NPSGP
Subject: Report on Skagit River Flood, 27 - 29 November 1949

discharges by about 25,000 second-feet. The actual crest was near the top of most of the levee system and an additional 5,000 second-feet would have caused major failure of the levees.

5 Incls: (in trip.)
1. Marked aerial print
~~6-6-56~~
2. Skagit River Picture No. 1
3. Picture No. 2
4. Picture No. 5
5. Pictures Nos. 6&7

E. C. ITSCHNER
Colonel, Corps of Engineers
District Engineer

Le Staff File

cc: Steinborn

S.S.
~~Steinborn~~
~~Clark~~
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Gulbridge
~~Little~~
~~Brown~~ B
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~~Symmes~~
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SUBJECT: Report on Skagit River Flood, 27 - 29 November 1949

TO: Division Engineer
North Pacific Division
Corps of Engineers
500 Pittock Block
Portland 5, Oregon

1. Authority. - The following report on the Skagit River flood of 27 - 29 November 1949 is submitted in compliance with paragraph 4223.05 d of Orders and Regulations.

2. Meteorology. - Precipitation during the month of October was below normal over the Skagit Basin with no snow accumulation below elevation 5,000 feet. Starting 8 November, steady precipitation fell over the basin through 14 November. During the period 8 - 12 November, the precipitation was light to moderate, falling as snow above elevation 3,500 feet. Heavy rains fell from 12 - 14 November, accompanied by rising temperatures, removing all snow on the ground up to 4,500 feet. The rains subsided and became light and showery from the 15th through 21st of the month. On 22 November a stationary low pressure center began deepening in the North Pacific with frontal systems moving out of the low toward the coast. Precipitation became light and steady on 22 November over western Washington and British Columbia. By the 25th, the low center in the Pacific had become deep and intense, located approximately at latitude 50°, longitude 158°, and was moving slowly northeastward. A cold front was moving through western Washington causing moderate rains. The low pressure center was most intense during the 26th and a well defined frontal system moved over western Washington causing gale winds and continued moderate to heavy rains. The frontal system brought a large influx of warm air which caused much convective activity with precipitation falling as rain up to elevations of 5,000 feet. By the 27th, the low pressure area was filling, the cold front of the frontal system had passed into eastern Washington, and the precipitation moderated through the end of the month, falling as snow above 3,500 feet. Precipitation increased with elevation and was heaviest on 26 November with 24-hour precipitation of 2.85 inches at Concrete, elevation 270 feet; 4.21 inches at Skagit Power

Plant (near Newhalem), elevation 505 feet; and 5.75 inches at Mt. Baker Lodge, elevation 4,150 feet. The total precipitation falling during the 54-hour period from 12:00 midnight 25 November to 6:00 a.m. 28 November (the most intense part of the storm), was 3.5 inches at Concrete, 5.5 inches at Skagit Power Plant, and 6.52 inches at Mt. Baker Lodge.

3. Hydrology. - As a result of the precipitation occurring 8 through 21 November, soil moisture was above normal throughout the Skagit Basin. This precipitation caused a minor peak to occur on the lower Skagit River on 14 November. However, the flow receded to slightly above the November average before the flood-producing precipitation occurred. The discharge of Skagit River near Concrete was approximately 10,000 second-feet on 22 November which was comparable to the normal November flow. Skagit River near Concrete rose from a flow of 30,000 second-feet to a peak of 158,000 second-feet (noon 27 November) in approximately 24 hours. Skagit River near Mount Vernon, on the lower river, rose from 40,000 second-feet to a peak of 112,000 second-feet (3:00 a.m. 28 November) in a 31-hour period. The reduction of peak discharge between the upper station, near Concrete, and the lower station, near Mount Vernon, is the result of valley storage. Interruption of secondary highway travel on some of the lower valley roads begins when Skagit River flows reach about 67,000 second-feet near Mount Vernon. The river was above this discharge for about 40 hours.

4. The Skagit River crest discharge of 158,000 second-feet near Concrete is the maximum observed since 13 December 1921 when an unregulated crest discharge of 240,000 second-feet was recorded.

