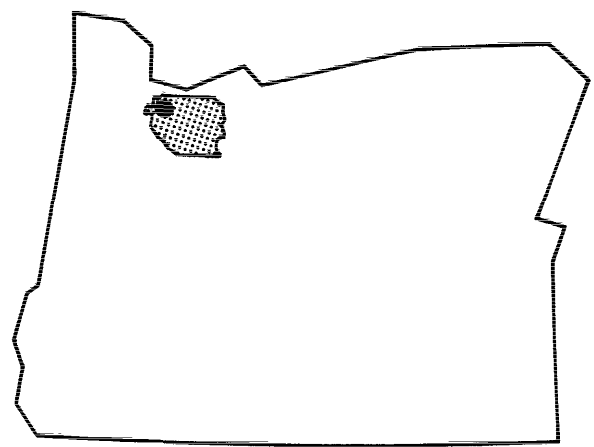
FLOOD INSURANCE STUDY



CITY OF OREGON CITY, OREGON
CLACKAMAS COUNTY

AUGUST 1979

FEDERAL EMERGENCY MANAGEMENT AGENCY
FEDERAL INSURANCE ADMINISTRATION

COMMUNITY NUMBER-410021

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PUBLISHED SEPARATELY:

FLOOD INSURANCE STUDY

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Flood Insurance Study is to investigate the existence and severity of flood hazards in the City of Oregon City, Clackamas County, Oregon, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to convert Oregon City to the regular program of flood insurance by the Federal Insurance Administration. Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain development.

1.2 Coordination

Streams requiring detailed study were identified at a meeting held in June 1977, attended by representatives of the study contractor, the Federal Insurance Administration, and Oregon City. Results of the hydrologic analyses were coordinated with the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the U.S. Soil Conservation Service.

The results of this study were reviewed at a final community coordination meeting held on October 11, 1978. Attending the meeting were representatives of the Federal Insurance Administration, the study contractor, and the city. This study incorporates all appropriate comments, and all problems have been resolved.

1.3 Authority and Acknowledgments

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were performed by James M. Montgomery, Consulting Engineers, for the Federal Insurance Administration, under Contract No. H-4583. This work, which was completed in June 1978, covered all significant flooding sources affecting the City of Oregon City.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Oregon City, Clackamas County, Oregon. The area of study is shown on the Vicinity Map (Figure 1).

