UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

FLOODS OF 1956 IN THE ESQUATZEL COULEE AREA IN WASHINGTON

by

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Prepared in cooperation with the
U. S. Bureau of Reclamation

Open file report

57-3

Tacoma, Washington
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PREFACE

This report was prepared at the request of the U. S. Bureau of Reclamation, Ephrata, Washington, by the Tacoma district of the Water Resources Division, U. S. Geological Survey under the supervision of F. M. Veatch, District Engineer and the general supervision of J. V. B. Wells, Chief, Surface Water Branch.

The U. S. Bureau of Reclamation, Ephrata office, furnished most of the funds for completing the report, the remainder being supplied by the U. S. Geological Survey. The Bureau also furnished a high-water profile of the Coulee for about 64 miles of its length, area-capacity curves for the sump into which the Coulee flows, a set of maps showing the area inundated by the flood water, and all of the photographs included in the report.

The U. S. Army Engineers, Walla Walla office, furnished precipitation data and an isoheyetal map for the area under consideration.

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ABSTRACT

As a result of heavy rains and snow falling on frozen ground, a flood occurred in the Esquatzel Coulee area on February 21-22, 1956, which, in Connell, was the greatest known since the town was settled in about 1888. Long-time residents of Connell report that the flood was much greater than the next highest ones, those of August 1907 and February 1949. Damage to municipal works, residential areas, and business property was estimated at more than a million dollars.

Three other noteworthy floods occurred in 1956 that are included in this report but none was as destructive as the February flood. On January 4 a minor flood occurred that in general was confined to the main channel. The flood of May 8 was severe in two small areas, one near Lind and the other near Connell. Some farms and the town of Connell were damaged by flood water. On July 2 an intense rain just east of Connell resulted in a small lake forming downtown but damage was considered negligible.

INTRODUCTION

The Esquatzel Coulee basin and surrounding area have been subjected to several damaging floods since the area was settled. These floods usually resulted from heavy or cloudburst type rains during the spring and summer months. However, snowmelt may have contributed considerably to the spring floods.

The principal area under consideration is the Esquatzel Coulee basin. The report also includes some data on the areas adjacent to this basin. Other drainages included are Weber and Lind Coulees to the north, Scooteney Reservoir to the west, and Washtucna and Smith Canyon to the east. Plate 1 shows the general features of the area.

The flood of February 1956 was caused by a heavy rain falling on frozen ground covered by varying amounts of snow. The greatest amount of precipitation measured was 1.57 inches on the hills just south of Lind. The high peak discharge in the upper part of Providence Coulee may have been affected somewhat by the washing out of a Northern Pacific Railway fill in the NE¼ NE¼ sec. 1, T. 16 N., R. 32 E. The flood reached the highest stage known along the channel from above Cunningham to the north edge of the Pasco airport where it terminated in a lake about one mile long in the sandy wasteland. This flood was general over the entire area covered by this report.

A second damaging flood occurred in the town of Connell, this time in May 1956, when the runoff from a cloudburst in sections 21 and 22 just east of town breached a low earth dam about one mile east of town. Only a part of the flood water was released but there was enough to flood the town. The dam was about 5 feet high and 300 feet long and had been constructed by a farmer about 20 years ago to flood the grain field behind the structure. At this same time a cloudburst occurred on the hills just south of Lind which flooded small drainages

and contributed a considerable amount of water to Providence Coulee. These floods were restricted to the local areas of occurrence and caused no damage after reaching the main Coulee channels.

The flood of January 4 resulted from general rains in the Esquatzel Coulee basin. It was not disasterous because all channels were capable of carrying the peak flows.

The last flood occurred on July 2 as a result of a cloudburst just east of Connell. This was the only area affected and resulted in negligible damage even though a small lake several inches deep formed in the business district.

The town of Connell has witnessed several floods in past years but 1956 will undoubtedly go down in history as the first and possibly the only year in which the town's business district was under water three times.

Peak discharges were determined at 43 sites for the two main flood events as shown on Plate 1. Sites 16, 31, and 39 are regular gaging stations. For the February flood 36 sites in addition to the gaging stations were selected to provide adequate coverage of the flood area. Four other sites were added in areas of excessive runoff after the May flood, making the total of 43 sites.

DESCRIPTION OF BASIN

The Esquatzel Coulee drainage basin is comprised of an area about 10 miles wide and 50 miles long lying between Lind, Adams County, and Pasco, Franklin County, in eastern Washington.

The Coulee, which is a dry stream channel most of the time, is called Esquatzel in the reach from its terminus, in the dry wasteland at the Pasco airport, upstream to Connell. At Connell the name changes to Providence and the Coulee is so known throughout the remainder of its length north and east of Connell.

Providence Coulee heads in the high ground, elevation 1,850 feet, about 3 miles south of Lind and travels in a generally southerly direction through the towns of Cunningham and Hatton. It picks up the second largest tributary in the basin, Hatton Coulee, about 2 miles below Hatton and continues south to complete its 30-mile journey from the headwaters to Connell. There, under the name of Esquatzel Coulee, the channel extends southwest to Mesa, then south about 3 miles to the confluence with its largest tributary, Old Maid Coulee, then on south through Eltopia to its end in a sandy sump, minimum elevation 375 feet, a few miles north of Pasco, a total distance of about 70 miles from its headwaters.

The climate is arid with hot summers and cold winters. The average annual precipitation is about 9.5 inches and the mean annual temperature 50 degrees. The driest months are July and August, each with about 0.2 inch of precipitation; and the wettest months are November and December with about 1.3 inches each month. The hottest recorded temperature at the weather station near Hatton is 112° F and the coldest is -30° F.

The total area draining to the sump is about 500 square miles. The channel becomes less steep about 5 miles downstream from Connell

and it also becomes more absorptive. The peak discharge for the February flood increased as the crest moved downstream to Connell and decreased from Connell to Pasco.

HISTORIC FLOOD DATA

The town of Connell, Washington was first settled about 1888 after the railroad was constructed between Spokane and Pasco. Connell became the trading center for nearby farms and at present has a population of about 850.

Information on past floods was obtained from several long-term residents of Connell. The different sources were in close agreement so it is believed that the major floods can be placed very nearly in their true relative order of magnitude. All were agreed that the flood of Feb. 21, 1956, peak discharge 5,560 cfs (cubic feet per second), was the largest known since the settlement began. The flood of August 1907 was generally thought to be the second largest, although some believed that the flood of February 1949 (1,760 cfs) was the second largest. The fourth largest is considered to be that of February 1906; fifth, that of Jan. 4, 1956 (1,470 cfs). Other floods mentioned were January 1905, February or March 1912, February 1916, 1919, May or June 1923, and 1951. Another flood occurred at Connell on May 8, 1956, (1,470 cfs) after the above information was obtained. From all of the information gathered, the flood of February 1956, is shown to be by far the largest since at least 1888. The U. S. Bureau of Reclamation has records obtained from the Northern Pacific Railway Company showing that floods

also occurred in Esquatzel Coulee January 1906, February 1907, January 1909, February 1913, January 1925, and February 1932. Discharge data are not available for these floods. Only the peak stages at various bridges were furnished.

A rather small amount of snow lay on frozen ground prior to the February 1956 peak. The ground was bare in some places but was covered to 5 inches elsewhere in the basin. The rain varied roughly between ½" and 1½" for this peak. None of these features appear exceptional in themselves but the combination was very real in producing a flood.

Heavy snows were reported to have occurred in other years as follows: in 1916 when snow was about 2½ feet deep, in 1919 when snow was slightly deeper, and in 1931 when snow was probably less than in 1916 but very deep. The flow that occurred during these snow runoff periods was controlled by moderate weather which produced diurnal fluctuations and prevented major flood proportions from being reached.

DESCRIPTION OF FLOODS

Flood of January 4, 1956

On January 4 a small flood occurred in Esquatzel Coulee that raised the stage nearly to the top of the banks at several locations but did no damage. The peak discharge increased from 333 cfs at Cunningham to 1,520 cfs at Connell, but by the time the crest reached Eltopia the discharge was only 126 cfs.

Two good photographs were obtained near gaging stations a few

hours after the crest of the flood.

Figure 1 is a photograph of Providence Coulee just upstream from the gaging station at Cunningham a few hours after the peak of the January 4 flood.

Figure 2 shows Esquatzel Coulee a few hundred feet upstream from the gaging station at Connell about 3 hours after the crest of the January 4 flood.

Flood of February 21-22, 1956

Snow and rain on frozen ground caused the great flood of February 21-22 in Providence and Esquatzel Coulees and adjacent drainage basins.

The ground was frozen to a depth of several inches by the cold weather which began on February 15. Table 1 shows extremely cold weather February 15-18 and temperatures well below freezing February 19-20.

Snow was a factor in this flood but its direct contribution to the peak discharge is very difficult to analyze. Table 2 shows the amount of snow on the ground at the U. S. Weather Bureau stations prior to the flood. The additional snow data listed, which were obtained from local residents, show very little snow on the ground just before the flood except on the higher ground just south of Lind in the headwaters of Providence Coulee.

Rainfall was the predominant factor causing the flood, not because the total fall was outstanding, but because practically all of it became surface runoff due to the frozen ground.

A view looking upstream of the flood waters passing under the County Road Bridge at Station 266 (Esquatzel Report). This view was taken from near the U.S.G.S. Gaging Station in Cunningham. The picture was taken a few hours after the flood had peaked on January 4, 1956.
USBR Photo P-222-117-36806 Jan. 4, 1956

Figure 1. Providence Coulee at Cunningham during the January flood.

A view of the flood waters looking south in Connell from the County Road Bridge at Station 1012 (Esquatzel Coulee). This picture was taken approximately 3 hours after the flood had peaked. Note the flood marks as indicated by the snow line.
USBR Photo P-222-117-36810 Jan. 4, 1956

Figure 2. Esquatzel Coulee (Providence Coulee) at Connell during the January flood.

Table 1.- Temperature data in Esquatzel Coulee area

Location on plate 2	Weather station	Elev. (in ft.)		February 1956									
				13	14	15	16	17	18	19	20	21	22
				Temperature in degrees Fahrenheit									
Y	Eltopia	925	Max:	40	41	32	22	22	25	35	40	41	38
			Min:	28	22	2	2	10	1	12	15	30	29
D	Hatton	1,358	Max:	39	38	32	21	29	25	35	45	41	38
			Min:	28	22	2	-1	13	8	13	25	32	32
Z	Kennewick	392	Max:				26	25	25	30	38	46	41
			Min:				7	15	12	15	18	33	32
S	Lind	1,625	Max:	38	36	33	18	22	27	34	39	39	38
			Min:	27	21	-1	-1	11	0	19	26	31	31
U	Othello	1,110	Max:	42	40	36	21	26	24	37	36	38	38
			Min:	31	25	3	2	10	7	15	17	31	29
X	Ruff	1,440	Max:	34	34	27	18	19	25	34	39	40	36
			Min:	21	19	2	-2	9	3	11	22	32	31

Table 2.- Snow data in Esquatzel Coulee area

Location on plate 2	Weather station	Elev. (in ft.)		February 1956							
				16	17	18	19	20	21	22	23
D	Hatton	1,358	Snowfall	0	3.0	0	0.5	0	0	T	2.0
			Snow on ground (inches)	0	3	2	2	0	0	0	T
Z	Kennewick	392	Snowfall	0	1.8	0	0.6	0	0	T	0.3
			Snow on ground (inches)	0	2	1	2	1	0	0	0
S	Lind	1,625	Snowfall	0	1.3	0	0.5	0	0	0	1.3
			Snow on ground (inches)	0	1	1	2	1	T	T	1

Information from local residents

	Elev. (in ft.)
Three inches of snow near Warden	1,300
Five inches of snow on hills south of Lind	1,800
Very little snow near Connell	850
One inch of wet snow in Lind	1,400
Snow about gone at Cunningham	1,200
Practically no snow at Hatton	1,100
No snow 8 miles east of Othello	1,200
No snow in Scooteney drainage	1,200

Plate 2 shows the sites at which precipitation data were obtained, the amount of rainfall measured at each site, and isohyets for the storm. The heaviest concentration occurred in the headwaters of Providence Coulee where 1.57 inches was measured.

