REPORT ON FLOODS OF December 1975 and January 1976

PUGET SOUND, WASHINGTON COASTAL, and EASTERN SLOPE CASCADE RIVER BASINS, WASHINGTON

June 1977

REPORT ON FLOODS OF DECEMBER 1975 AND JANUARY 1976

I. INTRODUCTION

The floods of December 1975 and January 1976 covered approximately 115,000 acres of land in Washington State and caused damages totaling more than $33 million. Ten river basins suffered substantial inundation losses, and 12 counties were declared disaster areas by the President of the United States. Flood crests approached historical record levels. This report on the floods is in 13 sections, including an introduction, general section, 10 sections with detailed flood descriptions for each of the affected river basins, and a concluding section describing economic and social impacts during and after the floods. The river basin sections start with the Nooksack River Basin, the northernmost basin adjacent to Puget Sound, continuing with basins as they appear in a southerly direction and ending with the Yakima River Basin in eastern Washington. Following the text are tables containing quantitative data, photographs, and plates with climatological and hydrological data.

1. Authority. This report on floods has been prepared pursuant to the provisions of ER 500-1-1, paragraph 72.72, 1 September 1975, and authority provided by the 4th Indorsement, DAEN-CWO-E, 30 June 1976, to letter NPSEN-PL-W, 26 March 1976, subject: Post-Disaster Report - December 1975 and January 1976 Floods.

2. Scope. This report covers the December 1975 and January 1976 rain floods that occurred in the following 10 river basins of Washington State: Nooksack, Skagit, Stillaguamish, Snohomish, Cedar, Green, Puyallup, and Nisqually Rivers of Puget Sound; the Chehalis River Basin on the Washington coast; and the Yakima River Basin on the eastern slope of the Cascade Mountains. The floods resulted from two distinct storm periods, 29 November to 4 December 1975 and 14-16 January 1976. The report presents descriptions of meteorology, hydrology, flood-fight activities, and flood damages and damages prevented. Also included are general descriptions of the affected river basins, flood details for each storm, and flood activities during and after the storms. Additional coverage is devoted to the Snohomish River, as this basin sustained the most damage. Flood information quantified in this report was compiled from data available during and immediately after the flood and may be superseded by later publications of reporting agencies.

II. GENERAL

1. Meteorology. Two storm periods over western Washington during the winter of 1975-1976 produced damaging flows in many river basins which drain the slopes of the Cascade Mountains in Washington State. The 29 November to 4 December 1975 storm produced disastrous flooding that overtopped many levees. The second storm, on 13-16 January 1976, produced rains of much less magnitude. During and following the floods, meteorological details on rain, snow, and temperature were collected at climatological stations that are part of a flood-reporting network. The stations are telemetered to monitoring agencies to provide real-time data during the storm event. Locations of climatological stations in the flood-reporting network are shown on plate 1.

a. 29 November - 4 December 1975. For a few days preceding this storm period, the Pacific Northwest region was dominated by a protective high-pressure ridge that shunted more-intense storms northward through western Canada and southeastern Alaska. By 29 November, the high-pressure ridge had flattened out and moved eastward, to be replaced over western Washington by a strong inflow of warm saturated air. Heavy rain began over western Washington late on 29 November and early on 30 November. It did not moderate at most stations until near midnight on 30 November. Snow began falling over the Cascades late on 29 November, and the rate of fall became increasingly heavy as the warmer air arrived. Snow in the mountains had changed to heavy rain by the afternoon of 30 November. Precipitation continued throughout the next 3 days, surging between moderate and heavy. The total storm period of late evening on 29 November to early morning on 4 December included three distinct storms, following each other in close succession. Accumulated precipitation for eight climatological stations throughout western Washington during 29 November through 5 December is shown on plates 2 and 3. Storm events at the Stampede Pass weather station at 4,000 feet elevation in the Cascades are considered to be representative of events at the headwater regions of the western Cascade Mountain drainages. Precipitation at Stampede Pass began early on 30 December. It received 4 inches of precipitation the first day, more than half of it snow and the rest falling as rain. Much of the rain was retained within the snowpack. As the warm air mass arrived at Stampede Pass, the temperature rose about 25° F in a few hours to near 40° F. The wet snowpack was estimated to be completely conditioned and yielding runoff by the end of the first day. During the next 24 hours, from midnight on 30 November to midnight on 1 December, a near-record 6.9 inches of rain fell at Stampede Pass. This was augmented by 3.0 inches of snowmelt for a combined 24-hour contribution to runoff of 9.9 inches. Rainfall and snowmelt continued to 3 December. Precipitation diminished the morning of 4 December, and the temperature dropped to below freezing, reducing snowmelt. The rainfall and snowmelt contributed to a total storm runoff at Stampede Pass estimated at 21.6 inches. Curves showing accumulated precipitation, snow-water equivalent, and air temperature at the Stampede Pass climatological station for 29 November through 6 December are on plate 4.

