NORTHEAST FLOOD STUDIES

INTERIM REPORT
ON
REVIEW OF SURVEY

THAMES RIVER BASIN

QUINEBAUG RIVER SUB-BASIN

CONNECTICUT AND MASSACHUSETTS

U.S. Army Engineer Division, New England
Corps of Engineers
Boston, Mass.

31 January 1958

ARMY-NED-BOSTON

SYLLABUS

The Division Engineer finds that there is urgent need for a revision of the existing flood control project on the Thames River and tributaries in order to insure the stability of present development, the security of the inhabitants, and the preservation of existing economic values. He finds that the Quinebaug River produces major flood damages along its course and concludes that a flood control reservoir in the Quinebaug River watershed, in addition to the authorized reservoirs, is necessary and warranted.

The Division Engineer recommends that the authorized plan for flood control in the Thames River Basin be revised to include the West Thompson Dam and Reservoir at a total estimated first cost to the United States of $4,030,000. He further recommends that the West Thompson project be authorized primarily for flood control with the addition of features beneficial to pollution control, fish and wildlife, and recreation which may be found desirable and justified during the course of advanced planning studies.

INTERIM REPORT ON REVIEW OF SURVEY
THAMES RIVER BASIN
QUINEBAUG RIVER SUBBASIN

TABLE OF CONTENTS

Par.		Page
	SECTION I - AUTHORITY	
1	AUTHORIZING RESOLUTION	1
2	ASSIGNMENT OF STUDY	1
	SECTION II - SCOPE	
3	SCOPE OF REPORT	2
4	SCOPE OF STUDIES	2
	a. Topographic surveys	2
	b. Site explorations	2
	c. Economic investigations	2
	d. Office studies	2
	e. Real estate studies	2
	f. Consultation with interested parties	2
	g. Field reconnaissance	2
	SECTION III - PRIOR REPORTS	
5	PUBLISHED REPORTS	3
	a. "308" Report	3
	b. 1940 Report	3
	c. NENYIAC Report	3
	SECTION IV - DESCRIPTION	
6	LOCATION AND EXTENT	4
7	TOPOGRAPHY	4
8	GEOLOGY	4
9	STREAM CHARACTERISTICS	4
	a. Main stream	4
	b. Tributaries	5
	(1) French River	5
	(2) Five Mile River	5
	(3) Moosup River	5
	(4) Pachaug River	5
	c. Channel capacities	5
10	AREA MAPS	6

Par.		Page
	SECTION V - ECONOMIC DEVELOPMENT	
11	POPULATION	7
	a. General	7
	b. Distribution	7
	c. Concentration	7
12	TRANSPORTATION	7
	a. Railroads	7
	b. Busses	7
	c. Highways	7
13	MANUFACTURING	8
	a. Extent of manufacturing	8
	b. Distribution of industry	8
	c. Leading industries	8
	d. Important manufacturing centers and their products	8
14	NATURAL RESOURCES	8
	a. Water supply	8
	b. Water power	9
	c. Recreational use of water	9
	d. Forestry and agriculture	9
	e. Mineral resources	9
	SECTION VI - CLIMATOLOGY	
15	GENERAL	10
16	TEMPERATURE	10
17	PRECIPITATION	10
	SECTION VII - RUNOFF AND STREAMFLOW DATA	
18	GAGING STATION RECORDS	11
	SECTION VIII - FLOODS OF RECORD	
19	HISTORIC FLOODS	12
20	RECENT FLOODS	12
	SECTION IX - STANDARD PROJECT FLOOD	
21	GENERAL	13

Par.		Page
	SECTION X - EXTENT AND CHARACTER OF FLOODED AREA	
22	GENERAL	15
23	QUINEBAUG RIVER	16
	a. General	16
	b. Southbridge, Mass.	16
	c. Putnam, Conn.	16
24	FRENCH RIVER	16
	a. General	16
	b. Webster, Mass.	16
	SECTION XI - FLOOD DAMAGES	
25	GENERAL	17
26	UPPER QUINEBAUG RIVER	19
	a. General	19
	b. Southbridge, Mass.	19
27	LOWER QUINEBAUG RIVER	19
	a. General	19
	b. Putnam, Conn.	19
28	FRENCH RIVER	20
	a. General	20
	b. Webster, Mass.	20
29	RECURRING LOSSES	20
30	AVERAGE ANNUAL LOSSES	21
	SECTION XII EXISTING CORPS OF ENGINEERS' FLOOD CONTROL PROJECTS	
31	AUTHORIZED PROJECT	22
	SECTION XIII IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES	
32	GENERAL	24
33	IMPROVEMENTS BY NON-FEDERAL AGENCIES	24
	a. Southbridge, Mass.	24
	(1) Nuisance Brook	24
	(2) Cohasse Brook	24
	(3) Cady Brook	24
	b. Putnam, Conn.	24

Par.		Page
	SECTION XIV - IMPROVEMENTS DESIRED	
34	PUBLIC HEARING	25
	a. Flood control dam and reservoir	25
	b. Putnam, Conn., local protection	25
	c. Southbridge, Mass., local protection	25
	d. Killingly, Conn., local protection	26
	e. Grosvenor Dale, Conn., local protection	26
	f. Plainfield, Conn., local protection	26
	g. Webster, Mass., local protection	26
35	CONSULTATIONS WITH LOCAL INTERESTS	26
	SECTION XV FLOOD PROBLEMS, RELATED PROBLEMS, AND SOLUTIONS CONSIDERED	
36	GENERAL	27
37	RESERVOIRS	27
38	LOCAL PROTECTION	27
	a. Southbridge, Mass.	28
	(1) McKinstry Brook	28
	(2) Nuisance Brook	28
	(3) Cady Brook	28
	(4) Cohasse Brook	29
	(5) Dean Brook	29
	b. Leicester, Mass.	29
	c. Webster, Mass.	29
	d. Grosvenor Dale, Conn.	29
	e. Putnam, Conn.	30
	f. Killingly, Conn.	30
	g. Plainfield, Conn.	31
39	ZONING	31
40	RELATED WATER RESOURCE DEVELOPMENTS	32
	a. Hydroelectric power	32
	b. Fish and wildlife	33
	SECTION XVI - FLOOD CONTROL PLANS	
41	GENERAL	34
42	WEST THOMPSON DAM AND RESERVOIR	34
43	RED BRIDGE DAM AND RESERVOIR	34
44	PUTNAM LOCAL PROTECTION PROJECT	35
45	DEGREE OF PROTECTION	35
46	HYDROLOGIC AND HYDRAULIC CONSIDERATIONS	36
	a. Analysis of floods	36
	b. Typical tributary contribution flood	36
	c. Spillway and outlet capacities	36
47	RESERVOIR REGULATION	37
48	PROVISIONS AGAINST ENCROACHMENT	37

Par.		Page
	SECTION XVII - MULTIPLE-PURPOSE FEATURES	
49	GENERAL	38
	SECTION XVIII - RECREATIONAL DEVELOPMENT	
50	GENERAL	39
	SECTION XIX ESTIMATES OF FIRST COSTS AND ANNUAL CHARGES	
51	GENERAL	40
	SECTION XX - ANNUAL BENEFITS	
52	ANNUAL FLOOD-DAMAGE PREVENTION BENEFITS	45
53	ENHANCEMENT BENEFITS	45
54	FISH AND WILDLIFE EFFECTS	45
	SECTION XXI PROJECT FORMULATION AND ECONOMIC JUSTIFICATION	
55	GENERAL	46
	SECTION XXII - PROPOSED LOCAL COOPERATION	
56	GENERAL	48
	SECTION XXIII COORDINATION WITH OTHER AGENCIES	
57	GENERAL	49
	SECTION XXIV - DISCUSSION	
58	FLOOD PROBLEMS	50
59	SOLUTIONS CONSIDERED	50
60	SELECTION OF PLAN	50
61	COSTS AND BENEFITS	52
	SECTION XXV - CONCLUSIONS	
62	GENERAL	53
	SECTION XXVI - RECOMMENDATIONS	
63	GENERAL	54

TABLES

Number		Page
1	Gaging Stations - Quinebaug River Subbasin	11
2	Comparative Flood Magnitudes	14
3	August 1955 Flood Losses - Quinebaug River Subbasin	18
4	Authorized Reservoirs in the Quinebaug River Subbasin	23
5	Cost Estimate - West Thompson Dam and Reservoir	42
6	Cost Estimate - Red Bridge Dam and Reservoir	43
7	Cost Estimate - Putnam Local Protection	44
8	Summary of Economic Data for Projects Studied	47

PLATES

1 Basin Map

2 Profiles

3 West Thompson - Reservoir Map

4 West Thompson - General Plan

APPENDICES

A Digest of Public Hearing

B Hydrology and Hydraulics

C Flood Losses and Benefits

D West Thompson Dam and Reservoir

E Red Bridge Dam and Reservoir

F Putnam Local Protection

G Other Projects Studied

H Hydroelectric Power Studies

I Letters of Comment

OFFICE OF THE DIVISION ENGINEER
U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
BOSTON, MASSACHUSETTS

SUBJECT: Interim Report on Review of Survey for Flood Control, Thames River Basin, Quinebaug River Subbasin, Connecticut and Massachusetts

TO: Chief of Engineers, Department of the Army, Washington 25, D. C., ATTENTION: ENGWF

SECTION I - AUTHORITY

1. AUTHORIZING RESOLUTION

Resolution by the Committee on Public Works of the United States Senate, adopted September 14, 1955, states in part:

> That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review previous reports on the * * * Thames River, Massachusetts and Connecticut * * * in the area affected by the hurricane flood of August 1955, to determine the need for modification of the recommendations in such previous reports and the advisability of adopting further improvements for flood control and allied purposes in view of the heavy damages and loss of life caused by such floods.

2. ASSIGNMENT OF STUDY

In letter dated September 14, 1955, the Chairman of the Committee on Public Works of the United States Senate transmitted the foregoing resolution to the Chief of Engineers and requested appropriate attention. By first indorsement dated September 16, 1955, the Chief of Engineers assigned the study and the preparation of a report thereon to the Division Engineer, U. S. Army Engineer Division, New England.

SECTION II - SCOPE

3. SCOPE OF REPORT

This interim report of survey scope comprises a review of the flood problems in the watershed of the Quinebaug River, a major subbasin in the Thames River Basin. The purpose of the survey is to determine the advisability and economic feasibility of further improvements for flood control and allied purposes.

4. SCOPE OF STUDIES

a. Topographic surveys. Recent U. S. Army Map Service and U. S. Geological Survey maps were used in the study. Centerline profiles of potential dam sites on the Quinebaug River were run to field-check these maps. Plane table surveys, supplemented by river cross sections, were made of Putnam, Conn.

b. Site explorations. Subsurface explorations by borings and test pit and geologic reconnaissance were made at potential dam sites.

c. Economic investigations. Surveys of flood damages were made after the floods of 1938, 1948, and 1955. The surveys consisted of personal interviews with municipal and state officials, officers of industrial concerns, and private individuals experiencing losses.

d. Office studies. Office studies consisted of preliminary hydrologic and hydraulic analyses and determination of approximate quantities and costs of the major items of construction and relocations.

e. Real estate studies. Field reconnaissance and determination of recent sales in the reservoir areas were used as the basis for estimates of real estate costs.

f. Consultation with interested parties. A public hearing was held in Putnam, Conn., on December 12, 1956, at which time interested parties requested consideration of improvements in various areas in the Quinebaug River Subbasin. A synopsis of the hearing is given in Section XIV. Meetings have been held with state, city, and town officials relative to the several plans under consideration.

g. Field reconnaissance. Field reconnaissance of the problem areas and sites of potential improvements was made by the Division Engineer and representatives of his office.

SECTION III - PRIOR REPORTS

5. PUBLISHED REPORTS

Flood control in the Quinebaug River Subbasin has been considered in three published reports on the Thames River Basin:

a. "308" Report. A report dated December 1, 1930 and printed as House Document 644, 71st Congress, 3d session, covered navigation, flood control, power development, and irrigation in the Thames River Basin. The report found that further improvements were not warranted at that time.

b. 1940 Report. A preliminary examination and survey of, and review of reports on, the Thames River for flood control and other purposes, dated April 11, 1940, was printed as House Document 885, 76th Congress, 3d session. The report recommended construction of one local channel improvement project at Norwich, Conn., and seven flood control reservoirs, including four in the Quinebaug River Subbasin at Buffumville, Hodges Village, East Brimfield and Westville. The plan was authorized by Public Law 228, 77th Congress, 1st session, approved August 18, 1941.

c. NENYIAC Report. Flood control in the Quinebaug River Subbasin is also considered in Part Two, Chapter XX of "The Resources of the New England-New York Region," a comprehensive report on power potentialities and on the land, water, and related natural resources of the region. Prepared by the New England-New York Interagency Committee, the report was submitted to the President of the United States by the Secretary of the Army on April 27, 1956. The basin plan set forth in this report includes 3 flood control reservoirs in the Quinebaug River Subbasin: Hodges Village on the French River in Oxford, Mass., Buffumville on the Little River in Charlton, Mass., and East Brimfield on the Quinebaug River in Sturbridge, Mass. This report is printed as Senate Document 14, 85th Congress, 1st Session.

SECTION IV - DESCRIPTION

6. LOCATION AND EXTENT

The Quinebaug River Subbasin is located in south-central New England and lies within the confines of New London, Tolland, and Windham Counties in Connecticut; Hampden and Worcester Counties in Massachusetts; and Providence, Kent, and Washington Counties in Rhode Island. The Quinebaug Subbasin watershed has a maximum length of approximately 55 miles, an average width of about 15 miles, and a maximum width of about 23 miles along the Massachusetts-Connecticut border. Its total drainage area of 744 square miles accounts for slightly more than 50 percent of the total drainage area of the entire Thames River Basin. A map of the Quinebaug River Subbasin is shown on Plate No. 1.

7. TOPOGRAPHY

The Quinebaug River Subbasin lies completely within the uplands of New England. The entire subbasin is maturely eroded with rounded hills rising above relatively narrow valleys. Swamps and lakes occupy many of the broader valleys, particularly in the northern part of the watershed. The largest body of water in the subbasin is Lake Chaubunagungamaug (1,280 acres), also known as Lake Webster, located directly east of Webster, Mass. Elevations are generally less than 400 feet above sea level in most of the Connecticut part of the basin. In the Massachusetts portion, most of the hills reach heights in excess of 800 feet, with some hilltops on the northwest divide of the watershed exceeding elevations of 1,200 feet above mean sea level. The highest point in the watershed is Mount Pisgah (1,264 feet) in the town of Wales, Mass.

8. GEOLOGY

The Quinebaug River Subbasin is underlain by crystalline rocks characteristic of the New England Upland. The bedrock, which is generally mantled throughout the subbasin by glacial till, frequently projects through the thin cover of till on the hills and at places in the valleys where the streams have uncovered bedrock spurs. Overlying the till or bedrock in the valleys are extensive deposits of stratified sand, silt, and gravel occurring as wash plains and terraces. Throughout the subbasin, generally, foundations and soils are suitable for all types of flood control structures, and suitable construction materials in adequate quantities are readily available near the site of the recommended plan of improvement.

9. STREAM CHARACTERISTICS

a. Main stream. The Quinebaug River is the principal tributary of the Shetucket River which, in turn, is the principal tributary of the Thames. The Quinebaug rises in the northeast part of the town of Union, Conn., at a small pond in the village of Mashapaug at an elevation of 690

feet above mean sea level. The river follows a sinuous course in a general northerly direction for about 8 miles to East Brimfield, Mass., and then generally southeastward for about 25 winding miles to its confluence with the French River at Mechanicsville in the southwest part of the town of Thompson, Conn. From there the Quinebaug flows more or less south for about 43 miles to empty into the Shetucket River just north of the city of Norwich, Conn. The Quinebaug has a total length of approximately 76 miles and a total fall of about 670 feet.

b. Tributaries. The principal tributaries of the Quinebaug River are the French, Five Mile, Moosup, and Pachaug Rivers.

(1) The French River is the largest and most important tributary of the Quinebaug. It rises in Greenville Pond in the southwestern part of the town of Leicester, Mass., and flows south for about 28 miles through the towns of Oxford and Webster, Mass., and Thompson, Conn., to its junction with the Quinebaug at the village of Mechanicsville, Conn. It has a drainage area of 111 square miles and a total fall of about 470 feet.

(2) The Five Mile River rises in Little Pond in the northeast part of the town of Thompson, Conn., near the Massachusetts-Connecticut line, and flows in a general southerly direction for 22 miles through the towns of Putnam and Killingly, Conn., to its confluence with the Quinebaug at the borough of Danielson. The Five Mile has a drainage area of 77 square miles and a total fall of 318 feet.

(3) The Moosup River rises in a small pond near the Connecticut-Rhode Island boundary in the town of Foster, R. I., flows generally south for about 8 miles to a point about 1 mile west of the village of Greene in the town of Coventry, R. I., then flows generally west through the towns of Sterling and Plainfield, Conn., for about 14 miles to its confluence with the Quinebaug about 1.5 miles below the village of Wauregan, Conn. It has a drainage area of 88 square miles and a total fall of about 400 feet.

(4) The Pachaug River rises in Beach Pond in the town of Voluntown, Conn., near the Connecticut-Rhode Island state line and follows a very devious westward course for about 15 miles through the towns of Voluntown and Griswold, Conn., to empty into the Quinebaug at Jewett City. The Pachaug has a drainage area of 60 square miles and a total fall of 186 feet.

c. Channel capacities. Where the streams pass through cities and villages or other heavily built-up or industrialized areas, channel capacities are frequently inadequate for other than minor flood flows due to encroachment by structures.

10. AREA MAPS

The Quinebaug River and its watershed are shown on standard quadrangle sheets of the U. S. Geological Survey (1:31,680 and 1:62,500) and on standard quadrangle sheets of the Army Map Service (1:25,000). Profiles of the Quinebaug and French Rivers are shown on Plate 2.

SECTION V - ECONOMIC DEVELOPMENT

11. POPULATION

a. General. The Quinebaug River Subbasin contains all or part of 19 Massachusetts, 18 Connecticut, and 6 Rhode Island towns. The estimated population of the basin (based on the 1950 Census) is approximately 105,400, of which about 54,400 are in Massachusetts, 49,650 in Connecticut, and 1,350 in Rhode Island.

b. Distribution. The population of the Quinebaug River Subbasin is about evenly divided between urban and rural. The Massachusetts portion of the basin has about 65 percent of its population urban and 35 percent rural, while the Connecticut portion of the basin has 39 percent of its population urban and 61 percent rural.

c. Concentration. Although there are no large municipalities in the subbasin, sizable concentrations of population are located at Southbridge (17,519) and Webster (13,194) in Massachusetts, and at Killingly (10,015), Putnam (9,304), and Plainfield (8,071) in Connecticut.

12. TRANSPORTATION

The transportation needs of the Quinebaug River Subbasin are served by 2 railroads, 5 interstate bus lines, and many trucking companies. Except for airstrips at Southbridge, Leicester, Woodstock, and Griswold, there are no commercial air facilities in the basin, and scheduled airline passenger or freight service is not generally available within the subbasin. The small area in the northernmost part is served by the Worcester Airport.

a. Railroads. Eight towns have passenger and freight train service, and 5 additional towns have freight train service only. The main line of the Boston & Albany Railroad crosses the northernmost tip of the subbasin. The Worcester-New London-New York City line of the New Haven Railroad traverses the basin from north to south, making rail service accessible to every part of the subbasin.

b. Busses. Nine of the subbasin's towns, including 5 which do not have passenger train service, are on direct bus routes to New York City, Albany, Hartford, Springfield, Worcester, Boston, and Providence.

c. Highways. The subbasin is crisscrossed by a network of paved roads, and every town in the subbasin has access by automobile to shopping centers at Worcester, Providence, Norwich, Willimantic, and Springfield. The main routes in the network are: U. S. 6, 44, and 20; the new Massachusetts Turnpike; and Conn.-R.I. 14 crossing east to west; and Mass.-Conn. Routes 93 and 12 running north and south. Conn.-Mass. Route 15 joins the Massachusetts Turnpike in the northwest portion of the subbasin to form the main route from Boston to New York City.

13. MANUFACTURING

a. Extent of manufacturing. Manufacturing is the major economic activity in the Quinebaug River Subbasin. Most of the labor force living in the basin is employed in manufacturing, and almost two-thirds of the towns located in the subbasin are the sites of manufacturing plants.

b. Distribution of industry. Although Putnam, Conn., and Southbridge and Webster, Mass., (all located in the northern half of the subbasin) account for approximately 65 percent of the employed manufacturing workers of the subbasin, manufacturing activity is fairly evenly distributed throughout the entire watershed in virtually every town or village along the banks of the Quinebaug, Moosup, and French Rivers. The town of Southbridge alone accounts for about 25 percent of the industrial production in the subbasin, while the town of Webster and the city of Putnam account for 20 percent each. The group of villages which form the town of Plainfield, Conn., are next in importance with a combined 16 percent of the subbasin's manufactures.

c. Leading industries. The most widespread and by far the most important industrial activity in the subbasin is the textile and clothing industry, constituting about 43 percent of the subbasin's manufacturing activity, while the most localized industry is shoe manufacturing, employing about 7 percent and located entirely in the town of Webster. Other leading industries of the Quinebaug River Subbasin are, in the order of their importance: optical goods, employing about 22 percent of all manufacturing workers; fabricated metals and machinery, employing about 13 percent; and furniture, employing about 6 percent.

d. Important manufacturing centers and their products. The more important manufacturing centers in the subbasin and their principal products are: Southbridge--optical goods, machinery, and electronic equipment; Putnam--textiles and garments, and optical goods; Webster--textiles and shoes; Plainfield--furniture; Moosup (Plainfield)--textiles and cosmetic containers; Wauregan (Plainfield)--combed cottons; Jewett City (Griswold)--insulated wire and cables; Glasgo (Griswold)--textile dyeing and finishing; and Rochdale (Leicester)--textiles.

14. NATURAL RESOURCES

Water is the only important natural resource of the Quinebaug River Subbasin. Sands, gravels, and some granite in the area are suitable for commercial use.

a. Water supply. Nearly 71,000 people use water for domestic purposes from public sources within the Quinebaug River Subbasin. About 54 percent is surface water, while the remainder is from ground water sources. The rivers in the basin are also important sources of water for industrial uses. The textile industry is the largest consumer of industrial water,

requiring great quantities of relatively clean, soft water for washing and dyeing. The optical goods industry is also a large user, requiring water for grinding and rinsing operations. The Water Resources Division of the U. S. Geological Survey states that ample surface water supplies appear to be available for prospective uses, although a need for additional water for industrial uses during low flow periods has been expressed by officials of industries in Southbridge, Mass. Large additional ground water supplies also appear to be available but require evaluation.

b. Water power. According to the Federal Power Commission report of 1953, there are 18 hydroelectric plants in the Quinebaug River Subbasin with a total installed capacity of 10,630 kilowatts. The largest plant, owned and operated by the Connecticut Light & Power Company at Preston, Conn., has an installed capacity of 2,000 kilowatts and a gross head of 25 feet. This is the only public utility plant in the basin, all others being owned and operated by industries. Few industries rely entirely on water power at the present time. Many have installed steam-electric generating plants, and others rely on purchased power from utility companies for their entire needs or to augment hydropower.

c. Recreational use of water. Twelve state forests and parks located wholly or in part in the Quinebaug River Subbasin afford opportunities for fishing, hunting, camping, swimming, and picnicking. A number of well-stocked ponds and streams provide fishing in many parts of the watershed. Most of the lakes and ponds in the subbasin are extensively developed with colonies of summer homes, with the greatest concentration of summer cottages being located at Lake Chaubunagungamaug in Webster, Mass.

d. Forestry and agriculture. Although much of the Quinebaug River Subbasin is wooded, most of this consists of second or third growth and brush with little commercial value. Because of shallow soil cover and irregular terrain, agriculture is also relatively unimportant in the subbasin, with less than 10 percent of the watershed area being used for the cultivation of crops. The predominant agricultural pursuits in the subbasin are poultry raising and dairying.

e. Mineral resources. There are few minerals of commercial value to be found in the area, and the mineral production in the subbasin is limited to sand, gravel, and some granite.

SECTION VI - CLIMATOLOGY

15. GENERAL

The climate of the Quinebaug River Subbasin is generally moderate. In the southern portion of the subbasin, due to the tempering influence of nearby Long Island Sound, summers are not excessively hot and winters are generally mild, with hot spells in summer and cold periods in winter usually being of short duration. This moderating influence decreases with the distance from the coast, and winters are colder at the higher elevations in the northern part of the watershed. The subbasin is subject to frequent but short periods of heavy precipitation. The subbasin lies in the path of the "prevailing westerlies" and of cyclonic disturbances that cross the country from the west or southwest and converge on the Northeast. It is also exposed to occasional coastal storms that travel up the Atlantic Seaboard, some of them being of tropical origin and of hurricane intensity.

16. TEMPERATURE

Mean annual temperatures vary from 47 to 50°F. throughout the subbasin. Average monthly temperatures vary widely throughout the year, ranging from between 68 and 72°F. in July and August to between 23 and 30°F. in January and February. Extremes in temperature range from occasional highs in the upper nineties to infrequent lows of about -10°F. At North Grosvenor Dale, Conn., about 6 miles north of Putnam, temperatures have ranged from a low of -25°F. to a high of 103°F.

17. PRECIPITATION

The average annual precipitation over the Quinebaug River Subbasin is about 44 inches, with variances from about 41 inches in the vicinity of Norwich, Conn., to about 50 inches in the upper watershed of the Moosup River. Distribution of precipitation throughout the year is fairly uniform. The range between maximum and minimum values of average monthly precipitation at any one location within the watershed is about 1 inch. Annual snowfall increases with the distance from the coast, with the greatest depths being experienced on the higher elevations, varying from about 37 inches in the south to more than 50 inches in the upland areas of Massachusetts. The water content of the snow cover in the early spring seldom averages more than 2 inches over the entire subbasin, but occasionally reaches amounts of 4 to 6 inches or more at upland locations.

SECTION VII - RUNOFF AND STREAMFLOW DATA

18. GAGING STATION RECORDS

At the present time there are 8 stream-gaging stations distributed throughout the Quinebaug River Subbasin. The U. S. Geological Survey has published records of river stages and streamflows at these locations for varying lengths of time since 1918. The records are generally good to excellent except for those periods of no gage-height record or ice effect, when they are fair. Before and during the floods of 1938, coverage was incomplete and no records are available for the French River and for the Quinebaug River above the Massachusetts-Connecticut line until after that time. The locations of stream-gaging stations in the subbasin, together with their respective drainage areas and periods of record, are listed in Table 1.

TABLE 1

GAGING STATIONS - QUINEBAUG RIVER SUBBASIN

Location	Drainage Area	Period of Record
Quinebaug River at Westville, Mass.	93.8	1940 - 1955
Quinebaug River at Quinebaug, Conn.	157	1932 - 1953
Quinebaug River at Putnam, Conn.	331	1930 - 1953
Quinebaug River at Jewett City, Conn.	711	1919 - 1955
Little River at Buffumville, Mass.	27.7	1940 - 1955
French River at Webster, Mass.	85.3	1950 - 1955
Five Mile River at Killingly, Conn.	58.2	1938 - 1953
Moosup River at Moosup, Conn.	83.5	1933 - 1953

SECTION VIII - FLOODS OF RECORD

19. HISTORIC FLOODS

Major historic floods in the Quinebaug River Subbasin include those of September 1828, March 1876, February 1886, and March 1888. Records indicate that the 1888 flood was severe only on the French River, while the first three were progressively the greatest general floods of record prior to that of March 1936. Data on these floods is meager and unreliable. Recorded losses are not excessive, probably because they occurred before the present extensive industrial development in the basin.