Table 3 is a list of the locations where precipitation data were collected. It also shows the amount of rainfall, the time and dates it occurred, and the name of the person making the observation. A reference to the location on plate 2 is made also.

The peak discharge increased from 2,160 cfs at Cunningham to 5,560 cfs at Connell as the crest moved down the main channel. From Connell downstream the peak decreased to 2,740 cfs just before it entered the sump area near Pasco. The peak discharges are discussed further under the section on stages and discharges.

A railroad fill washed out just above site 13 near the head of Providence Coulee after it had ponded a considerable amount of water. The effect of the washout on the peak discharge in the lower Coulee is not known because of the timing of the tributary peak flows. The storing and sudden release of the flow must have increased the peak discharge in the upper part of Providence Coulee, but downstream from where the large tributary enters the channel just below Cunningham, the peak discharge may have been either increased or decreased.

The largest flow determined in this flood was 372 cfs per square mile at site 13 from an area of 7.53 square miles. Although this basin was in the area of heaviest precipitation the peak discharge undoubtedly was affected as described above.

Table 3.- Precipitation data in Esquatzel Coulee area

Index no. plate 2	Location	1956 Date	Time of rain Began	Time of rain Ended	Amount precip. in inches
A	Hart Farm, NE¼ sec. 11, T. 14 N., R. 32 E.	Feb. 21	6 pm Feb. 20	Morn. Feb. 21	1.00
B	Art, Johnson, NE¼ sec. 27, T. 15 N., R. 31 E.	Feb. 20 & 21	5 pm Feb. 20		1.15
C	P. W. Wright NE¼ sec. 26, T. 15 N., R. 33 E.	Feb. 21			.66
D	Mrs. Genevieve Gehres SW¼ sec. 22, T. 15 N., R. 33 E.	Feb. 20 & 21	7 pm Feb. 20	2:30 pm Feb. 21	.96
E	Mr. E. C. Loeber NE¼ sec. 14, T. 13 N., R. 31 E.	Feb. 20 & 21	6 pm Feb. 20	3 pm Feb. 21	.91
F	Mr. Ludwig Grassl SW¼ sec. 24, T. 12 N., R. 32 E.	Feb. 21	7 pm Feb. 20	3 pm Feb. 21	.74
G	Mr. Lester Smith Center sec. 24, T. 12 N., R. 33 E.	Feb. 20	6 pm Feb. 20	9 pm Feb. 21	1.10
H	Mr. Elton Largent SE¼ sec. 7, T. 13 N., R. 34 E.	Feb. 20 & 21	1 am Feb. 20	4 pm Feb. 21	.92
J	Mr. Ralph Watson NE¼ sec. 12, T. 14 N., R. 33 E.	Feb. 20 & 21	Eve. Feb. 20	3 pm Feb. 21	.91
K	Mr. Oliver Dilling W½ sec. 20, T. 14 N., R. 31 E.	Feb. 20 & 21	5 am Feb. 20	2 pm Feb. 21	1.01
L	Mr. G. W. Kliphardt NE¼ sec. 26, T. 16 N., R. 30 E.	Feb. 20			.80
M	Mr. L. D. Lyle S½ sec. 11, T. 15 N., R. 31 E.	Feb. 20 & 21	8:30 pm Feb. 20	4 pm Feb. 21	1.10
N	Mr. F. S. Damon N½ sec. 4 T. 15 N., R. 32 E.	Feb. 20 & 21	5 am Feb. 20	2 pm Feb. 21	1.25

Table 3.- Precipitation data in Esquatzel Coulee area-- Continued

Index no. plate 2	Location	1956 Date	Time of rain Began	Time of rain Ended	Amount precip. in inches
O	Mr. Warren Stine Center sec. 34, T. 14 N., R. 32 E.	Feb. 20 & 21	7 pm Feb. 20	7 pm Feb. 21	1.08
P	Mr. W. R. Paslay N½ sec. 2, T. 15 N., R. 34 E.	Feb. 20	7 pm Feb. 20		1.00
Q	Mr. Chester Smith NW¼ sec. 9, T. 16 N., R. 35 E.	Feb. 20 & 21	2 pm Feb. 19	12:00 NOON Feb. 21	1.50
R	Mr. Floyd Maier NE¼ sec. 33, T. 17 N., R. 33 E.	Feb. 20 & 21			1.57
S	Dryland Experiment SE¼ sec. 32, T. 18 N., R. 34 E.	Feb. 20 & 21	9 am Feb. 20	1:30 pm Feb. 21	1.12
T	Mr. R. J. Knodel S½ sec. 19, T. 17 N., R. 35 E.	Feb. 20 & 21			1.53
U	Bureau of Reclam. Othello, N½ Sec. 3, T. 15 N., R. 29 E.	Feb. 21	Midnite Feb. 20	Noon Feb. 21	.69
V	Ritzville N½ sec. 23, T. 19 N., R. 35 E.	Feb. 20 & 21			.71
W	Mrs. Kleinbach Sec. 23, T. 15 N., R. 30 E.	Feb. 21			.88
X	Ruff Sec. 9, T. 19 N., R. 30 E.	Feb. 21			.50
Y	Eltopia Sec. 2, T. 11 N., R. 29 E.	Feb. 21			1.03
Z	Kennewick Sec. 36, T. 9 N., R. 29 E.	Feb. 21			.70

Note: All precipitation measured in standard 8" rain gage.

The next highest peak discharge was 287 cfs per square mile from an area of 0.21 square miles just south of Lind, and the third highest was 243 cfs per square mile from a 2.74-square mile area about 4 miles northeast of Cunningham.

A very small amount of flow entered Connell from the east during this flood. A peak discharge of 30 cfs was estimated for this inflow.

Several pictures of the flood were taken just before and after the peak. Figures 2 and 3 give a good comparison of the January and February flood stages.

Figure 3 is a photograph of Esquatzel Coulee at Connell taken during the February flood from about the same location as Figure 2.

Figures 4 and 5 show the town of Connell during the February flood. Figure 4 is a downstream view showing State Highway 11-A in the foreground. Figure 5 shows the same grain elevator but is an upstream view taken from a point about 1,800 feet downstream from State Highway 11-A.

Figure 6 shows the road fill at Eltopia damaged by Esquatzel Coulee flood water on February 22. The picture was taken about 9 hours after the flood had peaked.

The stream channels in the adjacent basins to the east and west of Esquatzel Coulee carried the flood flows without a great deal of damage occurring. The water ran over the roads at some small bridges and culverts but this occurred in the lesser populated areas.

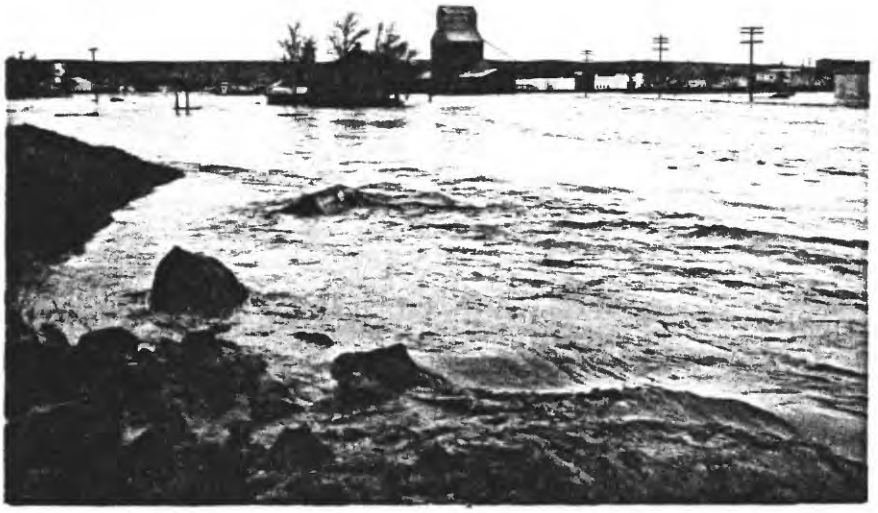
Lind and Weber Coulees to the north of Esquatzel Coulee were quite hard hit by the flood. Although the flood flow was confined

A view of the floodwaters at Connell looking south from State Highway 11-A crossing of Providence Coulee. The floodwaters have completely obscured the natural channel which passes beneath the two bridges shown near the center of the picture. USBR Photo P-222-117-36908 11:30 a.m. Feb. 21, 1956

Figure 3. Esquatzel Coulee (Providence Coulee) at Connell during the February flood.

A view looking southwest toward the town of Connell showing floodwaters at State Highway 11-A Crossing of Providence Coulee. This bridge is located at Station 1012 (Esquatzel Report). Note the floodwaters have entirely covered the Northern Pacific Railway tracks indicated by the crossing sign at the left approach to the bridge and the next bridge downstream.
USBR Photo P-222-117-36907 11:30 a.m. Feb. 21, 1956

Figure 4. Flood Scene in Connell during the February flood.



A view of the floodwaters looking northeast toward the town of Connell. This picture was taken near Station 1030 (Esquatzel Report). The natural channel, which was completely inundated, lies between the large house and the grain elevator shown in the center of the photograph.
USBR Photo P-222-117-36916 11:30 a.m. Feb. 21, 1956

Figure 5. Flood scene in Connell during the February flood.

A view of the County Road Bridge and washed out approach near Station 760 (Esquatzel Report) at Eltopia. This photograph was taken approximately 9 hours after the flood had peaked at Eltopia. The Main Line track of the Northern Pacific Railway can be seen in the right background.
USBR Photo P-222-117-36950 9:00 a.m. Feb. 22, 1956

Figure 6. Esquatzel Coulee at Eltopia during the February flood.

within the banks of Lind Coulee in the town of Lind, the sidehill run-off was very great. Lind Coulee flooded the highway about 3 miles north of Warden for several hours. Weber Coulee flooded U. S. Highway 10 about 11 miles due north of Warden. In this same area the Northern Pacific Railway was under water and the roadbed washed out in several places.

Flood of May 8, 1956

This flood resulted from small-area cloudbursts and was generally confined to two areas in the Coulee basin.

In the area just south of Lind the streams were extremely high until they passed out of the rainfall zone, where the peaks soon began to decrease in magnitude due to channel storage. In the immediate area of the storm, however, considerable amounts of mud and rock were washed onto highways and in some cases the roads were inundated for brief periods of time.

The official rain gage north of Lind recorded only 0.47 inch of rain on May 8. In Lind it was reported that 2 inches of rain was measured as having fallen in slightly over an hour's time. Some farmers in the cloudburst area estimated that 3 to 4 inches fell there.

The second cloudburst struck an area to the east of Connell which drains through the town to Esquatzel Coulee. The amount of rain that fell in the area is not known but a peak discharge of 1,900 cfs per square mile was measured about three miles east of town. This is

similar in magnitude to the peak that occurred south of Lind (site 17).

The runoff from the storm east of Connell was retained for some time behind an earth dam about a mile upstream from the town. Then a section of the dam washed out and a flood wave of heavily silted water moved down through the south side of town flooding basements and washing out lawns. The peak discharge of this flood at site 30, 0.4 mile east of Connell, was measured as 260 cfs. The flood water drained into Esquatzel Coulee in Connell and disappeared into the channel bottom before reaching Eltopia.

Flood of July 2, 1956

A rain and hail storm struck the area just east of Connell again on July 2 causing a small flash flood that made a 10-inch deep lake six blocks wide in downtown Connell. No damage was reported and the water was soon drained from the area. A peak discharge of 30 cfs was estimated to have occurred at site 30.

FLOOD DAMAGE

Flood of January 4, 1956

No damage was reported for this flood.

Flood of February 21-22, 1956

The main line of the Northern Pacific Railway closely follows Esquatzel and Providence Coulees for almost their entire length. The railroad was completely washed out at several locations and sustained minor damage at others. The tracks were inundated at many points at

the crest of the flood.

The flood water went over the banks of Providence and Esquatzel Coulee channels throughout most of their length. The towns of Connell and Mesa were severely damaged because they were located on the Coulee bottom. Considerable portions of the business and residential areas were inundated. Cunningham and Hatton are on slightly higher ground so are less subject to damage except for facilities along the railroad tracks. Figures 7-10 are maps showing the areas flooded in these towns.