5. Flood Fighting Activities - On 28 November 1949 personnel from the Seattle District were dispatched to flooded areas on Skagit River in response to requests for assistance from local interests. The representatives furnished technical assistance and supervision to previously organized civilians, National Guardsmen, a detail of soldiers from Fort Casey and a Navy contingent of about 50 men from the Whidby Island Naval Air Station. Military and Naval personnel assisted County employees in strengthening sloughing and seeping levees, in controlling sand boils by constructing sandbag rings, and in constructing sandbag dikes. County equipment was used in this work. The Master and eight members of the U. S. Pipeline Dredge SWINOMISH assisted local citizens in placing sandbags to strengthen a threatened levee on the north fork of Skagit River. Ten thousand sandbags were dispatched to the area to provide a reserve in the event the local supply proved insufficient. Because the river stage dropped suddenly the sandbags were not needed.

Seattle District costs for flood fighting activities are estimated as follows:

Transportation	$300
Pay rolls & per diem	550
District overhead	50
	$900

Personnel involved in flood fighting activities are estimated as follows:

Military and naval personnel	160
Washington State National Guardsmen	168
Local civilian personnel	2,500
Seattle District, Engineering Division	1
" " Operations "	11
" " Supply "	5
Total	2,845

6. Flood Observations. - An observer from the Seattle District, Engineering Division, was in the flood area before the flood crested and for about 33 hours thereafter. The observer was the project engineer for the current review survey for flood control on Skagit River and his findings will be used in the studies he is directing. The observer also served as liaison with Operations Division personnel in the field and with local interests seeking assistance from the Corps of Engineers.

7. Flood Damage. - The damage reported herein was compiled from reports by District personnel in the field at the time of the flood or immediately thereafter. Damage is estimated at about $467,000. No lives were lost because of the flood. An estimated breakdown of the total damage is given in the following tabulation:

Item		Damage
Flood fighting		$29,000 (cost)
Land - 14,800 acres flooded; crops, clean-up, fences, and private bridges		93,000
Buildings:		
Farm	$150,000	
Town of Hamilton	51,000	201,000
Railroad - Great Northern Railway		
Repairs and detour costs		29,000
Wire lines:		
Power	$4,000	
Telephone	6,000	10,000

Livestock	2,000
Refugees - added cost of living away from home for 400 persons	2,000
Levees - replacing damaged parts; exclusive of flood fighting	23,000
Subtotal	$389,000
Additional 20 percent to cover items not included or underestimated	78,000
	$467,000

a. Highways Out of Service. - State highway 1-A above Sedro-Woolley was blocked in the morning of 27 November; Clear Lake - Sedro-Woolley highway closed in the afternoon of 27 November; Mount Vernon - Stanwood highway below Conway closed in the evening of 27 November by break in railroad fill; and numerous secondary roads in flooded areas or immediately adjacent to levees were closed.

b. Railroads Out of Service. - Great Northern main line washed out just south of Conway. Traffic rerouted over Northern Pacific line tracks to Burlington and Mount Vernon. Break repaired by 30 November.

8. Operation of existing levees. - All levees in the flood plain were built and are fairly well maintained by local interests. Flooding within the levee system occurred in four areas as the levees proved inadequate because of insufficient height and cross section. The inclosed marked aerial map shows the location of each of the four areas, extent of approximate flooding and indicates the location and type of flood-fighting operation. A brief description of each failure is given in the following paragraphs:

a. District No. 15. - Flood waters breached the levee along the north fork of Skagit River protecting District No. 15 and inundated approximately 900 acres of cultivated farm land; the impounded waters overtopped the tidewater levee along Hall Slough causing five breaks, and breached the Skagit Bay tidewater levee at two locations. The inclosed photographs Nos. 1 and 2 show the flooded area and breaks in the levee near Skagit Bay.

b. Hall Slough levee, District No. 21 - The impounded flood waters in District No. 15 passing through the breaks in its Hall Slough levee caused overtopping of the District No. 21 Hall Slough levee along a 1,500-foot length, which flooded 200 acres to shallow depths. This overtopping continued for 4 hours with the depth of water on the crest reaching a maximum of about one foot. The overtopped section varied in height from 5 to 7 feet above the landward toe and had a good sod

cover. No appreciable damage to the levee occurred - Skagit Pictures Nos. 6 and 7 show the levee during and after overtopping.