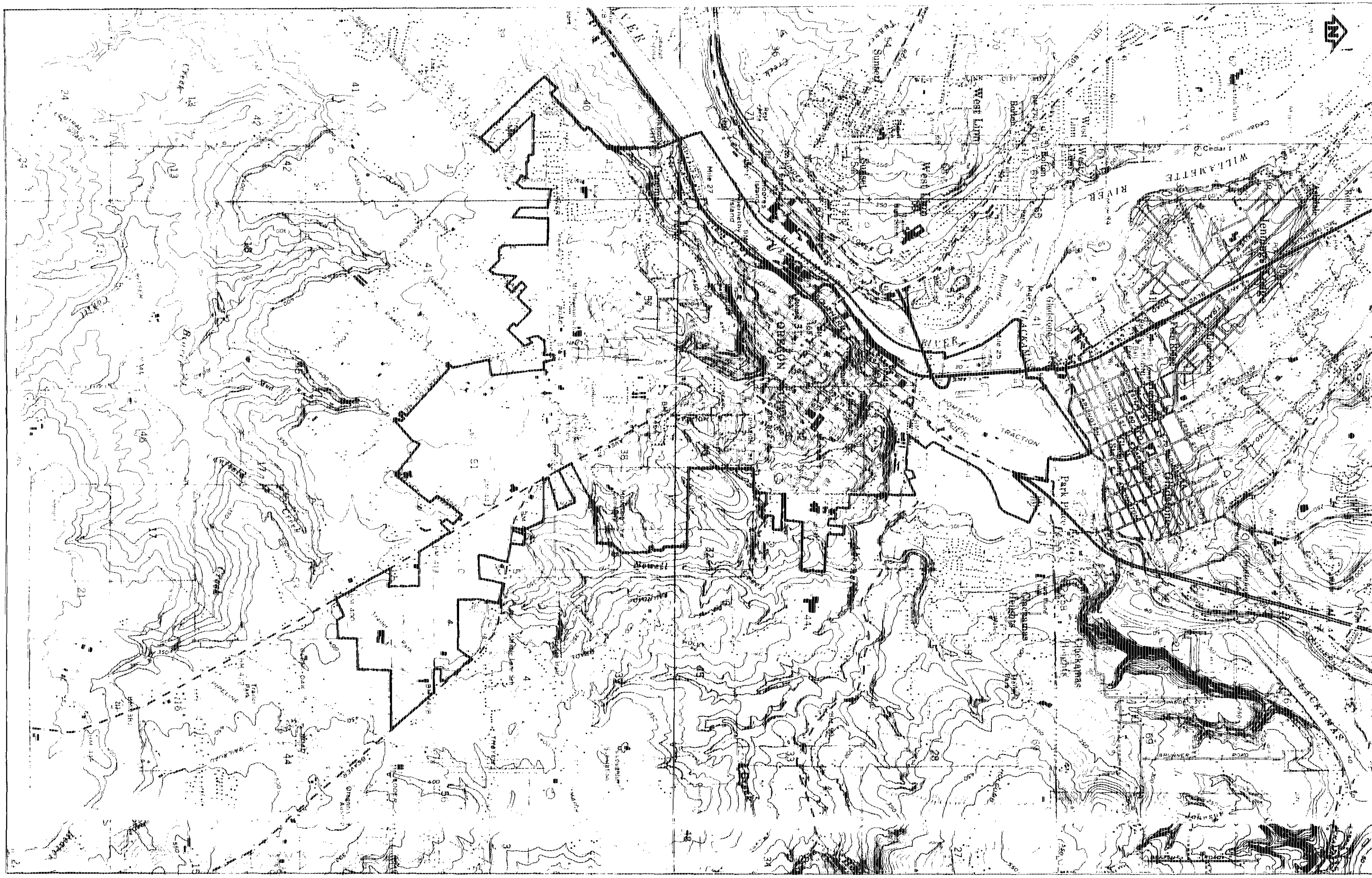

FIGURE 1

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF OREGON CITY, OR

(CLACKAMAS CO.)

APPROXIMATE SCALE

4000 0 4000 8000 12000 FEET

VICINITY MAP

Floods caused by overflow of the Willamette and Clackamas Rivers and Abernethy Creek within the corporate limits of Oregon City were studied in detail. No approximate studies were conducted within Oregon City.

Those areas studied by detailed methods were chosen with consideration given to all proposed construction and forecasted development through 1983.

2.2 Community Description

Oregon City is situated in the upper northwest corner of Clackamas County, in northwest Oregon. The City of Gladstone is directly north of Oregon City on the opposite side of the Clackamas River, and West Linn is directly northwest of Oregon City on the opposite side of the Willamette River.

Oregon City is located on the southeast periphery of the Portland, Oregon, metropolitan urban area. The total land area contained within the corporate limits is 4.9 square miles. According to U.S. census figures, the population has increased from 8,000 in 1960 (Reference 1) to 14,100 in 1977 (Reference 2).

The Willamette River, which flows northerly through Oregon City and forms its western corporate limits, is one of the principal rivers in Oregon. It extends 187 miles from its source at the confluence of the Middle and Coast Forks Rivers near Eugene, Oregon, to the mouth at the Columbia River. The total drainage area of the Willamette River is 11,200 square miles, approximately 10,100 square miles of which are upstream from Oregon City.

The Clackamas River, which flows westerly and forms part of the northern corporate limits of Oregon City, is a major tributary of the Willamette River. It extends approximately 80 miles from its source in the Cascade Range to its junction with the Willamette River, at Oregon City. The total drainage area of the Clackamas River is 937 square miles.

Abernethy Creek, also a tributary of the Willamette River, flows westerly through Oregon City. It extends approximately 16 miles and has a total drainage area of 30 square miles.

Approximately 70 percent of the city has been developed. Within the flood plains studied, development is mainly commercial and light and heavy industry. Less than 1 percent of the total city housing lies within the flood plain.

Oregon City is located along a gorge of the Willamette River. Development began adjacent to the river and progressed up and away from the river. The topography has formed a lower commercial-industrial area, an intermediate area with mixed commercial-residential development and an upper area that is predominantly residential.

Other than the rocky broken ground in the southeast portion of the city, the soil is typically silt loam or clay loam which naturally support deciduous trees and shrubs, with a mix of coniferous trees.

The climate is characterized by warm, dry summers and mild, wet winters. Temperatures are usually moderate, ranging from an average monthly minimum in January of 33°F to an average monthly maximum in July of 82°F (Reference 3). The average annual precipitation is 45.3 inches, with 86 percent of the precipitation occurring from October to May (Reference 4).

2.3 Principal Flood Problems

The past history of flooding on the streams within Oregon City indicates that flooding occurs in the winter and spring seasons. The larger floods on the Willamette and Clackamas Rivers resulted from abnormally heavy or prolonged rainfall, combined with snowmelt and frozen or nearly saturated ground surfaces. Although floods on Abernethy Creek can result from rainfall on its drainage area, the largest floods result from backwater from the Willamette River.

During the flooding season of October through April, cyclonic storms from the Pacific Ocean sometimes produce intense rainfall on the three drainage basins. When these storm fronts move in a downstream direction, greater discharges are produced. If this condition is accompanied by rapid snowmelt and frozen ground in the upper watersheds, large floods can result.