The town of Connell sustained the greatest damage of any one locality. The mayor estimated a total damage figure of $798,200 for the town. Private property damage was assessed at $415,700 while damage to municipal facilities was estimated at $382,500. A breakdown of the damage is as follows:

Roads and streets	$275,000
Sewerplant and lines	50,000
Bridges	50,000
Water mains	7,500
Business property	215,700
Residential property	200,000
	$798,200

Water reached a depth of 3 feet in the business district and several inches of mud were deposited everywhere. About 50 families were evacuated from their homes.

The town of Mesa as a whole was damaged to a greater extent than

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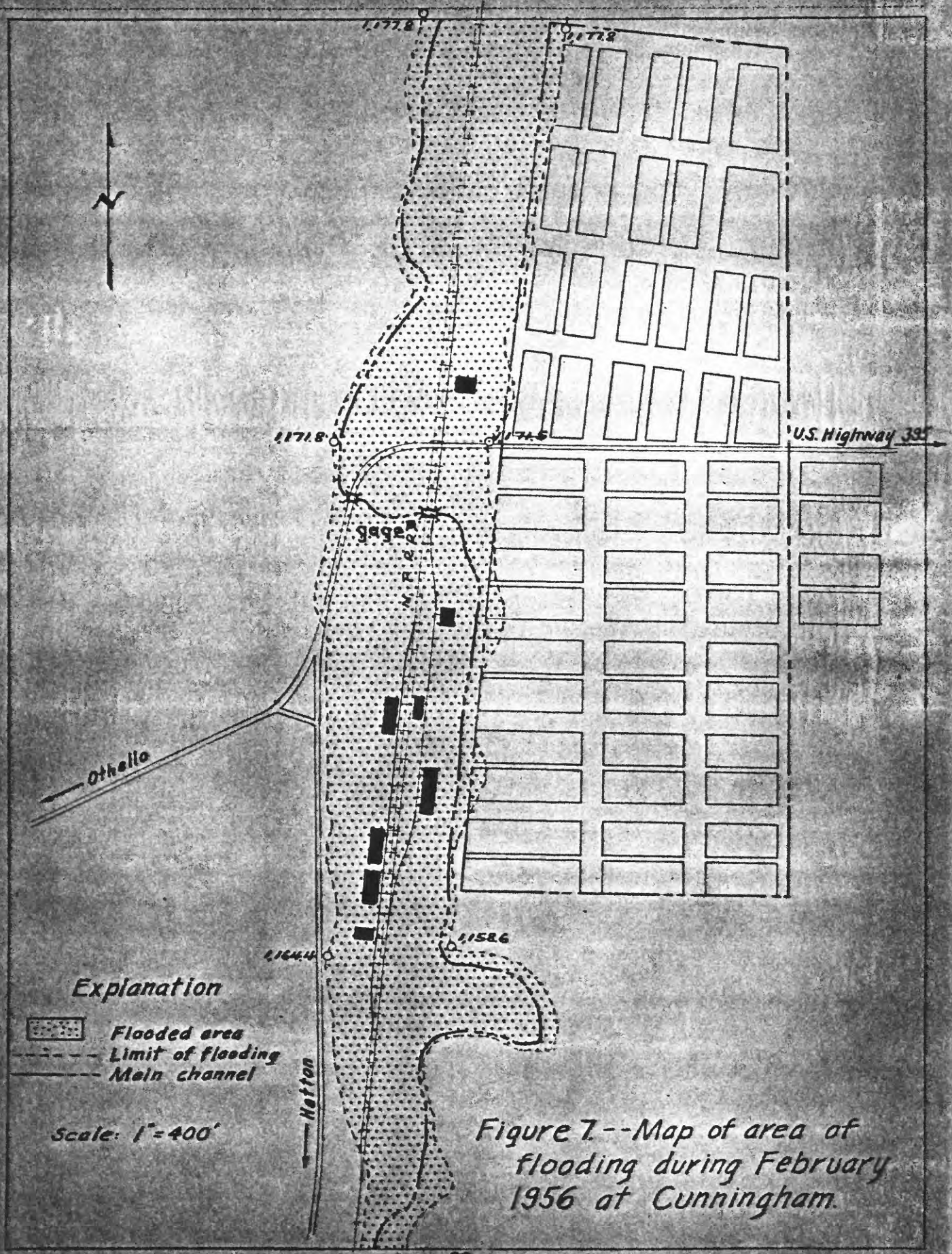

Figure 7.--Map of area of flooding during February 1956 at Cunningham.

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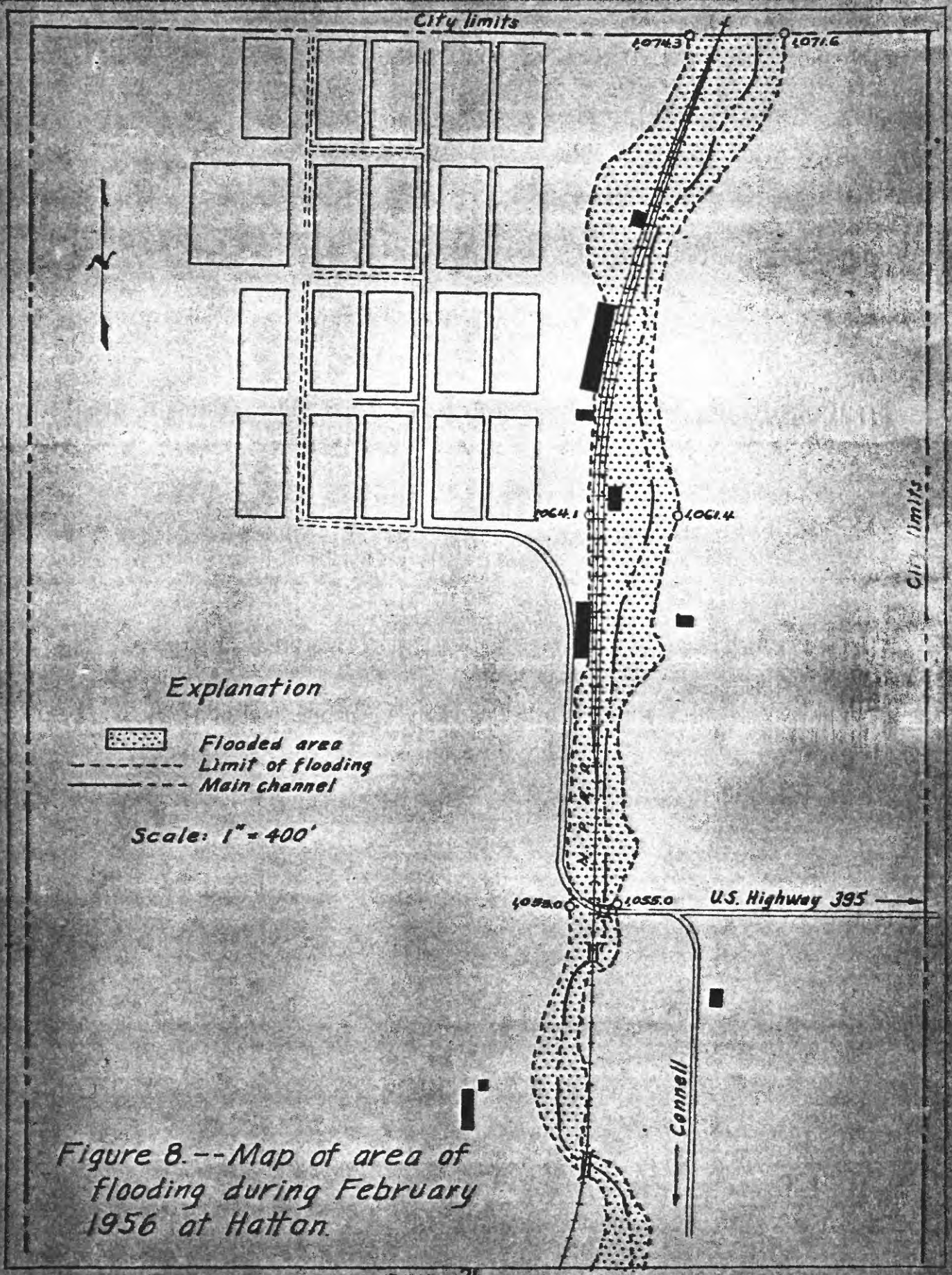

Figure 8.--Map of area of flooding during February 1956 at Hatton

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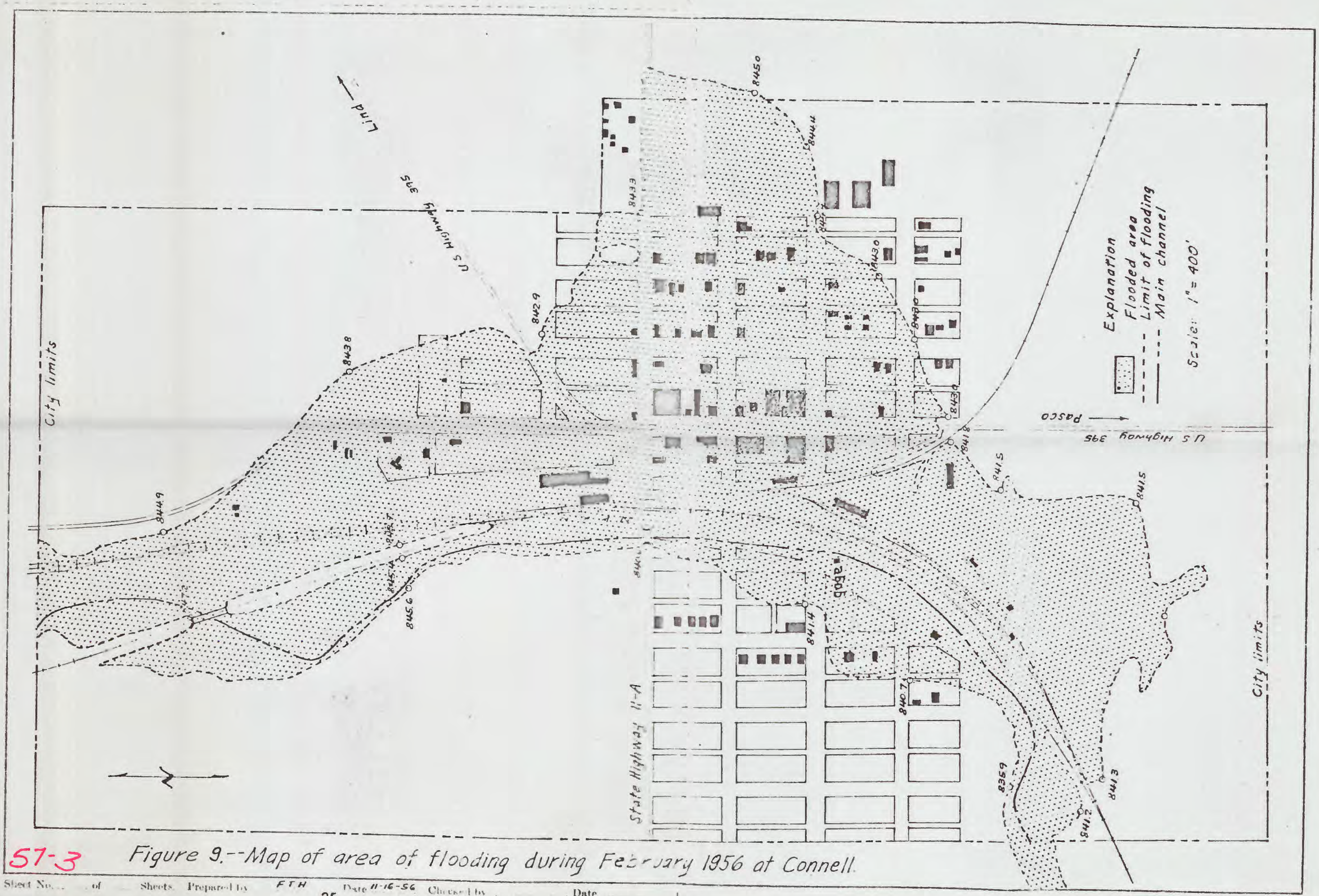

57-3 Figure 9.--Map of area of flooding during February 1956 at Connell.

