications (U.S. Department of the Interior, 1964; Collings, Cummans, Nassar, 1975) were compared to Woodland Creek relationships developed from gage data for the 10-, 2-, 1-, 0.2 percent peak discharges. The regional relationships were not used because they do not define the local conditions. A series of lakes in the headwater temporarily stores water which decreases the peaks. For defining the peak discharge-frequency relationship, a U.S. Geological Survey stream-gaging station on Woodland Creek, with a 19-year record (Collings et al., 1975), was used as the source of data. This station is located 1.25 miles downstream of the corporate limits. Values of the 10-, 2-, 1-, 0.2 percent peak discharges were obtained from a log-Pearson Type III distribution of annual peak flow data at this station in accordance with guidelines set forth by the U.S. Water Resources Council (1976). To represent the discharges of Woodland Creek at Draham Street NE, the station discharges were adjusted for the difference in drainage area at the station and at Draham Street NE by a power factor (0.8) found typical for western Washington streams.

Regional relationships used for several lakes in Lacey, Olympia, and Thurston County were developed for estimating the differences between mean lake elevation and the 10-, 2-, 1-, 0.2 percent peak elevations, based on log-Pearson Type III analysis of records (7 to 35 years in length) for nine lakes in western Washington with similar hydrologic settings (“Surface Water Supply”, 1955, 1964, 1971; U.S. Department of the Interior, 1971-1974; “Water Resources Data”, 1971-1974). These relationships were applied to determine the flood-peak elevations of Bigelow, Clear, Chambers, Hicks, Ken, Lawrence, Long, Pattison, Setchfield, Summit, and Tempo Lakes by adding difference values to lake elevations at time of photography in March and April 1977 (Walker and Associates), which were considered to be at the mean levels.

In the City of Olympia, Tumwater, and Tenino; fifty-one continuous-record stream-gaging stations, with record lengths of 6 to 62 years, and 14 peak-stage, partial record stations, with from 7 to 26 years of peak data, from hydrologically similar sites (U.S. Department of the Interior, -1971; 1971-1974; 1975; 1976; 1977) were used as the source of data for defining the peak discharge-frequency relationship for Outlet of Black Lake and for each stream studied in the City of Tenino. Values of the 10-, 2-, 1-, 0.2 percent peak discharges were obtained from a log-Pearson Type III distribution of annual peak flow data at these sites in accordance with the guidelines set forth in U.S. Water Resources Council Bulletin 17 (1976).

In the City of Olympia, tidal peak elevation-frequency relationship was developed by analyzing 71 years of annual peak tides, as recorded at the Seattle Tidal Station (U.S. Department of Commerce, 1975), with the log-Pearson Type III method, using +0.2 skew. Values of the 10-, 2-, 1-, 0.2 percent tidal peak elevations were then transferred to Olympia using the tide prediction tables (U.S. Department of Commerce, 1974). These relationships were applied to the Budd Inlet area.

Capitol Lake was created in 1951 by construction of an earth-fill dam on the intertidal estuary where Deschutes River and Percival Creek formerly joined Budd Inlet. Tide gates are used to fill the lake to approximately the elevation of the mean-higher-high tide, but an extreme high tide or riverflow can cause much higher elevations in the lake, just as they did in the former estuary. There is some difference between flood elevations for Capitol Lake and Budd Inlet, but elevations obtained during the extreme high tide of December 15, 1977, demonstrate that the difference is small. That difference was added to the 10-, 2-, 1-, 0.2 percent tidal elevations for Budd Inlet and used for Capitol Lake.

The analyses reported herein reflect the stillwater elevations due to tidal and wind setup effects, but do not include the contributions from wave action effects, such as the wave-crest height and wave runup. Nevertheless, this additional hazard due to wave action effects should be considered in planning of future development.

Tidal and wind setup effects for Budd Inlet were determined by comparing the high-water mark elevations of the December 1977 storm against the recorded high tide levels as transferred from Seattle. These effects were added to the values of the 10-, 2-, 1-, 0.2 percent tidal peak elevations.

In the City of Tenino, regional relationships in existing publications (U.S. Department of the Interior, 1964; Magnitude and Frequency, 1975) did not produce satisfactory results for the 10-, 2-, 1-, 0.2 percent peak discharges in comparison with those obtained for the gaged sites by the log-Pearson Type III distribution. Therefore, new regional relationships of basin characteristics (drainage area and precipitation) to streamflow characteristics (10-, 50-, 100, and 500-year peak discharges) were developed for determining peak discharges at all sites in the study areas. A list of published gage records used as the source of data for defining peak discharge-frequency relationship are listed below in Table 4, "USGS Gages Used in the Hydrologic Analysis."

TABLE 4 - USGS GAGES USED IN THE HYDROLOGIC ANALYSIS

STREAM NAME AND LOCATION	GAGE NUMBER	PERIOD OF RECORD
Black River near Littlerock	12029000	1942 - 1950
Chehalis River near Grand Mound	12027500	1928 - 1978
Deschutes River near Tumwater	12080000	1945 - 1964
Deschutes River near Rainier	12079000	1949 - 1975
Nisqually River near McKenna	12088400	1947 - 1978
Skookumchuck River below Bloody Run Creek	12026150	1929 - 1933
Skookumchuck River near State Highway 507	12026400	1967 - Present
Woodland Creek near Pleasant Glade Road, NE	12081000	1949 - 1969

A total of 43 other continuous-record stream-gaging stations and 14 peak-stage partial-record stations from hydrologically similar sites, most of which were in Pierce and Thurston Counties (U.S. Department of the Interior, -1971; 1971-74; 1975-78), were also used in the hydrologic analyses.

Values of the 10-, 2-, 1-, 0.2 percent peak discharges were obtained from a log-Pearson Type III distribution of annual peak flow data at these sites in accordance with the guidelines set forth in U.S. Water Resources Council-Bulletin 17 (U.S. Water Resources Council, 1976).

The possibility of using previously developed regional peak discharge frequency relationships was investigated (U.S. Department of the Interior, 1964; 1975). However, these relationships were not used because of additional flood-frequency data available since they were developed, modifications to the accepted methodology of computing flood-frequency data using log-Pearson Type III analysis, and the need for relationships that would more accurately reflect localized conditions. Therefore, new regional relationships of basin characteristics (drainage area and precipitation) to stream flow characteristics (10-, 2-, 1-, 0.2 percent peak discharges) were developed for determining peak discharges at all sites in the study area. Between these values, peak discharges were prorated by distance, which is approximately proportional to drainage area.

Analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for each tidal or lacustrine flooding source studied in detail affecting the county.

Elevations for Trosper Lake were developed from a culvert rating on Percival Creek using discharges from the peak discharge-frequency relationships (U.S. Department of the Interior, 1968). Elevations were verified by information supplied by long-time residents of the area.

Elevations for Black Lake are controlled by outlets at the north and south ends of the lake and were derived by hydraulic analyses of Black River and Outlet of Black Lake.

The tidal peak elevation-frequency relationships for Budd Inlet were developed by analyzing 71 years of annual peak tides as recorded at the Seattle Tidal Station by the National Oceanic and Atmospheric Administration or, with the log-Pearson Type III method (U.S. Water Resources Council, 1976), using +0.2 skew. Values of the 10-, 2-, 1-, 0.2 percent tidal peak elevations were then transferred to Budd Inlet and Nisqually Reach by applying adjustments determined from tide prediction tables (U.S. Department of Commerce, 1978) and the high tide of December 15, 1977.

In the City of Yelm, the basin area for the study reach is approximately 9.3 square miles at the upper end and approximately 11.2 miles at the downstream study limit, and varies in elevation from approximately 560 feet in the hills near the City of Rainier to approximately 120 feet at the Nisqually River. Average annual rainfall over the basin is approximately 44 inches. Portions of Yelm Creek run dry in most years, particularly in late summer and early fall. Typical winter flows are low, and appear to result primarily from discharge from the groundwater system. The U.S. Geological Survey (USGS) operated a flow gage on Yelm Creek near the City of Yelm (Gage No. 12089700) from 1968 through 1976. The gage was located in the upper watershed, just downstream of Morris Road, and had a drainage area of 1.7 square miles. Because of the short period of record at the gage and the small portion of the study basin measured, this gage was not applicable to this study.