20. RECENT FLOODS

The Quinebaug River Subbasin has experienced 6 major floods in the past 30 years, as follows: November 1927, March 1936 (2 floods), July and September 1938, and August 1955. The November 1927 flood was a localized flood, being severe only on the Moosup River. The floods of March 1936 resulted from the storms of March 9-13 and 16-22. The first rise surpassed the previous record flood and the second rise, in turn, surpassed the first rise in most parts of the basin. The July 1938 flood was generally smaller than the March 1936 floods, but considerable portions of the lower Quinebaug River were flooded, as well as its tributaries as far north as the French River. The flood of September 1938 resulted from an intense storm preceding a disastrous hurricane, which dumped 10 to 14 inches of rainfall on the subbasin. Except for the Quinebaug River Subbasin below Putnam, this flood is the second greatest flood of record. The greatest flood of record in the Quinebaug River Subbasin occurred in August 1955 when hurricane Diane deposited record amounts of precipitation on the subbasin. The peak discharges for this flood were two to three times the magnitude of previously recorded floods. Comparative flood magnitudes for the floods of March 1936, September 1938, and August 1955 are given in Table 2 in the following section.

SECTION IX - STANDARD PROJECT FLOOD

21. GENERAL

The magnitude of the August 1955 flood made it necessary to reappraise the flood potentials of the Quinebaug River Subbasin. Analyses of the 1955 flood indicated a substantial increase in the peaks of unit hydrographs, previously used for determination of the standard project flood in this subbasin, particularly for intense storms following an antecedent wet period. Determination of the precipitation amounts for the standard project storm and the development of the storm pattern followed procedures described in Civil Engineer Bulletin No. 52-8, Standard Project Flood Determinations. The standard project flood, used as a guide in determining flood control requirements, is shown in Table 2 for selected index points.

TABLE 2

COMPARATIVE FLOOD MAGNITUDES
FLOODS OF MARCH 1936, SEPTEMBER 1938, AUGUST 1955, AND STANDARD PROJECT FLOOD

LOCATION	DRAINAGE AREA (Sq.miles)	STAGE IN FEET				PEAK DISCHARGE IN C.F.S.			
		March 1936	Sept 1938	Aug 1955	Stand.Proj. Flood	March 1936	Sept 1938	Aug 1955	Stand Proj Flood
Quinebaug River									
Westville, Mass.	94	10.0*	13.0*	16.1	16.0	4,100*	9,000*	17,500	17,000
Southbridge, Mass.	126	8.3	10.0	14.9	13.7	6,500*	12,000*	36,000*+	28,500
Quinebaug, Conn.	157	13.4	16.2	19.0	18.5	10,500	14,100	35,000*+	33,300
Putnam, Conn. (Above Little R)	295	13.4	14.3	20.0	21.0	16,000	19,000	45,000	52,000
Putnam, Conn. (Below Little R)	331	17.3	19.5	26.5	27.5	17,200	20,900	48,000	55,000
Jewett City, Conn.	711	24.0	21.7	29.0	35.5	29,200	22,800	40,700	61,500
French River									
Webster, Mass.	85	15.9*	12.4*	26.0	27.5	4,700	2,700	14,400	16,300
Little River									
Buffumville, Mass.	28	11.3*	5.5*	15.5	15.6	3,700*	570*	8,340	8,500

*Estimated
+Affected by dam failure

SECTION X - EXTENT AND CHARACTER OF FLOODED AREA

22. GENERAL

Forming the largest tributary area in the 1,470-square mile Thames River Basin, the Quinebaug River system drains 744 square miles in south-central Massachusetts and northeastern Connecticut. The area has a long history of industrial development, and a large percentage of the population is concentrated in the industrial communities located in the narrow flood plain of the Quinebaug and its principal tributary, the French River. The largest of the many communities vulnerable to serious flooding are Southbridge and Webster, Mass., and Putnam, Conn.

The leading industrial activities of the Quinebaug River watershed are the manufacture of textiles and such diversified products as optical goods, shoes, machine tools, furniture, electrical equipment, and other metal and rubber products. Optical goods and textiles are produced at Southbridge, and textiles are manufactures and processed at Webster and Dudley, Mass., and at Putnam, Griswold, Killingly, and Plainfield, Conn. The industrial payrolls in these communities were an estimated $46,000,000 in 1954.

The August 1955 flood had a pronounced effect upon nearly all of the industrial communities with economies geared to textile production. Approximately 43 percent of the manufacturing activity in the watershed is in textile production, a notably depressed industry in recent years, and herculean efforts are being made by many of the flooded concerns to recover their losses and attempt to remain in business. Although some gains are being made in attracting small, diversified industries to several of the larger communities, available industrial space is not fully utilized in flood-prone plants in many of the communities along the Quinebaug and French Rivers. Reservoir projects currently under construction on both the Quinebaug and French Rivers will greatly reduce the frequency of flooding and will remove some of the reluctance to utilize fully the existing industrial space.

Labor surpluses continue to plague the larger communities, particularly Southbridge, Webster, Dudley, Thompson, and Putnam, and many workers commute to plants outside the watershed area. The current feeling by many New England textile officials is that the period of liquidations and plant movements is ending, and increased demands for textile products will be noted in the next few years as the national population growth continues its upward trend and increased legislative assistance is given to depressed, domestic industries.

The Quinebaug watershed is adequately serviced by modern highway and railroad systems. Two interstate highways and 3 branch railroads parallel the Quinebaug and French Rivers, and systems of other highways, railroads, and utility lines traverse the flood areas of both rivers at numerous points.

23. QUINEBAUG RIVER

a. General. Southbridge, Mass., and Putnam, Conn., the largest of the industrial towns in the Quinebaug River valley, are vulnerable to widespread and damaging flooding. Other areas severely affected by flooding are Charlton, Sturbridge, and Dudley, Mass., and Plainfield, Thompson, Killingly, and Griswold, Conn.

b. Southbridge, Mass. In the city of Southbridge, the largest community in the watershed, some 570 acres are subject to inundation. Approximately 350 residential properties and 70 commercial establishments are located in the flood area, with the largest concentration in the area between Central Street and Cady Brook. Industries located in the flood plain, which employ more than 63 percent of the local labor force, had an annual payroll estimated at $13,600,000 for 1954. The American Optical Company, the largest employer in Southbridge, is vulnerable to severe flooding in 3 plants located along the Quinebaug River near the mouth of Cady Brook.

c. Putnam, Conn. Putnam, the third largest community in the watershed, is located on both banks of the Quinebaug River, a short distance downstream from the French River confluence. Approximately 300 acres in Putnam are subject to flooding. Located in the flood plain are more than 235 dwellings, 40 commercial establishments, 2 fuel storage plants, several public buildings, and 9 industrial firms. During 1954 these firms employed nearly 45 percent of the local labor force and had an annual payroll of $2,600,000. Urban renewal of a portion of the flood-prone area of the city under the Federal Urban Renewal Act is scheduled for the near future.

24. FRENCH RIVER

a. General. Extensive areas are subject to destructive flooding along the French River, notably in Webster, Mass. Other nearby flood-problem areas include portions of Dudley and Oxford, Mass., and Thompson, Conn.

b. Webster, Mass. There are approximately 160 highly developed acres in the flood-prone area of Webster, the second largest community in the Quinebaug River watershed. Seventeen of Webster's industries are exposed to flooding. These industries had an annual payroll of approximately $6,000,000 in 1954, representing about half of the total industrial payroll in the community. Over 50 residential buildings, 43 commercial establishments, and 2 utility plants are located in the flood plain, with a heavy concentration in the vicinity of the Main Street bridge.

SECTION XI - FLOOD DAMAGES

25. GENERAL

The flood of August 1955 brought unprecedented destruction to highly developed areas along the Quinebaug and French Rivers. Damage surveys conducted immediately after the flood revealed that $54,680,000, or nearly 90 percent of the total property loss in the Thames River Basin, occurred in the Quinebaug River Subbasin. Of this amount, $30,000,000 occurred in Massachusetts and $19,000,000 in Connecticut along the main stems of the Quinebaug and French Rivers.

In Massachusetts, where 8 lives were lost, Southbridge, Charlton, Webster, and Dudley were the principal damage centers. The hardest hit towns in the Connecticut portion of the basin were Putnam, Thompson, and Plainfield. Widespread flooding involved over 900 dwellings and 180 commercial establishments in the Quinebaug and French River watersheds. Damages to highways, bridges, utilities, and public buildings were extensive, causing complete and lengthy disruption of transportation and communication facilities. Damages sustained by 60 industrial concerns amounted to nearly $30,000,000, over 60 percent of the total losses along the Quinebaug and French Rivers.

Prior to the flood of August 1955, the floods of record were those of March 1936 on the French River and September 1938 on the Quinebaug River. Flood damages in March 1936 amounted to over $3,000,000 along the French River and $2,000,000 in the Quinebaug River. In September 1938, a flood of major proportions along the Quinebaug River resulted in a total loss of over $4,500,000. Principal damage centers in both floods were the communities of Brimfield, Sturbridge, Southbridge, Charlton, Dudley, and Webster, Mass., and Putnam and Thompson, Conn. Table 3 presents the 1955 experienced flood losses in the Quinebaug River Subbasin, tabulated by river, town, and type of loss.

TABLE 3

AUGUST 1955 FLOOD LOSSES
QUINEBAUG RIVER SUBBASIN
MASSACHUSETTS - CONNECTICUT
(Losses in $1,000)

Town	Urban	Rural	Industrial	Utility	Highway	Railroad	Total
Quinebaug River Area							
Brimfield, Mass.	-	-	-	-	660	-	660
Sturbridge	290	-	50	-	620	-	960
Charlton	420	-	1,410	-	1,160	50	3,040
Southbridge	3,760	-	13,370	-	1,630	20	18,780
Dudley	10	-	80	-	80	30	200
Thompson, Conn.	90	20	1,920	-	110	-	2,140
Putnam	2,700	20	3,000	1,120	810	700	8,350
Pomfret	20	10	-	-	690	110	830
Killingly	180	-	350	80	310	-	920
Brooklyn	70	-	100	-	-	-	170
Plainfield	10	-	2,100	-	500	-	2,610
Griswold	60	-	730	-	-	50	840
Total Quinebaug	7,610	50	23,110	1,200	6,570	960	39,500
French River Area							
Oxford, Mass.	260	-	710	-	530	40	1,540
Webster	760	-	4,550	1,600	410	280	7,600
Dudley	520	-	1,970	-	170	200	2,860
Thompson, Conn.	430	-	1,280	10	450	1,010	3,180
Total French	1,970	-	8,510	1,610	1,560	1,530	15,180
Total	9,580	50	31,620	2,810	8,130	2,490	54,680

26. UPPER QUINEBAUG RIVER

a. General. Flooding of the Quinebaug River above the French River confluence, extending from the headwater areas near Brimfield downstream through Sturbridge, Southbridge, and Dudley, Mass., and Thompson, Conn., resulted in a total loss of over $25,700,000. The heaviest concentration of losses occurred in Southbridge, by far the hardest hit community in the entire basin.

b. Southbridge, Mass. Flooded by the waters of both the Quinebaug River and Cady Brook, Southbridge experienced losses of over $18,000,000. Some 350 dwellings in the Southbridge area were flooded and 70 commercial establishments suffered damages ranging from flooded and silted basements to complete loss of stock, equipment, and buildings. Eight highway bridges in the city were destroyed and extensive sections of several roads were undercut and washed out.

Losses sustained by Southbridge industries amounted to over $13,000,000. The American Optical Company, located near the confluence of Cady Brook and the Quinebaug River, was particularly hard hit when the flood overtopped and breached dikes constructed by the company following the 1938 flood.

27. LOWER QUINEBAUG RIVER

a. General. Communities along the Quinebaug River between the French River confluence and the mouth of the Quinebaug sustained a total loss of about $13,700,000. The city of Putnam, Conn., situated a few miles downstream from the Quinebaug-French confluence, suffered over half of the total loss in this reach. Other hard hit towns in this area were Thompson and Plainfield, where heavy damages were sustained by several industrial concerns.

b. Putnam, Conn. The swift current and extreme depth of flooding brought severe damage to more than 200 homes and 40 commercial establishments in Putnam. Foundations of many buildings were scoured out, several buildings were completely destroyed and a number of stores suffered a total loss of stock and equipment. In the Middle and Arch Street area floodwaters inundated the second floor of some buildings. Damage to railroad facilities, including the total loss of a 200-foot railroad trestle, accounted for approximately one-tenth of the total loss in the city.

28. FRENCH RIVER

a. General. Damages in the French River area of the subbasin amounted to a total loss of nearly $15,200,000. The principal damage center in the area was Webster, Mass., where half the total loss was sustained. The towns of Dudley, Mass., and Thompson, Conn., flooded by both the French and Quinebaug Rivers, also suffered major losses.

b. Webster, Mass. Industrial losses accounted for 60 percent of the total loss in Webster. A number of textile mills on the banks of the French River suffered heavy damage, including complete destruction of several mill buildings. Some 200 dwellings and over 50 commercial establishments were damaged. Aggregate damage to highways, bridges, and railroad lines resulting from French River flooding accounted for about 10 percent of the total loss in Webster. Two bridges were washed out, and 1 section of Chase Avenue was scoured to a depth of 6 feet as the river cut a new channel. When the Texas Pond dam in Oxford breached, a channel 150 feet wide and up to 40 feet deep was cut through U. S. Route 20.

29. RECURRING LOSSES

Under economic conditions existing in 1957, a recurrence of the 1955 flood stages would cause a total loss estimated at $55,500,000 along the Quinebaug and French Rivers and the Shetucket and Thames River reaches which would be affected by discharges from the Quinebaug River. Approximately $39,600,000 of this loss would occur along the main stem of the Quinebaug River and the downstream areas around the Quinebaug and Shetucket River confluences. The remaining loss of $15,900,000 would be sustained in areas along the French River.

A recurrence of the September 1938 flood, the most damaging flood in the Thames River Basin prior to the record flood of August 1955, would cause losses of $17,700,000 with $15,450,000 of this loss occurring along the Quinebaug River and $2,250,000 along the French River. A recurrence of the March 1936 flood in the basin would result in a total loss of $14,500,000, with damages of $7,600,000 along the French River and $6,900,000 along the Quinebaug River. Urban renewal in Putnam would change the recurring loss picture. There is, however, insufficient data to fully evaluate recurring losses for the redeveloped area at this time.

30. AVERAGE ANNUAL LOSSES

Natural annual losses - losses occurring without flood protection in the Quinebaug River system and the Shetucket and Thames River reaches affected by discharges from the Quinebaug River - are estimated at $2,136,000 at 1957 price level. Of this total, annual losses of $1,148,000 occur along the Quinebaug River, $737,000 along the French River, and $251,000 along the lower reaches of the Shetucket and Thames Rivers. Projects in the authorized system would reduce the total annual losses to $539,000.

SECTION XII - EXISTING CORPS OF ENGINEERS' FLOOD CONTROL PROJECTS

31. AUTHORIZED PROJECT

The Flood Control Act of August 18, 1941 approved a system of reservoirs and channel improvement in the Thames River Basin in accordance with plans printed in House Document No. 885, 76th Congress, 3d session, and authorized $6 million for initiation and partial accomplishment of the project. The Flood Control Act of December 22, 1944 authorized the completion of the approved plan. The works covered by this project consist of 7 dams and reservoirs on tributaries of the Thames River in Massachusetts and Connecticut, within a radius of 45 miles from Norwich, Conn., and channel enlargement of the Shetucket River at Norwich. Pertinent data on the 4 dams and reservoirs located within the Quinebaug River Subbasin are given in Table 4. Costs are as of the last printed Annual Report (1956) of the Chief of Engineers. The current construction status of these projects is briefly described in the following paragraphs.

The site of the Buffumville Dam and Reservoir is on the Little River, a tributary of the French River, in the town of Charlton, Mass., 5 miles northwest of Webster, Mass., and 15 miles north of Putnam, Conn. Construction of the dam is nearing completion, with completion of the project scheduled for the Summer of 1958.

The site of the Hodges Village Dam and Reservoir is on the French River, 6 miles north of Webster and 16 miles north of Putnam. Acquisition of property required for this project has been initiated. Agreements for abandonment of railroad lines in the reservoir area have been reached with the companies involved and have been approved by the Interstate Commerce Commission. Construction of the dam was advertised on 4 November 1957, with construction scheduled to start during the Spring of 1958 and be completed in 1959.

The site of the East Brimfield Dam and Reservoir is on the Quinebaug River, 1 mile west of the village of Fiskdale, Mass., and 20 miles northwest of Putnam. Acquisition of property required for this project has been initiated. Agreements relative to relocation of highways in the reservoir area have been reached with appropriate state, county, and town agencies. Relocation of an oil pipeline which traverses the reservoir area is being accomplished by the owner. Construction of the dam is scheduled for completion early in 1960.

The site of the Westville Dam and Reservoir is on the Quinebaug River, 2 miles west of Southbridge, Mass., and 15 miles northwest of Putnam. Planning for this project has been started.

The authorized projects will, upon completion, provide varying degrees of flood protection for areas under consideration in this report.

TABLE 4

AUTHORIZED RESERVOIRS IN THE QUINEBAUG RIVER SUBBASIN

Name	HODGES VILLAGE	BUFFUMVILLE	EAST BRIMFIELD	WESTVILLE
STREAM	French R.	Little R.	Quinebaug R.	Quinebaug R.
DISTANCE ABOVE MOUTH OF QUINEBAUG R.	56.5 miles	56.7 miles	64.5 miles	59.0 miles
DRAINAGE AREA	31.1 sq miles	26.5 sq miles	67.5 sq miles	26.0 sq miles (net)
HEIGHT OF DAM	55 ft.	66 ft.	55 ft.	50 ft.
TYPE	Earthfill	Earthfill	Earthfill	Concrete-gravity
RESERVOIR CAPACITY	13,000 ac-ft	12,700 ac-ft	30,000 ac-ft	12,000 ac-ft
ESTIMATED FEDERAL COST				
Construction	$1,456,000	$2,178,000	$1,914,000	$2,704,000
Land and damages(*)	3,844,000	722,000	5,186,000	3,846,000
TOTAL	$5,300,000	$2,900,000	$7,100,000	$6,550,000
ESTIMATED ANNUAL COST OF OPERATION & MAINTENANCE	$20,000	$20,000	$20,000	$20,000
Annual Charges	215,000	127,200	274,600	261,600
Annual Benefits	413,000	367,000	372,000	310,000
Benefit:Cost Ratio	1.9	2.9	1.4	1.2
STATUS	Under Construction	Under Construction	Under Construction	Under Design

(*) Includes highway, railroad and utility relocations.
Benefits and costs as of 1956.

SECTION XIII - IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES

32. GENERAL

No projects for flood control or other beneficial use of water in the Quinebaug River Subbasin have been constructed by other Federal agencies. Numerous small water supply reservoirs and ponds for individual use and water power have been constructed throughout the subbasin. These, however, have a negligible effect on flood stages. The Commonwealth of Massachusetts is currently constructing flood control improvements on 3 streams tributary to the Quinebaug River in Southbridge. The State of Connecticut is considering construction of a stoplog structure in Putnam. These projects are briefly described in the following paragraph.

33. IMPROVEMENTS BY NON-FEDERAL AGENCIES

a. Southbridge, Mass.

(1) Nuisance Brook. This project includes construction of a diversion canal approximately 500 feet long and installation of approximately 2,900 feet of 48-inch reinforced concrete pipe. The project is designed to divert a substantial portion of flood flows from the brook directly to the Quinebaug River, thereby bypassing the heavily built up sections along the lower reaches of the stream. The cost of this work is approximately $140,000.

(2) Cohasse Brook. The project consists of widening, deepening, and straightening approximately 2,300 feet of the brook from a point near its confluence with the Quinebaug River upstream to the vicinity of Cohasse Street. The cost of this work is approximately $36,000.

(3) Cady Brook. In conjunction with the reconstruction of the Charlton Street bridge which was washed out in the 1955 flood, the Commonwealth of Massachusetts is improving the channel of Cady Brook for a distance of 200 feet downstream and 300 feet upstream of the new bridge. The project consists of widening and deepening the channel and construction of concrete retaining walls on both sides of the new channel. The work, exclusive of bridge costs, is estimated to cost $115,000. Approximately $129,000 was expended in clearing, widening, and straightening the channel of this brook following the August and October 1955 floods.

b. Putnam, Conn. The State of Connecticut is preparing plans for construction of a stoplog structure across the railroad at or immediately upstream of the Providence Street bridge. This bridge, which is being reconstructed, was washed out in the August 1955 flood by floodwaters flowing down the railroad cut. The project is being designed to provide protection against the standard project flood modified by the four authorized upstream reservoirs. The estimated cost of the work is $105,000.

SECTION XIV - IMPROVEMENTS DESIRED

34. PUBLIC HEARING

A public hearing was held in Putnam, Conn., on December 12, 1956 to obtain the views of interested parties with respect to flood control and allied measures. Approximately 175 persons were in attendance, including representatives of state and local governments, industrial establishments, and civic organizations. Improvements requested included a flood control dam and reservoir on the Quinebaug River immediately above Putnam, Conn., and local protective works encompassing channel improvements and dam modifications at several locations in the Quinebaug River Subbasin. The preponderance of local opinion favored a flood control dam and reservoir and local protective measures at Putnam, Conn., and Southbridge, Mass. Digests of the public hearing and of letters from interested parties relative to the hearing are included in Appendix A.

a. Flood control dam and reservoir. The Mayor of Putnam proposed a fifth flood control reservoir, in addition to the 4 already authorized in the upper Quinebaug River Subbasin. Many representatives of the Putnam area, including municipal, civic, and industrial organizations, concurred in the Mayor's proposal. The suggested location for this dam is on the Quinebaug River in the relatively undeveloped area north of Mechanicsville, as near the city of Putnam as possible.

b. Putnam, Conn., local protection. The Mayor of Putnam also requested consideration of a stoplog barrier across the railroad cut in the northerly section of Putnam. The barrier could be located either under the new Providence Street bridge or at a point farther north and would prevent the breakthrough of water through the railroad cut as had occurred in previous floods. He also requested consideration of channel improvement and modifications to 1 or more of the 3 dams in Putnam. These proposals received support similar to the Mayor's proposal for another dam upstream. The Chief Engineer of the Connecticut State Flood Control and Water Policy Commission (now the Connecticut State Water Resources Commission), stated that his agency intended to construct the stoplog structure as part of the local contribution to flood control. Other local proposals for Putnam included dredging and straightening of the channel of the Quinebaug River through Putnam.

c. Southbridge, Mass., local protection. The Town Engineer of Southbridge requested permanent flood protection on the Quinebaug River and its tributaries, including dredging and widening, dikes and floodwalls, stream clearance, and the establishment of stream encroachment boundaries. His specific requests for Southbridge included improvements on the Quinebaug River, Nuisance Brook, Cohasse Brook, Cady Brook, Dean Brook, and McKinstry Brook. Similar or additional improvements were requested by other local municipal, civic, and industrial organizations.

d. Killingly, Conn., local protection. The Town Manager of Killingly, Conn., asked for local improvements at Killingly, including dredging and widening of the Quinebaug River at various points and better control of the Five Mile and Whetstone Rivers.

e. Grosvenordale, Conn., local protection. An official of the mill at Grosvenordale requested improvement of the French River to prevent a repetition of the catastrophic losses suffered by the mill in the August 1955 and previous floods.

f. Plainfield, Conn., local protection. An official of the mill at Wauregan (Plainfield) requested improvement of the Quinebaug River to prevent a repetition of the losses suffered by the mill in the August 1955 and previous floods.

g. Webster, Mass., local protection. A request was made for an examination of Lake Chaubunagungamaug in Webster, Mass. In the flood of August 1955 and in previous floods, the lake had almost overtopped its dam and other low points on its periphery. Sudden release of the impounded waters through failure of the dam or dikes would cause great damage to Webster and other downstream communities.

35. CONSULTATIONS WITH LOCAL INTERESTS

Meetings were held with representatives of the New York Regional Office of the Housing and Home Finance Agency; the Urban Renewal Administration; Redevelopment Agency and Planning Commission of the City of Putnam; Town Engineers of Southbridge, Webster, and Putnam; and representatives of various industries throughout the basin.

SECTION XV - FLOOD PROBLEMS, RELATED PROBLEMS, AND SOLUTIONS CONSIDERED

36. GENERAL

The Quinebaug River Subbasin is susceptible to floods caused by heavy rains or a combination of heavy rains and melting snow. Runoff is rapid due to generally hilly topography. Flooding has been aggravated by inadequate channels, restricted bridge openings, and small dam failures. Many areas in the flood plains contain industrial and commercial developments as well as residential sections. The 4 authorized reservoirs in the Quinebaug River Subbasin will provide substantial protection for the affected communities. However, with these 4 reservoirs in operation, a recurring 1955 flood would still produce $18,700,000 in damages.

All possible and practicable methods for solving the flood problems were considered. Methods considered included reservoirs to supplement the 4 presently authorized, dikes and flood walls, channel improvement, diversion of floodwaters, flood plain zoning, and evacuation and resettlement. The most feasible methods for providing flood protection are described in succeeding paragraphs.

The magnitude of the flood losses and possible reductions limited the solutions to the choice of 1 of 2 reservoirs or 1 local protection project at Putnam, Conn. Two small projects have been authorized for study under the provisions of Section 205 of the 1948 Flood Control Act, as amended, and are not included in this report. Flood plain zoning as a partial, long range solution is discussed in paragraph 39. Other problems in the subbasin whose solution may be allied with flood control are discussed in paragraph 40.

37. RESERVOIRS

The 4 authorized reservoirs, described in paragraph 31, were reanalyzed and found to be economically justified. Average annual losses remaining after these reservoirs are sufficient to warrant consideration of additional flood protective works.

Additional favorable reservoir sites in this subbasin are very limited owing to extensive developments in the area. Investigations revealed 2 sites which warranted further study. These are the Red Bridge and West Thompson dam sites on the Quinebaug River, just upstream from Putnam, Conn. The sites are 2.8 miles apart and are alternatives to each other. Both reservoirs were found to be economically justified.

38. LOCAL PROTECTION

Local flood protection works were considered for various communities. These works would include dikes, flood walls, and channel improvements,

individually or in various combinations. The projects studied proved to be uneconomical except for dikes and flood walls at Putnam, Conn. Two other small projects in Massachusetts have not been evaluated. These latter 2 projects, along Cady Brook in Southbridge and the French River in Leicester, will be considered further under authority of Section 205 of the 1948 Flood Control Act, as amended.

Local protection studies along the main river were based on a design flood equal to the standard project flood modified by the 4 authorized reservoirs and a fifth reservoir at West Thompson or Red Bridge. Studies for Putnam were also made without consideration of a fifth reservoir. The largest flood of record, that of August 1955, was adopted as the design flood for the tributaries. An analysis of annual losses and annual costs indicated that uneconomical projects would remain uneconomical against any other adopted design flood. The most feasible local protection plans are described briefly in the following subparagraphs.

a. Southbridge, Mass. The town of Southbridge has experienced flooding along the Quinebaug River and 5 tributary brooks: McKinstry, Nuisance, Cady, Cohasse, and Dean Brooks. Protection against floods from the Quinebaug River proper will be largely provided by construction of the authorized Westville and East Brimfield reservoirs. Damage along the lower reaches of the tributary brooks will be lessened to some extent because of a reduction in the backwater effect of the main river. Tributary problems and solutions are as follow:

(1) McKinstry Brook would flood overbank to a depth of 5 to 6 feet from its mouth upstream to Pleasant Street bridge during a design flood. This depth would be increased to between 10 and 12 feet in the Plimpton Street area upstream from Pleasant Street bridge. Because of the heavily developed condition of the area, a rectangular concrete-lined channel would be the most feasible solution to this flood problem. Flood losses in this area are insufficient to warrant such a project.