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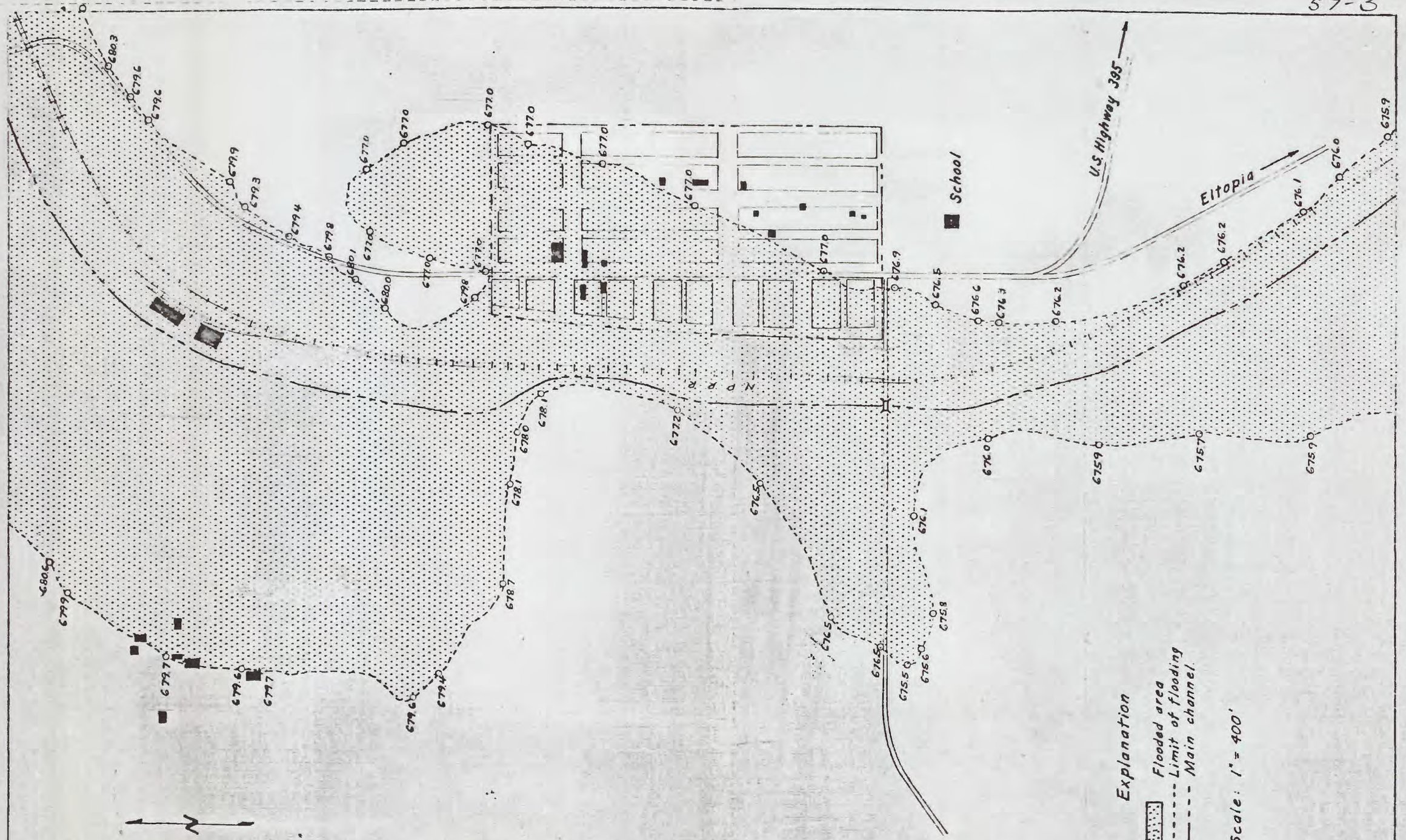

Figure 10.--Map of area of flooding during February 1956 at Mesa.

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any other locality. The mayor estimated that 85 percent of the town was affected at a cost of about $300,000. Residential damage was assessed at $100,000 and municipal works at $200,000.

Minor damage occurred in other communities along the channel.

Many culverts and bridges were damaged or destroyed and flood waters temporarily inundated many low spots on county roads in the area. U. S. Highway 10 was flooded for a short period of time by Weber Coulee north of Warden and U. S. Highway 395 was closed to traffic in Connell.

The damage to farmland and buildings was not very large because the precipitation was not of extreme cloudburst proportions and the ground, being frozen, did not erode to any great extent.

Flood of May 8, 1956

Damage to residential areas in Connell was the major item during this flood. Many basements were filled with mud and water and in a few instances shallow water covered the floors of houses. The business district suffered some damage, mostly due to the heavy concentration of silt in the water, which was described as having the consistency of thick cream. Water stood 8 inches deep in the post office. A ditch had to be cut through U. S. Highway 395 to allow the water to flow into Esquatzel Coulee.

Another area of damage was near Lind. Roads were covered with mud and water for short periods of time and the railroad suffered minor damage in a few locations.

The greatest damage to an individual occurred on the farm of

John Kulm a few miles south of Lind where damages of $60,000 were estimated. A 60' x 120' steel machine shed, a 50' x 50' frame building, one truck, and a self-propelled combine were destroyed. Other trucks, tractors, and equipment were severely damaged.

Flood of July 2, 1956

No damage was reported although a shallow lake about six blocks wide formed in downtown Connell.

FLOOD PROFILE

A high-water profile of the February flood was obtained on Esquatzel Coulee from the sump at the Pasco airport to Connell and on Providence Coulee from Connell to the east line of Sec. 1, T. 16 N., R. 32 E. only a few miles from the headwaters. The total distance along the low-water channel was measured as 63.4 miles. Figure 11 is a plot of the peak water-surface elevations along the channel. Locations where discharges were measured, towns, main tributary streams, and other pertinent data necessary for orientation are shown on the graph. The starting point (zero mileage) was the edge of the lake formed at the north edge of the Pasco airport.

Table 4 is a mileage log that lists the mileage to the pertinent features along the channel and the elevation of high-water profile at that point. The log also shows the channel stationing used by the U. S. Bureau of Reclamation in drainage studies.

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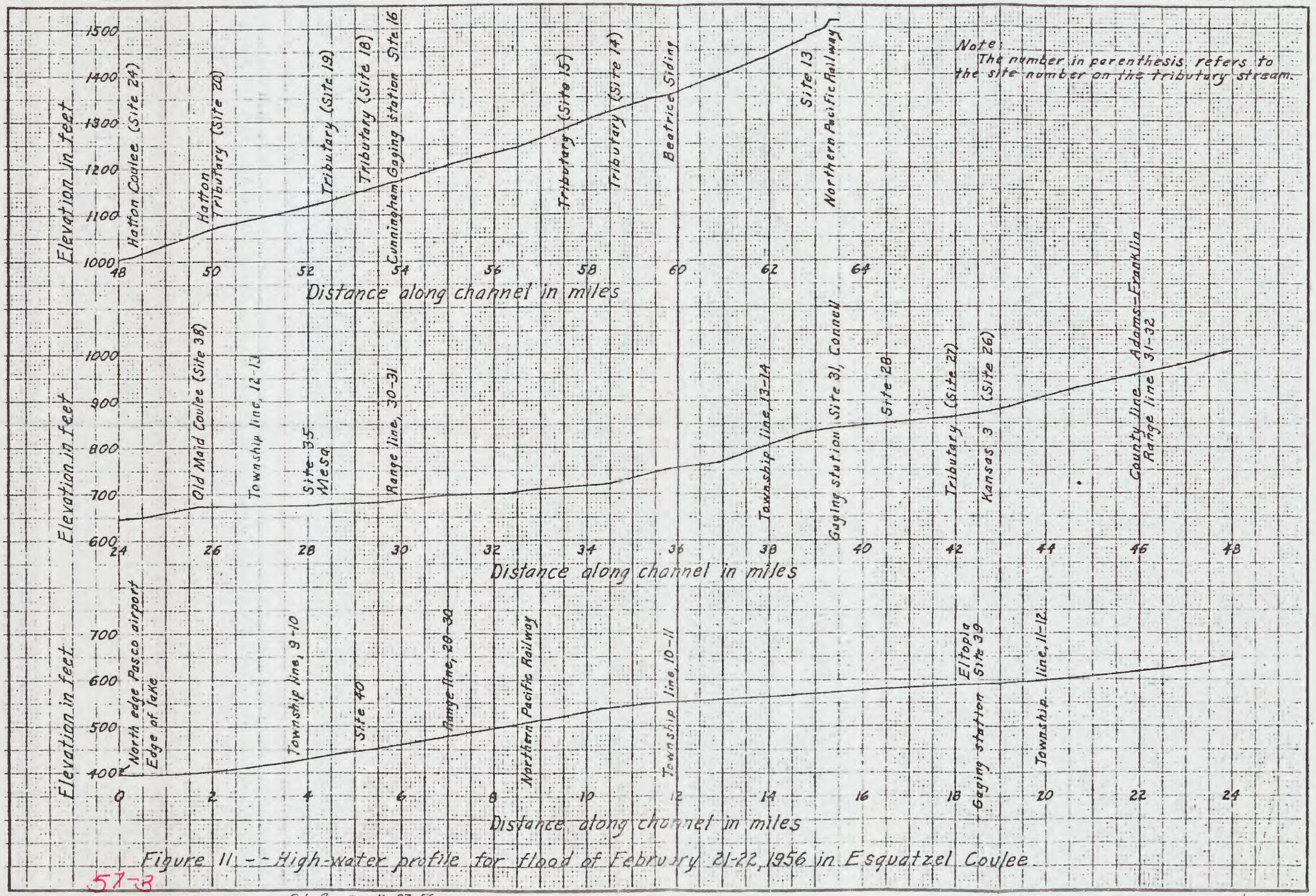

Figure 11 -- High-water profile for flood of February 21-22, 1956 in Esquatzel Coulee

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Sheet No. ..... of ..... Sheets. Prepared by GLB Date 11-27-56 Checked by ..... Date .....

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Table 4.- Mileage log for Esquatzel Coulee showing high-water elevations for flood of February 21-22, 1956

Location	Distance upstream from north edge Pasco airport	Stationing from USBR report of March 1955	High-water elevation
Lowest point in sump	None	1744	394.5
North edge Pasco airport (south edge sump)	0.0	None	394.5
South line, sec. 12, T. 9 N., R. 29 E.	.4	1702+60	394.5
Township line, 9-10	3.7	1530+20	424.7
Site 40	5.1	1460+00	447.4
Range line, 29-30	7.0	1360+80	479.0
Northern Pacific Rwy (1st crossing)	8.7	1267+00	511.4
Township line, 10-11	11.8	1103+00	551.6
Town of Eltopia	18.2	770+00	589.0
Gaging station, site 39	18.5	754+00	592.1
Township line, 11-12	19.9	682+50	597.6
Old Maid Coulee, site 38	25.7	375+00	673.5
Township line, 12-13	26.9	309+80	675.7
Site 35	28.0	258+00	676.2
Town of Mesa	28.3	240+00	678.1
Range line, 30-31	29.8	162+50	685.0
North line sec. 21, T. 13 N., R. 31 E.	32.9	0+00-1360+00	708.7
Township line, 13-14	37.9	1098+80	802.5
Gaging station, site 31	39.4	1020+00	840.7
Town of Connell	39.5	1012+50	842.0
Site 28	40.5	966+00	850.7
Tributary, site 27	41.9	890+00	864.1

Table 4.- Mileage log for Esquatzel Coulee -- Continued.