b. 13-16 January 1976. Minor flooding occurred on a few western Washington streams during this period as warm, moist air surged into the region. Rainfall began late on 13 January and continued through 15 January. The warm-air mass caused the temperature at Stampede Pass to rise above freezing on 14 January. Freezing levels rose to nearly 10,000 feet on 15 and 16 January, causing heavy snowmelt. Two-day rainfall amounts ranged generally from 2 inches at lower elevations to 6-7 inches at higher elevations in the Cascade Mountains and along the highly orographic slopes of the coastal mountains. Accumulated precipitation for eight climatological stations throughout western Washington during the period 13-16 January is shown on plates 5 and 6. Accumulated precipitation and air temperature for the Stampede Pass climatological station are shown on plate 7 for the period 13-16 January.

2. Hydrology. Runoff for the two storm periods is discussed in following paragraphs. Streamflows are indexed to respective damage levels at various locations. Zero-damage stage indicates the level at which streamflows begin to exceed channel capacity and general flooding begins to occur on lowlands. Flood-fighting efforts usually are initiated as requested when zero-damage stage is anticipated or exceeded. Major-damage stage indicates the level when a stream flows across its valley lowlands with apparent disregard for the main channel. At major-damage stage, portions of highways are out of service, buildings are inundated, levee failures are imminent, and an extreme emergency situation exists. River stages were collected during and following the floods at stream-gaging stations that are part of a flood-reporting network. These stations are telemetered by monitoring agencies to provide real-time data during the storm event. The locations of stream-gaging stations in the flood-reporting network are shown on plate 8. A summary of characteristics and floods of record at the stream-gaging stations is shown on table 2.

a. December 1975 Flood. The intense rainfall and accompanying snowmelt produced damaging streamflows in 10 river basins: the Nooksack, Skagit, Stillaguamish, Snohomish, Cedar, Green, Puyallup, Nisqually, Chehalis, and Yakima. The near-record rainfall produced streamflow rises on all rivers on 1 December. All but one river rose between .2 and .4 foot per hour to the zero-damage level, except for the Skagit River near Concrete which rose at .6 foot per hour. Zero-damage levels were exceeded during the afternoon and evening of 1 December and morning and afternoon of 2 December. Rivers continued to rise and fall in response to melting mountain snow and rainfall surges. Most of the rivers experienced three crests, with the highest one occurring on 3 or 4 December. The more-sluggish Chehalis

River experienced one crest at Grand Mound at 2 a.m. on 5 December. The rivers crested from near major-damage to 5.6 feet above their major-damage levels. Rivers with Corps of Engineers' flood-control reservoirs crested from 2.4 to 3.4 feet below their major-damage levels. The amount of time unregulated rivers remained above zero-damage levels varied from 52 hours at Gold Bar to 130 hours at Grand Mound. Durations above major-damage levels for the same rivers varied from 21 hours at Gold Bar and Ferndale to 79 hours at Renton. Recurrence intervals for streamflow peaks on rivers between the Snoqualmie and Chehalis Rivers varied from 14 years at Carnation to 30 years at Renton. Recurrence intervals for streamflow peaks on the remaining rivers were between 7 and 11 years.

b. January 1976 Flood. Streamflows exceeded zero-damage levels in three river basins: Snohomish, Snoqualmie, and Chehalis. The rivers rose on 14-15 January, peaked on 16 January, and receded below zero-damage levels by 17-18 January. The rivers crested between .7 and 1.7 feet below their major-damage levels. Recurrence intervals of the streamflow peaks were less than 5 years. Although January storm crests were lower than December storm crests, floodwaters caused significant damage by entering developed areas through levee sections that had been damaged by the December storm, and by hampering repair and cleanup operations that still were underway following the December flood. Detailed descriptions of floodflows are in the respective river basin sections of this report.