(2) Nuisance Brook flooding is caused by inadequate road culverts. A diversion of this brook, currently under construction by the Commonwealth of Massachusetts, will provide flood protection for up to rare floods. No additional work by the Federal Government is warranted at this time.

(3) Cady Brook channel was substantially improved after the 1955 floods. The Commonwealth of Massachusetts is currently improving a 500-foot reach through the Charlton Street bridge. The channel from the State project downstream to the mouth of the brook and upstream in the Randolph Street area will remain inadequate to discharge a design flood. The resulting overbank flooding would be 3 feet deep in the Randolph Street area and 6 feet deep in the lower portion of the channel. Additional channel improvement would be the most feasible solution to the flood problem here. This plan will be considered further under authority of Section 205 of the 1948 Flood Control Act, as amended.

(4) Cohasse Brook causes flood damage along its course through the developed areas of Southbridge. The Town has requested that the brook channel be cleared and widened. The Commonwealth of Massachusetts is now in the process of accomplishing this work, beginning at the Chestnut Street culvert and extending upstream for 2,300 feet. The improvements under way are considered adequate.

(5) Dean Brook seriously damaged the Town sewage treatment plant during the August 1955 flood. A new treatment plant, valued at $560,000, is under construction on higher ground. No other structures are affected by overflows from this brook. No flood protection is warranted since the treatment plant is being relocated to higher ground and no other structures are involved.

b. Leicester, Mass. Improvements to provide protection for the Rochdale section of Leicester are being considered under the provisions of Section 205 of the 1948 Flood Control Act, as amended. The project would provide for improving 1,000 feet of the French River channel and for constructing 170 feet of flood wall and 550 feet of earth dike along the right bank.

c. Webster, Mass. Residual flood losses along the French River in Webster, after construction of the authorized Buffumville and Hodges Village reservoirs, are insufficient to justify further protective works at this time.

A large lake within the town, Lake Chaubunagungamaug, is considered a flood threat by local interests. They feel that the lake is in danger of sudden drawdown, either by dam failure or by overflow and scour at a saddle in its perimeter. The low point in the saddle is 2 feet lower than the present top of the dam, which was raised 18 inches after the August 1955 flood. Investigations revealed that the lake has made no contributions to past floods, and that under present conditions the probability of overtopping the saddle, and particularly the dam, is rare. No improvements by the Federal Government are considered to be warranted. Excess flood surcharges should be permitted to discharge freely over the saddle and across Route 193 which crosses the saddle. As a precautionary measure, local interests could riprap the shoulders of Route 193 for a distance of 500 feet at the low point. This would protect the saddle against scour. They should, in any event, maintain a close watch at this point during critical periods so that emergency action could be taken against any observed scour or erosion.

d. Grosvenordale, Conn. A large industrial plant and a residential section along Route 12 in the Grosvenordale section of Thompson were flooded during the August 1955 and previous floods. This flooding is the result of overflow from a mill pond on the French River. The pond is used by the industrial plant for power and fire protection. Two solutions to this problem were considered. First, modifying the dam by the addition

of a 7-foot high bascule gate. The second solution would consist of constructing a 2,000-foot long flood wall from the dam upstream to high ground. Neither of these plans is economically justified.

e. Putnam, Conn. The city of Putnam has experienced damaging floods from overflow of the Quinebaug River. During the August 1955 flood, floodwaters overflowed a local mill pond and coursed through a railroad cut to pour into congested residential and commercial areas. This pond overflow is the result of floodwater impoundment due to an inadequate dam spillway and river channel in the vicinity of Providence Street. August 1955 flood damages were further aggravated by converging flows and swift currents. The 4 authorized reservoirs would provide Putnam with inadequate protection against major floods.

Two solutions to the Putnam flood problem are feasible. The first is the construction of a reservoir at either of 2 alternate sites on the Quinebaug River, immediately upstream from the city. Such a reservoir project would be economical and would supplement the 4 authorized Quinebaug River Subbasin reservoirs.

The second solution is the construction of dikes and flood walls, individually or in various combinations with channel rectification and modification of the 3 existing dams. These various plans were also considered as increments to a fifth reservoir. The 1 local protection plan which proved to be economical is based on a 4-reservoir system and would provide for the construction of dikes and flood walls along the left bank of the Quinebaug River.

f. Killingly, Conn. The borough of Danielson and the village of Rogers, both in the town of Killingly, suffered flood damage during August 1955. In Danielson, the Quinebaug River channel is large enough to pass the standard project flood modified by the 4 authorized reservoirs and a fifth reservoir at West Thompson or at Red Bridge. Further consideration of flood protection for this reach is not warranted at this time.

In the village of Rogers, the river channel is large enough to accommodate a standard project flood modified by reservoirs. However, the present spillway section of a local dam is incapable of discharging this flood without overtopping of the non-overflow sections. This overtopping would cause flood damages which could be prevented by raising the dam 2 to 3 feet. Economic studies revealed that raising the dam would be unjustified. Damage is also caused to a mill and a group of houses by overflow of a headrace canal. This problem will be eliminated by the mill owners who are planning to install a headgate at the upper end of the canal.

The Five Mile River, which empties into the Quinebaug River at Danielson, and its principal tributary, Whetstone Brook, are considered flood threats by local interests. Investigation disclosed that this view

stems primarily from the feeling that these streams are heavy contributors to flood flows on the main river. Actually, little damage has been suffered in past storms along either of these streams. The watershed of the Five Mile River, including Whetstone Brook, contains a substantial amount of natural and man-made storage. U.S.G.S. gaging station records for the Five Mile River indicate no serious flood contribution by this stream. Further study is considered unwarranted.

g. Plainfield, Conn. The Wauregan Mills in the village of Wauregan have been badly damaged in the past by overflow of the Quinebaug River. The 4 authorized reservoirs would provide a high degree of protection for this plant. Either of the 2 reservoirs discussed in this report, West Thompson or Red Bridge, would substantially augment this protection. Further protection could be provided by the construction of a low dike. Studies revealed that such dike construction would be uneconomical.

39. ZONING

The State of Connecticut passed a flood plain zoning law during the 1957 session of its General Assembly. Section 9c of Public Act No. 364 authorizes the State Water Resources Commission to establish flood plain zoning lines to prevent encroachment on the waterways. Proposed zoning lines for the Quinebaug River are intended to establish waterways generally defined as the limits of a flood 5 times as large as the mean annual flood.

The establishment of flood plain zoning lines in accordance with Connecticut law would by no means be a complete solution to the Quinebaug River Subbasin flood problem. Such zoning, however, would be of some benefit over an extended period of time. It would prohibit the erection of additional structures in hazardous locations and thus prevent the compounding of future flood damages. It would also bar the future replacement of structures which are within the zoning lines at the time of their establishment.

The solution to the flood problem resulting from major floods in the urban lowlands of the Quinebaug River Subbasin must be sought elsewhere than in flood plain zoning. Such zoning must of necessity be limited to moderate discharges. Even for moderate floods, the effectiveness of zoning is a long term proposition which must await the gradual recession of existing encroachments. Zoning, therefore, can be considered as a partial solution which would gradually become effective after an indefinite lapse of time and, in any event, would generally be limited to moderate floods. The establishment of flood plain zoning lines is nevertheless an advisable procedure, although more immediate and effective solutions to the flood problem are available in reservoir and local protection works. Such zoning would also be advisable for the Massachusetts portion of the Quinebaug River Subbasin.

40. RELATED WATER RESOURCE DEVELOPMENTS

The Quinebaug River Subbasin needs for related water resource development include hydroelectric power, fish and wildlife, recreation, and pollution abatement. Control and abatement of pollution are being handled at state and local levels with the assistance of the Department of Health, Education and Welfare. Recreational development is discussed in paragraph 50. The following paragraphs discuss hydroelectric power and fish and wildlife developments.

a. Hydroelectric power. The New York Regional office of the Federal Power Commission requested that hydroelectric power be considered upstream from Putnam, in conjunction with flood control reservoir studies. The 2 economical flood control sites, Red Bridge and West Thompson, were investigated for possible dual use to include power development. Power at the upper site, Red Bridge, is impractical because of existing developments which preclude an increase in reservoir capacity to accommodate power storage. At the lower site, West Thompson, power development is possible but is limited by existing improvements which dictate the selection of maximum reservoir elevation. A higher elevation would have been desirable but would cause excessive property damage.

Three possible power installations were investigated for the West Thompson site. In all instances the reservoir would have 44,600 acre-feet of usable power storage and 7,600 acre-feet of dead storage. It would also have 25,600 acre-feet of flood control storage, equivalent to 6 inches of runoff from the net drainage area of 80 square miles. The gross drainage area, before reduction by the authorized East Brimfield and Westville reservoirs, is 173.5 square miles. The usable power storage could be used to maintain a minimum dependable flow of 155 c.f.s., based on a mass curve for a 20-year period of record from 1932 to 1951.

The 3 power plans investigated were for a power station at the dam, utilizing load factors of about 50 and 10 percent; and a power station downstream from the center of Putnam, requiring 13,500 feet of 16-foot diameter penstock and utilizing a load factor of about 10 percent. All 3 of these plans proved uneconomical. The costs of the power features alone, exclusive of the allocable costs of the dam and reservoir, exceed the at-site value of power. The New York Regional office of the Federal Power Commission has reviewed these studies and concurs in the conclusion that power development at the West Thompson dam is uneconomical at this time. Pertinent data on the 3 plans is summarized in the following table.

	PLAN		
	1	2	3
Load factor, percent	51	8.2	9.5
Average net head, feet	54	108	62
Turbine, type	Kaplan	Francis	Propeller
Turbine capacity, hp.	2,500	28,000	12,500
Generator capacity, kw.	1,200	15,000	7,500
Average annual output, kw.-hr.			
At site	7,700,000	17,500,000	10,500,000
At existing downstream plants	3,000,000	--	--

b. Fish and wildlife. The Regional Director of the Fish and Wildlife Service of the United States Department of the Interior is of the opinion that the Red Bridge and West Thompson reservoir areas have a potential for upland game and waterfowl. A shallow pool might also be an asset. Raising the dam and spillway about 1 foot would provide a fish and wildlife pool without encroaching on the flood control storage. In the event that a reservoir is authorized, the Regional Director recommends that:

(1) Additional detailed studies be conducted, as necessary, after the project is authorized, in accordance with Section 2 of the Act of August 14, 1946 (60 Stat. 1080); and such reasonable modifications be made in the authorized project facilities as may be agreed upon by the Chief of Engineers, for the preservation and propagation of fish and wildlife resources.

(2) Federal lands and project waters in the project area be open for free use for hunting and fishing as long as title to the lands and structures remains in the Federal Government, except for sections reserved for safety, efficient operation, or protection of public property.

(3) Leases of Federal land in the project area reserve the right of free public use of such land for hunting and fishing.

(4) The report of the Division Engineer include the preservation and propagation of fish and wildlife resources among the purposes for which the project is to be authorized.

The Connecticut Board of Fisheries and Game has a long-range program to develop the fish and game resources of this drainage system. This program would include the restoration of sea-run fish. If pollution is abated and existing dams are provided with fishways, a future flood control dam may require a fish-passage facility.

SECTION XVI - FLOOD CONTROL PLANS

41. GENERAL

The presently authorized plan for flood control in the Quinebaug River Subbasin consists of 4 reservoirs. Studies made for this report disclosed that a fifth project is economically justified at this time. The choice of a fifth project is limited to 1 of 2 reservoirs or a local protection project for Putnam, Conn. The most economically feasible of these 3 potential projects is the West Thompson reservoir on the Quinebaug River, 2.0 miles upstream from Putnam. The other reservoir, Red Bridge, is an alternative to West Thompson. The Red Bridge dam site is 2.8 miles upstream from the West Thompson dam site. Lack of economic justification precludes the construction of both a reservoir and a local protection project at Putnam. The 3 projects are described in the following paragraphs.

42. WEST THOMPSON DAM AND RESERVOIR

The West Thompson dam would be located on the Quinebaug River in the town of Thompson, Conn. The site is in the village of West Thompson, 2.0 miles upstream from the city of Putnam. The dam would be a rolled earth-fill structure with a length of 2,400 feet and a maximum height of 70 feet above streambed. A 400-foot long dike with a maximum height of 24 feet would be required northeast of the dam. Reservoir overflows would discharge through a side channel spillway in the west (right) abutment. The dam would impound a reservoir 5 miles long with a surface area of 1,200 acres at spillway crest elevation 341 feet, m.s.l. The reservoir would provide a flood control storage capacity of 25,600 acre-feet, equivalent to 6.0 inches of runoff from its net drainage area of 80.0 square miles below the authorized Westville and East Brimfield reservoirs.

Construction of the West Thompson project would involve the acquisition of 1,200 acres of land and 39 sets of buildings. It would also require 3.0 miles of road relocation. Pertinent drawings are bound at the end of the report.

43. RED BRIDGE DAM AND RESERVOIR

The Red Bridge dam, an alternative to West Thompson, would be located on the Quinebaug River in the town of Thompson, Conn. The site is 4.8 miles upstream from the city of Putnam and 2.8 miles upstream from the West Thompson site. The dam would be a rolled earth fill structure with a length of 1,140 feet and a maximum height of 90 feet above streambed. Reservoir overflows would discharge through a side channel spillway in the east (left) abutment. The dam would impound a reservoir 6 miles long with a surface area of 1,100 acres at spillway crest elevation 370 feet m.s.l. The reservoir would provide a flood control storage capacity

of 24,700 acre-feet, equivalent to 6.0 inches of runoff from its net drainage area of 76.5 square miles below the authorized Westville and East Brimfield reservoirs.

Construction of the Red Bridge project would involve the acquisition of 1,370 acres of land and 114 sets of buildings. It would also require the relocation of 4.4 miles of road and 2 cemeteries with a total of 125 graves.

44. PUTNAM LOCAL PROTECTION PROJECT

Local protection improvements for the city of Putnam were investigated as increments to the 4 authorized Quinebaug River Subbasin reservoirs and as increments to a possible 5-reservoir system, including the previously discussed West Thompson reservoir or its alternative, Red Bridge. These studies considered dikes and flood walls, individually or in various combinations with channel rectification and modification of 3 existing dams. The only plan which proved to be economically justified is based on flow reductions by a 4-reservoir system. It would provide for the construction of dikes and flood walls along the left bank of the Quinebaug River and would protect 95 acres of urban development in Putnam.

The plan would provide for 5,600 feet of earth dike and 1,600 feet of concrete flood wall, starting from high ground at Powhattan Street near the Belding-Heminway factory and extending downstream to high ground at the railroad bridge near Arch Street. Three stoplog structures would be required across Bridge, Pomfret, and Arch Streets. An additional 500 feet of dike with 3 more stoplog structures would be required across a railroad cut near the upper end of the project. Failure to dike this cut would allow floodwaters to flank the riverside improvements. Interior drainage would be handled by a collector system and a 75,300 g.p.m. pumping station. The project would be designed to protect against a design flood of 38,000 c.f.s., which represents the standard project flood reduced by the 4 authorized reservoirs.

Construction of this left bank plan would require a small amount of land taking and minor modification of existing utilities. No buildings would have to be acquired.

45. DEGREE OF PROTECTION

The West Thompson or Red Bridge reservoirs, in conjunction with the authorized reservoirs, would have sufficient capacity to completely store a recurrence of the March 1936 and September 1938 floods. The storage would have been completely utilized during the August 1955 flood and some spillway discharge would have occurred. This discharge would occur during the flood recession and hence would not synchronize with the peak flows from the uncontrolled areas. The standard project flood would also

produce some desynchronized spillway discharge. The local protection project for Putnam was designed for the standard project flood modified by the 4 authorized reservoirs. The design discharge represents a flow 30% greater than the record flood of August 1955 modified by the authorized reservoirs.

Construction and operation of the 4 authorized reservoirs would reduce the stage of a recurring August 1955 flood by 4.2 feet at the U.S.G.S. gage in Putnam, the key damage center in the Quinebaug River Subbasin. Supplemental protection by either the West Thompson or the Red Bridge reservoirs would reduce this flood stage by another 6.3 feet, for a total reduction of 10.5 feet. The discharge modified by the 5 reservoirs would be within channel banks at this point.

46. HYDROLOGIC AND HYDRAULIC CONSIDERATIONS

a. Analysis of floods. An analysis of the major floods of March 1936, September 1938, and August 1955 was made in order (1) to determine the discharge contribution of tributaries and local areas to flood flows at the principal damage centers, and (2) to properly evaluate (a) the flood characteristics and potentialities of the various streams, and (b) the necessity for reservoir control and/or local protection measures. The studies indicated that the area on the Quinebaug River above the proposed West Thompson dam site was a major contributor to the flood flows at downstream damage points.

b. Typical tributary contribution flood. In order to evaluate the relative flood control effectiveness and the economics of projects, a synthetic flood was developed to represent a typical distribution of tributary flood contribution in the Quinebaug River Subbasin. The floods of record were used to determine the relative shape and timing of the flood hydrographs with the peak discharges and volumes related to frequency curves and average annual runoff.

c. Spillway and outlet capacities.

(1) Spillway capacities have been derived in accordance with established procedures, using the probable maximum precipitation centered over the watersheds.

(2) Outlet sizes were selected to satisfy the following criteria: (a) obtain outlet discharges equivalent to the downstream safe channel capacity with a pool elevation corresponding to 20 percent of the reservoir storage; (b) permit emptying the reservoir in a reasonable period of time, and (c) provide adequate diversion capacity during construction. The number and size of gates were selected to provide flexibility during all operating conditions and provide sufficient capacity to satisfy the preceding outlet criteria with one gate inoperative.

47. RESERVOIR REGULATION

The operation of either the West Thompson or Red Bridge reservoirs would be in conjunction with the 4 authorized upstream reservoirs in the Quinebaug River Subbasin. Operation would be effected whenever flows were expected to exceed downstream channel capacity and, for damage zones below the mouth of the Quinebaug River, would be coordinated with the existing Mansfield Hollow and other future reservoirs in the Thames River Basin. The entire reservoir system would substantially lower flood crests on the French, Quinebaug, Shetucket, and Thames Rivers.

48. PROVISIONS AGAINST ENCROACHMENT

The State of Connecticut proposes to establish flood plain zoning lines along the Quinebaug and French Rivers in the near future. Establishment of these lines would insure against future encroachments which would tend to nullify the effectiveness of a local protection project or limit reservoir outlet discharges and thereby increase the time required for emptying. Zoning is further discussed in paragraph 39.

SECTION XVII - MULTIPLE-PURPOSE FEATURES

49. GENERAL

Reservoir multiple-purpose features are limited to the possible provisions for recreational development and for a fish and wildlife pool. Final determination of the justification for such a pool is contingent upon detailed studies which will be made by the U. S. Fish and Wildlife Service subsequent to the authorization of a reservoir. Paragraph 40b. contains additional information on fish and wildlife uses. Paragraph 50 discusses recreational development.

SECTION XVIII - RECREATIONAL DEVELOPMENT

50. GENERAL

The primary recreation need in Southern New England, including the environs of the West Thompson and Red Bridge dam sites, is for water areas accessible to the public. Either of the 2 reservoirs could probably satisfy a part of this need if a pool were provided. However, the forms of water use would be contingent upon pollution conditions in the Quinebaug River. The New England-New York Interagency Committee tentatively reports that the water in this reach of the Quinebaug River during periods of low flow could be used for boating, but not for general water activities. Impoundment of these waters would undoubtedly increase the polluted condition and make water use less likely.

Pending improvement of water quality through pollution abatement, it appears that wildlife management in either of these reservoir areas, as recommended by the Fish and Wildlife Service, would be the best use. Depending upon the area acquired in fee, facilities could be developed for picnicking and hiking without creating a conflict with wildlife management. Regulated hunting could provide an additional source of active recreation in the area.

SECTION XIX - ESTIMATES OF FIRST COSTS AND ANNUAL CHARGES

51. GENERAL

First costs and annual charges for the 3 economical projects - West Thompson and Red Bridge reservoirs and Putnam Local Protection - are summarized below. The principal features of first costs and annual charges for these 3 projects are presented in Tables 5 through 7. A summary of economic data for all projects studied is contained in Table 8 on page 47.

SUMMARY OF FIRST COSTS AND ANNUAL CHARGES
(1957 Price Level)

	West Thompson Reservoir	Red Bridge Reservoir	Putnam Local Protection
First Costs:			
Federal	$4,030,000	$4,790,000	$1,330,000
Non-Federal	-	-	12,000
Total First Costs	4,030,000	4,790,000	1,342,000
Annual Charges:			
Federal	166,200	193,300	48,100
Non-Federal	10,000	14,000	4,400
Total Annual Charges	$176,200	$207,300	$52,500

Estimates of first costs and annual charges have been prepared on the basis that the total costs of flood control reservoirs providing basin-wide benefits and construction costs of local protection projects would be borne by the Federal Government. Local interests would bear the costs of lands and relocations necessitated by local protection projects, and would maintain and operate the projects after completion.

Unit prices used in estimating construction and relocation costs are based on average bid prices for similar work in the same general region. The adopted unit prices are adjusted to the 1957 price level and include minor items of work which do not appear in the cost estimates. Valuation of property is based on the Market Data Approach and reflects values in recent sales in the area. Land costs are based on estimated fee value.

All estimates include an allowance for contingencies. The costs for engineering and overhead are estimated lump sums based on knowledge of the site and experience on similar projects.

Annual charges are based on an annual interest rate of 2.5 percent with amortization of the project cost distributed over a 50-year period. Allowances are also made for maintenance, operation, and interim replacement of equipment. For reservoirs, the tax loss on lands removed from taxation is included; for local protection projects, it is estimated that the loss of taxable lands would be offset by the increase in the value of property protected.

TABLE 5

COST ESTIMATE
WEST THOMPSON DAM AND RESERVOIR
(1957 Price Level)

First costs		
Land and damages	$ 800,000	
Relocations: Roads	343,000	
Reservoir	67,000	
Dam	2,152,000	
Buildings, grounds, and utilities	74,000	
Permanent operating equipment	19,000	
Total direct cost	3,455,000	
Preauthorization studies	20,000	
Engineering and design	318,000	
Supervision and administration	237,000	
Total estimated first cost		$4,030,000
Federal investment		
Total Federal first cost	4,030,000	
Interest during construction	100,000	
Gross Federal investment	4,130,000	
Salvage value of land	140,000	
Net Federal investment		$3,990,000
Annual charges		
Federal:		
Interest	103,300	
Amortization	40,900	
Maintenance and operation	20,000	
Major replacements	2,000	
Total Federal annual charges		$ 166,200
Non-Federal:		
Estimated loss of taxes		10,000
Total annual charges		$ 176,200

TABLE 6

COST ESTIMATE
RED BRIDGE DAM AND RESERVOIR
(1957 Price Level)

First costs		
Lands and damages	$1,846,000	
Relocations:		
Roads	788,000	
Cemeteries	38,000	
Reservoir	42,000	
Dam	1,456,000	
Buildings, grounds, and utilities	74,000	
Permanent operating equipment	19,000	
Total direct cost	4,263,000	
Preauthorization studies	20,000	
Engineering and design	290,000	
Supervision and administration	217,000	
Total estimated first cost		$4,790,000
Federal investment		
Total Federal first cost	4,790,000	
Interest during construction	120,000	
Gross Federal investment	4,910,000	
Salvage value of land	182,000	
Net Federal investment		$4,728,000
Annual charges		
Federal:		
Interest	122,800	
Amortization	48,500	
Maintenance and operation	20,000	
Major replacements	2,000	
Total Federal annual charges		$ 193,300
Non-Federal:		
Estimated loss of taxes		14,000
Total annual charges		$ 207,300

TABLE 7

COST ESTIMATE
PUTNAM LOCAL PROTECTION
(1957 Price Level)

Federal first costs		
Earth dikes	$ 250,000	
Flood walls	400,000	
Drainage	220,000	
Pumping station	230,000	
Total direct cost	1,100,000	
Preauthorization studies	2,000	
Engineering and design	130,000	
Supervision and administration	98,000	
Total Federal first cost		$1,330,000
Federal investment		
Total Federal first cost	1,330,000	
Interest during construction	33,000	
Total Federal investment		$1,363,000
Non-Federal investment		
Land and damages	2,000	
Relocations: Utilities	10,000	
Total non-Federal investment		$ 12,000
Annual charges		
Federal:		
Interest	34,100	
Amortization	14,000	
Total Federal annual charges		$ 48,100
Non-Federal:		
Interest	300	
Amortization	100	
Maintenance and operation	3,000	
Major replacements	1,000	
Total non-Federal annual charges		4,400
Total annual charges		$ 52,500

SECTION XX - ANNUAL BENEFITS

52. ANNUAL FLOOD-DAMAGE PREVENTION BENEFITS

Flood-damage prevention benefits for projects studied were derived by determining the difference between the annual losses of $539,000 remaining in the affected areas after loss prevention by the authorized projects and the annual losses remaining after addition of each project as an incremental unit.

Of the projects studied, 3 projects, West Thompson Dam and Reservoir, Red Bridge Dam and Reservoir, and local protection for the left bank at Putnam merit discussion. Flood-damage prevention benefits for each of these projects, as an incremental unit after the authorized projects, are listed below:

West Thompson Dam and Reservoir	$229,000
Red Bridge Dam and Reservoir	221,000
Putnam Local Protection	56,000

53. ENHANCEMENT BENEFITS

Studies indicate that higher utilization of vacant or partially utilized land and floor spaces would be encouraged by the addition of either of the dam and reservoir projects or the left bank local protection project at Putnam to augment the authorized system of reservoirs. The evidence supporting this conclusion is not specific enough, however, to permit a proper assignment of enhancement benefits.

54. FISH AND WILDLIFE EFFECTS

The Regional Director of the U.S. Fish and Wildlife Service finds that construction of either the West Thompson or the Red Bridge dam and reservoir would adversely affect wildlife to a moderate degree as a result of periodic flooding of habitat. Pheasants and cottontail rabbits would suffer the greatest loss. He further finds that the topographic and vegetative characteristics of the reservoir sites offer good to excellent possibilities for development for upland game and/or waterfowl. A small pool would have considerable value to waterfowl and other wildlife, particularly in conjunction with development of bordering uplands. There also exists the possibility that, following pollution abatement, such a pool might be developed as a fishery resource.

SECTION XXI - PROJECT FORMULATION AND ECONOMIC JUSTIFICATION

55. GENERAL

Three projects were found economically justified when considered each in turn as an increment to the 4 authorized reservoirs. The West Thompson and Red Bridge reservoirs are alternatives to each other. Available flood protection benefits are insufficient to justify both another reservoir and a local protection plan for Putnam.

Economic data for the various projects studied is listed in Table 8. Estimated reservoir costs exclude a permanent pool for fish and wildlife purposes. The justification for such a pool at either reservoir, presently estimated to cost $50,000, would be determined during the advanced planning stage subsequent to a project authorization. Reservoir benefits were estimated as increments to the 4 authorized reservoirs. Costs and benefits for local protection projects were evaluated as increments to the authorized reservoir system or, where pertinent, to an expanded system which would include West Thompson reservoir or its alternative, Red Bridge. In the case of Putnam, studies were made assuming both a 4 and a 5-reservoir system because of the extensive scope of the damages involved. The Putnam plans which are increments to a 5-reservoir system are identified by the letter "a" following the layout number. No annual benefits were estimated for projects where the residual annual losses were less than the annual charges.

The West Thompson reservoir would provide both the greatest amount of incremental protection, as reflected by the annual benefits, and the maximum excess of benefits over costs as shown by the economic data presented in Table 8.