Location	Distance upstream from north edge Pasco airport	Stationing from USBR report of March 1955	High-water elevation
Kansas 3, site 26	42.7	840+00	876.0
Township line, 14-15	45.9	676+80	955.9
Adams-Franklin County line	45.9	676+80	955.9
Hatton Coulee, site 24	48.3	554+70	1011.5
Town of Hatton	49.8	474+00	1065.0
Tributary, site 20	50.1	463+00	1074.0
Tributary, site 19	52.4	341+00	1129.5
Tributary, site 18	53.2	299+00	1152.0
Gaging station, site 16	53.8	268+00	1170.5
Town of Cunningham	53.8	268+00	1170.5
Township line, 15-16	53.9	264+70	1171.6
Tributary, site 15	57.5	90+00	1282.0
Tributary, site 14	58.6	29+00	1322.0
Site 13	62.8	None	1480.0
Northern Pacific Railroad	63.3	None	1517.4
East Line, sec. 1, T. 16 N., R. 32 E.	63.4	None	1517.4

STAGES AND DISCHARGES

Three recording gaging stations are located on Esquatzel and Providence Coulees, at Cunningham, Connell, and Eltopia. All were in operation during the flood periods but the record was affected in some instances by the heavy silt load and the extreme stage in February.

Peak discharges were obtained at the 3 gaging stations and at 40 miscellaneous sites as follows:

Flood date	Gaging stations	Miscellaneous sites	Total
January	3	0	3
February	3	36	39
May	3	*8	11

* 4 of the miscellaneous sites used in May are the same ones as used in February.

Indirect methods of measuring discharge, such as slope-area and culvert methods, were utilized at all 43 sites.

Table 5 is a list of the peak discharges determined for the floods of January, February and May. It shows the land-line location of each site, a map reference number, and the drainage area, as well as the peak discharge.

The records obtained at the gaging stations during the February flood have been used to make discharge and volume studies. The record for Providence Coulee at Cunningham is not complete and a part of the gage-height graph had to be estimated. It is believed that the estimated record will give fairly good results in the volume studies.

Table 5.- Peak discharges for floods of 1956 in the Esquatzel Coulee area.

Index no. (plate 1)	Name of stream and location	Drainage area (sq mi)	Flood date	Discharge (cfs)	Runoff (csm)
	CRAB CREEK BASIN, WASH.				
1	Paha Coulee near Lind In the N½ sec. 34, T. 18 N., R. 34 E., at railroad crossing, 0.3 mile north of U. S. Highway 395 and 5 miles northeast of Lind.	16 (approx.)	May 8	826	51.6
2	Lind Coulee Tributary near Lind In the NE¼ sec. 24, T. 17 N., R. 33 E., at U. S. Highway 395 crossing 1.3 miles southeast of Lind.	0.21	Feb. 21	60.3	287
3	Lind Coulee at Lind In the NW¼ sec. 13, T. 17 N., R. 33 E., at county road crossing in Lind.	138 (approx.)	Feb. 21	5,150	37.3
4	Lind Coulee above Weber Coulee near Warden On line between sec. 27 and sec. 28, T. 18 N., R. 30 E., at county road crossing 3 miles above Weber Coulee and 3.3 miles north of Warden.	299 (approx.)	Feb. 21	7,160	24.0
5	Bowers Coulee near Schrag In the SE¼ sec. 4, T. 18 N., R. 32 E., 0.2 mile south of U. S. Highway 10 and 3 miles east of Schrag.	120 (approx.)	Feb. 21	5,000	41.7
6	Weber Coulee near Warden On line between sec. 9 and sec. 10, T. 18 N., R. 30 E., at county road crossing 3 miles above mouth and 7 miles north of Warden.	265 (approx.)	Feb. 21	9,400	35.5

Table 5.- Peak discharges for floods of 1956 in the Esquatzel Coulee area--Continued.

Index no. (plate 1)	Name of stream and location	Drainage area (sq mi)	Flood date	Discharge (cfs)	Runoff (csm)
	CRAB CREEK BASIN, WASH. (CONT.)				
7	Warden Coulee (EL63.8E Wasteway) near Warden In the E½ sec. 29, T. 17 N., R. 30 E., 600 ft. downstream from N. P. Railroad bridge, 1,400 ft. upstream from East Low Canal siphon, and 2½ miles southwest of Warden.	31.4	Feb. 21	1,120	35.6
	SCOOTENEY RESERVOIR BASIN				
8	Kansas No. 1 near Othello On line between sec. 35 and sec. 36, T. 16 N., R. 30 E., at county road crossing about 2½ miles southeast of Bruce, and 7.7 miles east of Othello.	24.8	Feb. 21	1,360	54.8
9	Kansas No. 2 near Cunningham On line between sec. 33, T. 16 N., R. 31 E., and sec. 4, T. 15 N., R. 31 E., 5.6 miles west of Cunningham on Othello-Cunningham county road.	6.06	Feb. 21	175	28.9
10	Kansas No. 2 Tributary near Cunningham On line between sec. 32, T. 16 N., R. 31 E., and sec. 5, T. 15 N., R. 31 E., 6½ miles west of Cunningham on Othello-Cunningham county road.	3.16	Feb. 21	49.4	15.6
11	Scooteney Reservoir Tributary near Othello In the SE¼NE¼ sec. 4, T. 14 N., R. 30 E., about 0.3 mile above mouth, 4 miles below confluence of Kansas No. 1 and Kansas No. 2, 8½ miles southeast of Othello, 10 miles northwest of Connell, and 10½ miles north of Mesa.	120	Feb. 21	2,110	17.6

Table 5.- Peak discharges for floods of 1956 in the Esquatzel Coulee area--Continued.

Index no. (plate 1)	Name of stream and location	Drainage area (sq mi)	Flood date	Discharge (cfs)	Runoff (csm)
	ESQUATZEL COULEE BASIN				
12	Providence Coulee Tributary near Providence On line between sec. 33 and 34, T. 17 N., R. 33 E., at county road crossing 4.3 miles southwest of Lind.	0.19	May 8	24.0	126.
13	Providence Coulee near Cunningham In the SE¼ sec. 1, T. 16 N., R. 32 E., at county road crossing, 6½ miles northeast of Cunningham, and 7.2 miles southwest of Lind.	7.53	Feb. 21	2,800	372.
14	Providence Coulee Tributary No. 1 near Cunningham In the S½ sec. 12, T. 16 N., R. 32 E., at county road crossing 1.4 miles northeast of Beatrice, and 5½ miles northeast of Cunningham.	0.47	Feb. 21	88.6	188.
15	Providence Coulee Tributary No. 2 near Cunningham In the NE¼ sec. 22, T. 16 N., R. 32 E., at county road crossing 1½ miles south of Beatrice, and about 3 miles northeast of Cunningham.	2.74	Feb. 21	667	243.
16	Providence Coulee at Cunningham U.S.G.S. gaging station in the NW¼ sec. 4, T. 15 N., R. 32 E., on west side of Northern Pacific railroad tracks at Cunningham. (Slope-area determination at gage.)	27.5	Jan. 4	333	12.1

Table 5.- Peak discharges for floods of 1956 in the Esquatzel Coulee area--Continued.

Index no. (plate 1)	Name of stream and location	Drainage area (sq mi)	Flood date	Discharge (cfs)	Runoff (csm)
	ESQUATZEL COULEE BASIN (CONT.)				
16	Providence Coulee at Cunningham U.S.G.S. gaging station in the NW¼ sec. 4, T. 15 N., R. 32 E., on west side of Northern Pacific railroad tracks at Cunningham. (Slope-area determination 1¼ miles above gage.)	27.5	Feb. 21	2,160	78.5
16	(Discharge determined from rating table)	27.5	May 8	20.7	0.8
17	Providence Coulee Tributary near Lind Near center of sec. 10, T. 16 N., R. 33 E., 6 miles southwest of Lind.	3.31	May 8	4,860	1,470.
18	Providence Coulee Tributary at Cunningham In E½ sec. 4, T. 15 N., R. 32 E., at old rock pit, 0.5 mile upstream from mouth, and 0.5 mile southeast of Cunningham.	22.0	Feb. 21	1,770	80.5
18	(0.3 mile upstream from above site)	22.0	May 8	2,730	124.
19	Providence Coulee Tributary #3 near Cunningham In the NW¼ sec. 9, T. 15 N., R. 32 E., just upstream from mouth and 1.3 miles south of Cunningham.	0.93	Feb. 21	169	182.
20	Providence Coulee Tributary at Hatton In the SW¼ sec. 17, T. 15 N., R. 32 E., 0.2 mile upstream from mouth, and at north edge of Hatton.	3.31	Feb. 21	76.2	23.0

Table 5.- Peak discharges for floods of 1956 in the Esquatzel Coulee area--Continued.

Index no. (plate 1)	Name of stream and location	Drainage area (sq mi)	Flood date	Discharge (cfs)	Runoff (csm)
	ESQUATZEL COULEE BASIN (CONT.)				
21	Hatton Coulee Tributary near Lind In the NE¼ sec. 13, T. 16 N., R. 33 E., 0.8 mile upstream from mouth, 6½ miles south of Lind, and 10 miles northeast of Cunningham.	2.64	Feb. 21	117	44.3
22	Hatton Coulee Tributary near Cunningham On line between sec. 31, T. 16 N., R. 33 E., and sec. 6, T. 15 N., R. 33 E., 0.2 mile upstream from mouth, 0.8 mile upstream from Hatton Coulee, 4 miles east of Cunningham. (This is the farthest west of 2 culverts fitting this description.)	.72	Feb. 21	112	156.
23	Hatton Coulee Tributary near Hatton In the NE¼ sec. 28, T. 15 N., R. 32 E., 300 ft. upstream from mouth and 1.5 mile southeast of Hatton.	3.82	Feb. 21	186	48.7
24	Hatton Coulee near Hatton In the E½ sec. 29, T. 15 N., R. 32 E., 0.5 mile upstream from mouth and 1.4 miles south of Hatton.	49.6	Feb. 21	1,120	22.6
25	Kansas #3 near Hatton On line between sec. 10 and sec. 11, T. 15 N., R. 31 E., at county road crossing 3-3/4 miles northwest of Hatton.	13.5	Feb. 21	877	65.0

Table 5.- Peak discharges for floods of 1956 in the Esquatzel Coulee area--Continued.

Index no. (plate 1)	Name of stream and location	Drainage area (sq mi)	Flood date	Discharge (cfs)	Runoff (csm)
	ESQUATZEL COULEE BASIN (CONT.)				
26	Kansas #3 near Connell On line between sec. 5 and sec. 8, T. 14 N., R. 31 E., at county road crossing, 6 miles northwest of Connell.	39.6	Feb. 21	1,180	29.8
27	Providence Coulee Tributary near Connell On corner of sections 7, 8, 17 and 18, at county road crossing 2 miles upstream from mouth, and 3½ miles northeast of Connell.	54.2	Feb. 21	929	17.1
27	(Determination at same site.)	54.2	May 8	830	15.3
28	Providence Coulee above Connell In the NE¼ sec. 25, T. 14 N., R. 31 E., 1.2 miles upstream (north) from U.S.G.S. gage in Connell.	235	Feb. 21	5,570	23.7
29	Providence Coulee Tributary east of Connell In the NW¼ sec. 28, T. 14 N., R. 32 E., 2½ miles east of Connell.	1.96	May 8	3,720	1,900.
30	Providence Coulee Tributary at Connell In the SW¼ sec. 30, T. 14 N., R. 32 E., 0.4 mile east of U. S. Highway 395 in Connell and about 0.4 mile downstream from an earth filled dam. (Discharge estimated.)	5.53	Feb. 21	30	5.4

Table 5.- Peak discharges for floods of 1956 in the Esquatzel Coulee area--Continued.

Index no. (plate 1)	Name of stream and location	Drainage area (sq mi)	Flood date	Discharge (cfs)	Runoff (csm)
	ESQUATZEL COULEE BASIN (CONT.)				
30	Providence Coulee Tributary at Connell In the SW¼ sec. 30, T. 14 N., R. 32 E., 0.4 mile east of U. S. Highway 395 in Connell and about 0.4 mile downstream from an earth filled dam. (Slope-area determination at same site.)	5.53	May 8	260	47.0
31	Esquatzel Coulee at Connell U.S.G.S. gaging station in the NE¼ sec. 36, T. 14 N., R. 31 E., just downstream from Main Street in Connell. (Slope-area determination 0.6 mile below gage.)	241	Jan. 4	1,520	6.3
31	(Slope-area determination 0.6 mile below gage.)	241	Feb. 21	5,560	23.1
31	(Discharge from rating table.)	241	May 8	1,470	6.1
32	Hardesty Coulee near Connell Near center sec. 32, T. 14 N., R. 33 E., 1.3 miles north of Sulphur Lake and 7½ miles east of Connell.	10.4	Feb. 21	105	10.1
33	Rattlesnake Canyon near Lind On line between sec. 23 and sec. 26, T. 16 N., R. 34 E., at county road crossing, 9½ miles southeast of Lind.	14.0	Feb. 21	1,380	98.6

Table 5.- Peak discharges for floods of 1956 in the Esquatzel Coulee area--Continued.