3. Flood Damages. The flood damages in each river basin are described in that basin's respective section. A discussion of other economic and social disruptions caused by the floods is in the last section of this report. A summary of flood damages by category for each river basin is on table 3.

a. Evaluation Procedures. Flood damages were evaluated from field surveys, personal interviews, and damage survey reports.

(1) Surveys. Field surveys were made throughout 1976 to determine monetary damages and losses caused by the floods of December 1975 and January 1976. As some areas were flooded in both December and January, damage evaluation treated the two floods as one flood by combining damages from the second flood in the first flood estimate. Aerial photographs, flood-fighting maps, and topographic maps were used to delineate the extent of high water. To organize the surveys, parcels of the flooded areas were marked off and labeled by city blocks in residential areas or by individual homes and farms in rural areas. Buildings and improvements were designated as residential, industrial, commercial, or agricultural.

(2) Interviews. Dollar damages in all flooded areas were determined from over 1,000 personal interviews with homeowners, tenants,

farmers, and businessmen. State, county, and city agencies were contacted for estimates of damages to Federal and state highways, county roads, and city streets and for losses resulting from traffic delays and rerouting. Officials of public utility companies were contacted by letter, telephone, or personal interview for evaluation of losses to communications, power, sewers, and related items. Eyewitness accounts of flooding and reports of damage in local newspapers also were useful in identifying and quantifying flood damages.

(3) Damage Survey Reports. Counties that were declared disaster areas were eligible for Federal relief funds through the Federal Disaster Assistance Administration (FDAA). Many public agencies and municipalities submitted Damage Survey Reports (DSR's) to the FDAA. The DSR estimates were considered accurate estimates of actual costs and damages. These and other data were used to estimate costs and damages for such items as flood fighting, public facilities and utilities, fish and wildlife habitats, flood protective works, and roads and bridges.

b. Damage Categories. Flood losses and damages were determined for 10 categories:

(1) Residential. Losses or damage included damage to nonfarm residences and contents, appurtenant buildings, grounds, and additional living expenses.

(2) Commercial. Damages included losses or damage to all properties used in wholesale or retail business, trade, services or entertainment, and loss of business. Lost wages were included when such losses were not offset by employment in emergency activities during flood and rehabilitation periods.

(3) Industrial. Includes damages to properties and facilities used in manufacturing and processing commodities, heavy warehousing and distribution facilities, and loss of business.

(4) Public Facilities. Damages to parks, equipment, and furnishings owned or operated by Federal, state, county, or local governments were considered.

(5) Public Utilities. Includes damages to electric, water, and telephone plants; transmission poles and lines; and sewage systems.

(6) Agricultural. In addition to losses of crops, land, and livestock, includes damages to farm dwellings, barns, and other appurtenant buildings and their contents.

(7) Roads and Bridges. Included were inundation losses of roads, streets, pavement, sidewalks, bridges and other highway structures, supplies, and equipment. Monetary losses due to delays and rerouting of highway traffic were included.

(8) Railroads. Losses included damage to tracks, roadbed rights-of-way, supplies, and equipment. Also included were monetary losses resulting from railroad traffic delays and rerouting.

(9) Emergency Aid. Included expenditures for preservation of life and property, such as clearance of debris and wreckage, emergency repair or temporary replacement of private and public facilities, evacuation assistance, Federal aid for flood fighting, flood emergency preparation, rescue operations, police protection, and repair and restoration of damaged flood control works. Also includes Federal assistance to state and local governments for channel clearing, debris removal, and other emergency channel work on unimproved streams.

(10) Bank Erosion. Includes loss of land and replacement of rock revetments.