Peak discharge estimates for the 10-, 50-, and l00-year floods were computed using USGS regional flood-frequency equations (U.S. Department of the Interior, 1975). The 500-year discharge was determined by estimating the parameters of a log-Pearson Type III fit to the 2-, 10-, 25-, 50-, and 100-year USGS floodflow quantities. This equation was then used to compute the 500-year discharge. This analysis was done using the U.S. Army Corps of Engineers (USACE) PEARSN subroutine (U.S. Department of the Army, Corps of Engineers, 1990). Although no significant tributaries enter the study reach, modeled discharges were adjusted at the First Street culvert and 103rd Avenue bridge to reflect the variation in drainage area and contributions by a City storm drain that discharges to Yelm Creek upstream of First Street. No direct measurement of streamflow has ever been made within the study reach of Yelm Creek during a significant flood event. The flood of February 8-9, 1996, ranged between a 10- and 200-year event on basins in western Washington. Information from long-time residents of the City of Yelm indicates that flooding along Yelm Creek during the February storm was the worst that had ever been experienced on this reach of Yelm Creek. For purposes of calibration of the hydraulic model, it was assumed that the flow during the February 1996 flood was approximately equal to the 100-year discharge as computed using the USGS regression equations because of the similar hydro-meteorological conditions, regional observations of flooding, and anecdotal information.

A summary of Peak discharge-drainage area relationships for all streams studied by detailed methods is shown in Table 5, Summary of Discharges.

A summary of Peak elevation-drainage area relationships for all lakes studied by detailed methods is shown in Table 6, Summary of Elevations.

Countywide Analyses

No new hydrologic analyses have been performed as part of this countywide update.

TABLE 5 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
Black River					
At County Limits	124.0	2,820[1]	4,100[1]	4,940[1]	6,790[1]
Downstream of Confluence With Beaver Creek	99.0	1,550	2,220	2,490	3,200
Downstream of Confluence With Waddell Creek	58.7	1,250	1,770	2,000	2,560
Chehalis River					
At U.S. Geological Survey Gage No. 12027500 Near Grand Mound	895.0	38,600	50,100	55,000	66,600
Deschutes River					
At Olympia Brewery Dam	162.0	5,990	7,960	8,800	10,800
Upstream of Confluence With Spurgeon Creek	127.0	5,630	7,450	8,230	10,100
At Vail Loop Road Crossing	89.8	4,950	6,500	7,150	8,690
Upstream of Confluence With Mitchell Creek	44.1	2,690	3,590	3,980	4,900
Upstream Limit of Detailed Study	33.3	2,120	2,860	3,180	3,930
Outlet of Black Lake					
At Mouth	10.5	376	523	591	749
At Black Lake	5.0	219	303	342	431
Percival Creek					
At Sapp Road, SW	1.8	94	128	145	180
At 54th Avenue, SW	0.5	33	45	50	62
Scatter Creek					
At Downstream Limit of Detailed Study	15.5	403	561	633	803
At Grand Mound Road	14.6	364	508	572	725
At Olympia-Tenino Highway	12.4	342	477	537	680
At Confluence With Scatter Creek Tributary	11.0	314	436	492	622
Upstream of Confluence with Scatter Creek Tributary	4.6	167	230	258	324
Scatter Creek Tributary					
At Confluence With Scatter Creek	6.4	212	293	330	415
At State Highway 507	1.3	66	90	102	126
Skookumchuck River					
At State Highway 507	113.0	6,990	9,100	9,980	12,100
Upstream of Bucoda	90.2	6,400	8,290	9,060	10,900
Upstream of Confluence With Thompson Creek	65.9	5,790	7,440	8,110	9,700

TABLE 5 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
Woodland Creek					
At Pleasant Glade Road, NE	24.6	151	205	228	284
At Draham Street NE	13.6	94	127	142	176
Yelm Creek					
From First Street to Centralia Canal	11.2	220	310	350	445
From 103rd Avenue to First Street	9.8	200	285	325	410
From Upstream End of Study Reach to 103rd Avenue	9.3	185	265	300	375

[1]Includes Effect of Overflow From Chehalis River

TABLE 6 - SUMMARY OF ELEVATIONS

FLOODING SOURCE AND LOCATION	Elevation (Feet NAVD[2])			
	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
Black Lake	131.6	132.2	132.5	132.8
Bigelow Lake	164.3	164.6	164.7	164.9
Budd Inlet	13.6	13.9	14.1	14.3
Capitol Lake	13.9	14.8	15.0	15.7
Chambers Lake	199.2	199.4	199.5	199.7
Clear Lake	523.0	523.2	523.3	523.5
Hicks Lake	159.9	160.2	160.3	160.4
Ken Lake	140.3	140.6	140.7	140.9
Lake Lawrence	422.2	422.4	422.5	422.7
Long Lake	156.3	156.6	156.7	156.9
Nisqually Reach	12.9	13.3	13.4	13.7
Pattison Lake	156.5	156.8	156.9	157.2
Setchfield Lake	170.6	170.9	171.0	171.4
Summit Lake	462.7	462.9	463.1	463.3
Tempo Lake	259.1	259.3	259.4	259.6
Trosper Lake	159.9	160.9	161.1	161.7

[2]National American Vertical Datum of 1988

3.2 Hydraulic Analyses

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

Locations of selected cross sections 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.

For each incorporated community within Thurston County that had a previously printed FIS report, the hydraulic analyses described in those reports have been compiled and are summarized below.

Pre-countywide Analyses

In the Town of Bucoda, Skookumchuck River was studied by detailed methods.

Water-surface elevations for floods of the selected recurrence intervals were computed through use of the U.S. Geological Survey step-backwater computer program (U.S. Department of the Interior, 1976).

Much of the cross section data for the backwater analyses of Skookumchuck River were obtained from aerial photographs taken in April 1977 at a scale of 1:9600 (Walker and Associates, 1977). The underwater portions of the cross sections and the elevations and geometry of the Tono-Bucoda Road Bridge were obtained by field survey.

The approximate analysis in the vicinity of Main and Martina Streets was performed by field survey and engineering judgment.

In the City of Lacey, Woodland Creek was studied by detailed methods.

Water-surface elevations for floods of the selected recurrence intervals were computed for Woodland Creek using a combination of the U.S. Geological Survey step-backwater computer program (U.S. Department of the Interior, 1976), and computation of an elevation-discharge recurrence at a culvert (“Measurement of Peak Discharge at Culverts”, 1968).

Cross section data used for the backwater analyses for the Cities of Lacey, Olympia, Tumwater; City of Tenino and Thurston County were obtained from aerial photographs taken in April 1977, at a scale of 1:9600 (Walker and Associates, 1977). These data were supplemented by field measurement of the underwater portions. Elevation data and geometry for bridges, culverts, road overflow, and a few additional channel cross sections were obtained by field survey.

The underwater portions of the cross sections, elevations, and geometry of the Draham

Street NE culvert were obtained by field survey.

The hydraulic analyses for areas studied by approximate methods were based on flood-depth information, topographic maps (Harl Pugh and Associates, 1978), photographs (Walker and Associates, 1977), and field inspection.

In the City of Olympia, the Outlet of Black Lake was studied by detailed methods.

Water-surface elevations of floods for the selected recurrence intervals were computed through use of a combination of the culvert rating analyses (U.S. Department of the Interior, 1968) and U.S. Geological Survey step-backwater computer program (U.S. Department of the Interior, 1976).

Approximate flooding was determined using historical flooding information provided by local residents and field inspection of the area.

In the City of Tenino, Scatter Creek and Scatter Creek Tributary were studied by detailed methods.

Water-surface elevations of floods of the selected recurrence intervals for were computed through use of a combination of the U.S. Geological Survey E-43l step-backwater computer program ("Computer Applications for Step-Backwater", 1976), culvert rating analyses ("Techniques of Water-Resources Investigations", 1968), and computations of road overflows (U.S. Department of the Interior, 1967).

Starting water-surface elevations for the first cross section of a stream were computed from profile convergence from downstream cross sections and culvert ratings where an approach section was the section farthest downstream.

In Thurston County unincorporated areas, the following streams were studied by detailed methods: Deschutes River, Skookumchuck River, Scatter Creek, Scatter Creek Tributary, Chehalis River, Black River, Outlet of Black Lake, Percival Creek, Woodland Creek, Nisqually River, and Yelm Creek. Nisqually River has been converted to Zone A both in Thurston and Pierce County due to the extreme channel migration that has occurred since the effective models were created.