Index no. (plate 1)	Name of stream and location	Drainage area (sq mi)	Flood date	Discharge (cfs)	Runoff (csm)
	ESQUATZEL COULEE BASIN (CONT.)				
34	Rattlesnake Canyon near Connell In the SE¼ sec. 33, T. 14 N., R. 32 E., 2.7 miles east of Connell.	98.1	Feb. 21	1,350	13.8
35	Esquatzel Coulee at Mesa In the NE¼ sec. 35, T. 13 N., R. 30 E., 0.2 mile downstream from road crossing at south edge of Mesa.	293	Feb. 22	4,080	13.9
36	Old Maid Coulee near Connell On line between sec. 19, T. 13 N., R. 32 E., and sec. 24, T. 13 N., R. 31 E., at U. S. Highway 395 crossing 4.2 miles south of Connell.	17.8	Feb. 21	171	9.6
36	(Determination at same site.)	17.8	May 8	121	6.8
37	Dunnigan Coulee near Connell On line between sec. 25, T. 13 N., R. 31 E., and sec. 30, T. 13 N., R. 32 E., at U. S. Highway 395 crossing 6 miles south of Connell.	27.5	Feb. 21	465	16.9
38	Old Maid Coulee near Mesa In the NW¼ sec. 12, T. 12 N., R. 30 E., 0.5 mile upstream from mouth and 2½ miles south of Mesa.	69.4	Feb. 21	456	6.6

Table 5.- Peak discharges for floods of 1956 in the Esquatzel Coulee area--Continued.

Index no. (plate 1)	Name of stream and location	Drainage area (sq mi)	Flood date	Discharge (cfs)	Runoff (csm)
	ESQUATZEL COULEE BASIN (CONT.)				
39	Esquatzel Coulee at Eltopia U.S.G.S. gaging station in the SE¼ sec. 2, T. 11 N., R. 30 E., on upstream side of railroad bridge at north edge of Eltopia. (Discharge determined from rating table.)	391	Jan. 5	126	0.3
39	(Slope-area determined ½ mile below gage.)	391	Feb. 22	3,740	9.6
39	(No flow.)	391	May 8	0	0.
40	Esquatzel Coulee near Pasco In the SW¼ sec. 25, T. 10 N., R. 29 E., 0.5 mile downstream from county road to Richland ferry, and 6½ miles north of Pasco.	493	Feb. 22	2,740	5.6
	SMITH CANYON BASIN				
41	Smith Canyon Tributary near Connell In the SE¼NW¼ sec. 9, T. 12 N., R. 32 E., at county road crossing 8½ miles south of Connell.	1.71	Feb. 21	45.8	26.8
42	Smith Canyon near Eltopia In the NE¼ sec. 1, T. 11 N., R. 30 E., 1¼ miles northeast of Eltopia.	46.2	Feb. 21	462	10.0
43	Rye Grass Coulee near Eltopia In the NW¼ sec. 12, T. 11 N., R. 31 E., just upstream from unnamed tributary, 6½ miles east of Eltopia, and 14½ miles south of Connell.	17.6	Feb. 21	126	7.2

Tables 6, 7 and 8 are lists of gage heights and discharges selected at irregular time intervals in such a manner that plotting either value on a chart will give an accurate hydrograph of the data desired at those sites. The discharge hydrographs are shown as figure 12, which illustrates the sharpness of the peaks and the short periods of time that the streams were high. The high water lasted about 8 hours at Cunningham, only 16 hours at Connell, and about 24 hours at Eltopia.

The irregular-interval discharge data were converted into acre-feet and cumulative volume curves plotted for the three stations. The 3-day volume at Cunningham was computed to be about 1,100 acre-feet and for Connell and Eltopia the 3-day volume was about 5,000 acre-feet as shown on figure 13.

The peak discharges in cfs per square mile were plotted against drainage area on figure 14 to show the relationships between the magnitudes of the floods in various areas. In January the highest rate was 12.1 cfs per square mile for the gaging station at Cunningham (site 16) but in February the peak flow at this site was 78.5 cfs per square mile. Site 13 shows the highest peak discharge per square mile, 372 cfs, for the February flood. Extremely high rates of runoff occurred from the cloudburst storms in May when the rate per square mile reached 1,900 cfs.

The lake that formed in the sump at the north edge of the Pasco airport reached a maximum elevation of 394.5 feet during the February flood. The area-capacity curves for the sump, figure 15, show a lake

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Table 6.- Providence Coulee at Cunningham, Wash.

Gage height in feet, and discharge, in cubic feet per second, at indicated time, 1956

HOUR	GAGE HEIGHT	DISCHARGE	HOUR	GAGE HEIGHT	DISCHARGE	HOUR	GAGE HEIGHT	DISCHARGE	HOUR	GAGE HEIGHT	DISCHARGE
			Feb. 21			Feb. 23					
			7 am		*0	6 am	1.80	3			
			8	2.6	*10	12 m	1.70	2			
			9	3.9	*119	3:30	1.66	2			
			10	5.6	*430	4	2.84	20			
			11	8.2	*1,280	6	2.82	20			
			11:30	9.25	1,760	9	2.60	*10			
			12 m	9.51	1,900	12 pm	2.20	8			
			12:40	9.67	1,980		Mean	7			
			1:40	9.34	1,810						
			2:20	10.04	2,160						
			3:00	9.55	1,920						
			4	9.18	1,730						
			5	8.65	1,460						
			6	4.55	215						
			7	3.82	109						
			8	3.38	64						
			9	2.90	32						
			10	2.59	19						
			11	2.40	13						
			12 pm	2.28	10						
				Mean	556						
			Feb. 22								
			6 am	1.94	*4						
			12 m	1.73	*2						
			5	1.70	*2						
			7	2.20	8						
			9	2.20	8						
			12 pm	2.00	*5						
				Mean	5						

* Estimated.

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Table 7.- Esquatzel Coulee at Connell, Wash.

Gage height in feet, and discharge, in cubic feet per second, at indicated time. 1956

HOUR	GAGE HEIGHT	DISCHARGE	HOUR	GAGE HEIGHT	DISCHARGE	HOUR	GAGE HEIGHT	DISCHARGE	HOUR	GAGE HEIGHT	DISCHARGE
			Feb. 21			Feb. 23					
			9 am		0	2 am	4.20	80			
			10	3.70	36	4	4.42	110			
			11	5.30	313	6	4.25	86			
			12 m	10.00	2,300	12 m	3.73	31			
			1	10.55	3,420	3	3.61	23			
			2	10.70	3,690	5	3.67	27			
			3	11.50	4,800	7	3.59	21			
			4	12.68	5,560	9	3.83	40			
			5	12.32	5,380	12 pm	3.82	39			
			6	12.05	5,230		Mean	50			
			7	11.70	4,990	Feb. 24					
			8	11.15	4,600	6 am	3.78	35			
			9	10.45	4,040	10	3.75	33			
			10	9.80	3,470	12 m	3.68	28			
			11	9.00	2,810	6	3.51	16			
			12 pm	8.25	2,220	12 pm	3.35	7.8			
				Mean	2,160		Mean	26			
			Feb. 22			Feb. 25					
			1 am	7.40	1,530	6 am	3.28	5.0			
			2	6.60	1,010	9	3.26	4.4			
			3	6.08	702	12 m	3.34	7.3			
			4	5.65	530	12 pm	3.28	5.0			
			5	5.35	410		Mean	6.0			
			6	5.10	330	Feb. 26					
			7	4.84	252	12 m	3.27	4.7			
			8	4.62	186	12 pm	3.20	2.5			
			9	4.44	148		Mean	4.2			
			10	4.28	116	Feb. 27					
			11	4.14	86	12 m	3.13	1.2			
			12 m	4.02	69	12 pm	3.08	.5			
			2	3.86	47		Mean	1.4			
			3	3.90	52	Feb. 28					
			4	3.80	40	12 pm	3.00	0			
			6	3.70	30		Mean	0.2			
			12 pm	3.50	16						
				Mean	286						

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Table 8.- Esquatzel Coulee at Eltopia, Wash.

Gage height in feet, and discharge, in cubic feet per second, at indicated time. 1956

HOUR	GAGE HEIGHT	DISCHARGE	HOUR	GAGE HEIGHT	DISCHARGE	HOUR	GAGE HEIGHT	DISCHARGE	HOUR	GAGE HEIGHT	DISCHARGE
			Feb. 21			1 pm	12.83	1,370	Feb. 25		
			6 am	4.30	0	2	12.18	1,170	6 am	5.80	49
			7	6.60	104	3	11.67	1,020	9	5.65	42
			8	7.18	154	4	11.23	892	10	5.75	46
			9	7.23	159	5	10.72	765	2 pm	5.37	29
			10	7.13	150	6	10.20	650	3	5.43	31
			11	7.06	143	7	9.76	562	6	5.32	27
			12 m	8.08	248	8	9.50	510	12	5.14	20
			1	9.28	401	9	9.33	476		Mean	38
			3	10.46	591	10	9.17	446	Feb. 26		
			4	11.23	731	11	9.02	419	6 am	4.90	13.0
			5	12.02	884	12	8.92	401	11	4.46	3.0
			6	12.54	988		Mean	1,790	2 pm	4.64	6.8
			7	13.11	1,120	Feb. 23			4	4.53	4.4
			8	13.77	1,290	1 am	8.74	371	6	4.72	8.6
			9	14.56	1,480	3	8.47	328	12	4.52	4.2
			10	15.37	1,710	5	8.11	275		Mean	9.0
			10:30	15.65	1,800	7	7.75	226	Feb. 27		
			11	15.85	1,980	9	7.50	196	6 am	4.30	0
			12	16.41	2,140	11 am	7.18	160		Mean	0.5
				Mean	570	2 pm	6.90	131			
			Feb. 22			6	6.59	103			
			12:30 am	16.68	2,220	10	6.33	83			
			1	16.72	2,420	12	6.23	76			
			2	17.01	3,060		Mean	184			
			3	17.43	3,300	Feb. 24					
			4	17.90	3,450	4 am	5.81	50			
			5	18.13	3,560	8	6.46	93			
			5:15	18.23	3,740	12 m	6.77	119			
			6	17.93	3,560	6	6.35	84			
			7	17.34	3,270	12	6.04	63			
			8	16.43	2,820		Mean	84			
			9	15.62	2,430						
			10	14.74	2,080						
			11	14.10	1,820						
			12 m	13.46	1,590						