TABLE 8

SUMMARY OF ECONOMIC DATA FOR PROJECTS STUDIED
(1957 Price Level)

PROJECT	FIRST COST			ANNUAL CHARGES			ANNUAL BENEFITS (1)	BENEFIT: COST RATIO (2)
	Federal	Non-Federal	Total	Federal	Non-Federal	Total		
Dams and Reservoirs								
West Thompson	$4,030,000	$ -	$4,030,000	$166,200	$10,000	$176,200	$229,000	1.30
Red Bridge	4,790,000	-	4,790,000	193,300	14,000	207,300	221,000	1.07
Local Protection Projects								
Southbridge, Mass.								
McKinstry Brook	380,000	2,000	382,000	13,600	300	13,900	(4,500)	-
Grosvenordale, Conn.								
Dam Modification	163,000	-	163,000	5,800	2,000	7,800	(4,500)	-
Floodwall (Alternative)	338,000	2,000	340,000	12,000	300	12,300	(4,500)	-
Putnam, Conn. (Alt. plans) (3)								
I - Left bank	1,330,000	12,000	1,342,000	48,100	4,400	52,500	56,000	1.07
Ia - Left bank	600,000	12,000	612,000	21,700	3,900	25,600	(16,000)	-
I - Both banks	1,960,000	13,000	1,973,000	70,800	5,400	76,200	73,000	0.96
Ia - Both banks	1,100,000	12,000	1,112,000	39,800	4,900	44,700	(31,000)	-
II - Left bank	3,980,000	360,000	4,340,000	143,900	24,000	167,900	(75,000)	-
IIa - Left bank	3,870,000	360,000	4,230,000	139,900	24,000	163,900	(16,000)	-
II - Both banks	4,250,000	360,000	4,610,000	153,600	25,000	178,600	(137,000)	-
IIa - Both banks	4,120,000	360,000	4,480,000	148,900	25,000	173,900	(31,000)	-
IV - Both banks	3,100,000	110,000	3,210,000	112,100	15,000	127,100	(69,000)	-
IVa - Both banks	2,970,000	110,000	3,080,000	107,300	15,000	122,300	(14,000)	-
VI - Both banks	1,100,000	101,000	1,201,000	39,800	7,200	47,000	(38,000)	-
VIa - Both banks	1,090,000	101,000	1,191,000	39,400	7,200	46,600	(8,000)	-
Killingly, Conn.								
Rogers	8,000	1,000	9,000	280	120	400	150	0.37
Plainfield, Conn.								
Wauregan	53,000	4,000	57,000	1,800	300	2,100	700	0.33

(1) Figures in parentheses are residual annual losses which are maximum flood-damage prevention benefits possible.
(2) Benefit:cost ratio not given for projects where residual annual losses are less than annual charges.
(3) Plans without suffix "a" are based on design for standard project flood modified by 4 authorized reservoirs.
Plans with " " " " " " " " " " " " 4 " " and West Thompson or alternative Red Bridge reservoir.

SECTION XXII - PROPOSED LOCAL COOPERATION

56. GENERAL

The cost of constructing a reservoir at the West Thompson site, or its alternative Red Bridge site, would be wholly Federal since the benefits would be largely general in character. The local protection project considered for Putnam would entail the usual conditions of local cooperation in accordance with Section 3 of the Flood Control Act of 1936. This act requires local interests to provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction and operation of the project; hold and save the United States free from damages due to the construction works; and maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army. The responsibility for the relocation or modification of existing utilities or other facilities would rest with local interests under the requirements of lands and rights-of-way.

SECTION XXIII - COORDINATION WITH OTHER AGENCIES

5[illegible]. GENERAL

Plans for the West Thompson and Red Bridge reservoirs and the Putnam Local Protection project have been reviewed by the Federal, state, and local agencies concerned. The U. S. Bureau of Public Roads and the Connecticut State Highway Department have no objections to these projects. The Connecticut Water Resources Commission favors a fifth reservoir upstream from Putnam and supports either the West Thompson or Red Bridge projects.

The U. S. Fish and Wildlife Service believes that both the West Thompson and Red Bridge reservoir sites have a potential for upland game and waterfowl. Their views and recommendations are contained in paragraph 40b. The Connecticut Board of Fisheries and Game is concerned with the possible future requirements of a fishway in the event that sea-run fish are restored in the basin.

The New York Regional office of the Federal Power Commission requested that hydroelectric power development be considered in conjunction with flood control reservoir studies. They reviewed the studies made and concurred in the conclusion that power development is uneconomical at this time.

The Putnam Redevelopment Agency is preparing a redevelopment plan for the central portion of the city, including sections of the flood area. This plan has been initially approved by the Connecticut Redevelopment Agency and the Federal Housing and Home Finance Agency and final plans are under way. The Putnam Redevelopment Agency opposes dikes and flood walls because they believe that this type of structure would depreciate the value of redeveloped land. The agency prefers channel improvement or upstream reservoirs as the solution to Putnam's flood problem.

SECTION XXIV - DISCUSSION

58. FLOOD PROBLEMS

Flood protection for the Quinebaug River Subbasin is urgently needed. Many industrial and commercial establishments and residential developments are located in the flood plain. Six major floods have occurred in the last 30 years, causing widespread damage and disruption of the basin economy. With construction and operation of the 4 authorized reservoirs, a recurrence of the August 1955 flood would still produce losses of $18,700,000 in the Quinebaug River Subbasin.

59. SOLUTIONS CONSIDERED

All possible and practicable methods for solving the flood problems were considered. Feasible methods include reservoirs to supplement the 4 presently authorized, dikes and flood walls, channel improvement, and various combinations of these methods. Flood plain zoning would afford a partial long-range solution.

60. SELECTION OF PLAN

The most desirable plan for supplementing the authorized reservoir system in the Quinebaug River Subbasin consists of the construction of the West Thompson Reservoir on the main river. The dam site is 2.0 miles upstream from Putnam, Conn. This reservoir would control a net drainage area of 80.0 square miles which would be a 53 percent increase over the 151 square miles to be controlled by the 4 authorized reservoirs. Construction of this project would provide the greatest amount of flood damage prevention benefits to 11 cities and towns along the Quinebaug, Shetucket, and Thames Rivers, including Putnam, Killingly (Danielson and Rogers), Plainfield (Wauregan), Griswold (Jewett City), and Norwich. It would also provide the maximum excess of benefits over costs. State and local officials and interested parties support this project, and public sentiment is strongly in favor of early completion.

The Red Bridge Reservoir, an alternative to West Thompson, would provide nearly the same protection as West Thompson. The dam sites are 2.8 miles apart. The Red Bridge site is the inferior of the 2 projects because of higher cost due to substantially greater impact on existing developments. Construction of the Red Bridge Reservoir would require the acquisition of 114 sets of buildings compared to 39 sets for West Thompson. The Red Bridge project would also involve the relocation of 125 graves.

The construction of a local protection project for Putnam, Conn., is also economically justified. This plan would provide for the construction of dikes and flood walls with appurtenant works along the left bank of the Quinebaug River through most of the city.

The West Thompson Reservoir, in addition to providing benefits to other downstream communities, would give the left bank of Putnam substantially the same degree of protection against a standard project flood as would the local protection project. In addition, the West Thompson reservoir would provide protection to the right bank of Putnam where local protection works were found to be impracticable. Available benefits are insufficient to justify a reservoir at West Thompson and local protection measures for Putnam.

Investigations disclosed no favorable reservoir sites except West Thompson and Red Bridge. Studies of local protection works in the basin revealed no projects other than Putnam which would be economically justified at this time. Two small local protection projects in Massachusetts remain to be evaluated. These 2 projects, along Cady Brook in Southbridge and the French River in Leicester, will be considered further under authority of Section 205 of the 1948 Flood Control Act, as amended.

The Connecticut State Water Resources Commission plans to establish, under existing law, encroachment lines along the Quinebaug River and its tributaries. The lines, which amount to flood plain zoning, would establish waterways generally defined as the limits of a flood 5 times as large as the mean annual flood. In general, flood plain zoning in urban lowlands must of necessity be limited to moderate discharges. Its major effectiveness is a long term proposition which must await the gradual recession of existing encroachments. Zoning would also have immediate effects by prohibiting further encroachment on channel capacities. Zoning in the Massachusetts portion of the basin would also be advisable.

Related water resource developments are unwarranted at this time. Pollution abatement is being handled at State and local levels. Hydroelectric power development was studied at the request of the New York Regional Office of the Federal Power Commission, which reviewed the studies and concurred in the negative results. The recommendations of the U. S. Fish and Wildlife Service with respect to reservoir management are generally in accordance with existing policies for the management of reservoir lands. The Fish and Wildlife Service has pointed out that a permanent pool at the West Thompson or Red Bridge Reservoirs is desirable. Such a pool could be provided at either reservoir by constructing the dam and spillway 1 foot higher. They conclude, however, that such construction is not justified at this time. Easements for hunting and fishing, desired by the Connecticut State Board of Fisheries and Game, may be obtained by the State as an independent sovereign, without Congressional authorization. In the event of a reservoir authorization, subsequent detailed studies may also reveal the need for recreational development in accordance with existing statutes and regulations. However, the successful completion of the state and local pollution abatement program must precede recreational developments at either the Red Bridge or West Thompson reservoir sites.

61. COSTS AND BENEFITS

The total estimated first cost, annual charges, and annual benefits for the West Thompson and Red Bridge Reservoirs and the Putnam Local Protection project are summarized below. The ratios of benefits to costs are also shown.

SUMMARY OF ECONOMIC DATA

	Total First Cost	Annual Benefits	Annual Charges	Benefit-Cost Ratio
West Thompson Reservoir	$4,030,000	$ 229,000	$176,200	1.30
Red Bridge Reservoir	4,790,000	221,000	207,300	1.07
Putnam Local Protection	1,342,000	56,000	52,500	1.07

The West Thompson Reservoir would provide both the greatest amount of protection and the maximum excess of benefits over costs. Annual benefits are for each project acting alone as an incremental unit after the authorized projects. Available benefits are inadequate to justify more than 1 of the 3 projects shown.

Redevelopment plans of the Putnam Redevelopment Agency would, if carried out, probably reduce the annual benefits shown for each project. Available data is insufficient to adequately determine the exact effect of redevelopment on the economics of these projects. From presently available information, it appears that the reduction in benefits would not preclude development of the West Thompson Reservoir site, although it would adversely affect development of the Red Bridge site and make the local protection project uneconomical.

The total reservoir costs shown are for flood control developments only, exclusive of the added cost of $50,000 for providing a permanent fish and wildlife pool at either site.

SECTION XXV - CONCLUSIONS

62. GENERAL

It is concluded that periodic flood discharges produce major damages in the Quinebaug River Subbasin. The area will continue to face the threat of heavy damages after construction of the authorized reservoirs. Supplemental protection can be provided most suitably by construction of the West Thompson Reservoir at a total estimated first cost of $4,030,000. This project would afford a high degree of protection to 11 cities and towns along the Quinebaug, Shetucket and Thames Rivers. It is economically justified, incrementally, having a ratio of annual benefits to annual costs of 1.30 to 1. The frequency of major floods and the existing high concentration of industrial, commercial, and residential developments make immediate construction of the project imperative.

It is further concluded that construction of the West Thompson Reservoir should be contingent upon the zoning of the river channel through the downstream damage areas. This zoning would prevent further encroachments and would also prevent the replacement of obstructive or hazardous structures along the channel whenever they become obsolete.

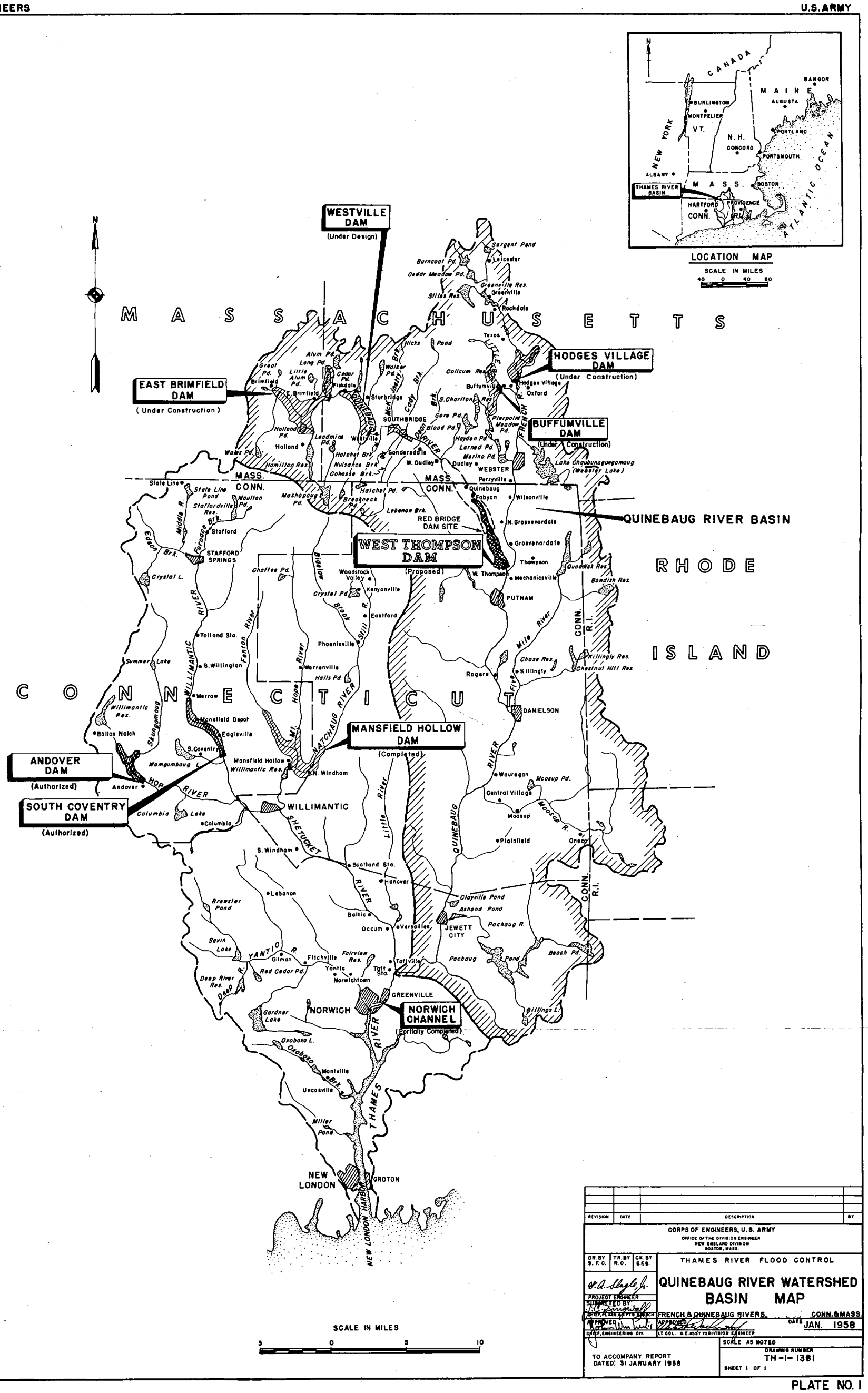
The West Thompson Reservoir has a valuable potential for fish and wildlife and recreational developments. The specific need and justification for these additional uses would be determined during advanced planning carried out after project authorization.

SECTION XXVI - RECOMMENDATIONS

63. GENERAL

It is recommended that the plan for the control of floods in the Thames River Basin, as contained in the Flood Control Act approved August 18, 1941 (Public Law No. 228, 77th Congress), be modified to provide for the construction of the West Thompson Dam and Reservoir on the Quinebaug River in Thompson, Conn., at a total estimated first cost to the United States of $4,030,000, and at an estimated annual maintenance and operation cost of $20,000, providing local interests zone the channel through the downstream damage areas to prevent further encroachments and to prevent the replacement of obstructive or hazardous structures along the channel whenever they become obsolete. It is further recommended that the West Thompson Dam and Reservoir be authorized primarily for flood control with the addition of features beneficial to pollution control, fish and wildlife, and recreation which may be found desirable and justified during the course of advanced planning studies.

ALDEN K. SIBLEY
Brigadier General, U.S. Army
Division Engineer



REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY S.F.C. | TR. BY R.O. | CK. BY G.F.G.

THAMES RIVER FLOOD CONTROL

QUINEBAUG RIVER WATERSHED BASIN MAP

FRENCH & QUINEBAUG RIVERS, CONN. & MASS.

DATE JAN. 1958

PROJECT ENGINEER
SUBMITTED BY:
CHIEF, PLANNING & REPORTS BRANCH
APPROVED:
CHIEF, ENGINEERING DIV.
APPROVED:
LT. COL. C.E. ASST. TO DIVISION ENGINEER

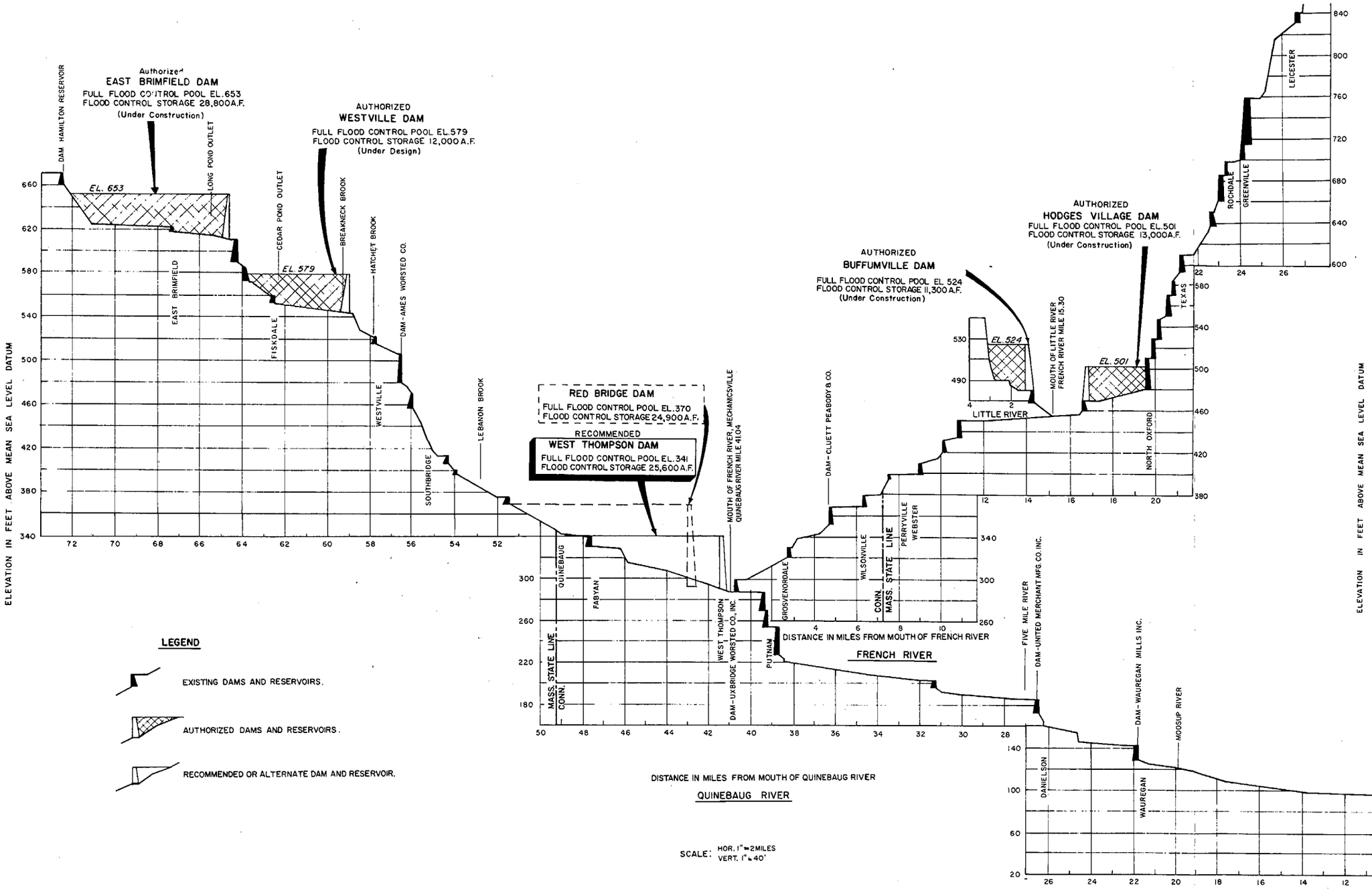
TO ACCOMPANY REPORT DATED: 31 JANUARY 1958

SCALE AS NOTED

DRAWING NUMBER TH-I-1361

SHEET 1 OF 1

PLATE NO. 1



REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY	TR. BY	CK. BY
J.W.D.	M.W.B.	G.F.B.

PROJECT ENGINEER

SUBMITTED BY
CHIEF, PLANN. & REP. BRANCH

APPROVED
CHIEF, ENGINEERING DIV.

APPROVED
LT. COL. C.E. ASS'T TO DIVISION ENGINEER

THAMES RIVER FLOOD CONTROL

PROFILES

QUINEBAUG & FRENCH RIVERS

CONNECTICUT AND MASSACHUSETTS

DATE JAN. 1958

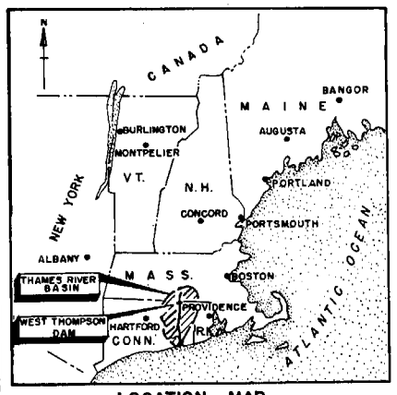
SCALE: AS NOTED

TO ACCOMPANY REPORT
DATED: 31 JANUARY 1958

DRAWING NUMBER
TH-1-1379

SHEET 1 OF 1

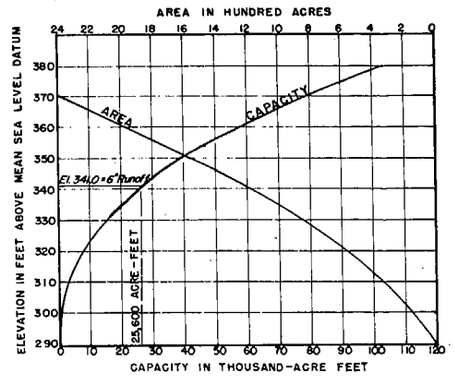
PLATE NO. 2



LOCATION MAP

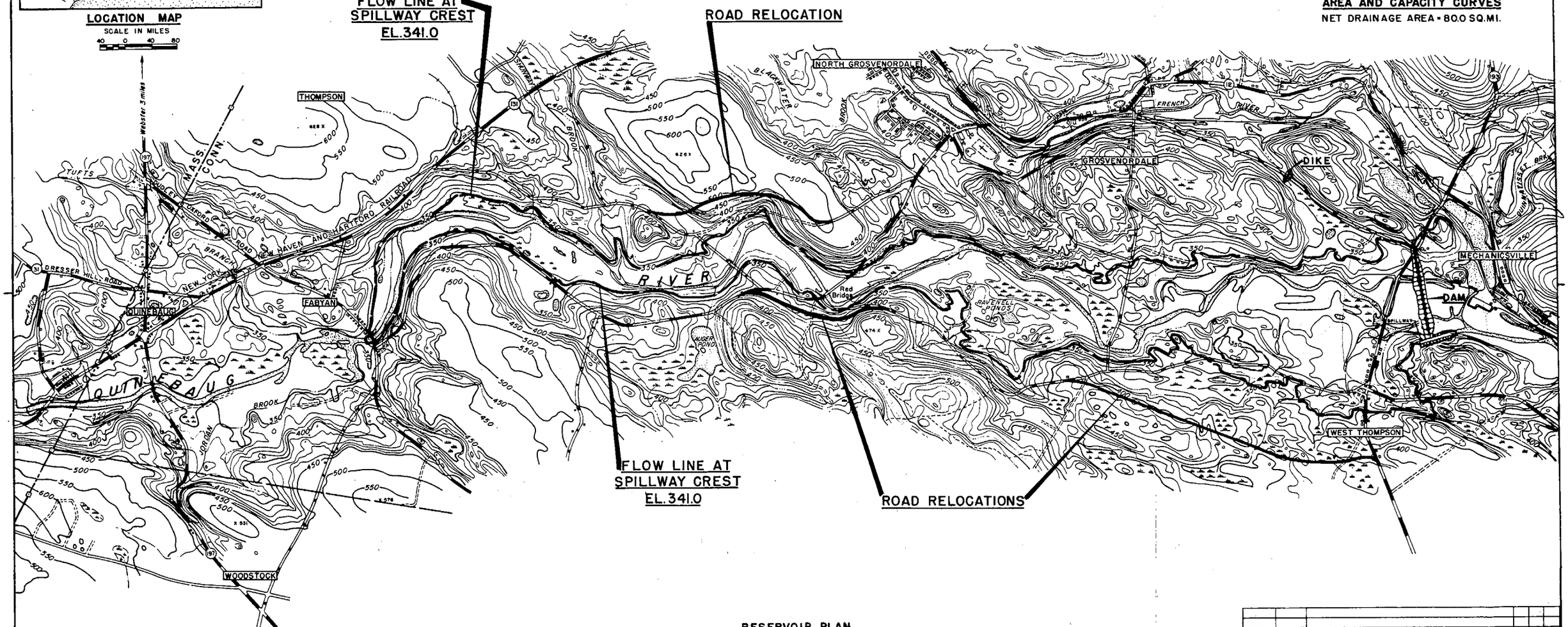
SCALE IN MILES

40 0 40 80



AREA AND CAPACITY CURVES

NET DRAINAGE AREA = 80.0 SQ.MI.



RESERVOIR PLAN

SCALE IN FEET

0 1000 2000 3000 FT.

LEGEND

- Existing gravel road
- Existing surfaced road
- Road Relocation
- State boundary
- Town boundary
- Reservoir at Spillway Crest El. 341.0

NOTES

Elevations refer to Mean Sea Level Datum.
Contour interval equals ten feet up to 450 feet.
Fifty-foot interval above 450 feet
Topography is based on U.S.G.S. Map.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON MASS

DR. BY W.T.N. | TR. BY A.J.H. | CK. BY J.W.D.

THAMES RIVER FLOOD CONTROL

WEST THOMPSON DAM
RESERVOIR MAP

W. A. Slagle, Jr.
PROJECT ENGINEER

SUBMITTED BY: CHIEF, PLANS & REPORTS BRANCH

APPROVED: CHIEF ENGINEERING DIV.

APPROVED: LT. COL. C.E. ASS'T TO DIVISION ENGINEER

QUINEBAUG RIVER — CONN.