There have been a number of major floods on the Willamette River (References 5, 6, and 7). The largest recent flood occurred as the result of a December 1964 storm that dropped from 6 to 10 inches of rainfall over the watershed and caused the freezing level to rise to the 10,000-foot elevation. A peak discharge of 403,000 cubic feet per second (cfs) for this flood was observed on December 25, 1964, at the Willamette Locks upper gage in Oregon City. This discharge exceeds that of the 100-year flow of 341,000 cfs. The flood of December 1861 is believed to be the greatest historical flood, with a peak discharge at the same gaging station estimated at 590,000 cfs. The second largest historical flood, in 1890, had an estimated discharge of 510,000 cfs. Both floods exceed the 500-year flow of 469,000 cfs. The January 9, 1923, peak discharge of 357,800 cfs and the January 3, 1943, peak discharge of 324,800 cfs are the fourth and fifth largest recorded floods, respectively, for the Willamette River at the upper gage.

Major floods have also occurred on the Clackamas River. The largest recorded flood at the gage near Clackamas occurred on December 22, 1964, with a peak discharge of 120,000 cfs. Other major floods on the Clackamas River occurred in March 1931, January 1923, and November 1960, with peak discharges of 82,000 cfs, 80,000 cfs and

73,000 cfs, respectively. The estimated 100-year discharge for the Clackamas River at the gaging station near Clackamas is 110,000 cfs.

Oregon City has sustained damage from flooding of the Willamette and Clackamas Rivers. The 1861 Willamette River flood inundated the main streets of Oregon City with 4 feet of water. Although the 1890 Willamette River flood had a smaller discharge than the 1861 flood, water from the later flood rose to a level 2.1 feet above the earlier flood, due to the presence of buildings along the river which reduced the channel capacity in Oregon City. The December 1964 flood also caused extensive damage in Oregon City. Waterfront industry and shopping areas along the Willamette and Clackamas Rivers received significant damage from this flood.

2.4 Flood Protection Measures

Willamette River flood stages at Oregon City are reduced significantly by 11 upstream storage projects operated by the U.S. Army Corps of Engineers. These projects have progressively been placed in operation since 1942, and provide a total flood-storage capacity of 1.7 million acre-feet. Three more reservoirs are authorized and are in preliminary planning stages. There are five dams on Clackamas River, but they are all run-of-the-river hydroelectric projects, not designed for flood control.

Regulatory measures have been adopted by Oregon City to guide new development in the flood plain consistent with the hazards involved (References 8 and 9). Finished floors must be at least 2 feet higher than the 100-year flood, and development within the floodway which would hinder flow is not permitted.

River stage forecasting for Willamette and Clackamas Rivers is the responsibility of the Portland River Forecast Center and the National Weather Service of the National Oceanic and Atmospheric Administration, U.S Department of Commerce. Forecasts and flood warnings prepared by the center are disseminated through Clackamas County Emergency Services, radio, television, and other news media. Forecasts are prepared for the U.S. Geological Survey gage on Clackamas River near Clackamas and for the U.S. Army Corps of Engineers gages above and below Willamette Falls.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail 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 which are expected to be equalled 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 flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equalled 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 which equals or exceeds the 100-year flood (1 percent chance of annual occurrence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported here 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 the peak discharge-frequency relationships for floods of the selected recurrence intervals for each stream studied in detail in the community.

For the Willamette and Clackamas Rivers, the hydrologic analyses performed by the U.S. Army Corps of Engineers in the Flood Insurance Studies for Gladstone and West Linn (References 6 and 7, respectively) were utilized in this study. The peak discharges for floods on these two rivers of the selected recurrence intervals were determined by statistical analysis of river gage records, using the standard log-Pearson Type III method as outlined by the U.S. Water Resources Council (Reference 10).

Willamette River peak discharges are based on stage-frequency curves for gages at Willamette Falls Locks and Morrison Bridge, Portland, Oregon (Reference 11). These flows were derived by correlation of stream flow records (Reference 12) and frequency-discharge curves (Reference 13) for gages upstream of the study area at Wilsonville and Salem, Oregon.

Willamette River stages were first recorded in 1879 at the Portland Morrision Bridge by the U.S. Weather Bureau (Reference 14). The gages at Willamette Falls Locks and Salem have also had long periods of record, dating back to 1915 and 1909, respectively. The gage at Wilsonville was established in 1948. Willamette Falls Locks gage is operated by the U.S. Army Corps of Engineers, and the other gages are operated by the U.S. Geological Survey.

Clackamas River frequency-discharge data (Reference 15) were based on records from the U.S. Geological Survey gaging station at River Mile 4.9. Those records are continuous since October 1962, the date of installation. Another gage, at Estacada, River Mile 23.1, has a continuous record since 1908. Flood data for the lower gage prior to 1962 were extrapolated by correlation with the Estacada gage.

Peak discharge-frequency relationships for Abernethy Creek were developed by regional hydrologic analysis utilizing prior discharge-frequency information for Abernethy Creek and statistical analyses of recorded runoff data for other nearby streams. Because there are no gaging stations on Abernethy Creek, the hydrologic analysis could not be based on the statistical approach that was used for the Willamette and Clackamas Rivers. The regional analysis was performed using a discharge-frequency curve developed by the U.S. Army Corps of Engineers for a 1970 study (Reference 5). This curve was adjusted slightly on the basis of the discharge-frequency curve for Johnson Creek, at the Sycamore gaging station.