IV. SKAGIT RIVER BASIN

1. Basin Description. The Skagit River originates in British Columbia, Canada, and flows southwesterly about 163 miles to Skagit Bay. Total area of the drainage basin is 3,105 square miles, including 400 square miles in Canada. Most of this basin is in Skagit County and is bordered on the north by the Nooksack Basin, on the south by the Stillaguamish and Snohomish Basins, on the east by the Cascade Mountains, and on the west by Puget Sound. Three hydropower dams on the Skagit River just above Newhalem regulate riverflows from 36 percent of the drainage basin above Concrete. Ross Reservoir has sufficient flood control storage to have a significant effect on flooding, but Gorge and Diablo Reservoirs are used only for power generation. The Sauk River enters the Skagit River 10.7 miles above Concrete and the Baker River enters the Skagit River at Concrete. Two hydropower dams on the Baker River regulate streamflows and provide some flood control from nearly all of the Baker River Basin which amounts to 11 percent of the Skagit River drainage above Concrete. About 3 miles downstream from Mount Vernon, the river divides and discharges through two distributaries of almost equal length, the North and South Forks. The land between the Forks is known as Fir Island. Numerous sloughs occur at the mouths of the North and South Forks. The flood plain is crossed by two railroads which serve as levee embankments where they are close to the river. The Skagit Basin has a diversified economic base made up of agriculture, forest products, fisheries, food processing, oil refining, and chemical industries. The largest farming area lies west of Sedro Woolley. Forest resources provide logs that are trucked to pulp and lumber mills in Anacortes, Everett, and Bellingham. Large migratory runs of salmon and steelhead provide a significant sport and commercial fishery resource.

2. Existing Flood Damage Reduction Improvements. Flood damage reduction structures include levees on the lower Skagit River, Ross Dam on the upper Skagit, and Upper Baker Dam on the Baker River.

a. Sixteen diking districts maintain about 56 miles of levees and 39 miles of sea dikes on the lower 21 miles of the Skagit and Samish Rivers which afford protection from floodflows from 3- to 14-year recurrence intervals. The entire city of Burlington relies on levees for flood protection. Hamilton, Conway, west Mount Vernon, the central business district of Mount Vernon, and residential areas to the south also are protected by levees.

b. Ross Reservoir is formed by a concrete arch dam completed to elevation 1615 in 1949. The reservoir has just over 1 million acre-feet of usable storage with 120,000 acre-feet between elevations 1592.0 and 1602.5 reserved for flood control storage. Flood storage is used when the discharge at Concrete is forecast to exceed 90,000 c.f.s. The effectiveness of the storage in reducing peak discharges at Concrete depends on the location of the storm center and runoff characteristics of the uncontrolled Sauk River.

c. Baker Lake is formed by the concrete gravity Upper Baker Dam, completed in June 1959. The lake has about 221,000 acre-feet of usable storage with 16,000 acre-feet reserved for lost channel storage replacement. An additional 84,000 acre-feet of flood control storage may be requested by the U.S. Army Corps of Engineers at the Upper Baker Reservoir provided Puget Sound Power and Light Company (PSP&L) is compensated for power losses incurred.

3. Runoff and Flow Characteristics. High water is experienced each year from snowmelt during the spring and early summer; however, the rise is relatively slow and of long duration and does not reach the major-damage stage. Major floods are caused by a series of rainstorms that move across the basin from the Pacific Ocean during the winter. Flows on the Skagit River originate from elevations near 7,000 feet in the Cascades above Newhalem and drop 7 feet per mile along the river to Concrete, then about 4 feet per mile to Sedro Woolley. Flows on the Sauk River originate at elevations near 9,000 feet and fall about 89 feet per mile above Darrington and 11 feet per mile near Sauk before entering the Skagit River. The high stream slopes above Concrete cause the discharge hydrograph to be characterized by a quick rise with a pronounced crest and fairly rapid recession to zero damage. Flood control storage releases from upstream reservoirs tend to hold discharges near zero damage after a storm. Fluctuations in river discharges dampen-out below Concrete because of routing effects, so the discharge hydrograph at Mount Vernon rises slower and has a broader crest than at Concrete. High streamflows that combine with high tides cause highwater along the Skagit River below Mount Vernon.

4. Floodflows. Streamflows along the Skagit River during the flood are reported from four U.S. Geological Survey (USGC) streamgage stations; "Ross Reservoir near Newhalem," "Skagit River near Newhalem," "Skagit River near Concrete," and "Skagit River near Mount Vernon." Storm streamflows along the Baker River are discussed in the paragraph on Baker River.

a. Ross Dam. Steady increases in Skagit River inflow to Ross Dam near Newhalem began early on 1 December. On 2 December, at 12:30 p.m., the Seattle District, Corps of Engineers, received a telephone call from the National Weather Service (NWS) providing a forecast that the Skagit River discharge would exceed 90,000 c.f.s. at Concrete by 4:00 p.m. on 2 December. At 12:40 p.m. on 2 December, the Corps of Engineers called Seattle City Light requesting that Ross Dam outflow be reduced to 5,000 c.f.s. mean power discharge. This request was according to flood control regulation details for use of storage allocated in Ross Reservoir, as specified in Article 36 of the city of Seattle's license from the Federal Power Commission (FPC). Skagit River reached