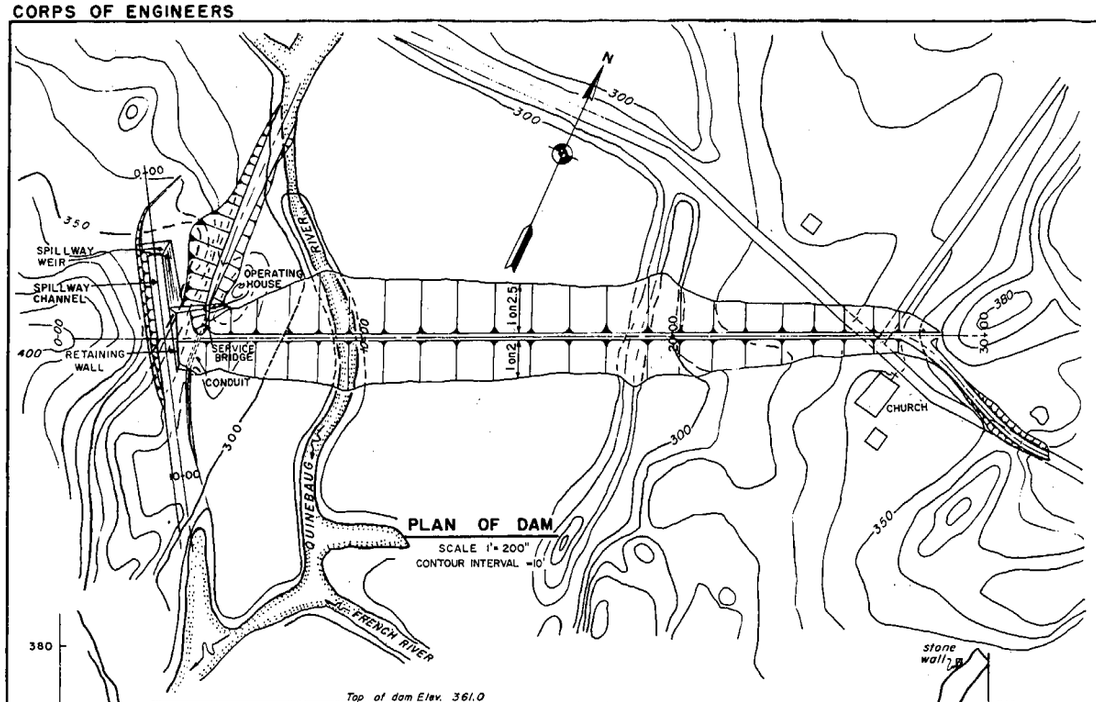
DATE JAN. 1958

TO ACCOMPANY REPORT DATED: 31 JANUARY 1958

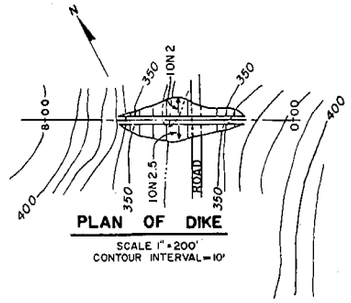
SCALE: AS NOTED

DRAWING NUMBER TH-1-1378

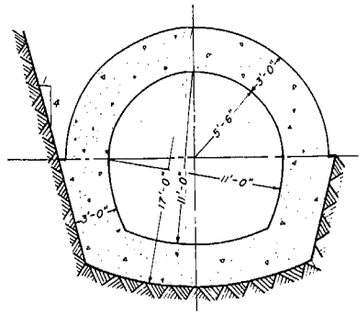
SHEET 1 OF 1



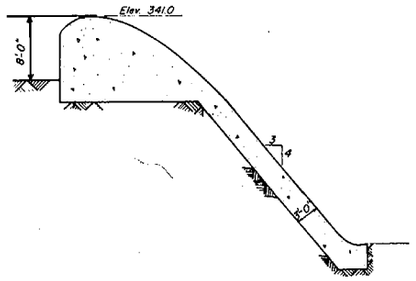
PLAN OF DAM
SCALE 1" = 200'
CONTOUR INTERVAL = 10'



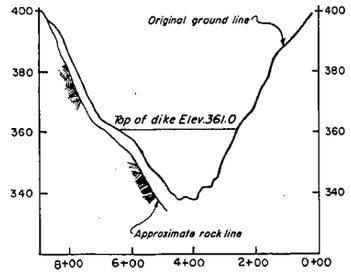
PLAN OF DIKE
SCALE 1" = 200'
CONTOUR INTERVAL = 10'



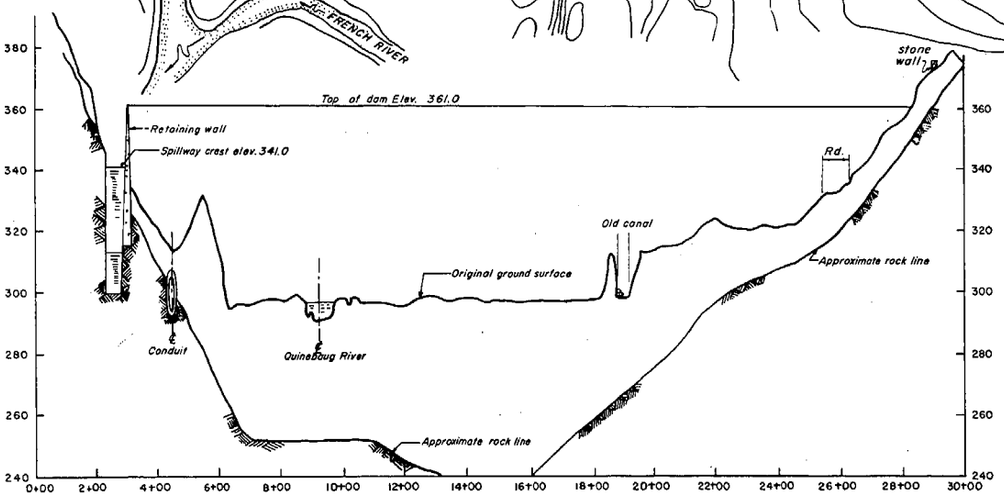
TYPICAL CONDUIT SECTION
SCALE 1/4" = 1'-0"



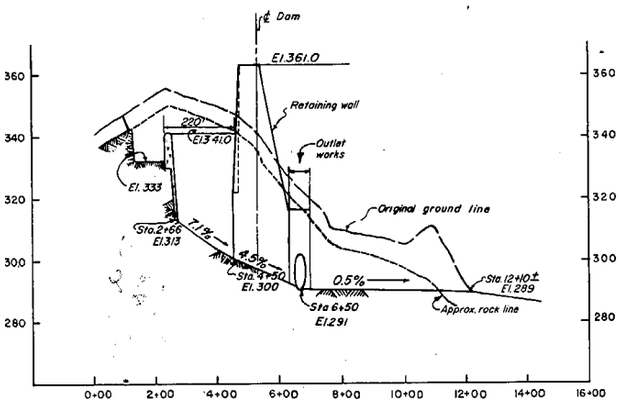
SECTION THRU SPILLWAY WEIR
SCALE: 1/8" = 1'-0"



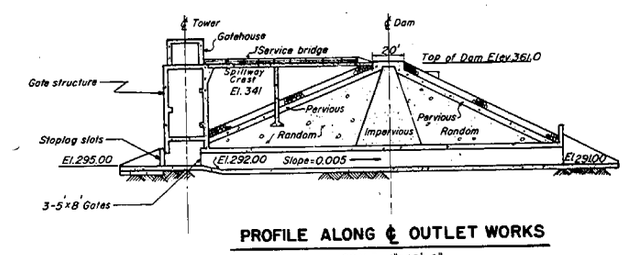
PROFILE ALONG ℄ DIKE
SCALE HOR. 1" = 200'
VERT. 1" = 20'



PROFILE ALONG ℄ DAM
SCALE: HOR. 1" = 200'
VERT. 1" = 20'



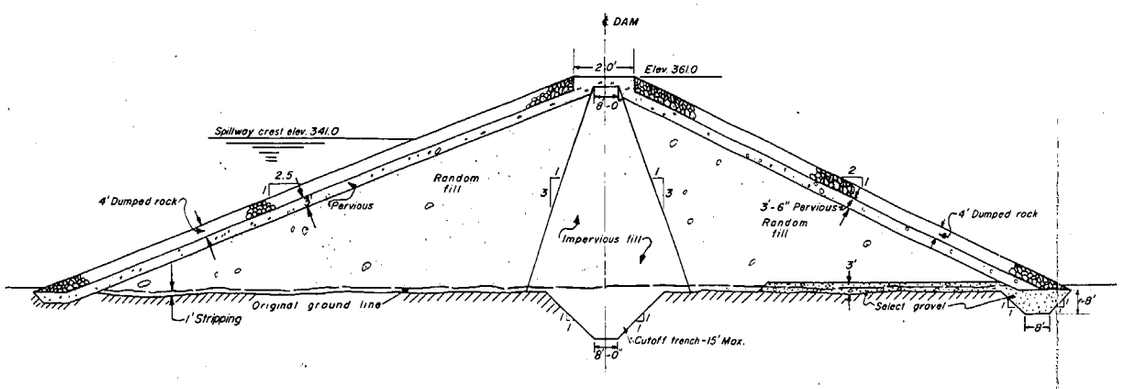
PROFILE ALONG ℄ SPILLWAY CHANNEL
SCALE HOR. - 1" = 200'
VERT. 1" = 20'



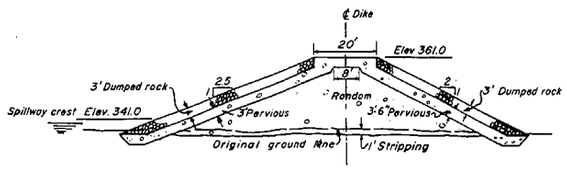
PROFILE ALONG ℄ OUTLET WORKS
SCALE 1" = 40'-0"

NOTES:

Topography based on U.S. Army Map Service map (1:25,000-1947)
Dam and dike profiles based on field survey.
Elevations refer to Mean Sea Level Datum.



MAXIMUM DAM SECTION
SCALE: 1" = 20'



MAXIMUM DIKE SECTION
SCALE: 1" = 20'

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY	TR. BY	CK. BY
J.C.B.	M.W.B.	J.W.D.

PROJECT ENGINEER

SUBMITTED BY: CHIEF PLANN. & REP. BRANCH

APPROVED: CHIEF ENGINEERING DIV.

APPROVED: LT. COL. C.E. ASST. TO DIVISION ENGINEER

THAMES RIVER FLOOD CONTROL
WEST THOMPSON DAM
GENERAL PLAN
QUINEBAUG RIVER CONN.

DATE JAN 1958

SCALE AS NOTED

DRAWING NUMBER TH-1-1380

SHEET 1 OF 1

TO ACCOMPANY REPORT DATED: 31 JANUARY 1958

APPENDICES

TABLE OF CONTENTS

A Digest of Public Hearing

B Hydrology and Hydraulics

C Flood Losses and Benefits

D West Thompson Dam and Reservoir

E Red Bridge Dam and Reservoir

F Putnam Local Protection

G Other Projects Studied

H Hydroelectric Power Studies

I Letters of Comment and Concurrence

APPENDIX A

DIGEST OF PUBLIC HEARING

APPENDIX A

DIGEST OF PUBLIC HEARING AND CORRESPONDENCE

1. This appendix presents a digest of the public hearing held by the New England Division at Putnam, Connecticut, on 12 December 1956. The purpose of the hearing was to ascertain the needs and desires for flood control and allied purposes on the Quinebaug and French Rivers, Thames River Basin, Connecticut, Massachusetts, and Rhode Island.

2. There is also included in this appendix a digest of correspondence from local interests relative to the hearing.

DIGEST OF PUBLIC HEARING - 12 DECEMBER 1956

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Hon. Horace Seely-Brown, Representative-in-Congress	Second District, Connecticut	--------	Asked that any of the proposals which could be justified under P.L. 685 be initiated as soon as possible.
Mr. John J. Curry, Engineer	Connecticut Flood Control & Water Policy Commission, Hartford, Conn.	--------	Commission wished to construct a stop-log structure at railroad cut in Putnam, but must know what C of E plans to construct before designing structure.
Mr. Malcolm E. Graf, Engineer	Div. of Waterways, Mass. Dept. of Public Works, Boston, Mass.	A conservation pool in one or both of the proposed East Brimfield & Westville Reservoirs, and a similar pool in the Buffumville Reservoir.	Improvements needed to improve low water flows for industrial process water. The Dept. offers the fullest cooperation in work of preparing flood control study.
Mr. James S. Klar, Planning Engineer	Connecticut Development Commission, Hartford, Conn.	--------	A Regional Planning Study now being conducted by the State for this area must be coordinated with any flood control program determined for the area.
Hon. John N. Dempsey, Mayor	City of Putnam, Conn.	A fifth flood control reservoir north of Putnam on the Quinebaug R.; a stoplog barrier in the RR cut under the Providence St. bridge or north of it; channel deepening and flood gates at one or more of the three dams in the city.	The reservoir would protect properties in Putnam as well as bridges & highway connections, the railroad, and other flood-prone properties along the river to the south; the stop-log barrier would prevent the break-through of water through the railroad cut; the dam improvements would reduce flood crests through the city.

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Henry A. Racicot, Town Engineer	Town of Southbridge, Mass.	Channel clearance, dikes, floodwalls, or other local improvements at 12 locations on the Quinebaug R. and its tributaries in the town of Southbridge.	Town Engineering Dept. has made a study of existing conditions in the Town of Southbridge, and place the assistance of the dept. at disposal of C of E.
Mr. Owen Bell, Town Manager	Town of Killingly, Conn.	Inspection of all private dams along Quinebaug, Five Mile, & Whetstone Rivers; dredging where shallow river beds are prevalent, specifically along the village of Rogers, the Danielson Acres, and at the Brooklyn bridge; widening of the river at old Brooklyn bridge; better dike control along the banks of Rogers; better control of the Five Mile & Whetstone Rivers.	In his opinion, many private dams could be eliminated and hence the removal of obstructions to the river's flow; the old Brooklyn Bridge is being removed by the State; The Five Mile & Whetstone empty into the Quinebaug at Killingly and have been flood threats in the past.
Mr. William L. St. Onge, Executive Director	Redevelopment Agency of City of Putnam, Conn.	Concurs in proposals of Mayor Dempsey of Putnam.	The utmost speed is necessary in obtaining adequate flood control for the city, in order for Putnam to improve & revitalize itself through Urban Redevelopment.
Dr. Robert Dinolt	Putnam Planning Commission, Putnam, Conn.	Concurs in proposals of Mayor Dempsey of Putnam.	A fifth reservoir will provide protection not only for Putnam itself, but for other important facilities in the valley below the city limits.

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Bower, President	Chamber of Commerce of City of Putnam, Conn.	Concurs in proposals of Mayor Dempsey of Putnam	Particularly interested in a fifth reservoir because of its potential benefits to business and industry, both in Putnam and in the much larger regional area downstream.
Mr. Gordon Harrower, President-Treasurer	Wauregan Mills, Wauregan, Conn.	Channel clearance, widening and dredging from the Wauregan dam south for about 3000 feet.	The channel has been reduced in capacity by at least 50% due to accumulation of debris. Unless this improvement is done, all future high waters pose a definite hazard to the Wauregan Mills which employs about 600 and had such extensive losses in the 1955 flood that it almost went out of business. Without this channel work, the mill may not remain at this location.
Mr. Horace P. Landry, Executive Secretary	Chamber of Commerce, Southbridge, Mass.	Storage in the East Brimfield Reservoir for stabilized minimum flow.	Needed for industrial uses, and to care for normal sewage wastes, public water supply, and recreation.
Mr. Edson L. Barlow, Plant Engineer	Belding-Heminway Corticelli, Putnam, Conn.	Repair of dam adjacent to their plant above the Providence Street Bridge and lengthening of the dam to permit greater flow; cleanup of debris from fire-destroyed building across the dam from their plant.	The dam, not owned by them, was partially destroyed and has been causing low level in the pond above the dam barely adequate to supply their requirements; the debris, in event of another flood, would create a bottleneck at the dam site.

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Stefan L. Grapnel, Chief Engineer	Belding-Corticelli Industries Inc., Grosvernor Dale, Conn.	Channel clearance on French River where it runs by their plant.	Channel is filled in with debris to a height that makes it impossible to draw water from it for the suction of their sprinkler fire pump. Possible fire in their plant could threaten entire surrounding area.
Mr. G. L. Busher, Superintendent, Bachman Uxbridge Worsted Corp.	Putnam Woolen Corp., Putnam, Conn.	-------	Had such a large loss in flood that company has never returned to full operation. Thinking of either moving or rebuilding elsewhere. Wants to know if they rebuild their waterpower dam, will it be discontinued by the C. of E. when flood control improvements are put into effect.
Mr. L. Gerald LaPointe, President	Lions Club, Putnam, Conn.	Concur in proposals of Mayor Dempsey of Putnam; also want straightening of channel between Providence St. Bridge & Bridge St. Bridge and at RR bridge on Park St. near South Main St.	--------
Mr. Armand LaCasse, Gen. Manager	LaPointe Instrument Co., Putnam, Conn.	Concur in proposals of Mayor Dempsey of Putnam, but would like control of Webster Lake, Mass.	The lake has overflowed in previous floods; if the lake gave, Putnam would be in serious danger.
Mr. Ferdinan Goznan, 1st Selectman	Town of Putnam, Conn.	Concur in proposals of Mayor Dempsey of Putnam; dredging of the river through Putnam.	Opposed to Putnam Redevelopment Committee plans to raze a large number of houses in area subject to flooding; believes dredging would be sufficient.
Mr. Bouchard	Private Individual	Straightening & dredging of the Quinebaug R. south of the Pomfret St. Bridge.	Would reduce flood hazard for residents bordering the river south of this bridge and for Monohanssett Village.

Speaker	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Walter J. Rucki	Private Individual	Dredging, straightening, and widening of the Quinebaug & French Rivers wherever needed; removal of horseshoe bend at lower Park St. at location called Priest Island.	Two weeks of good heavy rain or a heavy spring thaw could flood many cellars on Main St., Putnam, and areas below. In places the river is only a few feet below road level.
Mr. R. G. Philips, Maintenance Engineer	NY, NH & H RR Co., New Haven, Conn.	Rigid Government supervision of privately owned dams in Quinebaug & French Rivers.	Believes that neglect of these dams was direct cause of dike failures at N. Grosvenordale, Wilsonville, and Perrys, and of resulting severe damage to railroad property and other private property.
Mr. Edward J. Bourgeois, Chief Engineer	Sawyer Display, Putnam, Conn.	Dredging of river below Pomfret St. Bridge; straightening of curve at Priest Island; restoration or removal of the ruined railroad bridge at Arch St.	Improvements needed to protect Monohanssett Village.

LETTERS RECEIVED AT THE HEARING

Writer	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Newman E. Argraves, Commissioner	State Highway Dept., Hartford, Conn.	-----	Highway Dept. is on record as favoring such parts of the overall project as are shown by the C of E to be well justified economically. Dept. will be glad to join in such joint studies as may be necessary for proposed projects for Putnam.
Mr. John O. Martin, Asst. to the President	American Optical Co., Southbridge, Mass.	Concur in requests of Southbridge Chamber of Commerce and Town Engineer; wants dredging of channel of Quinebaug R. and erection of dikes and floodwalls.	Until the dams in East Brimfield and Westfield are constructed, our company and the jobs of our people are in a very vulnerable position. Urge construction of interim protective measures.
Mr. Alfred Cardin	Westwood Textile Mfg. Inc., Southbridge, Mass.	Channel clearance of Quinebaug R. and protective walls from Big Pond spillway to River St., and on McKinstry Brook from west side of Plimpton St. to confluence with Quinebaug R.	Letter of 11 Dec. 56 to Southbridge Board of Selectmen for submission at public hearing.
-------	Southbridge Sheet Metal Works, Southbridge, Mass.	Channel clearance and protective walls on Quinebaug R. from Big Pond spillway to River St., and on McKinstry Brook from west side of Plimpton St. to confluence with Quinebaug R.	Letter (undated) to Southbridge Board of Selectmen for submission at public hearing.

Writer	Interest Represented	Improvement Desired	Reasons Advanced and Other Remarks
Mr. Joseph R. Seremet	River Machine Tool Co., Southbridge, Mass.	Channel clearance & protective walls on Quinebaug R. from Big Pond spillway to River St., and channel clearance on McKinstry Brook from west side of Plimpton St. to confluence with Quinebaug R.	Letter of 10 Dec. 56 to Southbridge Selectmen for submission at public hearing.
Mr. C. J. Laliberte, Treasurer	F. X. Laliberte & Son Inc., Southbridge, Mass.	Dredging of Quinebaug R. between Central St. Bridge & Mechanic St. Bridge; reinforced concrete retaining wall from Central St. Bridge to Mechanic St. Bridge or beyond, with an extension above the grades to form a dike; widening of the river at some points.	These improvements would afford a great deal of safety from flood to all abuttors along these areas. (Letter of 10 Dec. 56 to Southbridge Selectmen to be submitted at public hearing.)
Mr. Dewey F. Lariviere, President & Treas.	Globe Tool & Die Mfg. Co. Inc., Southbridge, Mass.	Removal of remains of Big Pond Dam & widening of Quinebaug R. channel at this point; repair of retaining walls & riprap of the dike to prevent further erosion.	Unless these improvements are effected our entire plant and the jobs of 150 people are endangered.
Mr. Warren R. McNally	Private Individual	-------	Opposed to Putnam Redevelopment Committee plans to raze dwellings in area subject to flooding.

APPENDIX B

HYDROLOGY AND HYDRAULICS

APPENDIX B

HYDROLOGY AND HYDRAULICS

TABLE OF CONTENTS

Par.		Page
	A INTRODUCTION	
1	Scope	B-1
2	Description	B-1
3	Principal Tributaries	B-1
	B CLIMATOLOGY	
4	Temperatures	B-2
5	Precipitation	B-3
6	Snowfall	B-5
7	Storms	B-6
	a. General	B-6
	b. March 1936	B-6
	c. July 1938	B-6
	d. September 1938	B-6
	e. August 1955	B-6
	C STREAMFLOWS	
8	Records	B-7
9	Runoff	B-8
	D FLOODS OF RECORD	
10	Historic Floods	B-8
11	Recent Floods	B-8
12	Description of Recent Major Floods	B-9
	a. March 1936	B-9
	b. July 1938	B-9
	c. September 1938	B-9
	d. August 1955	B-9
13	Frequency	B-10
	E ANALYSIS OF FLOODS	
14	General	B-10
15	Method of Analysis	B-10
16	Flood Routing	B-10
17	Flood Characteristics	B-11
	a. General	B-11
	b. Relative Timing of Flood Crests	B-11
	c. Source of Floods	B-13

Par.		Page
	E ANALYSIS OF FLOODS (Cont.)	
18	Standard Project Flood	B-13
	a. Unit Hydrographs	B-13
	b. Flood Discharges	B-13
19	Typical Tributary Contribution Flood	B-13
	F FLOOD CONTROL RESERVOIRS	
20	General	B-15
21	Authorized Reservoirs	B-15
	a. Hodges Village	B-15
	b. Buffumville	B-15
	c. East Brimfield	B-15
	d. Westville	B-16
22	Proposed Reservoir	B-16
	G SPILLWAY AND OUTLET CAPACITIES	
23	Spillway Capacities	B-19
24	Outlet Capacities	B-19
	H EFFECT OF FLOOD CONTROL RESERVOIR PLANS	
25	General	B-20
	I RESERVOIR REGULATION	
26	General	B-20

APPENDIX B

HYDROLOGY AND HYDRAULICS

TABLES

Table	Title	Page
B-1	Monthly Temperature Record	B-2
B-2	Monthly Precipitation Record	B-4
B-3	Mean Monthly Snowfall	B-5
B-4	Streamflow Records	B-7
B-5	Major Floods	B-8
B-6	Relative Timing of Flood Crests	B-12
B-7	Tributary Contributions	B-14
B-8	Pertinent Data - Proposed Reservoirs	B-17
B-9	Effect of Flood Control Plans	B-21

APPENDIX B

HYDROLOGY AND HYDRAULICS

PLATES

Plate	Title
B-1	Basin Map
	Quinebaug River, Plan and Profile, Flood of August 1955
B-2	Mile 0 to 25
B-3	Mile 24 to 45
B-4	Mile 44 to 57
B-5	Mile 56 to 71
	French River, Plan and Profile, Flood of August 1955
B-6	Mile 0 to 18.3
B-7	Area-Depth Curves, Storms of Record, Northeastern United States
B-8	Probable Frequency of Peak Discharge
B-9	Flood of March 1936
B-10	" " September 1938
B-11	" " August 1955
B-12	Standard Project Flood
B-13	Typical Tributary Contribution Flood
B-14	West Thompson Reservoir, Flood Control Regulation

APPENDIX B

HYDROLOGY AND HYDRAULICS

A. INTRODUCTION

1. Scope. This appendix presents climatological and hydrological data for the Quinebaug River Basin, the analysis of floods of record, the development of synthetic floods, the analysis of various flood control measures, and the determination of flood reductions afforded by various flood control projects.

2. Description. The Quinebaug River, the largest tributary river in the Thames River basin, has a drainage area of 744 square miles, (see Basin Map, Plate No. B-1). It originates in several small brooks above East Brimfield, Massachusetts, flows southeasterly to Mechanicsville, Connecticut, where it is joined by the French River, thence southwesterly to its confluence with the Shetucket River, three miles above Norwich, Connecticut. It has an approximate length of 70 miles and a total fall of about 650 feet. The topography of the basin is rolling and contains numerous low hills. The channel, for the most part, is a series of flat mill ponds with extensive valley storage which modify minor floods. However, in every major flood to date, the ponds and valley storage have been filled by wet antecedent conditions; consequently, the runoff has been rapid. Failure of numerous small dams has added to the magnitude of the floods. Above the mouth of the French River, the Quinebaug River, fed by many small brooks, has an average slope of about 12 feet per mile. The major tributaries below the mouth of the French River are the Five Mile, Moosup and Pachaug Rivers. Flows from these latter streams are affected by valley storage in ponds, lakes and swamps. In this reach, the Quinebaug River drops about 70 feet in the first two miles; while below the slope averages about five feet per mile to the mouth. (See Plate Nos. B-2 through B-5).

3. Principal Tributaries. The principal tributaries of the Quinebaug are as follows: French (drainage area = 112 square miles), Five Mile (drainage area = 77 square miles), Moosup (drainage area = 88 square miles) and Pachaug (drainage area = 60 square miles). These four tributaries comprise approximately 45 percent of the drainage area of the Quinebaug River. The most important of these tributaries is the French River, which has its headwaters in Leicester, Massachusetts. It flows southerly a total distance of 28 miles with a drop of over 600 feet to its confluence with the Quinebaug River at Mechanicsville, Connecticut, (see Plate No. B-6). Lake Chaubunagungamaug (Webster Lake), with a drainage area of 11 square miles and a surface area of two square miles, is the only significant storage that is effective during a major flood.

B. CLIMATOLOGY

4. Temperatures. The mean annual temperature in the Quinebaug River Basin varies throughout the basin from 47 to 50 degrees Fahrenheit. At North Grosvenordale, seven miles north of Putnam, Connecticut, temperatures have ranged from a minimum of 25 degrees below zero to a maximum of 103 degrees. Freezing temperatures are common from the middle of November to the last of March with sub-zero temperatures occurring one or two days per year. Temperatures exceeding 100 degrees are rare. Table B-1 shows the mean monthly and mean, maximum, and minimum annual temperatures at New London, Connecticut, 15 miles south of the basin, Putnam, Connecticut, and Worcester, Massachusetts, 5 miles northeast of the basin.

TABLE B-1

MONTHLY TEMPERATURE RECORD
(Degrees Fahrenheit)

Station	New London Conn.	Putnam Conn.	Worcester Mass.
Elevation ft., m.s.l.	62	240	628
Years of Record	83	20	62
Mean Monthly			
January	29.9	25.9	25.5
February	29.9	27.9	25.4
March	37.5	35.5	35.0
April	46.9	45.9	45.7
May	57.4	56.2	57.3
June	66.2	64.9	66.0
July	71.8	70.5	71.1
August	70.4	68.4	68.9
September	64.4	60.9	62.0
October	54.3	51.5	51.8
November	43.4	40.2	40.1
December	33.1	29.1	28.5

TABLE B-1 (Cont.)

TEMPERATURE RECORD
(Degrees Fahrenheit)

Station	New London Conn.	Putnam Conn.	Worcester Mass.
Mean Annual	50.4	48.0	48.1
Maximum Annual	58.3	50.5	56.5
Minimum Annual	41.7	45.3	39.5

5. Precipitation. The average annual precipitation over the Quinebaug River Basin of approximately 42 inches, is uniformly distributed throughout the year. Table B-2 summarizes the mean monthly and mean, maximum, and minimum annual precipitation at six stations in or near the Quinebaug River Basin.