Peak discharge-drainage area relationships for Willamette River, Clackamas River, and Abernethy Creek are shown in Table 1.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of streams in the community were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each stream studied in the community.

Hydraulic analyses performed by the U.S. Army Corps of Engineers for the Willamette and Clackamas Rivers as part of Flood Insurance Studies conducted for Gladstone (Reference 6) and West Linn (Reference 7) were used in this study. New hydraulic analyses were performed by the study contractor for Abernethy Creek.

Water-surface elevations of the selected recurrence intervals along the Willamette River were computed by the U.S. Army Corps of Engineers using the HEC-2 step-backwater computer program (Reference 16). A step-backwater model developed by the U.S. Army Corps of Engineers, Seattle District (Reference 17) was used to develop water-surface elevations along the Clackamas River. Willamette River cross section data are based on channel soundings and overbank elevations from topographic maps at a scale of 1:24,000, with a contour interval of 2 feet (Reference 18). Similarly, Clackamas River cross sections came from a composite of channel data obtained by U.S. Army Corps of Engineers field surveys and overbank data taken from contour maps at a scale of 1:1200, with a contour interval of 2 feet (Reference 19). Cross sections for Abernethy Creek were developed from contour maps (Reference 19), a channel profile presented in a U.S. Army Corps of Engineers report (Reference 5), and bridge design drawings.

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 is computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second)			
		10-Year	50-Year	100-Year	500-Year
Willamette River At Willamette Locks Upper Gage	10,100	219,000	295,000	341,000	469,000
Clackamas River At Mouth	937	65,000	95,000	110,000	145,000
Abernethy Creek At Mouth	30	2,460	3,930	4,560	6,600

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgement and based on field observations of the streams and flood plain areas. Roughness values for the main channel of the Willamette River ranged from 0.028 to 0.040, with flood plain roughness values ranging from 0.050 to 0.100 for all floods. The roughness values for the main channel of the Clackamas River were 0.035, with flood plain roughness values ranging from 0.060 to 0.065 for all floods. Roughness values for the main channel of Abernethy Creek ranged from 0.030 to 0.040, with flood plain roughness values ranging from 0.033 to 0.100 for all floods. Roughness values for the Willamette and Clackamas Rivers were verified by the U.S. Army Corps of Engineers, using known discharges and high-water marks from the December 1964 flood.

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 starting water-surface elevations for the Willamette River profile computations came from a previous U.S. Army Corps of Engineers hydraulic analysis made for the Flood Insurance Study for Multnomah County (Reference 20). Starting elevations for Clackamas River flood profiles are based on Willamette River backwater elevations. Water-surface elevations for Abernethy Creek were controlled by backwater from the Willamette River. Starting water-surface elevations for the floodway analysis on Abernethy Creek were calculated using the slope-area method.

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

All elevations are referenced to the National Geodetic Vertical Datum (NGVD) of 1929. Elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage State and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Insurance Administration as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:1200, with a contour interval of 2 feet (Reference 19).

In cases where the 100- and 500-year flood boundaries are close together, only the 100-year flood boundary has been shown.

Flood boundaries for the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2).

Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to limitations of the map scale, such areas are not shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity and increases flood heights, thus increasing flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment in order that the 100-year flood be carried without substantial increases in flood heights. As minimum standards, the Federal Insurance Administration limits such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced.

The floodways presented in this study were computed on the basis of equal conveyance reduction for each side of the flood plain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood boundaries are close together, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