Water-surface elevations of floods of the selected recurrence intervals for the City of Tumwater and Thurston County were computed through use of a combination of the U.S. Geological Survey E-43l step-backwater computer program ("Computer Applications for Step-Backwater", 1976), culvert rating analyses ("Techniques of Water-Resources Investigations", 1968), and computations of road overflows (U.S. Department of the Interior, 1967).

Starting water-surface elevations for the first cross section of Skookumchuck River, Black River, Scatter Creek, Scatter Creek Tributary, and Chehalis River were determined by profile convergence from downstream cross sections. Starting water-surface elevations for Outlet of Black Lake, Percival Creek, and Woodland Creek were determined by flow over dam ratings or culvert ratings, where an approach section was the section farthest downstream. For Deschutes River, starting water-surface elevations were the ending elevations in the City of Tumwater Flood Insurance Study (FEMA, City of Tumwater, 1980).

Due to the meandering nature of the rivers in Thurston County, a profile base line, rather than the actual stream channel, was used to measure the distance between many cross sections on Deschutes River, Skookumchuck River, Scatter Creek, Chehalis River, Black River, and Nisqually River.

The Pacific Northwest River Basins Commission has established standard stationing points in River Miles along Deschutes River, Nisqually River, Skookumchuck River, Chehalis River, and Black River (Pacific Northwest River Basins Commission, 1969). River Mile stationing was not adopted for purposes of this study, however.

The acceptability of all assumed hydraulic factors, cross sections, and hydraulic structure data was verified by computations that duplicated the profiles of the January 1972 flood for Chehalis River, the February 1972 flood for Nisqually River, the January 1974 flood for Deschutes River, and the December 1977 flood for Skookumchuck River.

During a 100-year flood, Black Lake inundates Black River for approximately 4 miles downstream to Littlerock. In this reach, Black River essentially acts as an extension of Black Lake at the lake elevation of 133 feet until 123rd Avenue SW at Littlerock. Downstream of Littlerock at the Burlington Northern Railroad crossing, Black River flows out of its channel (for approximately 1 mile) southwestward over a small rise, where shallow flooding results. Once crossing this hill, the water collects in a deeper side channel, combining with backwater from a point further downstream along Black River.

Downstream of the Chicago, Milwaukee, St. Paul and Pacific Railroad, 100-year flows from Chehalis River travel northward to Black River. Floodwaters flow through Chehalis Indian Reservation and across 183rd Avenue SW, combining with Black River flow. Most inundation is less than 1 foot deep; however, depths exceed 1 foot in the incised channels that connect Chehalis River and Black River. Discharge from this flow does not enter Black River at any one point; therefore, effects from the additional inflow are not substantial on Black River within Thurston County.

The extent of approximate flooding was determined by field observation, stereo-photography, and historical flooding observations through interviews with local residents.

In the City of Tumwater, the following streams were studied by detailed methods: Deschutes River, Outlet of Black Lake, and Percival Creek.

Approximate flood boundaries were determined using historical flooding information provided by local residents and field inspection of the area.

In the City of Yelm, Yelm Creek was studied by detailed methods.

Hydrologic and hydraulic analyses were performed to determine flood elevations for the 10-, 2-, 1-, 0.2 percent flows, as well as the 100- and 500-year floodplain boundaries and floodway boundary. All detailed hydraulic analyses were computed using the USACE HEC-RAS computer program (U.S. Department of the Army, Corps of Engineers, 1997). The flooding is a function of flat topography, a highly vegetated channel, several under-sized culverts and bridges, road fills that encroach on the floodplain and in-stream fences that restrict flows.

Six road-crossing structures, consisting of two culverts and four bridges, influence hydraulic conditions in the study reach. Additional field data were surveyed at each crossing to ensure accurate representation within the HEC-RAS model.

The topography of Yelm Creek and its floodplain is represented in the HEC-RAS model using 28 cross sections surveyed by Northwest Hydraulic Consultants, Inc., in May 1997. The cross sections were extended using topographic mapping at a scale of 1:4,800, with a contour interval of 2 feet (DeGross Aerial Mapping, 1997), taken from aerial photographs flown in January 1997. Several additional cross sections were interpolated to improve the model's stability and accuracy, especially through the bridges and culverts. Vertical control for the surveys and mapping was achieved using four local monuments referenced to Thurston County survey control.

Starting water-surface elevations at the downstream end of the modeled reach were determined using the slope-area method.

The main channel is typically filled with thick grass and brush throughout the study reach, although some small sections are clear of vegetation (U.S. Department of the Interior, 1987; Chow, 1959). In addition to the dense vegetation, many fences cross the channel and floodplain and further restrict flow. The channel banks in many locations are covered with blackberry bushes, while the floodplain varies between cropped pasture and dense brush.

Countywide Analyses

No new hydraulic analyses have been performed as part of this countywide update.

For this countywide study, all flooding sources studied by detailed methods with were redelineated on new topographic data derived from the 2002 Puget Sound LiDAR Consortium (PSLC) Bare Earth LiDAR ASCII Points data, developed by TerraPoint, Inc. The LiDAR data has a Root Mean Square (RMS) vertical accuracy of approximately 30 centimeters.

In addition, the Nisqually River special flood hazard area was converted to approximate zone due to the extreme stream channel migration occurring since the original models where developed.

The Deschutes River floodway and floodway data tables were removed, also due to the extreme channel migration within the floodplain.

Channel roughness factors (Manning’s “n”) used in the hydraulic computations were chosen by respective contractors who performed the original studies. The Manning’s “n” values for all detailed studied streams are listed in the following table below:

TABLE 7 - MANNING'S "n" VALUES

Stream	Channel "n"	Overbank"n"
TOWN OF BUCODA		
Skookumchuck River	0.046	0.059-0.078
CITY OF LACEY		
Woodland Creek	0.042-0.044	0.050-0.055
CITY OF OLYMPIA		
Outlet of Black Lake	0.032-0.038	0.040-0.050
CITY OF TENINO		
Scatter Creek	0.038-0.055	0.040-0.055
Scatter Creek Tributary	0.038-0.055	0.040-0.055
THURSTON COUNTY		
Deschutes River	0.032-0.058	0.040-0.150
Skookumchuck River	0.032-0.058	0.040-0.150
Scatter Creek	0.032-0.058	0.040-0.150
Scatter Creek Tributary	0.032-0.058	0.040-0.150
Chehalis River	0.032-0.058	0.040-0.150
Black River	0.032-0.058	0.040-0.150
Outlet of Black Lake	0.032-0.058	0.040-0.150
Percival Creek	0.032-0.058	0.040-0.150
Woodland Creek	0.032-0.058	0.040-0.150
Yelm Creek	0.040-0.100	0.040-0.150
CITY OF TUMWATER		
Deschutes River	0.035-0.050	0.040-0.055
Outlet of Black Lake	0.035-0.050	0.040-0.055
Percival Creek	0.035-0.050	0.040-0.055
CITY OF YELM		
Yelm Creek	0.040-0.100	0.040-0.150

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

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.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD 88. Structure and ground elevations in the County must, therefore, be referenced to NAVD 88.

As noted above, the elevations shown in the FIS report and on the FIRM for Thurston County are referenced to NAVD 88. Ground, structure, and flood elevations may be compared and/or referenced to NGVD 29 by applying a standard conversion factor. The conversion factor to NAVD 88 is +3.47 feet, where:

$$NGVD29 + 3.47 \text{ ft} = NAVD88$$

Further, the BFEs shown on the FIRM represent whole-foot rounded values. For example, a BFE of 102.4 will appear as 102 on the FIRM and a BFE of 102.6 will appear as 103. Therefore, users that wish to convert the elevations in this FIS to NGVD 29 should apply the stated conversion factor to elevations shown on the Flood Profiles and supporting data tables in the FIS report, which are shown at a minimum to the nearest 0.1 foot.

For more information on NAVD 88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA publication FIA-20/June 1992, or contact the Spatial Reference System Division, National Geodetic Survey, National Oceanic and Atmospheric Administration, Silver Spring Metro Center, 1315 East-West Highway, Silver Spring, Maryland 20910 (Internet address: http://www.ngs.noaa.gov)

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS 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, Floodway Data tables, and Summary of Stillwater Elevation 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 flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps.