TABLE B-2

MONTHLY PRECIPITATION RECORD
(In Inches)

Station	Baltic Conn.	New London Conn.	Putnam Conn.	Southbridge Mass.	Webster Mass.	Worcester Mass.
Elevation ft., m.s.l.	140	62	240	720	450	628
Years of Record	18	83	19	43	75	111
Mean Monthly						
January	3.36	4.01	3.49	3.78	3.55	3.36
February	2.72	3.61	2.89	3.47	3.51	3.02
March	3.89	4.21	3.87	4.22	3.86	3.66
April	3.90	3.75	3.84	4.14	3.42	3.41
May	3.67	3.46	3.87	3.98	3.31	3.57
June	3.30	3.09	3.74	4.02	3.44	3.20
July	4.04	3.57	4.07	4.04	3.53	3.42
August	4.52	4.42	5.08	4.67	3.95	3.87
September	3.15	3.40	3.38	4.09	3.55	3.33
October	3.42	3.52	3.37	3.50	3.21	3.42
November	4.73	4.06	4.76	4.24	3.56	3.55
December	3.92	3.76	3.85	3.71	3.58	3.31
Mean Annual	43.58	44.61	45.74	46.77	42.82	40.72
Maximum Annual	54.68 (1953)	60.62 (1919)	62.07 (1951)	67.35 (1938)	56.72 (1888)	61.89 (1852)
Minimum Annual	30.71 (1941)	30.05 (1898)	30.71 (1941)	31.39 (1930)	29.99 (1930)	27.92 (1941)

6. Snowfall. Snowfall data of any significant value are available only at Putnam, Connecticut, and at Worcester and Southbridge, Massachusetts. The average annual snowfall varies from 55 inches at Worcester (62 years of record) to 42 inches at Putnam (20 years of record). Table B-3 summarizes the mean monthly and mean, maximum, and minimum annual snowfall at Putnam, Worcester and Southbridge.

TABLE B-3

MEAN MONTHLY SNOWFALL
(Average Depth in Inches)

Station	Putnam Conn.	Worcester Mass.	Southbridge Mass.
Elevation ft., m.s.l.	240	628	720
Years of Record	20	62	11
Month			
October	0.1	0.1	Trace
November	2.2	3.1	2.2
December	8.3	9.8	12.5
January	11.8	14.8	15.0
February	9.7	15.8	14.0
March	10.5	8.8	6.6
April	1.1	2.9	2.2
Mean Annual	42.4	55.3	52.5
Maximum Annual	94.5 (1955-1956)	98.5 (1947-1948)	99.2 (1955-1956)
Minimum Annual	14.3 (1936-1937)	24.6 (1936-1937)	23.2 (1941-1942)

7. Storms. a. General. Storms generally approach the New England Area from a westerly direction and are of moderate intensity. Great storms in this category occurred in March 1936 and July 1938. The most severe storms are of tropical origin, which, as they proceed northward, pass either directly over or within striking distance of the New England states. Such storms are usually attended by high winds and heavy precipitation. The great storms of September 1938 and of August 1955 are in this category. These four storms produced major floods in the Quinebaug River Basin. Area-depth curves for these storms, compared with other major storms which have occurred over northeastern United States, are shown on Plate No. B-7.

b. March 1936. A succession of four continental disturbances of the cold front type accompanied by heavy rains over the entire northeastern part of the United States occurred in the period of March 9-22, 1936. Heaviest rainfall occurred in the periods of March 9-13 and 16-22. The total rainfall in the Quinebaug River Basin varied from approximately six inches to over nine inches along the upper Quinebaug and French Rivers. (See Isohyetal Map, Plate No. B-9).

c. July 1938. Masses of tropical marine air moved into southeastern New England around the middle of the month and continued to stream over the section throughout the latter part of the month, being maintained by a persistent Bermuda high pressure area. Extremely heavy and frequent showers, particularly from the 18th to the 24th, occurred in this tropical marine air. The rainfall averaged seven inches over the entire basin in a period of seven days with most of the rainfall concentrated in four days.

d. September 1938. A cold front storm, stalled along the Atlantic coast, was followed by a rapidly moving tropical hurricane, resulting in record-breaking rainfalls over large areas of Connecticut, Massachusetts and New Hampshire, Rainfall amounts over the Quinebaug River Basin varied from seven inches in the lower portion of the basin to 13 inches in the headwaters. Isohyetals of the total rainfall over the Quinebaug River Basin are shown on Plate No. B-10.

e. August 1955. A high pressure system stagnated over the Northeastern United States and forced "Hurricane Diane" to move in a northeasterly direction south of Long Island on a course parallel to the southern New England coast. When "Hurricane Diane" changed its course as it traveled south of New England, it became recharged with moisture which it dumped over southern New England. The total rainfall over the Quinebaug River Basin varied from five inches at the lower end of the basin to 17 inches at the headwaters. Isohyetals of the total storm over the Quinebaug River Basin are shown on Plate No. B-11.

C. STREAM FLOWS

8. Records. At the present time, the U.S. Geological Survey operates eight gaging stations in the Quinebaug River Basin. The records are generally good to excellent except during periods of ice when they are rated fair. Records have been lost during major floods, but were reproduced from records at dams with peak discharges often determined from slope-area measurements. Flow data at the gaging stations are summarized in Table B-4.

TABLE B-4

STREAM FLOW RECORDS

Quinebaug River Basin

Location of Gaging Station	Drainage Area (Sq. Mi.)	Period of Record	Discharge Mean (c.f.s.)	Discharge Maximum (1) (c.f.s.)	Discharge Minimum (1) (c.f.s.)
Quinebaug River at Westville, Mass.	93.8	1940-1955	162	17,500 (2)	0.2
Little River at Buffumville, Mass.	27.7	1940-1955	47	8,340 (2)	0.5
French River at Webster, Mass.	85.3	1950-1955	171	14,400 (2)	3
Quinebaug River at Quinebaug, Conn.	157	1932-1955	278	49,300 (2)	1
Quinebaug River at Putnam, Conn.	331	1930-1955	570	48,000 (2)	8
Five Mile River at Killingly, Conn.	58.2	1938-1955	104	2,840 (3)	4
Moosup River at Moosup, Conn.	83.5	1933-1955	161	4,260 (4)	0.1
Quinebaug River at Jewett City, Conn.	711	1919-1955	1244	40,700 (2)	18

(1) Instantaneous discharge

(2) Occurred August 1955

(3) " July 1938

(4) " March 1936

9. Runoff. The average annual runoff for the basin, based on available records at the Jewett City gaging station, is about 23.7 inches (1.75 cubic feet per second per square mile) or just over 50 per cent of the average annual precipitation. Within the basin, the average annual runoff ranges from a maximum of more than 26 inches (1.93 cubic feet per second per square mile) from the drainage area of the Moosup River to a minimum of less than 20 inches (1.45 cubic feet per second per square mile) from the area around Webster Lake. More than one-half of the annual runoff occurs in the months of March, April and May, with the remainder uniformly distributed throughout the rest of the year.

D. FLOODS OF RECORD

10. Historic Floods. Between 1828 and 1900 four damaging floods occurred in the Quinebaug River Basin, one of which was localized. In March 1888, a general storm caused severe flooding on the French River, while an ice jam in the upper Thames River caused flooding in the city of Norwich. General floods occurred in September 1828, March 1876 and February 1886. The February 1886 flood resulted from a storm producing over seven inches of rainfall within a three-day period. Conditions were favorable for high runoff and, in some parts of the basin, a flood comparable to that of March 1936 was experienced.

11. Recent Floods. Five floods of major proportions have occurred within recent years, one of which was localized. This localized flood, a result of the great New England storm of November 1927, was severe only on the Moosup River. Pertinent data on the other major floods at the U.S. Geological Survey gaging stations on the Quinebaug River at Putnam and Jewett City, Connecticut are given in Table B-5. High water data, where available, are indicated on Plate Nos. B-2 through B-6.

TABLE B-5

MAJOR FLOODS

	Quinebaug River at Putnam, Conn. (D.A. = 331 Sq. Mi.)			Quinebaug River at Jewett City, Conn. (D.A. = 711 Sq. Mi.)		
Flood	Average Rainfall (Inches)	Peak Discharge Observed (c.f.s.)	Gage Height (Feet)	Average Rainfall (Inches)	Peak Discharge Observed (c.f.s.)	Gage Height (Feet)
March 1936	9.0	17,200	17.28	6.0	29,200	24.0
July 1938	6.0	9,560	13.0	7.0	25,000	22.5
September 1938	11.7	20,900	19.45	8.0	22,800	21.7
August 1955	12.5	48,000	26.5	6.0	40,700	29.0

12. Descriptions of Recent Major Floods.

a. March 1936. The March 1936 floods resulted from the storms of March 9-13 and 16-22. The hydrographs at all gaging stations show two rises separated by a recession almost to base flow. The first rise was caused by about three inches of rain falling on snow with approximately four inches of water content. River stages were also augmented by minor ice jams. The first rise surpassed the previous record flood in most of the basin and is still the maximum flood of record along the Moosup River. The second rise occurred while ponds and valley storage were still full from the first flood. The heavy rainfall in this second storm caused the rivers to rise to levels surpassing the first in most parts of the basin thus producing the third largest flood of record along the Quinebaug River below the French River.

b. July 1938. The July 1938 flood was generally smaller than the March 1936 flood, although the storm came at a time when conditions were favorable for heavy runoff. Precipitation during June was well above normal and the average precipitation in early July reduced the rate of depletion of storage in the ponds and swamps and retarded the drying out of the ground. Although this flood was by no means comparable with those of March 1936 and September 1938, considerable portions of the lower Quinebaug River and its tributaries, as far north as the French River, were flooded and considerable damage was caused.

c. September 1938. With the exception of the Quinebaug River Basin below Putnam, this flood is the second greatest of record. The storm producing the flood started with light rain gradually increasing in intensity and ending with a heavy downpour. This rainfall pattern was especially conducive to high peak discharges, due to the filling of ponds, lakes and swamps and the satisfying of initial soil moisture deficiencies before the intense rainfall occurred. Moreover, rainfall during the previous month was heavier than normal, thereby helping to reduce initial storage and infiltration losses.

d. August 1955. The greatest flood of record in the Quinebaug River Basin occurred in August 1955. As shown in Table B-5, the peak discharge at Putnam, Connecticut was over twice the magnitude of the previous record flood. Flood discharges on the upper Quinebaug River, as well as on its tributaries, exceeded all previous records. Between 11-15 August, "Hurricane Connie" brought three to four inches of rainfall to the basin, but very little runoff occurred as a result of dry antecedent conditions. However, When "Hurricane Diane" deposited record amounts of precipitation from 17-20 August on regions previously saturated by the rainfall of "Hurricane Connie", a runoff of record proportions occurred. The failure of many dams and bridges contributed substantially to peak discharges.

13. Frequency. The frequency or per cent chance of occurrence of peak discharges was determined from records of all gaging stations in the basin. The frequency analyses were made in accordance with procedures devised by Mr. L.R. Beard, Office of the Chief of Engineers. The method considers that the logarithmic values of annual peak flows are normally distributed, thereby permitting the application of standard statistical analysis. This enables the discharge-frequency curve to be defined by its mean values and standard deviations therefrom. The procedure is described in Civil Works Engineering Bulletins 51-1 and 51-14. The application to New England rivers is summarized in F.C.S. Memorandum No. 52-General-3, "Flood Frequency Studies in New England". Following the August and October floods of 1955, new frequency studies were initiated for all New England river basins. The mean and standard deviations for each gaged area were recomputed to include five years of additional flow data. Based on a regional analysis, a skew coefficient of 1.0 was adopted for the Quinebaug River Basin instead of a skew coefficient of 0.3 that was previously used. The natural discharge frequency curves at the U.S. Geological Survey gaging stations are shown on Plate No. B-8.

E. ANALYSIS OF FLOODS

14. General. An analysis of all recent floods in the Quinebaug River Basin was made in order: (1) to determine the discharge contributions of tributaries and local areas to flood flows at the principal damage centers, and (2) to properly evaluate (a) the flood characteristics and potentialities of the various streams, and (b) the necessity for reservoir control and/or local protection measures. These determinations were based on detailed studies of data collected during and after the major floods of March 1936, September 1938 and August 1955.

15. Method of Analysis. For purposes of hydrologic and hydraulic analysis, the Quinebaug River Basin was divided into basin subdivisions and routing reaches (See Plate No. B-1). The basin subdivisions were selected to fully utilize recorded hydrographs and other observed flood data. The limits of the routing reaches were located at U.S. Geological Survey gaging stations, at the mouths of principal tributaries or at other control points, such as dams, where stream flows could be computed. The component hydrographs for the basin subdivisions were either obtained from gaging station records or developed synthetically from the observed hydrographs and rainfall data of comparable gaged areas. The component hydrographs were routed downstream to determine their contributions to the flood peaks at downstream damage centers, using the Progressive Average-Lag Method of flood-routing described in the following paragraph.

16. Flood Routing. The Progressive Average-Lag Method of flood routing was adopted for use in the Quinebaug River Basin because of its adaptability for component routing. The method is empirical and develops an arithmetic relationship between inflow and outflow for a given reach, allowance being made for the distance of travel, the storage in the

reach, the amount of intervening inflow, and the relative timing of the peak flows. This method is described in E.M. Civil Works, Part CXIV, Chapter 8, September 1953. (ER 1110-2-1408).

17. Flood Characteristics.

a. General. From the studies of floods of record, general flood characteristics of the Quinebaug River Basin were evident. Although the two greatest floods of record, August 1955 and September 1938, were caused by heavy rainfall alone, a combination of rainfall and melting snow can develop into a major flood on the Quinebaug River, as was experienced in March 1936. Antecedent rainfall conditions and snow cover are especially important in view of the extensive pondage and flat topography of the basin. The major floods, as a rule, are preceded by a period of moderate rainfall, which saturates the ground and fills up the river channels and swamps, or a ripening of the snow cover in the springtime. It is evident from the study of floods of record that floods can occur in any month of the year with varying durations within the basin. The peak discharges on the Quinebaug River at Southbridge, Massachusetts and Quinebaug and Putnam, Connecticut are normally only a few hours in duration. The hydrographs have a quick rise, caused by rapid runoff of the nearby short steep brooks, and a more gradual recession produced by the slower runoff from the headwater areas. On the other hand, at Jewett City on the Quinebaug River, the flood discharges are of longer duration, slower rising and a more gradual recession, showing the effect of the valley storage.

b. Relative Timing of Flood Crests.

A study was made of the relative timing of flood crests on the Quinebaug River and its tributaries and the results are shown in Table B-6. This data was determined for natural conditions and does not include the effect of any flood control reservoirs. Inspection of this table shows that floods on the Quinebaug River usually crest at Southbridge about 10 hours after the time of rainfall concentration and a few hours later downstream at Putnam. Considering the distance, 15 miles, and the valley storage between Southbridge and Putnam, this appears rather fast, but the rapid runoff of the intervening local area tends to offset the effect of distance and valley storage. Upstream of Southbridge, floods generally crest after the peak has occurred at Southbridge, which demonstrates the slower runoff characteristics and effect of valley storage in the watershed above Westville.

Floods usually crest in the French River Basin at Hodges Village some 10 to 15 hours after the time of rainfall concentration, while on the Little River at Buffumville the floods generally crest a few hours later. At Webster, approximately six miles downstream, the flood hydrograph has a broader peak about five or ten hours after the peak at Hodges Village. This lag is more pronounced in minor than in major floods and is caused by the valley storage above Webster, which delays the peak. The flood crests arrive at the mouth of the French River on the recession side of the main Quinebaug River hydrograph.

During the August 1955 flood in the French River Basin, there was a closer synchronization of flood peaks, probably due to the greater magnitude of the flood, and the less effectiveness of the valley storage as well as the numerous dam failures.

Below Putnam, at Jewett City, flood crests generally occur 24 hours after the Putnam crest. This lag is caused by the distance of 30 miles and the extensive valley storage within this reach. The three major tributaries entering the Quinebaug River between Putnam and Jewett City are the Five Mile, Moosup and Pachaug Rivers. The flows on all three of these tributaries are affected by storage in ponds, lakes and swamps. As a result, floods on these tributaries may synchronize with the crest on the Quinebaug River, but, because of the effective storage on the tributaries and this section of the Quinebaug River, they are only minor contributors to floods at Jewett City.

TABLE B-6

QUINEBAUG RIVER BASIN

RELATIVE TIMING OF FLOOD CRESTS

	FLOOD OF MARCH 1936 (Lag in hours)	FLOOD OF SEPTEMBER 1938 (Lag in hours)	FLOOD OF AUGUST 1955 (Lag in hours)
Quinebaug River			
Westville, Mass.	16	12	13
Southbridge, Mass.	9	10	9
Putnam, Conn.	13	13	14
Jewett City, Conn.	33	39	36
French River			
Hodges Village, Mass.	12	14	11
Little River at Buffumville, Mass.	15	15	12
Webster, Mass.	20	24	13
Five Mile River			
Killingly, Conn.	-	23	36
Moosup River			
Moosup, Conn.	8	7	26

Note: The values shown in this table are the lag, in hours, from the time of rainfall concentration to the time of the peak flow.

c. Source of Floods. In order to determine the value of upstream reservoirs, the source or origin of floods above each damage center in the Quinebaug River Basin was ascertained from detailed studies of the recorded flood hydrographs. A summary of discharge contributions from tributaries and local areas to the flood peaks at Southbridge, Putnam and Jewett City on the Quinebaug River and Webster on the French River is tabulated in Table B-7 and shown graphically on Plates B-9 through B-11. The data indicates that the areas immediately above the damage centers are the prime contributors to the peak flows.

18. Standard Project Flood. The standard project flood developed for the Quinebaug River was based on the standard project storm rainfall, as described in Civil Engineer Bulletin No. 52-8, and on unit hydrographs derived from analyses of record floods. The standard project storm was oriented so as to give the most critical condition at Putnam, Connecticut.

a. Unit Hydrographs. Unit hydrographs were derived for all gaged areas in the Quinebaug Basin based on investigations of floods of record. As in other river basins, the August 1955 storm produced record-breaking discharges. Analyses of these discharges resulted in unit hydrographs much larger than previously computed, thus demonstrating that peaks of unit hydrographs vary considerably with the magnitude of the flood. Application of these revised unit hydrographs resulted in a greater standard project flood than derived in previous years.

b. Flood Discharges. The standard project flood runoff from the tributary areas was routed to Putnam and summated to produce a maximum discharge of 55,000 c.f.s., which is about 15 per cent greater than experienced in the record flood of August 1955. The flood hydrograph at Putnam was routed to Jewett City and combined with the runoff from the local area to determine the flow at Jewett City. A summary of the standard project flood derivation is shown on Plate No. B-12 with tributary and local contributions tabulated in Table B-7.

In determining the standard project flood at Putnam, modified by the authorized reservoirs at East Brimfield, Westville, Buffumville and Hodges Village and the proposed reservoir at West Thompson, it was assumed that the flood control reservoirs were empty at the beginning of the storm. All reservoirs, except East Brimfield would reach spillway crest, but spillway discharge contributions to peak flow would be insignificant. The standard project flood peak discharge at Putnam, modified by East Brimfield, Westville, Buffumville and Hodges Village, is 38,000 c.f.s. and, modified by the above reservoirs and West Thompson, 18,000 c.f.s.

19. Typical Tributary Contribution Flood. In order to evaluate the relative flood control effectiveness and the economics of projects, a synthetic flood was developed to represent a typical distribution of

TABLE B-7

TRIBUTARY CONTRIBUTIONS

TO

QUINEBAUG RIVER FLOOD PEAKS

THAMES RIVER BASIN, MASS. AND CONN.

Location	Basin Sub-Division	Contributing Component	Drainage Area		Discharge: March 1936		Discharge: September 1938		Discharge: August 1955		Discharge: Standard Project		Discharge: T.T.C.F.	
			(sq.mi.)	(%)	(c.f.s.)	(%)	(c.f.s.)	(%)	(c.f.s.)	(%)	(c.f.s.)	(%)	(c.f.s.)	(%)
Southbridge, Mass.	A	Area above E. Brimfield	68	54.0	2,100	31.8	4,820	37.1	3,000	8.3	12,100	42.5	4,800	36.6
	B	Local Area (E. Brimfield to Westville)	26	20.6	2,000	30.3	4,180	32.2	8,000	22.2	4,600	16.1	3,000	22.9
	C_1	Local Area (Westville to Southbridge)	32	25.4	2,500	37.9	4,000	30.7	25,000	69.5	11,800	41.4	5,300	40.5
			126	100.0	6,600	100.0	13,000	100.0	36,000	100.0	28,500	100.0	13,100	100.0
French River at Webster, Mass.	D	Area above Hodges Village	30	35.3	1,700	36.2	1,020	36.4	8,200	56.9	5,080	31.2	2,500	39.1
	E	Area above Buffumville	27	31.8	1,800	38.3	910	32.5	4,200	29.2	3,700	22.7	2,300	35.9
	F	Local (Hodges Village to Webster)	28	32.9	1,200	25.5	870	31.1	2,000	13.9	7,520	46.1	1,600	25.0
			85	100.0	4,700	100.0	2,800	100.0	14,400	100.0	16,300	100.0	6,400	100.0
Putnam, Conn.	A & B	Area above Westville	94	28.4	2,300	13.5	5,060	24.2	13,000	27.1	8,670	15.8	4,590	20.9
	C_1 & C_2	Local (Westville to Quinebaug)	63	19.0	6,800	40.0	6,640	31.8	15,000	31.2	17,580	31.9	8,390	38.1
	D & E & F	Area above Webster	85	25.7	2,700	15.9	2,000	9.6	9,600	20.0	10,650	19.4	4,400	20.0
	G	Local to Putnam	89	26.9	5,200	30.6	7,200	34.4	10,400	21.7	18,100	32.9	4,620	21.0
			331	100.0	17,000	100.0	20,900	100.0	48,000	100.0	55,000	100.0	22,000	100.0
Jewett City, Conn.	A & B	Area above Westville	94	13.2	2,400	8.2	5,600	24.6	10,300	25.3	6,900	11.2	4,100	16.2
	C_1 & C_2	Local (Westville to Quinebaug)	63	8.9	3,800	13.0	3,900	17.1	4,500	11.1	9,200	15.0	5,650	22.3
	D & E & F	Area above Webster	85	12.0	2,500	8.6	2,200	9.7	7,500	18.4	7,700	12.5	3,950	15.6
	G	Local to Putnam	89	12.5	2,900	9.9	2,700	11.8	9,400	23.1	7,800	12.7	3,950	15.6
	H	Local (Putnam to Jewett City)	155	21.8	11,400	39.1	6,500	28.5	5,000	12.3	17,000	27.6	4,500	17.8
	I	Five Mile River	77	10.8	1,700	5.8	900	3.9	1,300	3.2	4,200	6.8	1,100	4.4
	J	Moosup River	88	12.4	2,800	9.6	500	2.2	1,600	3.9	5,700	9.3	1,400	5.5
	K	Pachaug River	60	8.4	1,700	5.8	500	2.2	1,100	2.7	3,000	4.9	650	2.6
			711	100.0	29,200	100.0	22,800	100.0	40,700	100.0	61,500	100.0	25,300	100.0

tributary flood contributions in the Quinebaug River Basin. The floods of record were used to determine the relative shape and timing of the component hydrographs with the peak discharge and volume related to frequency curves and average annual runoff, respectively. These component hydrographs were combined and routed, where necessary, to develop the main river hydrographs. Typical routing coefficients were selected from analyzing record floods. Tributary and local contributions to the TTCF peaks at various locations in the basin are shown on Plate B-13 and in Table B-7. A detailed explanation of the derivation and application of a TTCF are given in the report of the New England-New York Inter-Agency Committee, Part 3, Volume 3, Section XIX.

F. FLOOD CONTROL RESERVOIRS

20. General. The recommended flood control plan for the Quinebaug River includes the four authorized reservoirs at Hodges Village, Buffumville, East Brimfield and Westville plus a proposed reservoir at West Thompson. Pertinent data for each of these reservoirs are summarized in the following paragraphs and are tabulated in Table B-8.

21. Authorized Reservoirs.

a. Hodges Village. The dam site is located on the French River at Hodges Village, town of Oxford, Massachusetts, one-half mile above the mouth of Little River. The dam which is currently under construction, will be of rolled-earth and rock-fill construction with concrete spillway. The reservoir will have a flood control capacity of 12,800 acre-feet, equivalent to 7.5 inches of runoff from the drainage area of 31.1 square miles, and will include a total area of 740 acres at spillway crest elevation of 501 feet, mean sea level.

b. Buffumville. The dam site is located on the Little River at Buffumville, town of Charlton, Massachusetts, 1.3 miles above its confluence with the French River, and controls a drainage area of 26.5 square miles. The dam, which is currently under construction, will be of rolled-earth fill construction with concrete spillway. The total capacity of the reservoir will be 12,700 acre-feet of which 11,300 acre-feet, equivalent to 8.0 inches of runoff, will be for flood control and 1,400 acre-feet, equivalent to 1.0 inch of runoff, will be retained for a permanent pool.

c. East Brimfield. The dam site is located in the Town of Sturbridge, Massachusetts, on the Quinebaug River, 64.5 miles above its confluence with the Shetucket River, and controls a drainage area of 67.5 square miles. The proposed dam will be of rolled-earth fill construction with concrete spillway. The capacity of the reservoir will be 30,000 acre-feet of which 28,800 acre-feet, equivalent to 8.0 inches of runoff, will be

for flood control and 1,200 acre-feet, equivalent to 0.3 inch of runoff, will be retained for a minimum pool. The area of the reservoir at spillway crest elevation of 653 feet will be 2,250 acres. Preliminary design has been completed.

d. Westville. The dam site is located on the Quinebaug River in the village of Westville, town of Sturbridge, Massachusetts, 3.7 miles above Southbridge, Massachusetts, and controls a net drainage area of 26 square miles below the East Brimfield Reservoir, and a total drainage area of 93.5 square miles. The reservoir will have 11,500 acre-feet of storage for flood control and 500 acre-feet for a minimum pool, equivalent to 8.7 inches and 0.4 inches from the net drainage area, respectively. The area of the reservoir at spillway crest elevation of 579 feet will be 1,200 acres. Planning for the project has been initiated.

22. Proposed Reservoir. The West Thompson Dam site is on the Quinebaug River in the town of Thompson, Connecticut, 0.1 mile upstream of the confluence of the French and Quinebaug Rivers and two miles upstream from Putnam, Connecticut. It controls a net drainage area of 80.0 square miles below the Westville Reservoir and a total drainage area of 173.5 square miles. The dam would be of rolled-earth fill construction with a concrete side-channel spillway. The reservoir would have a flood control capacity of 25,600 acre-feet, equivalent to 6.0 inches of runoff, and would include an area of 1,200 acres at spillway crest elevation of 341 feet, mean sea level.