The impounded flood waters in District No. 15, passing through the break near Skagit Bay impinged directly against a tidewater levee protecting District No. 21. This condition is shown on inclosed photograph Skagit River Picture No. 1. Erosion caused destruction of 450 feet of levee, thereby exposing 400 acres of land to inundation by high tides; emergency flood-fighting crews replaced the destroyed section of levee with sandbags. This sandbag levee was effective in preventing saltwater inundation of the area from high tides on Skagit Bay.

c. Dodge Valley road. - Along the right bank of the north fork of Skagit River a levee protecting approximately 60 acres of cultivated farm land was breached at two locations. The total length of the breaks was about 340 feet. Flood waters inundated the 60 acres but were stopped by a county road reinforced by day-and-night flood-fighting operations during a 3-day period. If the flood waters had not been held at the county road, more than 1,000 acres of farm land with farm residences would have been flooded, resulting in severe damage.

d. Mill Town levee, District No. 16 - District No. 16 is protected by a low levee of inadequate cross section and height, constructed along the left bank of Steamboat Slough. For a total of 1-1/2 miles this levee is paralleled by the main line of the Great Northern Railroad. Local interests have depended upon this railroad fill for protection and have not maintained the river levee. During the recent flood, the river levee was overtopped and destroyed in many sections and flood waters easily seeped through the railroad fill, causing severe piping which resulted in a 170-foot break. The inclosed photograph, Skagit River picture No. 5, shows this area and is marked to indicate the location of the break in the railroad fill. As a result of this break approximately 1,600 acres of cultivated farm lands with farm residences were inundated. Emergency flood-fighting operations prevented further flooding by sandbagging operations along an old cross dike about one-half mile north of Mill Town.

9. Operation of Existing Reservoirs. - The City of Seattle operates the Ross and Diablo power dams on the upper Skagit River. Puget Sound Power and Light Company operates a dam on Baker River, (a tributary of the Skagit), that controls storage in Shannon Lake. Diablo and Shannon reservoirs, with usable power storage of 76,000 and 132,000 acre-feet respectively, had little or no effect on the flood because of their

high pool level prior to the flood. Ross reservoir with a usable power capacity of 1,203,000 acre-feet had only 900,000 acre-feet in storage prior to the flood so was able to store the entire flood flow for 5 days. This storage was principally in the interests of power. The peak inflow into Ross reservoir was estimated at 52,000 second-feet with the outflow reduced to zero. A total of 1.4,000 acre-feet was stored in the reservoir in the 5-day flood period. Because of timing and valley storage the estimated reduction of the flood peak at Mt. Vernon affected by the storage at Ross is estimated at 25,000 second-feet.

10. Recommended Restoration Work. - Immediately following the subject flood, a representative of the Seattle District visited the flooded area at the request of Congressman Henry M. Jackson and the Board of County Commissioners for Skagit County. The inspection revealed that the existing levee systems were destroyed or severely damaged in 4 areas as described in paragraph 8 preceding. These areas are further described in a letter from this office to the North Pacific Division Engineer dated 21 December 1949, subject: "Emergency Flood Control problems along Skagit River, Washington." Two of these areas (8a and 8b) have already received emergency assistance; one by the Federal Government and the other by local interests. The work to be accomplished in the remaining two areas is summarized as follows:

a. Dodge Valley Road. - It is proposed to place an impervious blanket on the river side of this road and to raise the road approximately 3 feet. The total cost of this work to the Government would be about $12,000.

b. Mill Town Levee, District 16. - Work proposed in District 16 is the reconstruction of a levee for about 1-1/4 miles. An estimated $60,000 of Federal funds would be required for this work.

11. The reference letter recommended that the proposed work be authorized under the provisions of Section 208 of the 1948 Flood Control Act, subject to statutory requirements of local cooperation.

12. Summary. - Flooding in the Skagit delta was the result of overtopping and breaching of levees. The instances of levee failure were generally attributable to inadequate design. Restoration and reconstruction works in the flood area estimated to cost $72,000 have been recommended in a previous letter to the North Pacific Division. These works will protect about 2,600 acres of farm land. The operation of the City of Seattle's Ross dam on the upper Skagit was principally in the interests of power but nevertheless reduced crest