Approximate flood boundaries were delineated using aerial photographs at a scale of 1:9600 (Walker and Associates, 1977), topographic maps at a scale of 1:4800, 4 feet contour interval (Harl Pugh and Associates, 1978); Flood Hazard Boundary Maps, and field inspection.

For this countywide study, all flooding sources studied by detailed methods with were redelineated on new topographic data derived from the 2002 Puget Sound LiDAR Consortium (PSLC) Bare Earth LiDAR ASCII Points data, developed by TerraPoint, Inc. The LiDAR data has a Root Mean Square (RMS) vertical accuracy of approximately 30 centimeters. Adjustments were made to approximate flood boundaries as well where necessary to tie into the redelineated detailed flood boundaries.

Before this countywide study, the detailed study flood boundaries were delineated on 2 and 4 foot topographic contour maps ranging in scales from 1:1200 to 1:4800.

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 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.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 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 segments on the basis of equal-conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections Table 8, "Floodway Data." In cases where the floodway and

1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 8, "Floodway Data." In order to reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

The floodway for Woodland Creek and a portion of Outlet of Black Lake (from cross sections E to H) coincide with the 100-year boundary because the channel velocity is high (at or near critical) and the flow is confined to the high-water channel. For these reasons, no information is presented for either Woodland Creek or a portion of Outlet of Black Lake in Table 8.

A floodway is not appropriate along Percival Creek upstream of 54th Avenue SW. This road impounds water from Trosper Lake; thus, there is no conveyance until floodwaters pass through the culvert.

Floodways along Deschutes River and Nisqually River were removed due to the significant amount of stream channel migration which has occurred since the original flood hazard study was performed.

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 1.

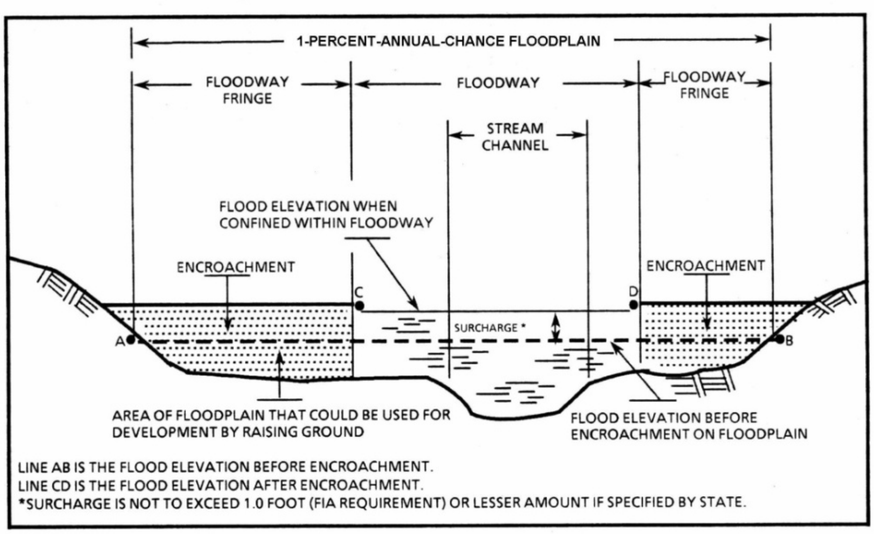


Figure 1. Floodway Schematic

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BLACK RIVER								
A	-4,762	300	2,619	1.5	101.6	101.6	102.4	0.8
B	-2,622	300	2,660	1.5	101.7	101.7	102.6	0.9
C	-772	300	2,238	1.8	102.0	102.0	102.9	0.9
D	0	300	1,774	2.2	102.2	102.2	103.0	0.8
E	220	285	1,886	2.1	102.3	102.3	103.1	0.8
F	1,014	300	1,944	2.0	102.7	102.7	103.4	0.7
G	3,417	291	1,052	3.8	104.1	104.1	104.5	0.4
H	7,929	214	1,568	2.5	106.8	106.8	107.0	0.2
I	11,107	160	1,053	3.7	108.2	108.2	108.5	0.3
J	11,271	244	1,273	3.1	108.8	108.8	109.0	0.2
K	17,774	300	2,870	1.0	109.6	109.6	109.9	0.3
L	22,532	300	3,115	0.9	109.8	109.8	110.2	0.4
M	27,756	300	2,651	0.9	109.9	109.9	110.3	0.4
N	33,086	300	2,732	0.9	110.0	110.0	110.5	0.5
O	38,675	300	2,757	0.9	110.2	110.2	110.8	0.6
P	44,338	300	2,526	1.0	110.4	110.4	111.0	0.6
Q	52,164	500	2,259	1.0	111.1	111.1	111.6	0.5
R	55,644	260	512	2.1	113.7	113.7	113.7	0.0
S	56,929	320	451	2.4	116.1	116.1	116.1	0.0
T	58,181	370	319	4.1	118.5	118.5	118.5	0.0
U	59,371	150	436	3.4	121.5	121.5	121.5	0.0
V	60,584	131	409	4.9	124.9	124.9	124.9	0.0
W	60,704	137	351	5.7	125.6	125.6	125.6	0.0
X	61,214	180	363	5.5	128.5	128.5	128.5	0.0
Y	61,909	140	477	4.2	131.3	131.3	131.3	0.0
Z	62,014	102	437	4.6	131.5	131.5	131.5	0.0

[1] Stream Distance in Feet from Moon Road Southwest

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

BLACK RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BLACK RIVER (Continued)								
AA	62,359	90	564	1.2	132.1	132.1	132.1	0.0
AB	62,744	123	411	1.7	132.1	132.1	132.1	0.0
AC	63,559	200	654	1.0	132.2	132.2	132.2	0.0
AD	64,979	200	1,390	0.5	132.3	132.3	132.3	0.0

[1] Stream Distance in Feet from Moon Road Southwest

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

BLACK RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CHEHALIS RIVER								
A	-12,208	1318/990[2]	7,578	6.8	109.3	110.0 [3]	110.0 [3]	0.0
B	-11,448	1300/756[2]	11,353	4.5	112.2	112.8 [3]	112.8 [3]	0.0
C	-10,638	1484/694[2]	11,481	4.5	112.8	113.4 [3]	113.6 [3]	0.2
D	-9,358	1880/880[2]	23,274	2.2	114.1	114.8 [3]	114.9 [3]	0.1
E	-8,578	1800/960[2]	16,835	3.1	114.3	115.0 [3]	115.1 [3]	0.1
F	-7,788	2040/1254[2]	19,354	2.7	114.8	115.5 [3]	115.6 [3]	0.1
G	-7 ,018	2400/1702[2]	21,177	2.7	115.1	115.9 [3]	116.0 [3]	0.1
H	-6,248	3040/2040[2]	20,939	2.7	115.6	116.4 [3]	116.5 [3]	0.1
I	-5,378	3583	23,240	2.4	116.3	117.1 [3]	117.2 [3]	0.1
J	-4,578	4068	32,031	1.8	116.8	117.6 [3]	117.6 [3]	0.0
K	-4,008	3906	28,755	2.0	117.0	117.7 [3]	117.8 [3]	0.1
L	-3,328	4240	28,463	2.0	117.2	118.0 [3]	118.0 [3]	0.0
M	-2,528	3652	25,078	2.3	117.6	118.3 [3]	118.3 [3]	0.0
N	-1,668	3120	19,373	2.9	118.1	118.8 [3]	118.8 [3]	0.0
O	-998	2760	16,160	3.5	118.9	119.4 [3]	119.4 [3]	0.0
P	-158	2460	14,545	3.9	119.7	120.1 [3]	120.1 [3]	0.0
Q	300	1850[4]	12,452	4.5	119.9	119.9	120.5	0.6
R	950	1760	12,538	4.5	120.5	120.5	121.3	0.8
S	1,620	1670	10,723	5.3	121.2	121.2	121.8	0.6
T	2,360	1610	10,054	5.6	122.2	122.2	122.7	0.5
U	3,155	1400	12,823	4.4	123.1	123.1	124.0	0.9
V	3,865	1190	8,951	6.3	123.4	123.4	124.4	1.0
W	4,615	1000	10,202	5.5	124.9	124.9	125.8	0.9
X	5,400	1000	10,442	5.4	125.9	125.9	126.6	0.7
Y	6,230	1000	11,912	4.7	126.9	126.9	127.5	0.6
Z	7,020	1150	9,937	5.7	127.7	127.7	128.0	0.3