TABLE B-8
PERTINENT DATA
PROPOSED DAMS AND RESERVOIRS
QUINEBAUG RIVER BASIN

PROJECT	HODGES VILLAGE MASS.	BUFFUMVILLE MASS.	EAST BRIMFIELD MASS.	WESTVILLE* MASS.	WEST THOMPSON CONN.
Location	French River Mile 16.5	Little River Mile 1.3	Quinebaug River Mile 64.5	Quinebaug River Mile 59.0	Quinebaug River Mile 41.5
Drainage Area, sq. mi.	31.1	26.5	67.5	26 (Net) 93.5 (Total)	80.0 (Net) 173.5 (Total)
			67.5 26 80 173.5		
Reservoir Storage, acre-feet:					
Flood control	12,800	11,300	28,800	11,500	25,600
Minimum pool	0	1,400	1,200	500	0
Total	12,800	12,700	30,000	12,000	25,600
Reservoir Storage, Inches of Runoff:					
Flood Control	7.5	8.0	8.0	8.3	6.0
Minimum Pool	0	1.0	0.3	0.4	0
Total	7.5	9.0	8.3	8.7	6.0
Reservoir Area, acres:					
Flood Control	740	530	2,270	1,200	1,200
Elevations, feet, m.s.l.:					
Top of Dam	520	539	672	593	361
Flood Control pool	501	524	653	579	341
Minimum pool	471.6	492.5	632	-	-
Stream bed	465	476	617	543	291

TABLE B-8 (Cont.)
PERTINENT DATA
PROPOSED DAMS AND RESERVOIRS
QUINEBAUG RIVER BASIN

PROJECT	HODGES VILLAGE MASS. French River Mile 16.5	BUFFUMVILLE MASS. Little River Mile 1.3	EAST BRIMFIELD MASS. Quinebaug River Mile 64.5	WESTVILLE* MASS. Quinebaug River Mile 59.0	WEST THOMPSON CONN. Quinebaug River Mile 41.5
Dam:					
Type	Rock and earth fill embankment	Rolled earth fill	Concrete and earth embankment	Concrete gravity	Rolled earth fill
Crest length, feet	2,050	3,255	510	400	2,370
Maximum height, feet	55	66	55	36	70
Spillway					
Type	Ogee overflow	Ogee overflow	Ogee overflow	Ogee overflow	Side channel
Crest length, feet	145	220	75	320	313
Crest elevation, feet, m.s.l.	501	524	653	579	341
Surcharge, feet	14	10.3	14.3	10.5	15.0
Design discharge, c.f.s.	25,800	29,800	15,100	7,080	69,000
Outlet Works:					
Type	Conduits thru spillway weir	Conduits thru spillway weir	Gates in open channel	Gates in open channel	
No. and size of gates	2-5.0'x6.0'	3-3.0'x4.5'	2-6.25'x11.0'	5-4.1'x10.0'	3-5.0'x8.0'
Discharge at spillway crest, c.f.s.	1,750	1,820	2,840	6,700	
Channel capacity below dam, c.f.s.	700	1,800	1,500	2,600	
Sill elevation	465.5	481.5	619	547	293

*Design details subject to revision during planning investigations.

G. SPILLWAY AND OUTLET CAPACITIES

23. Spillway Capacities. Spillway capacities for dams in the Quinebaug River Basin have been derived in accordance with established procedure involving detailed unit hydrographs and synthetic storms of probable maximum precipitation centered over the watersheds. The data for the probable maximum precipitation have been taken from Hydrometeorological Report No. 33. Consideration was given to the need for revising this data in view of the phenomenal storm of August 17-20, 1955. It was determined, however, that for relatively small watersheds the probable maximum rainfall provides a much more severe criterion than the 1955 storm and that no revision was required.

Unit hydrographs were derived from all applicable flood records in the basin, and for adjacent rivers where watershed characteristics were comparable. In general, unit hydrographs derived from the August 1955 flood were used without modification. The peaks of unit hydrographs derived from smaller floods were increased and the times of concentration shortened in order to simulate the runoff conditions anticipated during a spillway design flood. Losses were assumed to be 0.05 inches per hour. The hydrograph of the spillway design flood was developed by correlating the rainfall excess with the unit hydrographs.

The spillway design floods were routed through surcharge storage, assuming outlets inoperative, to determine various lengths of spillway versus surcharge elevations. The selected length of spillway and corresponding surcharge was based on the most economical combination. Freeboard requirements were computed for each dam based on fetch criteria and an assumed wind velocity concurrent with maximum surcharge. In general, a minimum freeboard of five feet has been used to determine the top elevation of the non-overflow sections of the dam. Pertinent data for the spillway are included in Table B-8.

24. Outlet Capacities. Outlet sizes were selected to satisfy the following criteria: (a) obtain outlet discharges equivalent to the downstream safe channel capacity with a pool elevation corresponding to 20 percent of the reservoir storage, (b) permit emptying the reservoir in a reasonable period of time, and (c) provide adequate diversion capacity during construction.

The type of outlet selected for each dam was based on the type of dam, site limitations, and economics. The number and size of gates were selected to provide flexibility during all operating conditions and provide sufficient capacity to satisfy the preceding outlet criteria with one gate inoperative. Discharge rating curves were determined by conventional methods of evaluating head losses for friction, entrance, gate slots, and transitions in terms of the velocity head at the portal. Pertinent data for the outlets are also shown in Table B-8.

H. EFFECT OF FLOOD CONTROL RESERVOIR PLANS

25. General. Two systems of reservoirs were studied in detail to determine the effectiveness of each. They are (1) the four authorized reservoirs, and (2) the four authorized reservoirs plus West Thompson Reservoir. Routings were made, as described in paragraph 16, to determine the modified river stages and discharges, by both systems, for the floods of March 1936, September 1938, August 1955, the standard project flood, and the typical tributary contribution flood. A summary of the natural and modified river stages and discharges for both systems at principal damage centers is shown in Table B-9.

I. RESERVOIR REGULATION

26. General. The reservoirs in the upper Quinebaug River Basin and the French River Basin will be regulated as a system to maintain flows within safe channel capacities insofar as possible. Key index points for regulatory discharges will be Southbridge, Putnam, and Jewett City on the Quinebaug River, and Webster on the French River. Control gates in the outlet structures will be partially or completely closed whenever the flows at these index points are expected to exceed the channel capacities. Actual regulation experience will be required to determine the safe capacity, but tentatively the regulated discharges will be as follows:

Location	Estimated Channel Capacity in c.f.s.
Southbridge	3,000
Putnam	7,500
Jewett City	15,000
Webster	1,000

Plates B-9 through B-13 show the effect of the proposed method of regulation on the floods of March 1936, September 1938, August 1955, standard project flood, and the typical tributary contribution flood. The regulation of these floods at the proposed West Thompson Dam and Reservoir is indicated on Plate No. B-14. The reservoir has sufficient capacity to have completely stored the March 1936 and September 1938 floods, but the storage would have been completely utilized during the August 1955 and standard project floods. Some spillway discharge would have occurred during the latter floods but this discharge would generally occur during the flood recession and hence would not synchronize with the peak flows from the uncontrolled areas. Following the recession of the downstream flood flows, the reservoirs will be emptied as quickly as possible, utilizing the full capacity of the downstream river channel.

TABLE B-9

EFFECT OF FLOOD CONTROL PLANS
AT
DAMAGE CENTERS ON QUINEBAUG RIVER

THAMES RIVER BASIN, MASS. & CONN.

River	Damage Center	Low Water Stage	March 19, 1936 Natural Stage ft.	March 19, 1936 Natural Flow c.f.s.	March 19, 1936 Modified Stage ft.	March 19, 1936 Modified Flow c.f.s.	March 19, 1936 Reduction Stage ft.	March 19, 1936 Reduction Flow c.f.s.	September 1938 Natural Stage ft.	September 1938 Natural Flow c.f.s.	September 1938 Modified Stage ft.	September 1938 Modified Flow c.f.s.	September 1938 Reduction Stage ft.	September 1938 Reduction Flow c.f.s.	August 1955 Natural Stage ft.	August 1955 Natural Flow c.f.s.	August 1955 Modified Stage ft.	August 1955 Modified Flow c.f.s.	August 1955 Reduction Stage ft.	August 1955 Reduction Flow c.f.s.
	AUTHORIZED PLAN																			
Quinebaug	Southbridge, Mass. Headwater Am. Optical Co. Dam	0.0	8.3	6,500	7.0	4,000	1.3	2,500	10.3	13,000	7.1	4,000	3.2	9,000	14.9	36,000	12.8	24,500	2.1	11,500
"	Putnam, Conn. U.S.G.S. Gage	4.0	17.5	17,000	15.5	13,200	2.0	3,800	19.5	20,900	15.6	13,400	3.9	7,500	26.5	48,000	22.3	29,300	4.2	18,700
"	Jewett City, Conn. U.S.G.S. Gage	4.0	24.0	29,200	23.3	26,100	0.7	3,100	21.7	22,800	19.0	16,500	2.7	6,300	29.0	40,700	24.2	28,100	4.8	12,600
French	Webster, Mass. U.S.G.S. Gage	5.0	15.9*	4,700	9.7	1,500	6.2	3,200	12.4*	2,800	8.8	1,200	3.6	1,600	26.0	14,000	16.2	4,900	9.8	9,100
	PROPOSED PLAN																			
Quinebaug	Southbridge, Mass. Headwater Am. Optical Co. Dam	0.0	8.3	6,500	7.0	4,000	1.3	2,500	10.3	13,000	7.1	4,000	3.2	9,000	14.9	36,000	12.8	24,500	2.1	11,500
"	Putnam, Conn. U.S.G.S. Gage	4.0	17.5	17,000	10.9	6,500	6.6	10,500	19.5	20,900	10.2	5,600	9.3	15,300	26.5	48,000	16.0	14,100	10.5	33,900
"	Jewett City, Conn. U.S.G.S. Gage	4.0	24.0	29,200	21.8	22,000	3.2	6,300	21.7	22,800	15.7	11,900	6.0	10,900	29.0	40,700	19.9	18,700	9.1	22,000
French	Webster, Mass. U.S.G.S. Gage	5.0	15.9*	4,700	9.7	1,500	6.2	3,200	12.4*	2,800	8.8	1,200	3.6	1,600	26.0	14,000	16.2	4,900	9.8	9,100

TABLE B-9 (Cont.)

EFFECT OF FLOOD CONTROL PLANS
AT
DAMAGE CENTERS ON QUINEBAUG RIVER

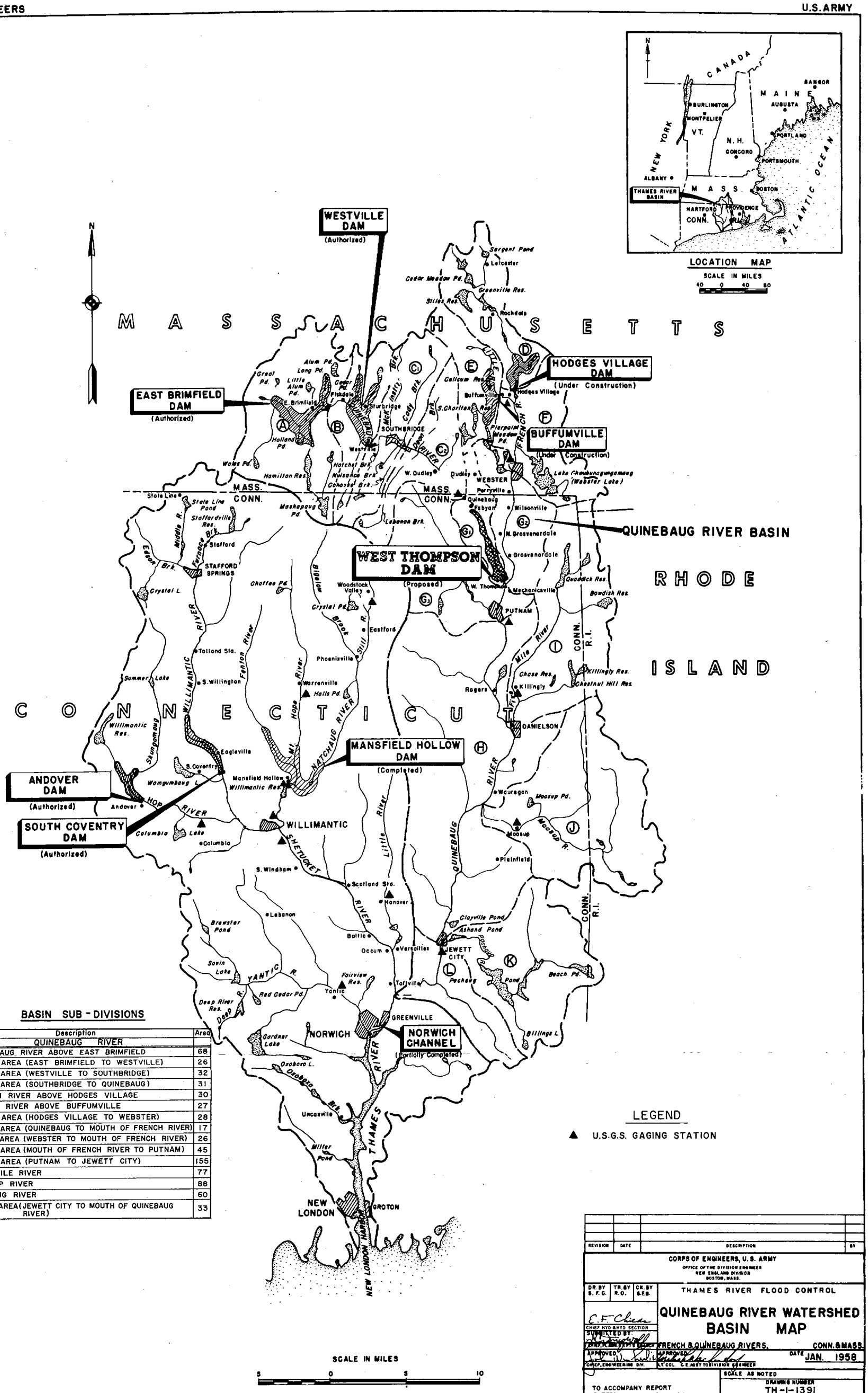
THAMES RIVER BASIN, MASS. & CONN.

River	Damage Center	Low Water Stage	Standard Project Flood: Natural Stage ft.	Natural Flow c.f.s.	Modified Stage ft.	Modified Flow c.f.s.	Reduction Stage ft.	Reduction Flow c.f.s.	T.T.C.F.(1): Natural c.f.s.	Modified c.f.s.	Reduction c.f.s.	Reduction Percent Reduction
	AUTHORIZED PLAN – East Brimf. Hodges Vill. Buffumville, Westville											
Quinebaug	Southbridge, Mass. Headwater Am. Optical Co. Dam	0.0	13.7	28,500	10.0	11,800	3.7	16,700	13,100	5,500	7,600	58.1
"	Putnam, Conn. U.S.G.S. Gage	4.0	27.5	55,000	24.4	38,500	3.1	16,500	22,000	15,500	6,500	29.6
"	Jewett City, Conn. U.S.G.S. Gage	4.0	35.5	61,500	31.8	50,200	3.7	11,300	25,300	19,100	6,200	24.5
French	Webster, Mass. U.S.G.S. Gage	5.0	27.5	16,300	19.5	7,500	8.0	8,700	6,400	2,100	4,300	67.3
	PROPOSED PLAN – W. Thompson added											
Quinebaug	Southbridge, Mass. Headwater Am. Optical Co. Dam	0.0	13.7	28,500	10.0	11,800	3.7	16,700	13,100	5,500	7,600	58.1
"	Putnam, Conn. U.S.G.S. Gage	4.0	27.5	55,000	19.1	20,200	8.4	34,800	22,000	7,600	14,400	65.4
"	Jewett City, Conn. U.S.G.S. Gage	4.0	35.5	61,500	28.5	40,000	7.0	21,400	25,300	15,900	9,400	37.1
French	Webster, Mass. U.S.G.S. Gage	5.0	27.5	16,300	19.5	7,600	8.0	8,700	6,400	2,100	4,300	67.3

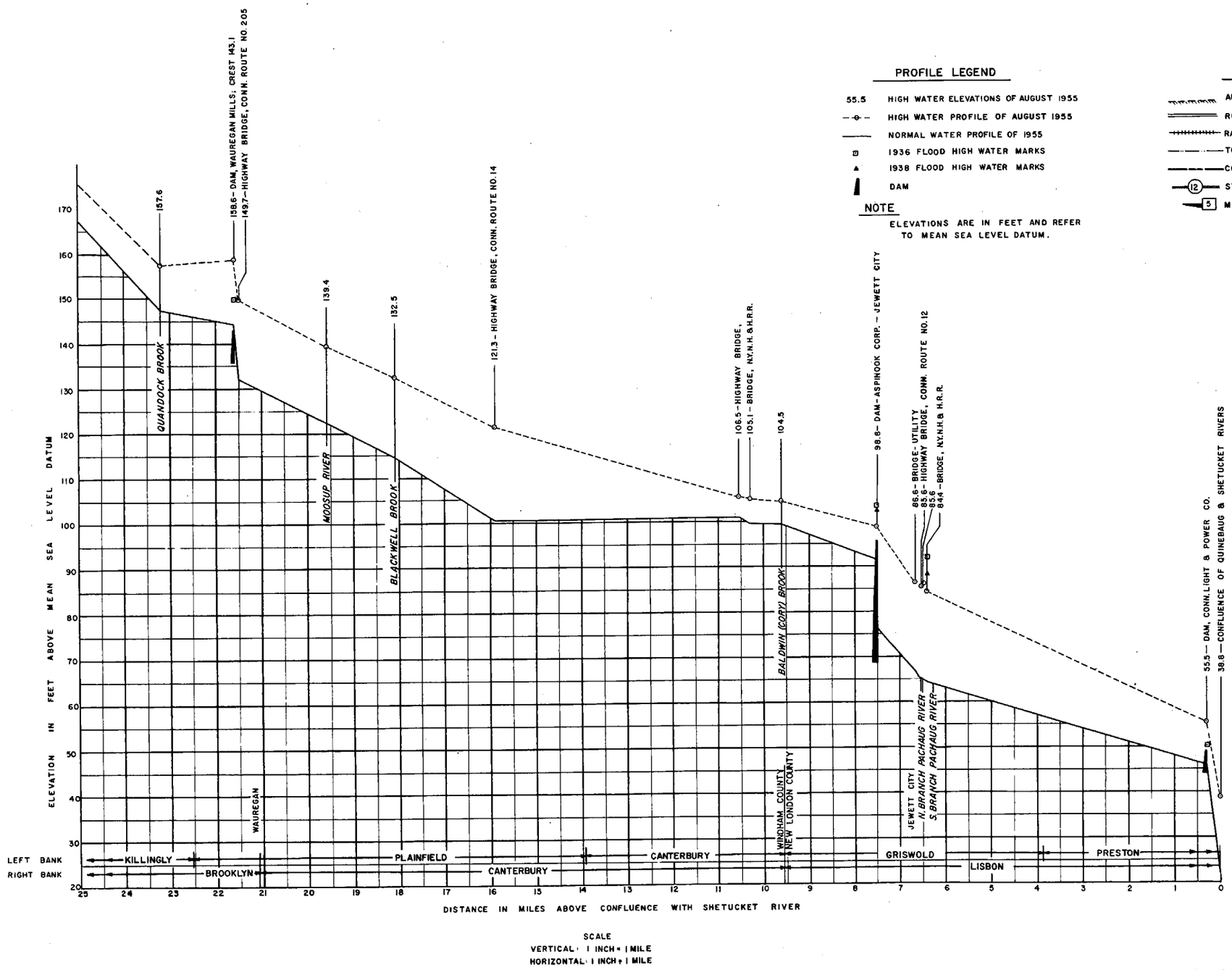
(1) T.T.C.F. used to determine percent reductions for economic studies only. Stage has no meaning.

* Estimated

The reservoirs in the Quinebaug River Basin will be regulated primarily for flood conditions within the basin, and, when necessary, coordinated with the flood control reservoirs in the Shetucket River Basin (Mansfield Hollow Reservoir presently completed) for the benefit of Norwich, Connecticut, located just below the confluence of the Quinebaug and Shetucket Rivers. From analyses of floods of record, it has been found that the Shetucket River Basin produces more rapid runoff than the Quinebaug River Basin, hence the Shetucket River is generally the larger contributor to the flood crests at Norwich. Because of this characteristic, regulation of the reservoirs in the Quinebaug River Basin for flood conditions on the Quinebaug River will also provide optimum effectiveness for Norwich. Details for the regulation of all reservoirs in the Thames River Basin will be incorporated in a Master Regulation Manual for the entire basin.



Area	Description	Area
	QUINEBAUG RIVER	
Ⓐ	QUINEBAUG RIVER ABOVE EAST BRIMFIELD	68
Ⓑ	LOCAL AREA (EAST BRIMFIELD TO WESTVILLE)	26
Ⓒ	LOCAL AREA (WESTVILLE TO SOUTHBRIDGE)	32
Ⓒ₂	LOCAL AREA (SOUTHBRIDGE TO QUINEBAUG)	31
Ⓓ	FRENCH RIVER ABOVE HODGES VILLAGE	30
Ⓔ	LITTLE RIVER ABOVE BUFFUMVILLE	27
Ⓕ	LOCAL AREA (HODGES VILLAGE TO WEBSTER)	28
Ⓖ₁	LOCAL AREA (QUINEBAUG TO MOUTH OF FRENCH RIVER)	17
Ⓖ₂	LOCAL AREA (WEBSTER TO MOUTH OF FRENCH RIVER)	26
Ⓖ₃	LOCAL AREA (MOUTH OF FRENCH RIVER TO PUTNAM)	45
Ⓗ	LOCAL AREA (PUTNAM TO JEWETT CITY)	155
Ⓘ	FIVE MILE RIVER	77
Ⓙ	MOOSUP RIVER	88
Ⓚ	PACHAUG RIVER	60
Ⓛ	LOCAL AREA (JEWETT CITY TO MOUTH OF QUINEBAUG RIVER)	33



PROFILE LEGEND

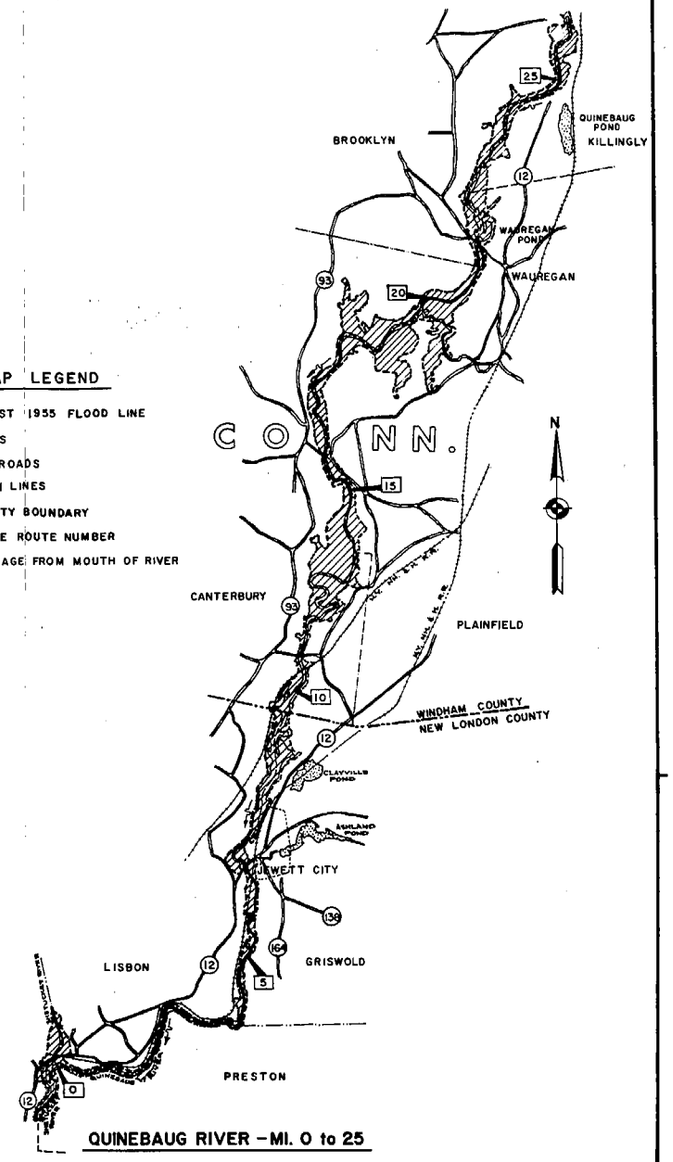
- 55.5 HIGH WATER ELEVATIONS OF AUGUST 1955
- HIGH WATER PROFILE OF AUGUST 1955
- NORMAL WATER PROFILE OF 1955
- 1936 FLOOD HIGH WATER MARKS
- 1938 FLOOD HIGH WATER MARKS
- DAM

NOTE

ELEVATIONS ARE IN FEET AND REFER TO MEAN SEA LEVEL DATUM.

MAP LEGEND

- AUGUST 1955 FLOOD LINE
- ROADS
- RAILROADS
- TOWN LINES
- COUNTY BOUNDARY
- (12) STATE ROUTE NUMBER
- [5] MILEAGE FROM MOUTH OF RIVER



QUINEBAUG RIVER - MI. 0 to 25

1955 FLOOD LIMITS

SCALE IN MILES

0 1 2 MI.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY | TR. BY | CK. BY

THAMES RIVER FLOOD CONTROL

QUINEBAUG RIVER
PLAN AND PROFILE
FLOOD OF AUGUST 1955 - MILE 0 to 25
THAMES RIVER WATERSHED CONN., MASS. & R.I.

E. F. Chilson
CHIEF H. & H. SECTION

SUBMITTED BY: [signature]
CHIEF PLANN. & RPTS. BRANCH

APPROVED: [signature]
CHIEF ENGINEERING DIV.