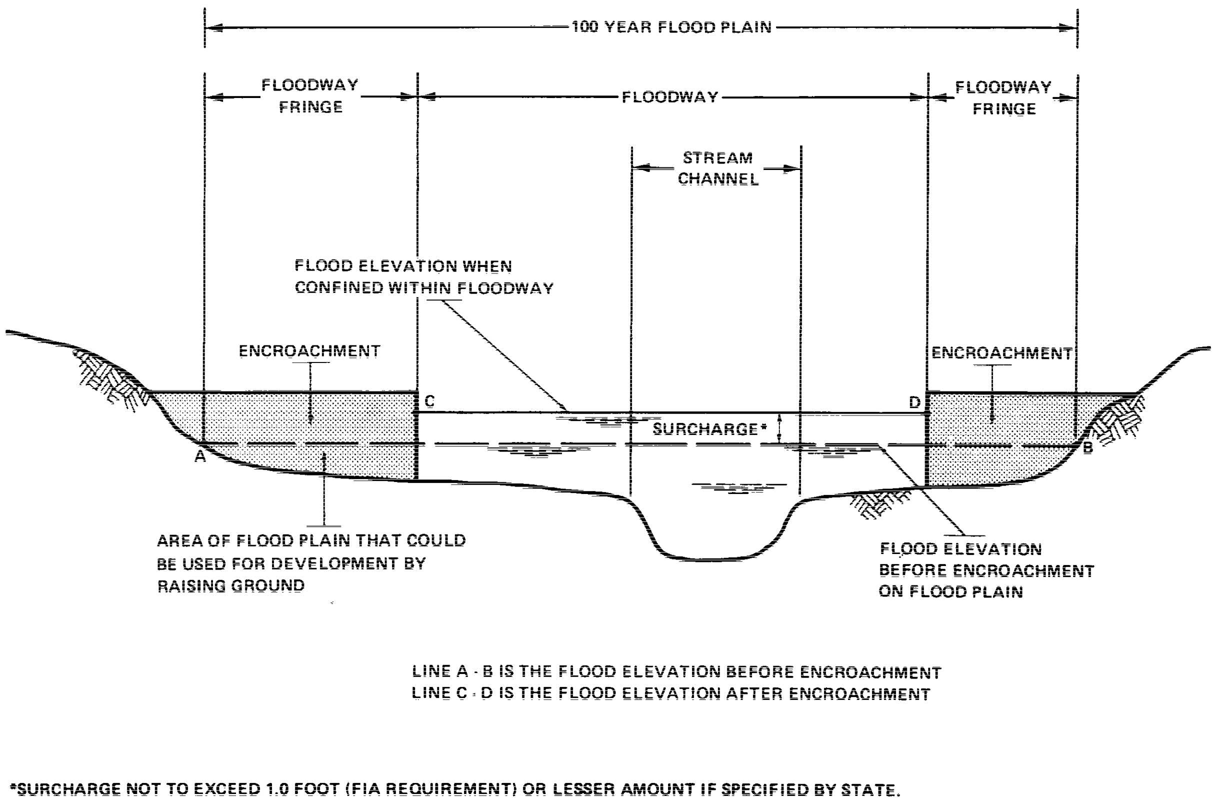

Figure 2. Floodway Schematic

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the Federal Insurance Administration has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting the City of Oregon City.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet

Two reaches meeting the above criteria were required for the flooding sources of the City of Oregon City. These included two on the Willamette River. The locations of the reaches are shown on the Flood Profiles (Exhibit 1).

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is the Federal Insurance Administration device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest one-half foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective Flood Hazard Factors, the entire incorporated area of the City of Oregon City was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zones A9 and A21: Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to Flood Hazard Factors.

Zone B: Areas between the Special Flood Hazard Areas and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

The flood elevation differences, Flood Hazard Factors, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are summarized in Table 3.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Oregon City is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the Federal Insurance Administration.

6.0 OTHER STUDIES

Information on the Willamette and Clackamas River, as presented in the 1976 Flood Insurance Study reports for Gladstone and West Linn (References 6 and 7, respectively) were incorporated directly into this report. Consequently, all flood insurance information presented herein is compatible with the information in those two reports. A 1970 U.S. Army Corps of Engineers Flood Plain Information report (Reference 5) was also reviewed in this study; however, information presented in that 1970 report has been superseded by the later Flood Insurance Study reports (References 6 and 7). Water-surface profiles for Abernethy Creek within Oregon City represent backwater elevations of the Willamette River. The 100-year profile on Abernethy Creek, as presented herein, is 0.7 foot below that shown in the 1970 Flood Plain Information report (Reference 5). This difference is attributed to revisions in the Willamette River 100-year profile as presented in the 1976 Flood Insurance Study for West Linn (Reference 7).

No other studies relative to water-surface elevations for streams studied by detailed methods in Oregon City were found to exist.

This study is authoritative for the purposes of the National Flood Insurance Program; data presented herein either supersede or are compatible with all previous determinations.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Willamette River							
Reach 1	0001	-10.6	-3.3	7.8	110	A21	Varies - See Map
Reach 2	0001	- 4.3	-1.7	3.3	045	A9	Varies - See Map

[1] Flood Insurance Rate Map Panel [2] Weighted Average [3] Rounded to Nearest Foot

TABLE 3

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF OREGON CITY, OR
(CLACKAMAS CO.)

FLOOD INSURANCE ZONE DATA

WILLAMETTE RIVER

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the office of the Federal Insurance Administration, Regional Director, Arcade Plaza Building, 1321 Second Avenue, Seattle, Washington 98101.