[1] Stream Distance in Feet from Chicago, Milwaukee, St. Paul & Pa Railroad
[2] Width/Width Within County Limits
[3] Elevations Computed Assuming Containment of Right Overbank Losses
[4] Width Including Island

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
THURSTON COUNTY, WA
AND INCORPORATED AREAS

FLOODWAY DATA

CHEHALIS RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CHEHALIS RIVER (Continued)								
AA	7,800	1350	12,338	4.5	128.3	128.3	129.2	0.9
AB	8,590	1300	13,668	4.0	128.9	128.9	129.9	1.0
AC	9,375	1250	11,243	4.9	129.5	129.5	130.4	0.9
AD	10,210	1230	12,738	4.3	130.4	130.4	131.2	0.8
AE	11,015	1070	11,388	4.8	130.9	130.9	131.6	0.7
AF	11,820	1000	12,333	4.5	131.8	131.8	132.4	0.6
AG	12,630	1200	12,509	4.4	132.3	132.3	133.0	0.7
AH	13,380	1500	13,554	4.1	132.9	132.9	133.6	0.7
AI	14,240	1840	19,002	2.9	133.2	133.2	134.2	1.0
AJ	15,010	2000	14,697	3.7	133.5	133.5	134.5	1.0
AK	15,780	1850	16,785	3.3	134.2	134.2	135.2	1.0
AL	16,545	1550	15,225	3.6	134.6	134.6	135.5	0.9
AM	17,315	1550	15,551	3.5	135.2	135.2	136.0	0.8
AN	18,040	1600	16,217	3.4	135.6	135.6	136.4	0.8
AO	18,980	2050	18,632	3.0	136.0	136.0	136.9	0.9
AP	21,000	2750	15,803	3.5	137.7	137.7	138.4	0.7
AQ	22,840	3400	22,178	2.5	139.6	139.6	140.6	1.0
AR	24,880	3370[2]	12,102	4.5	141.5	141.5	142.4	0.9
AS	26,930	2230	13,007	4.2	144.6	144.6	145.6	1.0
AT	27,730	1630	11,252	4.9	145.2	145.2	146.2	1.0
AU	28,510	950	9,092	6.1	145.8	145.8	146.7	0.9
AV	28,860	850	7,916	7.0	146.3	146.3	147.0	0.7
AW	29,610	725	8,238	6.7	147.0	147.0	147.7	0.7
AX	30,555	825	9,060	6.1	148.1	148.1	148.5	0.4
AY	31,325	1200	12,932	4.3	149.0	149.0	149.6	0.6
AZ	31,975	1500	13,795	4.0	149.6	149.4	150.1	0.7

[1] Stream Distance in Feet from Chicago, Milwaukee, St. Paul & Pacific Railroad

[2] Width Including Island

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

CHEHALIS RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
OUTLET OF BLACK LAKE								
A	140	28	66	8.9	98.2	98.2	98.2	0.0
B	656	39	109	5.4	104.3	104.3	104.3	0.0
C	1,197	35	74	8.0	115.3	115.3	115.3	0.0
D	1,322	31	115	5.2	117.0	117.0	117.0	0.0
E	1,565	50	182	3.3	117.7	117.7	117.7	0.0
F-G[2]								
H	2,605	29	113	5.2	125.5	125.5	125.5	0.0
I	3,091	39	116	5.1	126.9	126.9	127.0	0.1
J	3,616	90	245	2.4	127.5	127.5	127.9	0.4
K	4,129	90	284	2.1	127.7	127.7	128.2	0.5
L	4,517	70	182	3.2	127.8	127.8	128.3	0.5
M	4,956	65	177	3.3	128.4	128.4	128.7	0.3
N	5,632	80	239	1.7	128.9	128.9	129.5	0.6
O	6,241	49	156	2.6	129.0	129.0	129.9	0.9
P	6,790	65	166	2.4	129.8	129.8	130.4	0.6
Q	7,227	52	135	3.0	130.2	130.2	130.7	0.5
R	7,586	55	110	3.7	130.8	130.8	131.1	0.3
S	7,646	42	153	2.7	131.0	131.0	131.3	0.3
T	8,196	95	266	1.5	131.4	131.4	131.6	0.2
U	8,731	143	261	1.6	131.6	131.6	131.8	0.2
V	9,256	135	287	1.4	131.7	131.7	131.9	0.2
W	9,852	170	232	1.5	132.0	132.0	132.1	0.1
X	10,321	160	262	1.3	132.2	132.2	132.3	0.1
Y	10,874	180	433	0.8	132.2	132.2	132.4	0.2
Z	11,345	185	428	0.8	132.3	132.3	132.5	0.2
AA	11,855	145	393	0.9	132.3	132.3	132.5	0.2

[1] Stream Distance in Feet Above Mouth

[2] No Floodway

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

OUTLET OF BLACK LAKE

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
PERCIVAL CREEK								
A	40	53	258	0.6	144.4	144.4	145.2	0.8
B	338	54	230	0.6	144.4	144.4	145.2	0.8
C	908	55	159	0.9	144.5	144.5	145.3	0.8
D	1,538	53	155	0.9	144.6	144.6	145.4	0.8
E	2,118	13	29	2.8	145.2	145.2	145.9	0.7
F	2,598	15	39	2.0	147.4	147.4	147.5	0.1
G	3,118	35	35	2.3	148.6	148.6	149.1	0.5
H	3,528	25	39	2.1	150.3	150.3	150.7	0.4
I	3,958	20	25	3.2	152.7	152.7	152.7	0.0
J	4,073	104	342	0.2	160.5	160.5	160.5	0.0
K	4,533	159	283	0.2	160.5	160.5	160.5	0.0
L-O[2]								

[1] Stream Distance in Feet Above Sapp Road

[2] No Floodway

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

PERCIVAL CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SCATTER CREEK								
A	-11,229	75	306	2.1	240.6	240.6	241.5	0.9
B	-10,942	75	250	2.5	240.9	240.9	241.7	0.8
C	-10,326	50	188	3.4	241.7	241.7	242.4	0.7
D	-9,634	50	254	2.5	242.5	242.5	243.2	0.7
E	-8,898	50	217	2.9	243.1	243.1	243.9	0.8
F	-8,331	50	166	3.8	244.5	244.5	244.9	0.4
G	-7,681	60	238	2.7	245.6	245.6	246.1	0.5
H	-6,972	60	234	2.7	246.3	246.3	246.9	0.6
I	-6,330	70	263	2.4	247.3	247.3	247.7	0.4
J	-5,874	120	179	3.4	248.0	248.0	248.4	0.4
K	-5,202	120	252	2.4	249.5	249.5	250.2	0.7
L	-4,616	120	411	1.5	250.0	250.0	250.7	0.7
M	-3,982	100	344	1.8	250.4	250.4	251.0	0.6
N	-3,299	109	196	3.1	251.0	251.0	251.6	0.6
O	-2,750	130	373	1.6	251.8	251.8	252.4	0.6
P	-2,033	190	278	2.2	252.9	252.9	253.6	0.7
Q	-1,467	140	343	1.8	253.9	253.9	254.8	0.9
R	-996	106	286	2.2	254.4	254.4	255.2	0.8
S	-425	155	200	3.2	255.9	255.9	256.5	0.6
T	0	53	234	2.7	257.1	257.1	257.6	0.5
U	74	110	383	1.7	257.1	257.1	257.7	0.6
V	296	70	245	2.3	257.3	257.3	257.8	0.5
W	640	90	257	2.2	257.7	257.7	258.3	0.6
X	733	100	316	1.8	257.8	257.8	258.4	0.6
Y	911	110	225	2.5	257.9	257.9	258.5	0.6
Z	980	100	136	4.2	258.0	258.0	258.6	0.6

[1] Stream Distance in Feet from Grand Mound Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