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES BRANCH

File Number | Washington
District

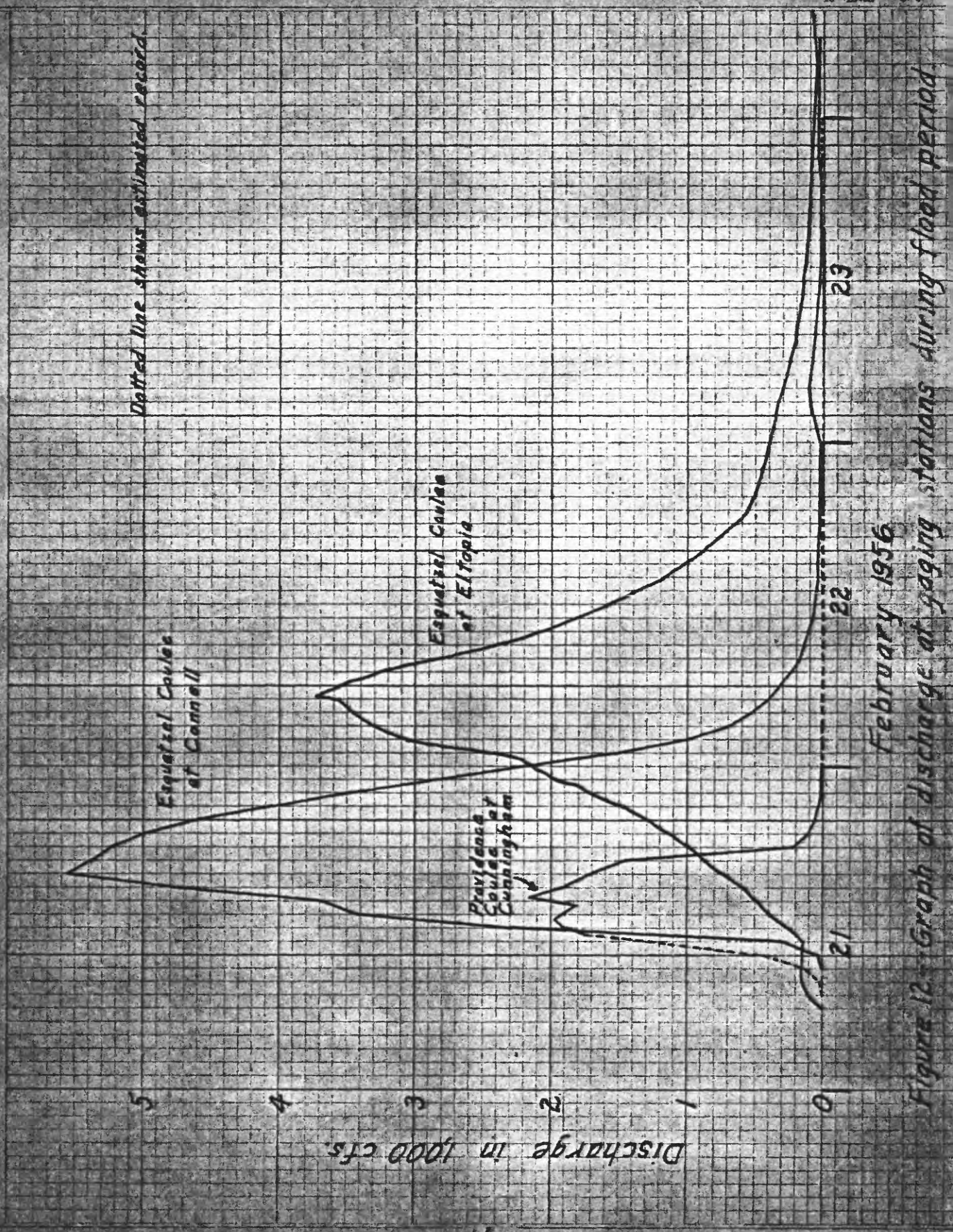
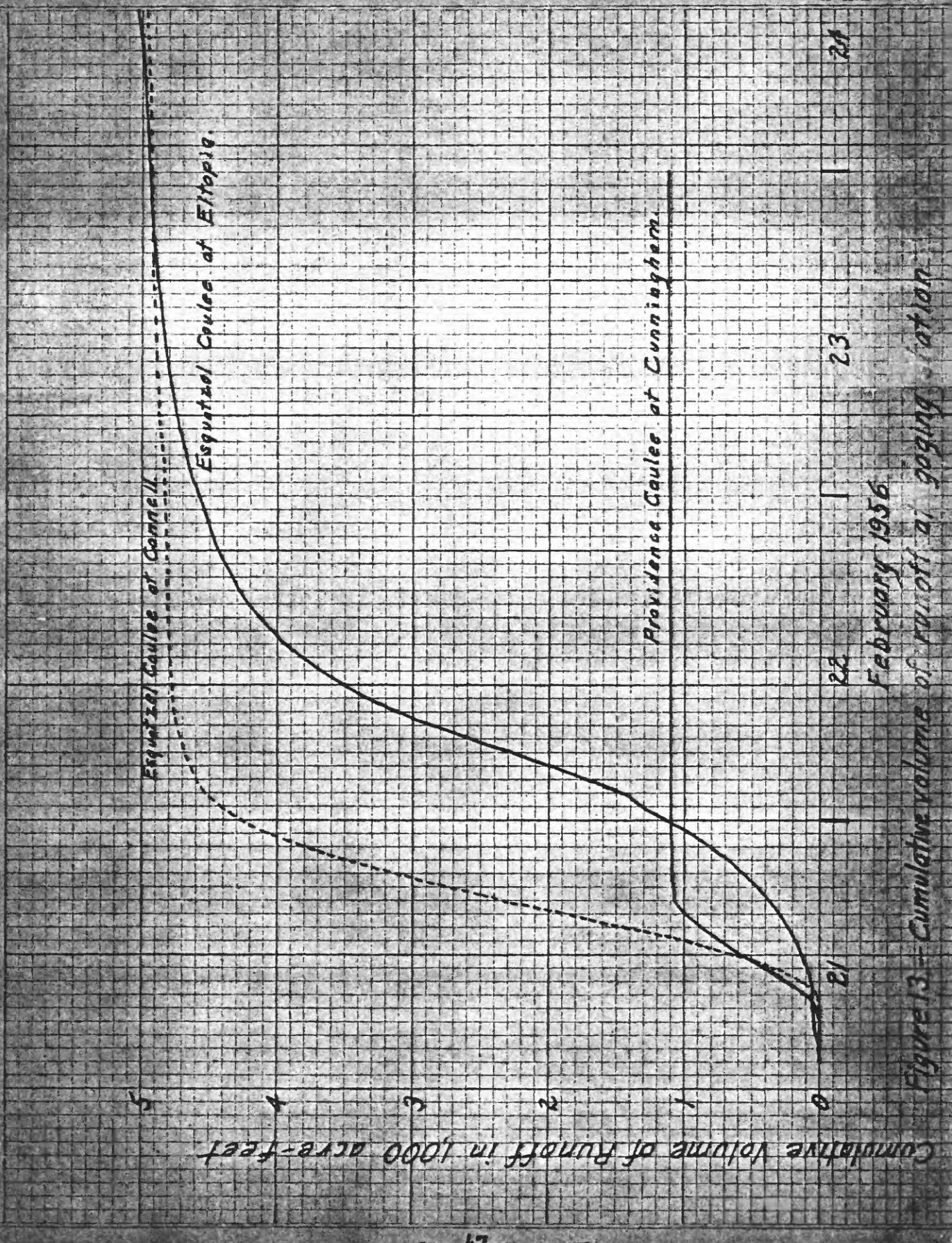
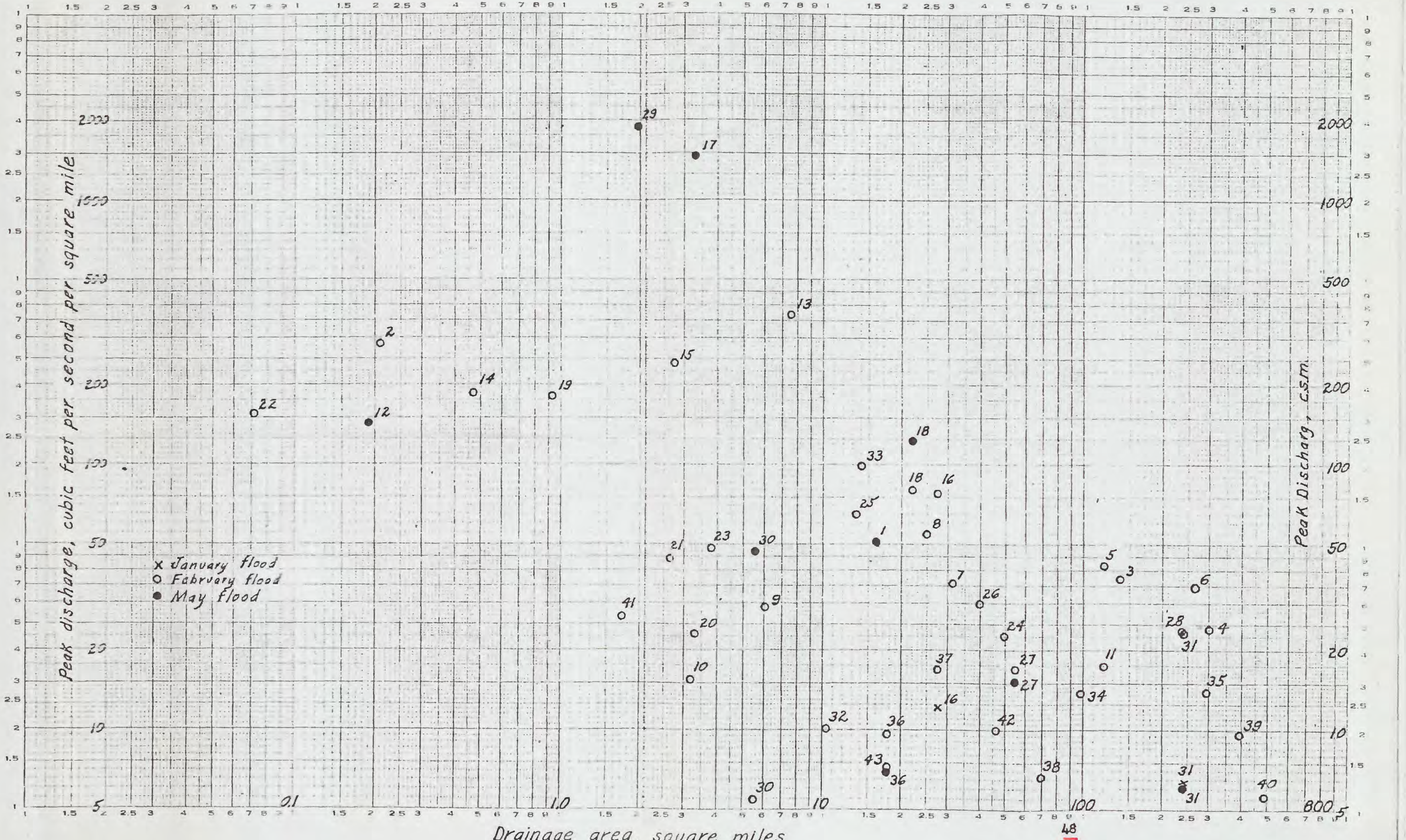


Figure 12.--Graph of discharge at gaging stations during flood period

Sheet No. ___ of ___ sheets. Prepared by GLB Date 11-19-56 Checked by ___ Date ___