90,000 c.f.s. at Concrete on 2 December at about 7 p.m. - 3 hours later than the forecast. Inflow to the dam peaked at 32,000 c.f.s. on 4 December at about 5 a.m. Skagit River receded below 90,000 c.f.s. at Concrete on 4 December at about 7:30 p.m. At 8:15 p.m. on 4 December, the Corps of Engineers notified Seattle City Light that discharges should be increased from Ross Dam because Skagit River discharge had receded below the control flow at Concrete. Project outflow was increased to 10,000 c.f.s. the evening of 4 December and increased again to 21,000 c.f.s. on the morning of 5 December while the inflow receded. At about 11 a.m. on 5 December, inflow finally dropped below outflow, and a maximum reservoir elevation of 1601.04 was reached (city of Seattle Ross Dam datum). The peak ended a reservoir rise averaging 3 feet per day. Storage of 104,000 acre-feet was used to control flood runoff, representing 87 percent of the allocated flood control storage of 120,000 acre-feet. Project outflow was maintained between 21,000 c.f.s. and 26,000 c.f.s. for the next 4 days to regain the reservoir space allocated to flood control. The rate of fall in reservoir level averaged 2.4 feet per day during this period. On the morning of 9 December, the reservoir reached flood control elevation 1592 feet and project outflow was reduced to pass inflow which had receded to a more usual flow magnitude. Without flood control regulation by Ross Dam the flood peak on the Skagit River near Concrete would have been about 39.5 feet (143,000 c.f.s.) 2.6 feet higher than the observed peak. Streamflows and reservoir stage at Ross Dam are shown on plate 10 for 1 through 10 December.

b. Baker River. Inflow to Upper Baker Dam began increasing at about noon on 1 December when Baker Lake was at elevation 704.83, 19.17 feet below full pool, and Lake Shannon was at elevation 437.07, 1.53 feet below full pool. At 2 a.m. on 2 December, Lake Shannon reached full pool and outflow was adjusted to nearly pass inflow until 4 December. Outflow from Baker Lake was maintained at 5,100 c.f.s. for flood control as confirmed by telephone communication between the Corps of Engineers and PSP&L on the afternoon of 2 December. Inflow to Baker Lake continued to increase and peaked about midnight on 3 December at about 25,000 c.f.s. Outflow from Baker Lake was increased to 10,100 c.f.s. at 10 p.m. on 3 December with the rising inflow. Outflow from Lake Shannon also continued to increase late on 3 December with rising inflow resulting in a peak discharge on Baker River at Concrete of 24,800 c.f.s. at 5:45 a.m. on 4 December. Inflow to Baker Lake quickly receded on 4 December dropping to below outflow at 10 a.m. when a maximum pool elevation 717.2 was reached. Storage used at Baker Lake during the 3-day period amounted to about 53,900 acre-feet. This is 37,900 acre-feet stored by PLS&L in the interest of flood control beyond that required for channel storage replacement. Without regulation by the Baker Project, the peak at Concrete would have been about 37.5 feet (127,500 c.f.s.), .6 foot higher than the observed peak.

c. Concrete. Skagit River level near Concrete, 51 miles downstream from Ross Dam, began rising late in the evening of 1 December. The river rose .6 foot per hour and reached zero-damage stage of 27.5 feet at 6 a.m. on 2 December. The rate of rise slowed to .3 foot per hour, and the river reached its first crest of 36.0 feet at 9 a.m. on 3 December. The river was falling slowly when more rainfall caused another rising trend of .3 foot per hour until the river reached its highest crest of 36.9 feet (122,000 c.f.s.) at 6:30 a.m. on 4 December, 4.6 feet above major-damage stage and 1-1/2 hours after the inflow to Ross Dam peaked. The river receded at .5 foot per hour, then leveled out at about 82,000 c.f.s. for about 5 hours on the morning of 5 December as increases in Ross Dam outflow arrived at Concrete. The river receded again at .5 foot per hour to below zero-damage stage at noon on 5 December. River levels remained near zero-damage for the next 4 days until Ross Reservoir returned to its flood control pool elevation on 9 December. The river was above zero-damage stage for 78 hours and above major-damage stage for 48 hours. Without flood control regulation by Ross Dam and the Baker River Projects, the flood peak would have been about 39.9 feet (147,000 c.f.s.), 3.0 feet higher than the obserserved peak. Streamflows near Concrete are shown on plate 11 for 1-10 December. The 4 December flood peak on the Skagit River near Concrete is the third highest peak since 1940, when Ross Dam was under construction. The recurrence interval is estimated at 7 years for this flood peak near Concrete.