SCATTER CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SCATTER CREEK (Continued)								
AA	1,113	64	178	3.2	258.5	258.5	259.4	0.9
AB	1,192	65	142	4.0	259.1	259.1	259.6	0.5
AC	1,524	145	351	1.6	259.9	259.9	260.4	0.5
AD	2,100	175	376	1.5	260.1	260.1	260.9	0.8
AE	2,557	110	215	2.7	260.5	260.5	261.4	0.9
AF	2,587	140	344	1.7	261.0	261.0	261.6	0.6
AG	2,861	85	232	2.5	261.2	261.2	261.8	0.6
AH	3,211	60	136	4.2	261.7	261.7	262.3	0.6
AI	3,386	220	1,664	0.3	266.4	266.4	267.4	1.0
AJ	3,557	170	1,237	0.5	266.4	266.4	267.4	1.0
AK	3,836	160	1,145	0.5	266.4	266.4	267.4	1.0
AL	3,916	200	1,254	0.5	266.4	266.4	267.4	1.0
AM	4,417	160	785	0.7	266.4	266.4	267.4	1.0
AN	5,014	130	564	1.0	266.4	266.4	267.4	1.0
AO	5,264	125	602	0.9	266.4	266.4	267.4	1.0
AP	5,696	100	414	1.3	266.5	266.5	267.5	1.0
AQ	6,112	70	289	1.9	266.8	266.8	267.6	0.8
AR	6,512	70	194	2.9	267.5	267.5	268.1	0.6
AS	7,066	100	229	2.4	268.5	268.5	269.4	0.9
AT	7,546	80	169	3.3	269.6	269.6	270.5	0.9
AU	7,885	80	140	4.0	271.9	271.9	272.0	0.1
AV	7,920	50	125	4.4	272.1	272.1	272.2	0.1
AW	8,441	60	176	3.2	273.7	273.7	273.9	0.2
AX	9,073	80	281	2.0	274.2	274.2	274.7	0.5
AY	9,654	90	317	1.8	274.5	274.5	275.1	0.6
AZ	10,310	90	167	3.3	275.3	275.3	276.0	0.7

[1] Stream Distance in Feet from Grand Mound Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

SCATTER CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SCATTER CREEK (Continued)								
BA	10,790 [1]	70	167	3.0	277.1	277.1	277.8	0.7
BB	11,390 [1]	40	49	5.3	283.0	283.0	283.1	0.1
BC	11,926 [1]	40	109	2.4	285.2	285.2	286.0	0.8
BD	12,439 [1]	40	62	4.2	286.9	286.9	287.6	0.7
BE	12,881 [1]	40	63	4.1	290.3	290.3	290.5	0.2
BF	13,576 [1]	40	85	3.1	292.9	292.9	293.3	0.4
BG	14,060 [1]	40	71	3.6	294.3	294.3	295.0	0.7
BH	14,604 [1]	50	85	3.0	296.5	296.5	297.2	0.7
BI	15,166 [1]	20	45	5.8	299.7	299.7	300.0	0.3
BJ	15,650 [1]	20	63	4.1	303.2	303.2	303.6	0.4
SCATTER CREEK TRIBUTARY								
A	635 [2]	60	134	2.5	278.8	278.8	279.4	0.6
B	1,340 [2]	50	98	3.4	280.3	280.3	281.1	0.8
C	1,397 [2]	60	74	4.4	280.5	280.5	281.4	0.9
D	2,005 [2]	54	118	2.8	283.6	283.6	284.6	1.0
E	2,637 [2]	50	173	1.4	284.6	284.6	285.2	0.6
F	3,255 [2]	65	115	2.0	285.1	285.1	285.5	0.4
G	3,311 [2]	65	132	1.8	285.2	285.2	285.6	0.4
H	3,887 [2]	55	81	1.3	285.8	285.8	286.2	0.4
I	4,489 [2]	14	38	2.7	286.7	286.7	286.9	0.2
J	5,075 [2]	16	32	3.2	288.3	288.3	288.3	0.0
K	5,428 [2]	34	66	1.5	289.0	289.0	289.0	0.0
L	6,024 [2]	22	26	4.0	290.8	290.8	290.8	0.0
M	6,549 [2]	115	79	1.3	293.3	293.3	293.3	0.0

[1] Stream Distance in Feet from Grand Mound Road

[2] Stream Distance in Feet Above Mouth

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

SCATTER CREEK and SCATTER CREEK TRIBUTARY

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SKOOKUMCHUCK RIVER								
A	-5,284	187/130 [2]	1,807	5.5	210.7	210.7	211.5	0.8
B	-4,709	180	1,521	6.6	211.2	211.2	212.0	0.8
C	-4,059	180	1,310	7.6	211.8	211.8	212.7	0.9
D	-3,500	156	1,547	6.5	213.2	213.2	213.8	0.6
E	-1,677	150	1,850	5.4	215.3	215.3	215.6	0.3
F	-1,111	150	1,831	5.5	215.8	215.8	216.0	0.2
G	-590	150	1,785	5.6	216.0	216.0	216.3	0.3
H	-83	150	2,167	4.6	216.4	216.4	216.7	0.3
I	0	155	1,742	5.7	216.4	216.4	216.7	0.3
J	204	160	1,791	5.6	216.6	216.6	216.8	0.2
K	802	200	1,456	6.9	216.9	216.9	217.2	0.3
L	2,046	200	1,288	7.8	219.3	219.3	219.7	0.4
M	2,666	200	1,617	6.2	222.1	222.1	222.1	0.0
N	3,249	200	1,330	7.5	222.9	222.9	222.9	0.0
O	3,854	174	1,264	7.9	224.2	224.2	224.3	0.1
P	4,473	259	1,831	5.5	225.7	225.7	226.2	0.5
Q	4,518	240	1,560	6.4	225.8	225.8	226.3	0.5
R	5,157	240	2,112	4.7	226.8	226.8	227.3	0.5
S	5,668	203	2,005	5.0	227.1	227.1	227.6	0.5
T	6,703	200	1,683	5.9	228.0	228.0	228.4	0.4
U	7,166	200	1,732	5.8	228.6	228.6	228.9	0.3
V	7,831	200	1,968	5.1	229.1	229.1	229.7	0.6
W	8,483	200	1,984	5.0	229.4	229.4	230.1	0.7
X	9,597	204	1,857	5.4	230.5	230.5	231.2	0.7
Y	10,817	166	2,186	4.6	232.1	232.1	232.8	0.7
Z	11,370	180	1,998	5.0	232.6	232.6	233.2	0.6

[1] Stream Distance in Feet from State Highway 507

[2] Width/Width Within Thurston County

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

SKOOKUMCHUCK RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SKOOKUMCHUCK RIVER (Continued)								
AA	12,560	200	1,748	5.7	234.1	234.1	234.8	0.7
AB	13,113	200	2,275	4.4	235.0	235.0	235.5	0.5
AC	14,283	200	2,123	4.7	236.1	236.1	236.6	0.5
AD	14,938	220	2,439	4.1	236.7	236.7	237.1	0.4
AE	15,622	250	2,238	4.5	237.2	237.2	237.6	0.4
AF	16,833	250	1,671	6.0	239.1	239.1	239.6	0.5
AG	17,400	230	2,091	4.8	239.8	239.8	240.7	0.9
AH	17,673	125	1,631	6.1	240.1	240.1	240.9	0.8
AI	18,117	120	1,420	7.0	240.9	240.9	241.6	0.7
AJ	18,663	115	1,562	6.4	242.1	242.1	242.6	0.5
AK	19,443	110	1,519	6.6	243.3	243.3	243.8	0.5
AL	20,043	110	1,563	6.4	244.2	244.2	244.7	0.5
AM	20,629	110	1,315	7.6	245.2	245.2	245.7	0.5
AN	21,600	110	1,197	8.3	247.6	247.6	248.1	0.5
AO	22,089	110	1,472	6.8	249.6	249.6	249.6	0.0
AP	22,380	115	2,092	4.8	250.3	250.3	250.3	0.0
AQ	22,848	120	1,512	6.6	250.9	250.9	250.9	0.0
AR	23,006	150	1,770	5.6	251.2	251.2	251.5	0.3
AS	23,585	200	1,937	5.2	252.0	252.0	252.2	0.2
AT	24,367	200	1,701	5.9	252.7	252.7	253.1	0.4
AU	25,099	200	1,874	5.3	253.9	253.9	254.5	0.6
AV	25,720	200	2,179	4.6	254.9	254.9	255.6	0.7
AW	26,290	200	2,296	4.4	255.3	255.3	256.1	0.8
AX	27,337	300	2,602	3.8	256.2	256.2	257.1	0.9
AY	27,938	300	3,610	2.5	256.6	256.6	257.5	0.9
AZ	28,507	300	3,260	2.8	256.8	256.8	257.7	0.9