8.0 BIBLIOGRAPHY AND REFERENCES

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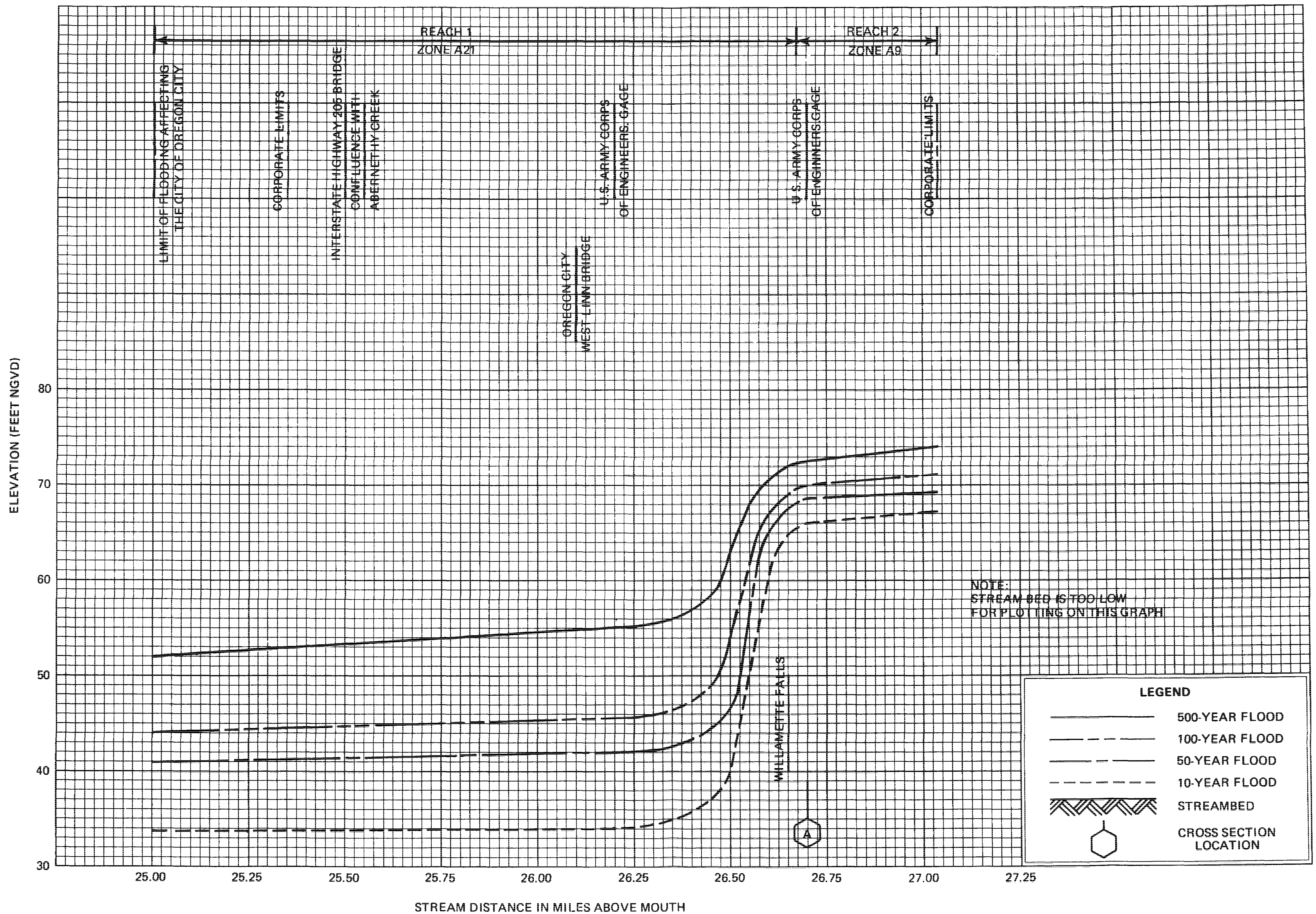