57-3

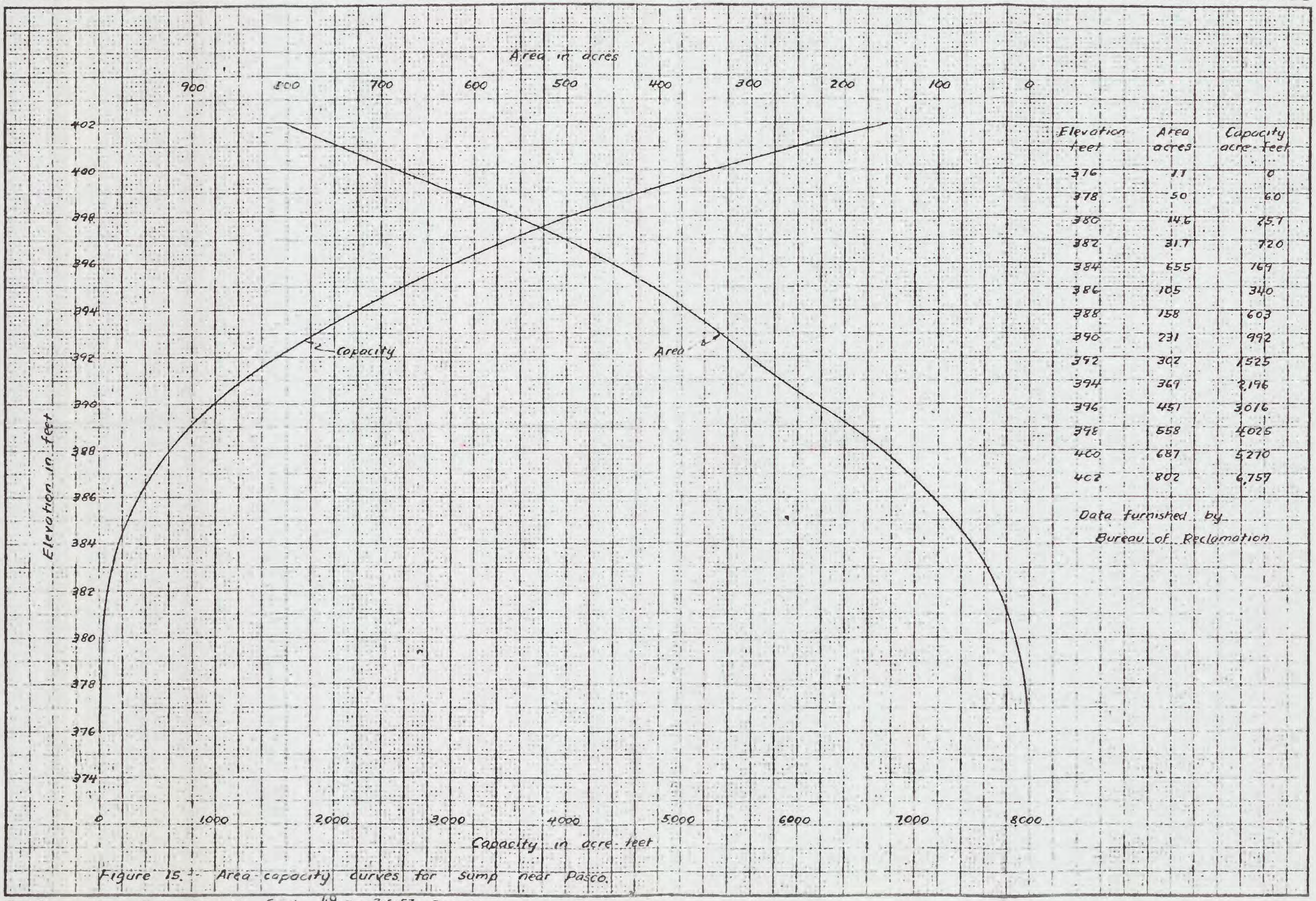
Figure 14.-- Relation of unit discharge to size of drainage area. Figure 14.

GLB 11-20-56

9-218-F
(March 1949)
Cross-Section—Double

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

File 57-3



Elevation feet	Area acres	Capacity acre-feet
376	1.1	0
378	50	60
380	146	257
382	317	720
384	655	1769
386	1105	3440
388	1558	6031
390	2231	9921
392	3027	15251
394	3697	21966
396	4511	30166
398	5588	40265
400	6871	52701
402	8027	67577

Data furnished by
Bureau of Reclamation

Figure 15.- Area-capacity curves for sump near Pasco.

Sheet No. ..... of ..... Sheets. Prepared by F.I.H. 49 Date 2-6-57 Checked by ..... Date .....

area of 388 acres and a volume of 2,400 acre-feet for this stage. The U. S. Bureau of Reclamation in previous studies determined that the airport runways are at elevation 402 feet. The point at which the sump would overflow into Pasco is at elevation 404 feet, and the sump has never been known to overflow. The capacity of the sump at the runway elevation, 402 feet, is 6,800 acre-feet.

FLOOD FREQUENCY

The gaging stations have been in operation only since 1953 which does not provide enough years of record to permit making a reliable flood-frequency curve. However, the historic data furnish indirectly a rough idea of the flood frequencies involved.

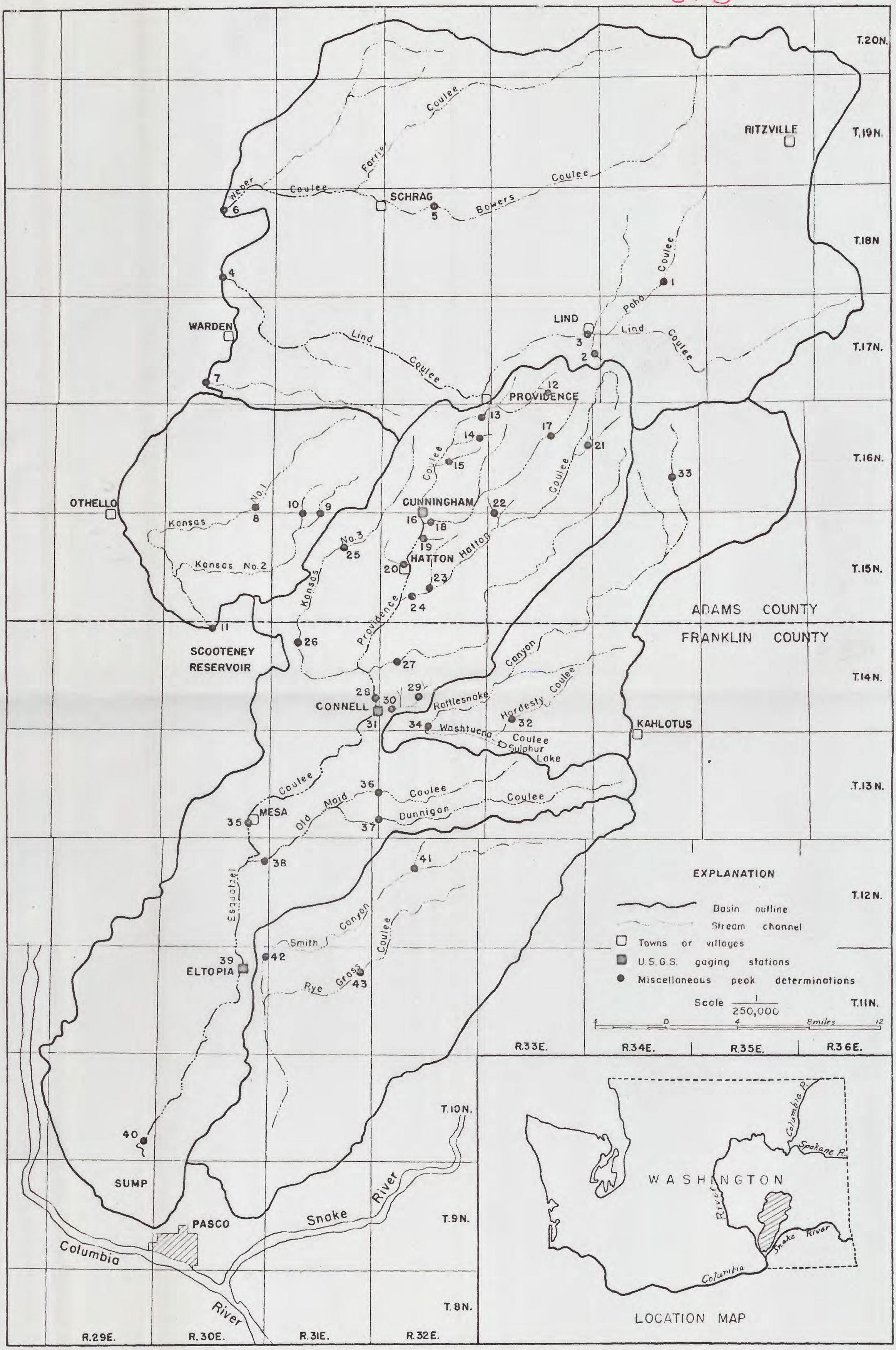
Floods of varying magnitude have occurred in at least 10 different years since 1905. All local residents contacted agreed that the flood of February 1956 was the largest known since the settlement of Connell. The floods of 1906, 1907 and 1949 were believed to be the three next largest, all of which may have been of about the same magnitude. At Connell the peak discharge of the 1949 flood was determined as 1,760 cfs and that of the February 1956 flood as 5,560 cfs. This indicates that the 1956 flood was of considerably greater magnitude than any of the others. In fact the peaks of January and May 1956 were not much less than the one of 1949.

On the basis of present methods of drawing flood-frequency curves very little can be done to produce such curves based on the available runoff information in this drainage basin. However, it is

known that the flood of February 1956 was the largest in about 69 years, which would, by U. S. Geological Survey computation methods, represent a plotting position of 70 years. When considering the magnitudes of the other floods, this would appear to be a minimum estimate of its recurrence interval.

57-3

PLATE 1

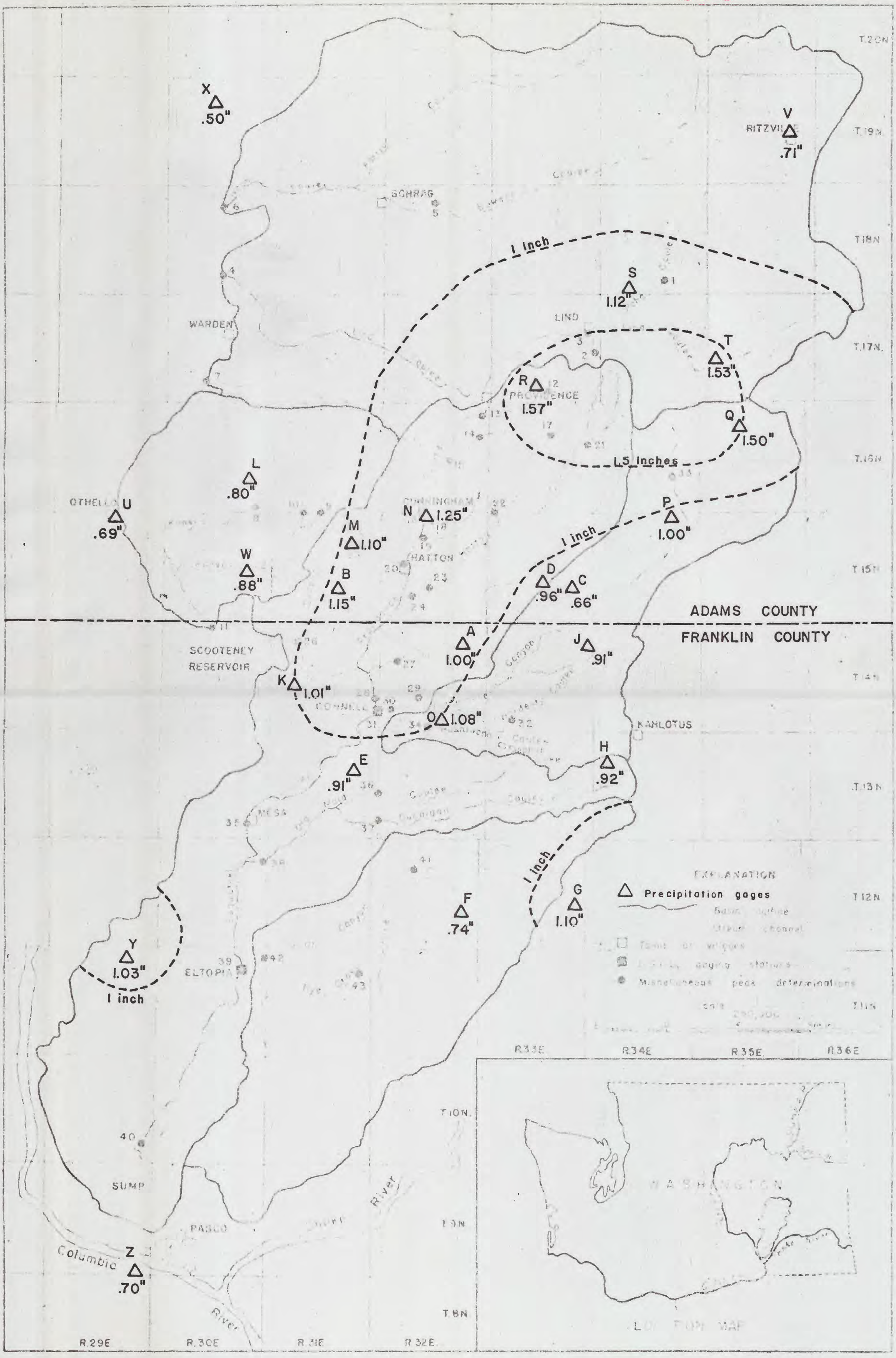


LOCATION MAP

MAP SHOWING LOCATION OF FLOOD DETERMINATION POINTS

57-3

PLATE 2



ISOHYETAL MAP SHOWING PRECIPITATION DURING FEBRUARY 20,21