d. Mount Vernon. Skagit River level near Mount Vernon, 38 miles downstream from Concrete, began rising late in the evening of 1 December. The river rose .4 foot per hour and reached zero-damage stage of 27.6 feet at 6 p.m. on 2 December. The rate of rise slowed to .3 foot per hour until the afternoon of 3 December. Instead of the river level falling, as observed at Concrete, the level slowed to a steady rise of about .1 foot per hour for another day. The river crested at 35.7 feet (129,200 c.f.s.) at 7:30 p.m. on 4 December, 5.6 feet above major-damage stage and 13 hours after the peak near Concrete. The river receded at .2 foot per hour to below zero-damage stage at 9 a.m. on 6 December. The river was above zero-damage stage for 87 hours and above major-damage stage for 67 hours. The river remained below zero-damage stage for the rest of the winter season. Streamflows near Mount Vernon are shown on plate 12 for the period 1-8 December. The 4 December flood peak on the Skagit River near Mount Vernon is the second highest peak of record, 1941-76, exceeded only by the 11 February 1951 peak of 36.8 feet (144,000 c.f.s.). The recurrence interval for this year's flood peak near Mount Vernon is estimated at 10 years.

5. Flood Damages. Skagit River flood damages were $3,247,000. Damages would have been much greater without a successful flood-fighting effort on the diking system along the lower Skagit River. Damages prevented by flood fighting were estimated at $8.7 million. Flood-affected cities on the Skagit and their 1976 populations are:

Mount Vernon (10,300), Sedro Woolley (5,260), Burlington (3,400), Concrete (590), Lyman (325), and Hamilton (223). Total residential damages of $899,000 were highest at Hamilton, west Mount Vernon, and Cascade River Park. Approximately 210 residential and vacation dwellings and 220 appurtenant structures were damaged during the flood. Agricultural damages totaled $309,000 and included losses of land, crops, and livestock and damage to more than 50 farm buildings. Most of the 7 ?00 acres of flooded agricultural land were in the Nookachamps drainage area and east of Sedro Woolley (upper Skagit River). Much of the flooded land was in hay and pasture. Emergency aid damages totaled $729,000, of which $310,000 was used to repair flood protective works and $397,000 was used for flood fighting. The remaining $22,000 covered refugee aid and temporary housing for 83 families. Total damages on the Skagit River Basin by category are summarized in table 3. Skagit County was declared a disaster area by the President of the United States on 13 December 1975.

6. Flood-Fight Activities. Thirty-seven Corps of Engineers personnel, in conjunction with the County Engineer's office and the Department of Emergency Services, directed the flood-fighting activities and provided technical assistance to Skagit County, cities of Hamilton, Burlington, and Mount Vernon, and many hundreds of residents. The Corp of Engineers rented 60 items of heavy equipment and used 170,000 sandbags and 16,640 tons of rockfill. Seattle District spent $397,000, but $8.7 million in damages were prevented by the flood fight. Flood-fight activities are discussed in the following paragraphs, beginning at Newhalem and proceeding downstream.

a. Newhalem to Sedro Woolley. A 300-foot-long berm was constructed on a county road at the Shangri La area, river mile (R.M.) 41.5. The berm was 6 feet high and 12 feet wide at the top and effectively protected the town of Hamilton and approximately 500 acres of native pastureland. At Hamilton, R.M. 40 to 40.5, a sand and gravel berm was placed along the riverside of East Hamilton Road for about 2,000 feet upstream of the Hamilton levee. Raising of Cockreham Island levee, R.M. 38.4 to 39.1, began on 2 December, but was discontinued as the fast-rising river overtopped the entire length and caused about six breaks.