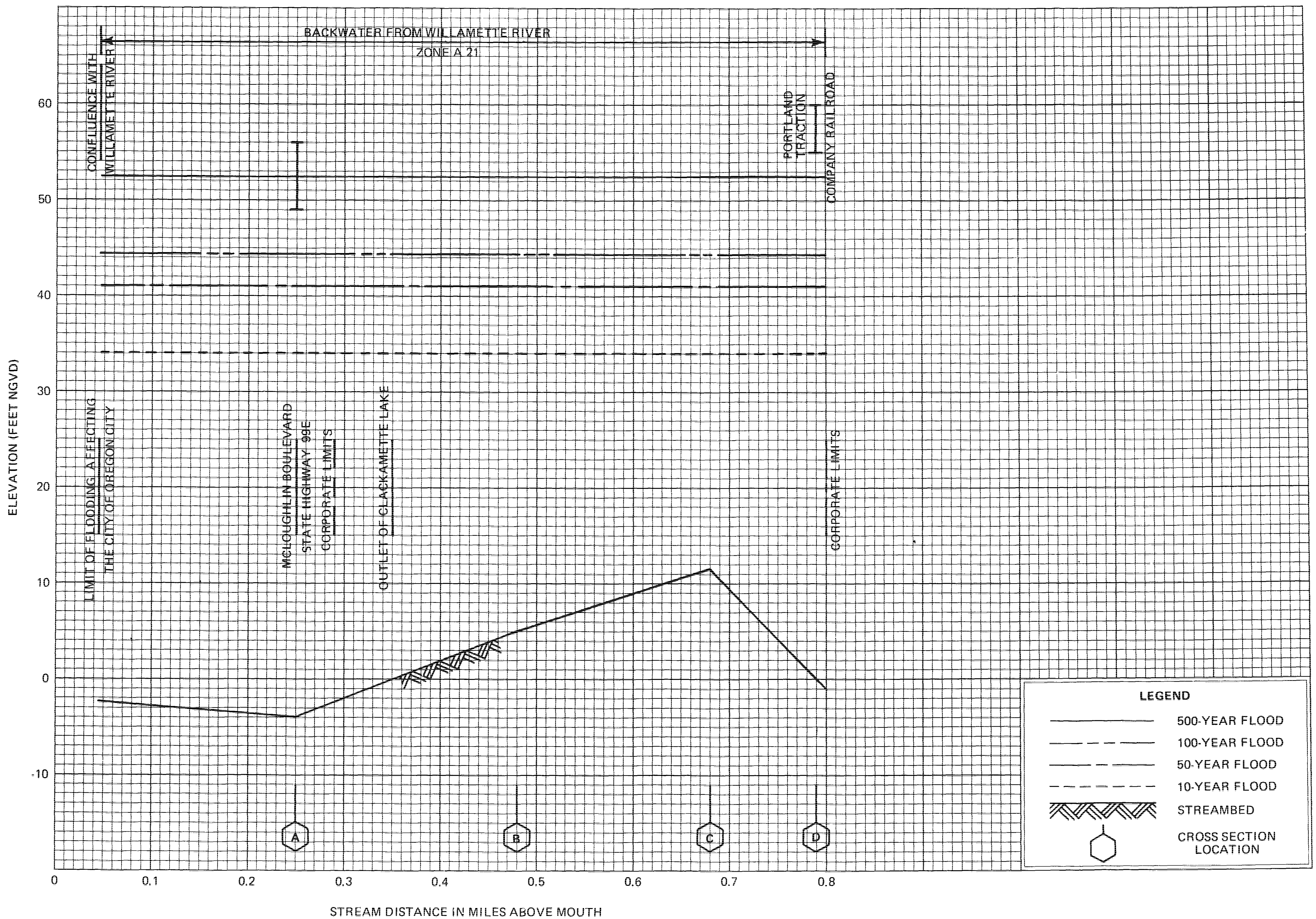
FLOOD PROFILES

WILLAMETTE RIVER

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF OREGON CITY, OR
(CLACKAMAS CO.)

01P



FLOOD PROFILES

CLACKAMAS RIVER

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF OREGON CITY, OR
(CLACKAMAS CO.)

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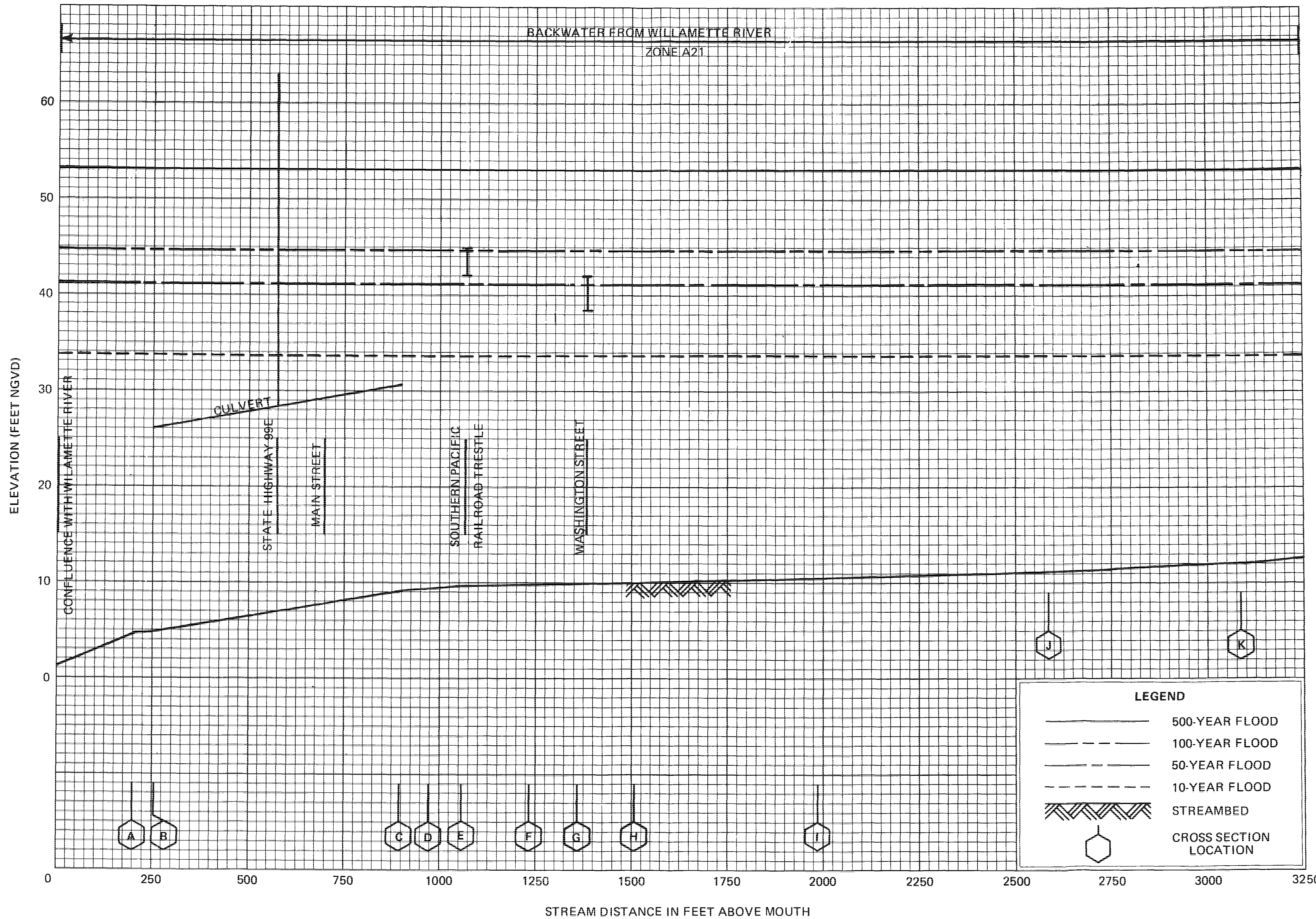