[1] Stream Distance in Feet from State Highway 507

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

SKOOKUMCHUCK RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SKOOKUMCHUCK RIVER (Continued)								
BA	29,088	232	3,183	2.9	257.0	257.0	257.9	0.9
BB	30,316	320	2,026	4.5	257.6	257.6	258.4	0.8
BC	31,492	350	2,442	3.7	259.0	259.0	260.0	1.0
BD	32,292	240	2,272	4.0	260.0	260.0	260.7	0.7
BE	33,149	300	2,533	3.6	260.9	260.9	261.4	0.5
BF	33,881	300	2,716	3.3	261.7	261.7	262.1	0.4
BG	34,381	257	2,753	3.3	262.0	262.0	262.5	0.5
BH	35,080	300	3,108	2.9	262.4	262.4	262.8	0.4
BI	36,029	219	2,752	3.3	263.0	263.0	263.4	0.4
BJ	36,963	179	1,905	4.8	263.6	263.6	263.9	0.3
BK	37,472	270	2,140	4.2	264.1	264.1	264.3	0.2
BL	38,105	550	4,058	2.2	264.7	264.7	265.1	0.4
BM	39,095	600	2,969	3.1	265.3	265.3	265.9	0.6
BN	40,165	303	2,145	4.2	266.4	266.4	267.4	1.0
BO	40,465	508	2,355	3.9	267.1	267.1	267.8	0.7
BP	41,594	350	1,859	4.9	269.7	269.7	269.8	0.1
BQ	42,204	300	1,368	6.6	271.1	271.1	271.1	0.0
BR	43,138	270	1,722	5.3	273.4	273.4	274.2	0.8
BS	43,499	270	2,032	4.5	274.5	274.5	275.0	0.5
BT	44,550	270	1,657	5.5	275.9	275.9	276.3	0.4
BU	45,826	270	1,947	4.7	278.0	278.0	278.6	0.6
BV	46,501	270	2,420	3.7	278.6	278.6	279.5	0.9
BW	47,637	200	1,763	5.1	280.0	280.0	280.8	0.8
BX	48,294	220	1,582	5.7	281.5	281.5	282.0	0.5
BY	48,943	250	2,006	4.5	283.0	283.0	283.6	0.6
BZ	50,372	220	1,640	5.5	284.8	284.8	285.6	0.8

[1] Stream Distance in Feet from State Highway 507

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

SKOOKUMCHUCK RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SKOOKUMCHUCK RIVER (Continued)								
CA	51,648	220	1,448	6.3	287.6	287.6	288.2	0.6
CB	52,802	220	1,454	6.2	290.8	290.8	291.3	0.5
CC	53,198	220	1,390	6.5	292.1	292.1	292.3	0.2
CD	53,817	280	1,967	4.6	293.2	293.2	293.8	0.6
CE	54,835	250	2,236	4.1	294.3	294.3	295.2	0.9
CF	55,487	250	1,724	5.3	295.2	295.2	295.9	0.7
CG	56,162	250	1,749	5.2	296.6	296.6	297.4	0.8
CH	57,373	254	2,039	4.4	298.7	298.7	299.2	0.5
CI	57,878	270	2,169	4.2	299.6	299.6	300.0	0.4
CJ	58,377	400	2,698	3.4	300.2	300.2	300.5	0.3
CK	59,898	240	1,632	5.6	302.2	302.2	302.6	0.4
CL	60,784	200	1,530	5.9	303.7	303.7	304.5	0.8
CM	61,061	230	1,535	5.9	304.2	304.2	304.9	0.7
CN	61,703	210	1,425	6.4	305.6	305.6	306.1	0.5
CO	62,577	250	1,925	4.7	307.1	307.1	307.9	0.8
CP	62,852	250	1,819	4.7	307.5	307.5	308.3	0.8
CQ	63,152	122	1,141	7.5	308.2	308.2	308.7	0.5
CR	63,253	135	1,364	6.3	309.2	309.2	309.5	0.3
CS	63,412	185	2,100	3.9	309.6	309.6	310.0	0.4
CT	63,666	250	2,525	3.2	309.8	309.8	310.3	0.5
CU	64,071	320	1,967	4.1	310.1	310.1	310.7	0.6
CV	64,466	370	2,826	2.9	310.3	310.3	311.1	0.8
CW	65,343	304	2,092	3.9	311.0	311.0	311.9	0.9
CX	66,343	350	2,317	3.5	312.4	312.4	312.9	0.5
CY	67,020	350	2,053	4.0	313.4	313.4	313.9	0.5
CZ	68,324	350	2,416	3.4	315.5	315.5	315.9	0.4

[1] Stream Distance in Feet from State Highway 507

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

SKOOKUMCHUCK RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SKOOKUMCHUCK RIVER (Continued)								
DA	69,956	350	1,826	4.4	317.9	317.9	318.1	0.2
DB	70,511	400	1,774	4.6	319.2	319.2	319.6	0.4
DC	71,050	400	2,194	3.7	320.2	320.2	321.0	0.8
DD	71,592	370	1,963	4.1	321.2	321.2	321.8	0.6
DE	72,153	314	2,319	3.5	322.1	322.1	322.7	0.6
DF	73,757	300	1,415	5.7	324.6	324.6	324.8	0.2
DG	74,698	269	1,513	5.4	327.3	327.3	327.4	0.1
DH	75,221	320	1,339	6.1	328.9	328.9	329.1	0.2
DI	76,367	225	1,445	5.6	332.4	332.4	333.4	1.0
DJ	76,940	250	1,473	5.5	334.2	334.2	334.9	0.7

[1] Stream Distance in Feet from State Highway 507

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

SKOOKUMCHUCK RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
YELM CREEK								
A	0	22	77	4.6	305.3	305.3	305.9	0.6
B	545	17	53	6.6	311.0	311.0	311.0	0.0
C	695	25	85	4.1	314.4	314.4	315.3	0.9
D	1,405	26	119	3.0	321.9	321.9	322.9	1.0
E	2,190	34	133	2.6	326.7	326.7	327.6	0.9
F	3,165	87	279	1.3	329.5	329.5	330.3	0.8
G	3,615	90	295	1.2	330.2	330.2	331.0	0.8
H	4,225	37	208	1.7	332.2	332.2	333.0	0.8
I	4,277	80	375	0.9	332.7	332.7	333.7	1.0
J	4,642	65	231	1.5	333.0	333.0	334.0	1.0
K	5,342	35	171	2.1	334.2	334.2	335.0	0.8
L	5,642	43	177	2.0	334.7	334.7	335.6	0.9
M	5,698	43	169	2.1	335.1	335.1	335.8	0.7
N	5,838	33	180	2.0	335.3	335.3	336.0	0.7
O	5,915	52	273	1.3	335.7	335.7	336.4	0.7
P	6,430	134	674	0.5	335.7	335.7	336.5	0.8
Q	7,200	135	529	0.6	335.7	335.7	336.6	0.9
R	7,985	147	389	0.8	335.9	335.9	336.9	1.0
S	8,685	135	260	1.3	336.5	336.5	337.4	0.9
T	9,400	102	233	1.4	338.8	338.8	339.8	1.0
U	9,645	30	93	3.5	340.8	340.8	341.4	0.6
V	9,680	45	178	1.8	341.7	341.7	342.6	0.9
W	9,850	59	232	1.4	342.1	342.1	343.0	0.9
X	10,360	37	167	2.0	343.6	343.6	344.5	0.9
Y	10,670	92	229	1.4	344.1	344.1	345.1	1.0
Z	11,160	82	240	1.3	344.5	344.5	345.5	1.0

[1] Stream Distance in Feet From Upstream Face of Centralia Power Canal Flume

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

YELM CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET, NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
YELM CREEK (Continued)								
AA	11,700	64	166	1.8	345.2	345.2	346.2	1.0
AB	12,000	28	88	3.8	346.7	346.7	347.3	0.6
AC	12,062	28	104	3.2	347.6	347.6	347.8	0.2
AD	12,262	42	130	2.3	348.1	348.1	348.8	0.7
AE	12,762	109	341	0.9	348.4	348.4	349.3	0.9
AF	13,012	62	166	1.9	348.6	348.6	349.5	0.9
AG	13,064	23	101	3.2	349.7	349.7	350.0	0.3
AH	13,209	79	254	1.2	349.7	349.7	350.7	1.0
AI	13,714	106	268	1.1	350.4	350.4	351.4	1.0
AJ	14,250	30	95	3.2	351.4	351.4	352.4	1.0

[1] Stream Distance in Feet From Upstream Face of Centralia Power Canal Flume

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA

AND INCORPORATED AREAS

FLOODWAY DATA

YELM 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 follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS 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 V

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

Zone VE

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

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile (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 floodplains 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.