b. Mount Vernon to Sedro Woolley, Right Bank. A ring dike was constructed against the Burlington Northern Railroad (BNRR) embankment in the Sterling Road area, R.M. 20.8, to contain the discharge from a buried culvert that was flushed out by high-pressure flood waters. The river was prevented from entering the Burlington Sewage Treatment Plant, R.M. 19.5, by lowering a metal plate down a manhole near the river to block the outfall. An area near Whitmarsh Road, R.M. 18.5, was contained by raising an access road about 3 feet. Ring dikes were placed along several hundred feet of BNRR embankment adjacent to Whitmarsh Road at R.M. 18, where the railroad embankment serves as the levee. Ring dikes also were installed in the George Hopper Road area to contain numerous seepages and boils along the toe of the fill.

c. Mount Vernon to Sedro Woolley, Left Bank. Water was ponded in Fahn's field, R.M. 17, with sandbags and a gravel berm along a county road to build up a 2-foot head to help slow seepage and provide some weight to a field where blowouts have occurred in the past. A large ring dike was constructed in a low area near the buildings at the Anacortes City Water Treatment Plant, R.M. 15, to control many boils and weigh the blistering sod. A total of 24,600 sandbags were placed by city of Anacortes personnel and equipment and about 280 personnel from Whidbey Island Naval Air Station. A cutoff dike was constructed with sandbags on 5 December to pond water over a blistered area in front of the treatment plant.

d. Mount Vernon to North Fork Mouth. Approximately 9,000 sandbags were used to weigh the toe and back slope of the levee near Baker Street, R.M. 12.8, and to build several ring dikes to contain numerous boils in four backyards. A sandbag mattress was built with 10,000 sandbags to contain multiple-pressure domes and seepage along the base of the levee at Kamb Road and Beaver Marsh Road, R.M. 7 to 8.5. A sand berm 850 feet long and 7 feet high was built to prevent overtopping at the south end of Bradshaw Road, R.M. 6. A sandbag wall 710 feet long and 2 feet high was built to prevent overtopping at Al's Landing Road, R.M. 4.6.

e. Mount Vernon to South Fork Mouth. A ring dike was built around a boil area of a concrete bulkhead at R.M. 12.2 that is on the inside of a railroad embankment and that protects a major portion of Mount Vernon. A sandbag wall 1,900 feet long and 3 to 4 feet high was erected in the city parking area along the left bank of the river at Mount Vernon. A sandbag spur dike was placed on an old dike just south of the Mount Vernon sewer plant, R.M. 11.5, to prevent the river current from eroding the sod-covered main dike. The dike failed between the Fisher Slough tide gates and BNRR at R.M. 4.5 of the South Fork. Closure of the break required the use of trucks to haul rock and sand for sandbagging operations. The Highway Department repaved undermined roads and shoulders to the Conway-Stanwood Road. Sandbags also were used to stop overtopping of low areas at the Fisher Slough Dike until heavier equipment could make repairs to soft spots and undercut areas.

f. Fir Island. Flood-fighting efforts used 13,300 sandbags to prevent overtopping and seepage at various locations near the confluence of the North and South Forks and downstream about 3 miles on both Forks. A gravel filter berm also was placed along the landward toe of the levee where seepage was the greatest. Helicopters took sandbags into areas where access roads were impassable.

TABLE 3

Summary of Damages by Category
December 1975 and January 1976 Floods

RIVER BASINS

Snohomish 1/

ohomish	Snoqualmie	Skykomish	Cedar	Green	Puyallup	Nisqually	Chehalis	Yakima
039,000	$375,000	$425,000	$648,000	$1,000	$124,000	$85,000	$722,000	$129,000
320,000	119,000	27,000	30,000	4,000	0	11,000	269,000	83,000
388,000	35,000	2,000	18,000	1,000	0	0	51,000	5,000
60,000	80,000	34,000	14,000	15,000	2,000	9,000	48,000	18,000
46,000	2,000	0	188,000	4,000	0	11,000	152,000	3,000
537,000	760,000	125,000	2,000	3,000	2,000	0	437,000	76,000
935,000	293,000	23,000	95,000	6,000	49,000	30,000	777,000	96,000
338,000	7,000	1,000	121,000	2,000	2,000	2,000	1,000	2,057,000
609,000	516,000	142,000	1,144,000	154,000	228,000	79,000	165,000	926,000
500,000	172,000	250,000	90,000	3,000	1,000	35,000	403,000	29,000
772,000	$2,359,000	$1,029,000	$2,350,000	$193,000	$408,000	$262,000	$3,025,000	$3,422,000

1 Skykomish Rivers.

P004