FLOOD PROFILES

ABERNETHY CREEK

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF OREGON CITY, OR
(CLACKAMAS CO.)

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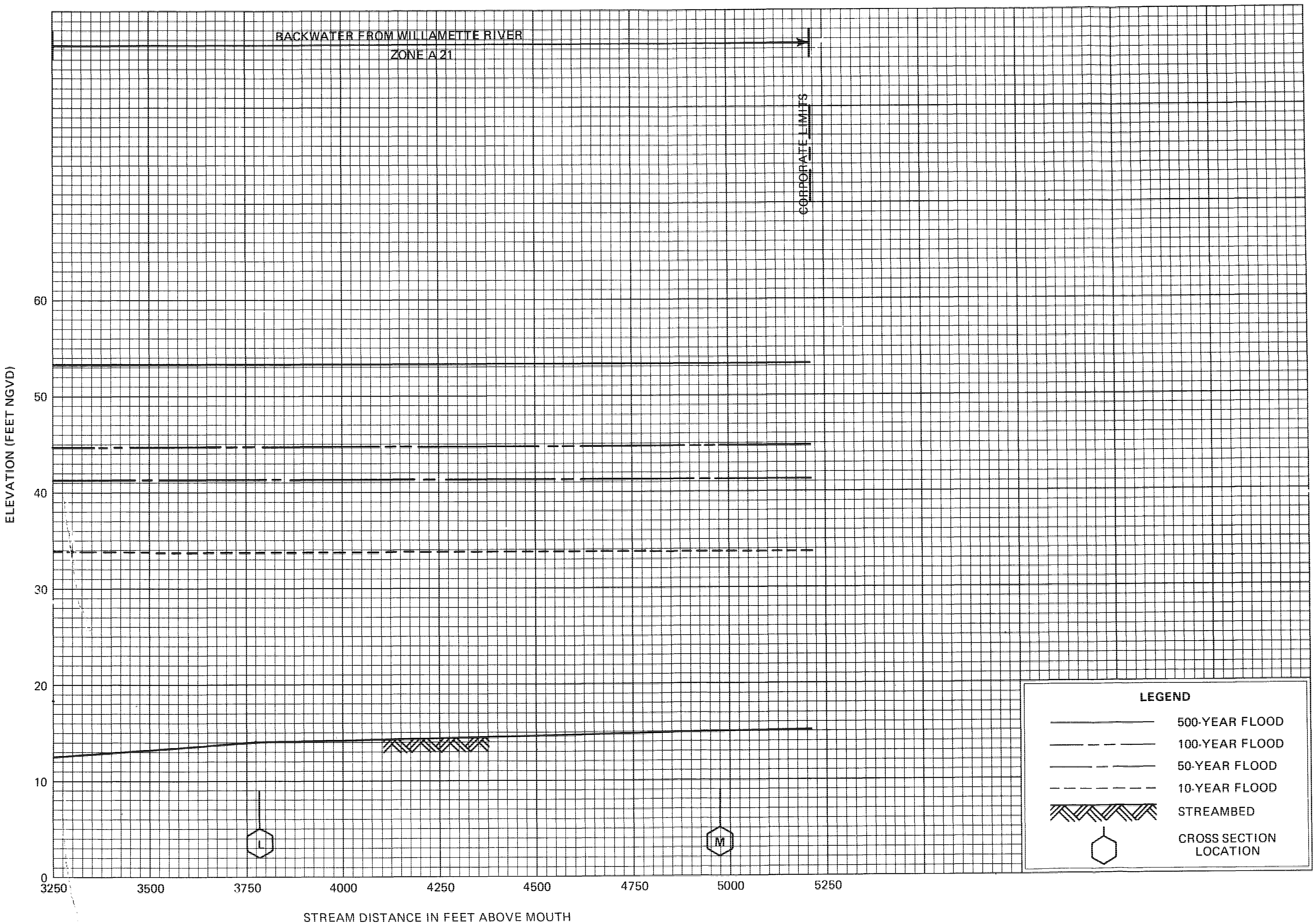

FLOOD PROFILES

ABERNETHY CREEK

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF OREGON CITY, OR
(CLACKAMAS CO.)

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