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

The countywide FIRM presents flooding information for the entire geographic area of Thurston 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 9, "Community Map History."

7.0 OTHER STUDIES

FIS reports were previously published for 8 cities and towns in Thurston County (References FEMA, December 1979; January 1980; March 1981; August 1981; April 1984; and June 1999).

Because it is based on more up-to-date analyses, this FIS supersedes the previously printed FISs for the communities within Thurston County.

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Thurston County has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS Reports, FHBMs, FBFMs, and FIRMs for all of the incorporated jurisdictions within Thurston County.

8.0 LOCATION OF DATA

Information concerning the pertinent data 33used in the preparation of this study can be obtained by contacting Federal Insurance and Mitigation Division, FEMA Region X, Federal Regional Center, 130 228th Street, SW, Bothell, Washington 98021-9796.

COMMUNTY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE(S)	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE(S)
Town of Bucoda	November 15, 1974	October 24, 1975	September 2, 1981	None
City of Lacey	June 28, 1974	October 3, 1975	July 16, 1980	None
City of Olympia	June 28, 1974	May 7, 1976	February 17, 1982	None
City of Rainer	None	N/A	None	None
City of Tenino	June 27, 1975	N/A	June 4, 1980	None
Thurston County	September 13, 1977	July 17, 1979	December 1, 1982	June 16, 1999
City of Tumwater	January 23, 1974	August 13, 1974	August 1, 1980	April 3, 1984
City of Yelm	October 22, 1976	N/A	June 16, 1999	None

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

THURSTON COUNTY, WA
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

9.0 BIBLIOGRAPHY AND REFERENCES

Federal Emergency Management Agency, Flood Insurance Study, City of Tumwater, Thurston County, Washington. Washington, D.C., April 3, 1984.

Federal Emergency Management Agency, Flood Insurance Study, City of Olympia, Thurston County, Washington. Washington, D.C., August 17, 1981.

Federal Emergency Management Agency, Flood Insurance Study, Town of Tenino, Thurston County, Washington. Washington, D.C., December 1979.

Federal Emergency Management Agency, Flood Insurance Study, City of Lacey, Thurston County, Washington. Washington, D.C., January 1980.

Federal Emergency Management Agency, Flood Insurance Study, Thurston County, Washington, Unincorporated Areas. Washington, D.C., June 16, 1999.

Federal Emergency Management Agency, Flood Insurance Study, City of Yelm, Thurston County, Washington. Washington, D.C., June 16, 1999.

Federal Emergency Management Agency, Flood Insurance Study, Town of Bucoda, Thurston County, Washington. Washington, D.C., March 2, 1981.

Harl Pugh and Associates, Topographic Map, Scale 1:4800; Contour Interval 4 feet: Thurston County (Bucoda, Lacey, Tenino, Olympia, Thurston County) Washington, 1978.

Pacific Northwest River Basins Commission, Columbia-North Pacific Region Comprehensive Framework Study of Water and Related Lands, Appendix VII, Flood Control, June 1971.

Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee, River Mile Index Puget Sound Basin, May 1969.

Pacific Northwest River Basins Commission, Hydrology and Hydraulics Committee, River Mile Index Pacific Coast Basin, July 1969.

Pacific Northwest River Basins Commission, Puget Sound Task Force, Comprehensive Study of Water and Related Land Resources, Puget Sound and Adjacent Waters, State of Washington, Appendix XII, Flood Control, March 1970.

Puget Sound LiDAR Consortium, with data collected by Terrapoint Aerial Services for the Puget Sound Regional Council, PSLC 2002 - Bare Earth LiDAR ASCII Points, 2002.

State of Washington, Office of Financial Management, Pocket Data Book 1977, Olympia, Washington, December 1977.

Thurston Regional Planning Council, Thurston County Flood Management Report, June 1975
U.S. Department of Agriculture, Soil Conservation Service, Series 1947, No. 6, Soil Survey, Thurston County, Washington, 1947.

U.S. Department of Agriculture, Soil Conservation Service, Soil Survey of Thurston County, Washington, Series 1947, No. 6, Issued September 1958.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, Climate of Washington (Climatography of the United States No. 60-45), Earl L. Phillips, February 1960 (Revised April 1965)

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Tide Listings (Written Communication), 1975.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Tide Tables, High and Low Water Predictions, 1975, West Coast of North and South America, 1974.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Tide Tables, High and Low Water Predictions, 1979, West Coast of North and South America, 1978.

U.S. Department of Commerce, Weather Bureau, Mean Annual Precipitation, 1930-57, State of Washington, Portland, Oregon, March 1965.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Thurston County, Washington (Unincorporated Areas), July 1979.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Olympia, Thurston County, Washington, May 1976.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Town of Bucoda, Thurston County, Washington, Scale 1:6000, November 1974.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Thurston County, Washington, Scale 1:24,000, July 1979.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Town of Yelm, Washington, Scale 1:7200, October 1976.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Lacey, Washington, Scale 1:7500, June 8, 1974, Revised October 3, 1975.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Town of Tenino, Thurston County, Washington, Scale 1:9600, June 1975.

U.S. Department of the Army, Corps of Engineers, Flood Plain Information, Skookumchuck River, Bucoda, Washington, February 1968.

U.S. Department of the Interior, Geological Survey, Water Resources Division, Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3, Chapter A3, Measurement of Peak Discharge of Darns in Indirect Methods, Washington, D.C., 1968.

U.S. Department of the Interior, Geological Survey, 15-Minute Series Topographic Map, Scale 1:62,500, Contour Interval 40 feet: Shelton, Washington (1953).

U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 20 feet: Squaxin Island, Washington (1959), Photorevised (1968); Tumwater, Washington (1959), Photorevised (1968 and 1973); Longbranch, Washington (1959), Photorevised (1968); Lacey, Washington (1959), Photorevised (1968 and 1973); Nisqually, Washington (1959), Photorevised (1968).

U.S. Department of the Interior, Geological Survey, Open-File report 76-499, Computer Applications for Step-Backwater and Floodway Analyses, User's Manual, 1976.

U.S. Department of the Interior, Geological Survey, Open-File Report 74-336, Magnitude and Frequency of Floods in Washington, J.E. Cummans, M.R. Collins, and E.G. Nassar, 1975.

U.S. Department of the Interior, Geological Survey, Reports WA75-1, WA76-1, WA77-1, Water Resources Data for Washington, Tacoma, Washington, 1975-1977.

U.S. Department of the Interior, Geological Survey, Water Resources Data for Washington, Part 1, Surface-Water Records, Tacoma, Washington, 1971-1974.

U.S. Department of the Interior, Geological Survey, Water Resources Division, Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3, Chapter A5, Measurement of Peak Discharge of Dams by Indirect Methods, Washington, D.C., 1967.

U.S. Department of the Interior, Geological Survey, Water Resources Division, "Measurement of Peak Discharge at Culverts by Indirect Methods," Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3, Chapter A3, Washington, D.C., 1968.

U.S. Department of the Interior, Geological Survey, Water Resources Division, Water Resources Data for Washington, Part 1, Surface Water Records, Tacoma, Washington, 1971-1974.

U.S. Department of the Interior, Geological Survey, Water-Supply Paper, Surface- Water Supply of the United States, Part 12, Pacific Slope Basins in Washington and Upper Columbia River Basin, Prior to 1971.

U.S. Department of the Interior, Geological Survey, Water-Supply Paper 1687, Magnitude and Frequency of Floods in the United States, Part 12, Pacific Slope Basins in Washington and Upper Columbia River Basin, G.L. Bodhaine and D.M. Thomas, 1964.

U.S. Water Resources Council, "Guidelines for Determining Flood Flow Frequency," Bulletin 17, March 1965.

Walker and Associates, Aerial Photographs, Scale 1:9600, Seattle, Washington, April 1977.

Washington State Department of Conservation, Washington Division Water Resources Water Supply Bulletin 10, Geology and Ground-Water Resources of Thurston County, Washington, Volume 2: Washington Division, 1966.