APPROVED: [signature]
LT. COL. C.E. ASST. TO DIVISION ENGINEER

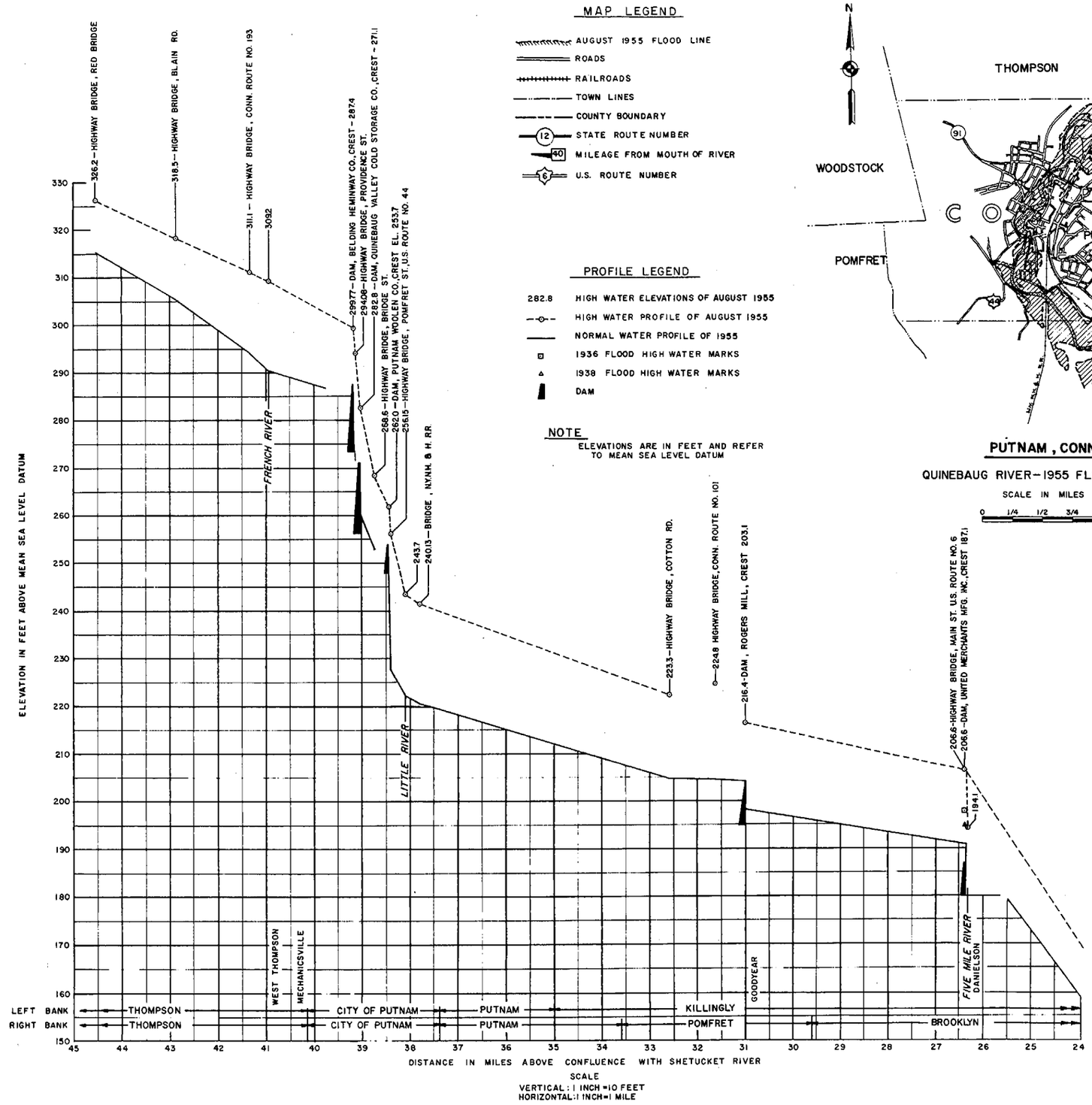
DATE JAN. 1958

SCALE AS SHOWN

ACCOMPANY REPORT
DATED: 31 JANUARY 1958

DRAWING NUMBER
TH-3-1030

SHEET 1 OF 4



MAP LEGEND

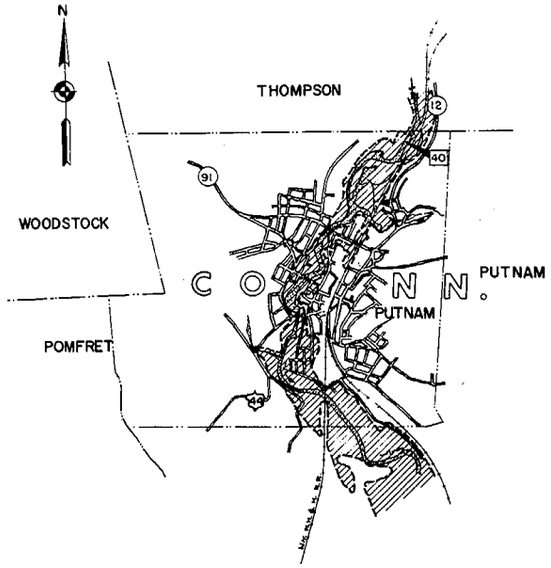
- AUGUST 1955 FLOOD LINE
- ROADS
- RAILROADS
- TOWN LINES
- COUNTY BOUNDARY
- (12) STATE ROUTE NUMBER
- [40] MILEAGE FROM MOUTH OF RIVER
- (6) U.S. ROUTE NUMBER

PROFILE LEGEND

- 282.8 HIGH WATER ELEVATIONS OF AUGUST 1955
- HIGH WATER PROFILE OF AUGUST 1955
- NORMAL WATER PROFILE OF 1955
- 1936 FLOOD HIGH WATER MARKS
- 1938 FLOOD HIGH WATER MARKS
- DAM

NOTE

ELEVATIONS ARE IN FEET AND REFER TO MEAN SEA LEVEL DATUM

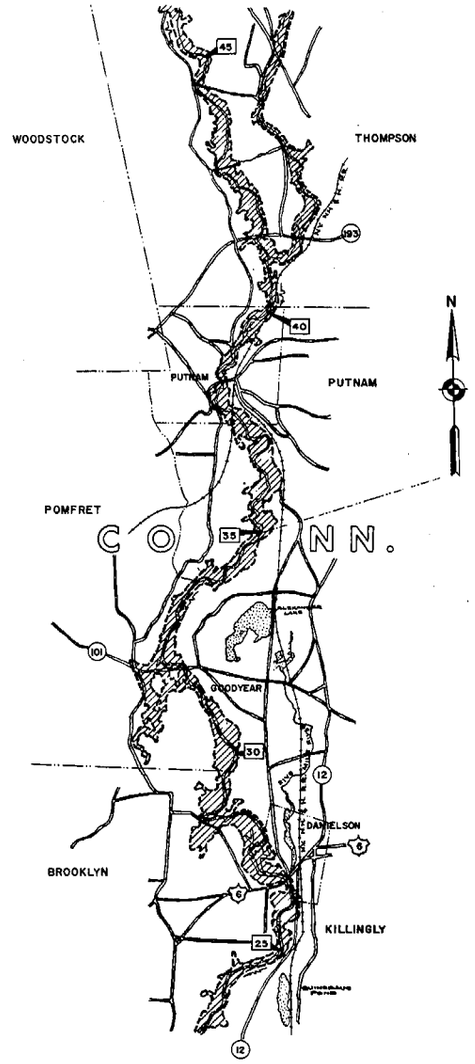


PUTNAM, CONN.

QUINEBAUG RIVER—1955 FLOOD LIMITS

SCALE IN MILES

0 1/4 1/2 3/4 1 MI.



QUINEBAUG RIVER—MI. 24 to 45

1955 FLOOD LIMITS

SCALE IN MILES

0 1 2 MI.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY | TR. BY | CK. BY

E. F. Chase
CHIEF, H & H SECTION

SUBMITTED BY: CHIEF, H & H SECTION

APPROVED: CHIEF, ENGINEERING DIV.

APPROVED: LT. COL. C. E. ASST. TO DIVISION ENGINEER

THAMES RIVER FLOOD CONTROL

QUINEBAUG RIVER
PLAN AND PROFILE
FLOOD OF AUGUST 1955—MILE 24 to 45
THAMES RIVER WATERSHED CONN., MASS. & R.I.

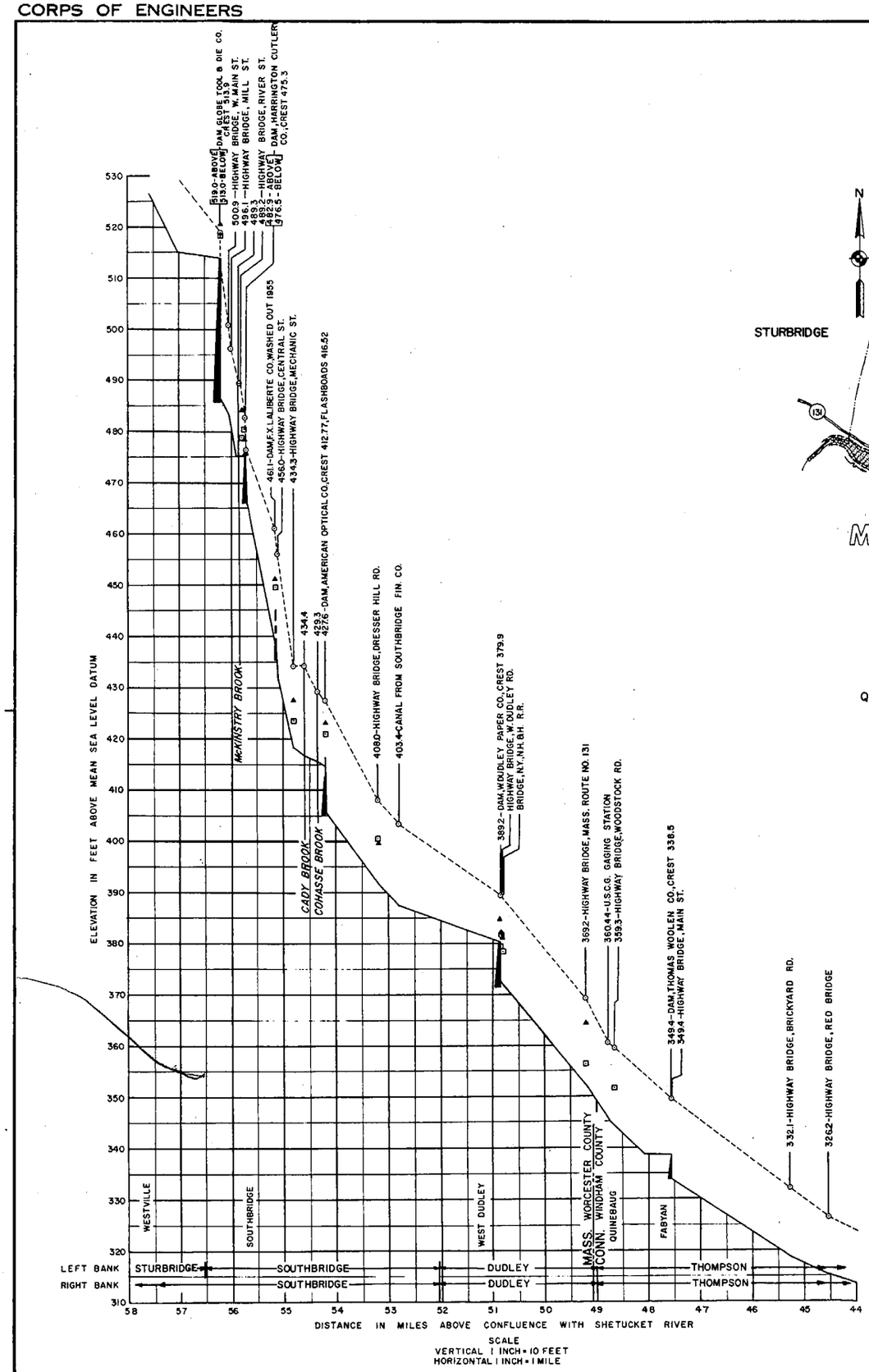
DATE JAN. 1958

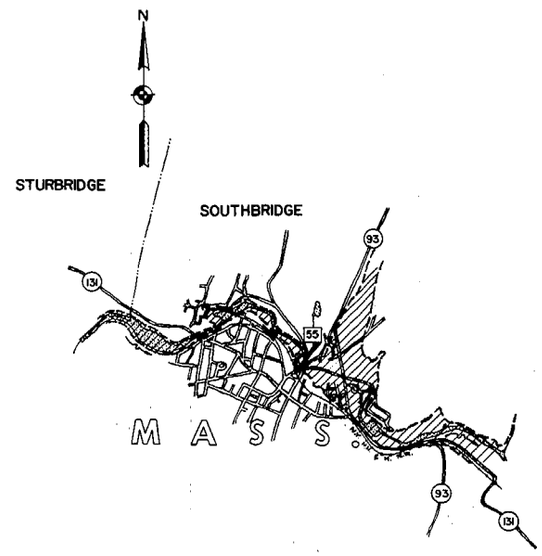
ACCOMPANY REPORT
DATED: 31 JANUARY 1958

SCALE: AS SHOWN

DRAWING NUMBER
TH-3-1031

SHEET 2 OF 4



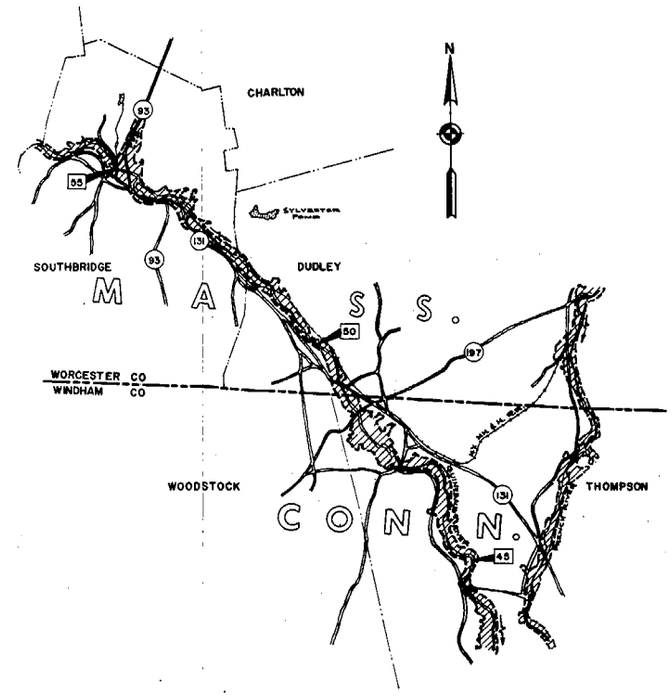


SOUTHBRIDGE, MASS.

QUINEBAUG RIVER – 1955 FLOOD LIMITS

SCALE IN MILES

0 1/4 1/2 3/4 1MI.



QUINEBAUG RIVER – MI. 44 to 57

1955 FLOOD LIMITS

SCALE IN MILES

0 1 2MI.

MAP LEGEND

- AUGUST 1955 FLOOD LINE
- ROADS
- RAILROADS
- TOWN LINES
- COUNTY BOUNDARY
- (93) STATE ROUTE NUMBER
- [40] MILEAGE FROM MOUTH OF RIVER

PROFILE LEGEND

- 349.4 HIGH WATER ELEVATIONS OF AUGUST 1955
- HIGH WATER PROFILE OF AUGUST 1955
- NORMAL WATER PROFILE OF 1955
- 1936 FLOOD HIGH WATER MARKS
- 1938 FLOOD HIGH WATER MARKS
- DAM

NOTE

ELEVATIONS ARE IN FEET AND REFER TO MEAN SEA LEVEL DATUM

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY | TR. BY | CK. BY

E. F. Chase
CHIEF, H. & H. SECTION

SUBMITTED BY
CHIEF, PLANN. & REPTS. BRANCH

APPROVED
CHIEF ENGINEERING DIV.

APPROVED
LT. COL. C.E. ASS'T TO DIVISION ENGINEER

DATE JAN. 1958

THAMES RIVER FLOOD CONTROL

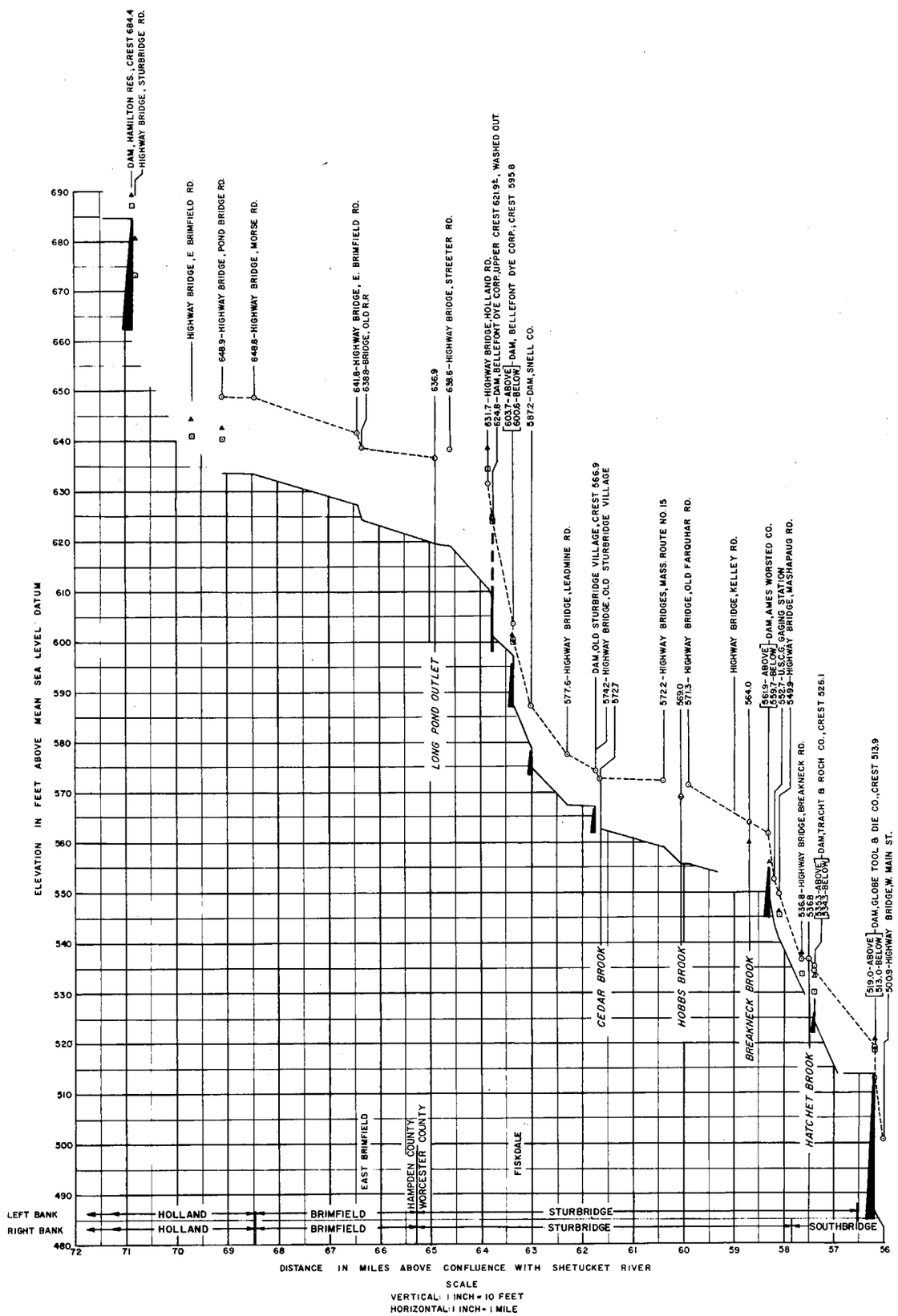
QUINEBAUG RIVER
PLAN AND PROFILE
FLOOD OF AUGUST 1955 – MILE 44 to 57
THAMES RIVER WATERSHED CONN., MASS. & R.I.

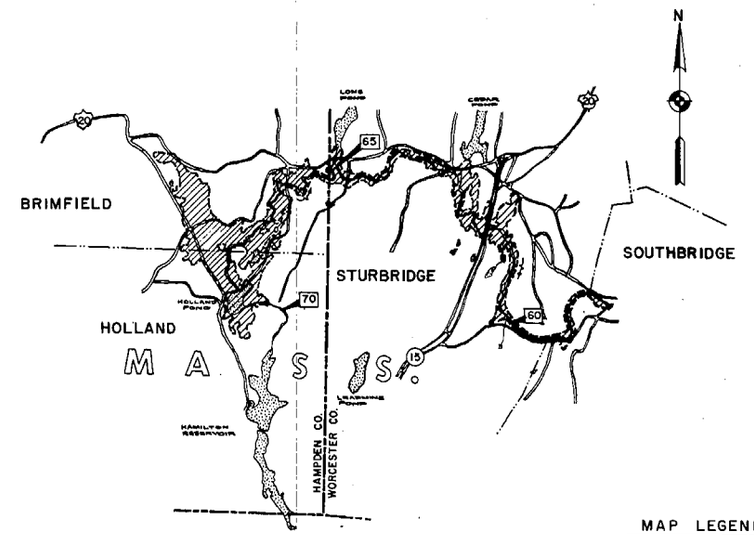
ACCOMPANY REPORT
DATED: 31 JANUARY 1958

SCALE: AS SHOWN

DRAWING NUMBER
TH-3-1032

SHEET 3 OF 4





QUINEBAUG RIVER-MI.56 to 71

1955 FLOOD LIMITS

SCALE IN MILES

0 1 2 MI.

MAP LEGEND

- AUGUST 1955 FLOOD LINE
- ROADS
- RAILROADS
- TOWN LINES
- COUNTY BOUNDARY
- (15) STATE ROUTE NUMBER
- [60] MILEAGE FROM MOUTH OF RIVER
- (20) U.S. ROUTE NUMBER

PROFILE LEGEND

- 574.2 HIGH WATER ELEVATIONS OF AUGUST 1955
- —o— HIGH WATER PROFILE OF AUGUST 1955
- ——— NORMAL WATER PROFILE OF 1955
- ▫ 1936 FLOOD HIGH WATER MARKS
- ▲ 1938 FLOOD HIGH WATER MARKS
- ▮ DAM

NOTE

ELEVATIONS ARE IN FEET AND REFER TO MEAN SEA LEVEL DATUM

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY | TR. BY | CK. BY

E. F. Chen
CHIEF H & H SECTION

SUBMITTED BY
CHIEF, PLANN & REP'T BRANCH

APPROVED
CHIEF ENGINEERING DIV.

APPROVED
LT. COL. C E ASST TO DIVISION ENGINEER

THAMES RIVER FLOOD CONTROL

QUINEBAUG RIVER

PLAN AND PROFILE

FLOOD OF AUGUST 1955 - MILE 56 to 71

THAMES RIVER WATERSHED CONN., MASS. & R.I.

DATE JAN. 1958

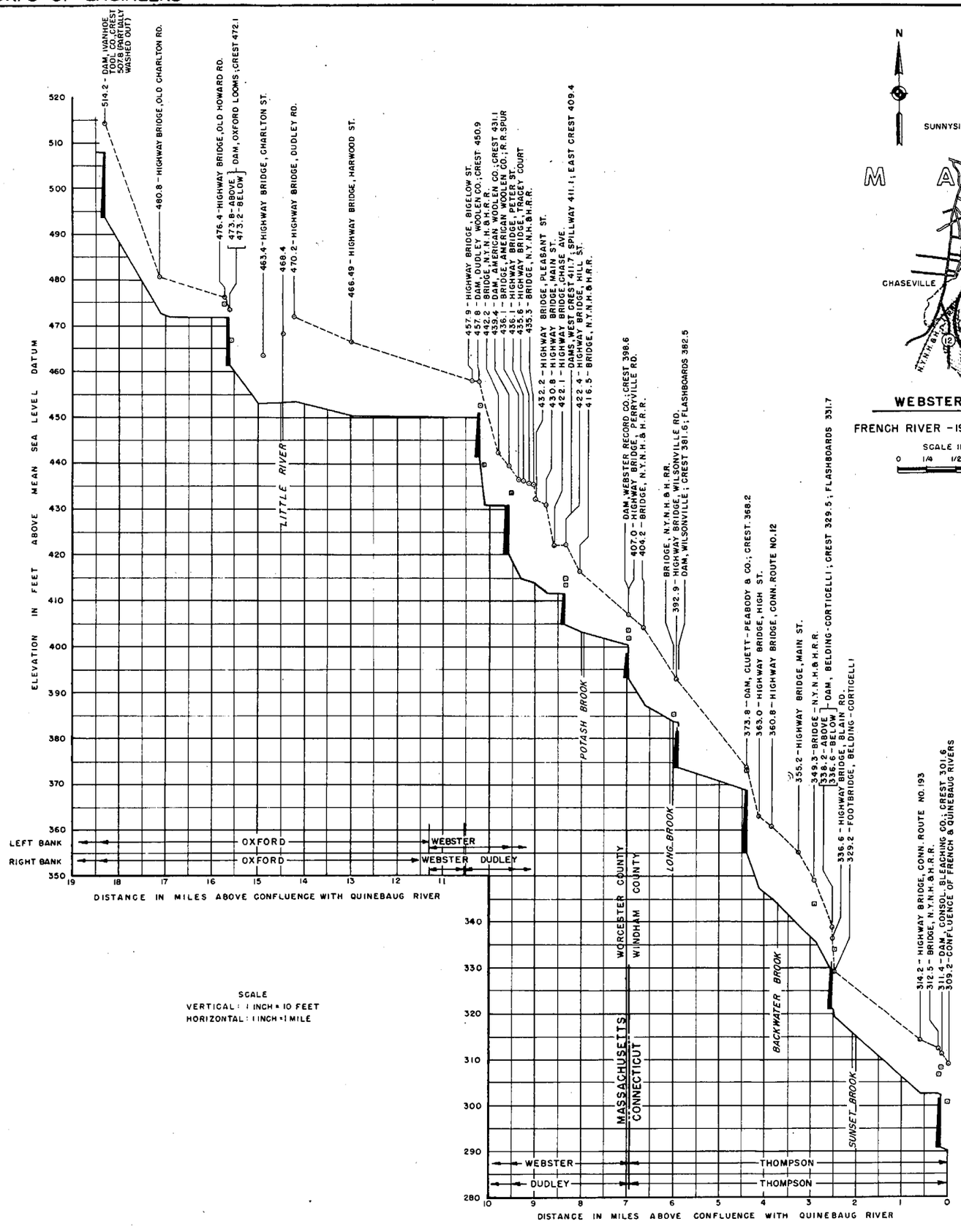
SCALE: AS SHOWN

ACCOMPANY REPORT
DATED: 31 JANUARY 1958

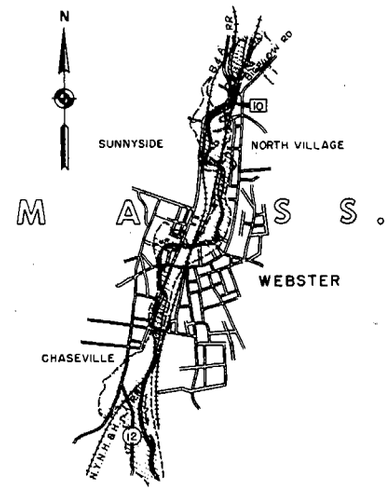
DRAWING NUMBER
TH-3-1033

SHEET 4 OF 4

PLATE NO. B-5



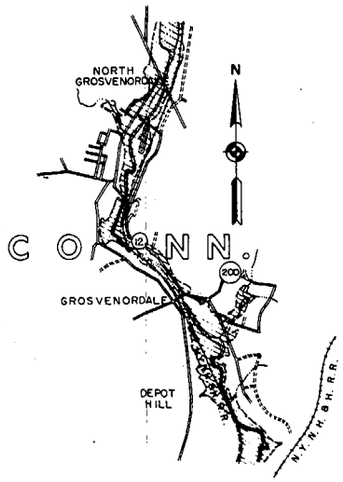
SCALE
VERTICAL: 1 INCH = 10 FEET
HORIZONTAL: 1 INCH = 1 MILE



WEBSTER, MASS.

FRENCH RIVER - 1955 FLOOD LIMITS

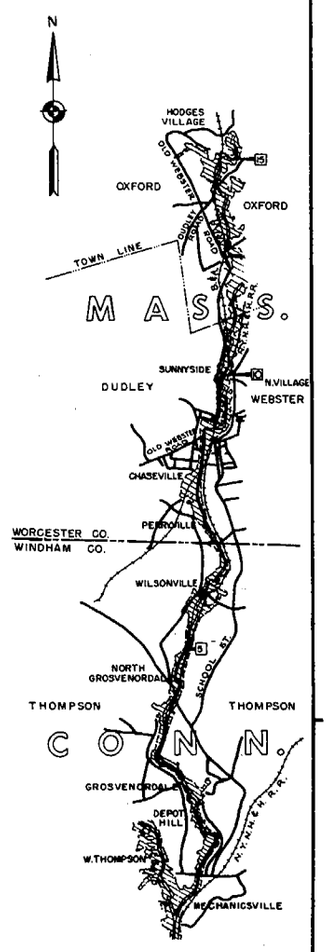
SCALE IN MILES
0 1/4 1/2 3/4 1 MI.



GROSVENORDALE, CONN.

FRENCH RIVER - 1955 FLOOD LIMITS

SCALE IN MILES
0 1/4 1/2 3/4 1 MI.



FRENCH RIVER - MI. 0 to 18.3

1955 FLOOD LIMITS

SCALE IN MILES
0 1 2 MI.

MAP LEGEND

- AUGUST 1955 FLOOD LINE
- ROADS
- RAILROADS
- TOWN LINES
- COUNTY BOUNDARY
- (12) STATE ROUTE NUMBER
- [10] MILEAGE FROM MOUTH OF RIVER

PROFILE LEGEND

- 314.2 HIGH WATER ELEVATIONS OF AUGUST 1955
- HIGH WATER PROFILE OF AUGUST 1955
- NORMAL WATER PROFILE OF 1955
- 1936 FLOOD HIGH WATER MARKS
- DAM

NOTE

ELEVATIONS ARE IN FEET AND REFER TO MEAN SEA LEVEL DATUM.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY | TR. BY | CK. BY

E. F. Chase
CHIEF H & H SECTION

SUBMITTED BY
CHIEF H. DRN. & P.S. BRANCH

APPROVED
CHIEF ENGINEERING DIV.

APPROVED
LT. COL. C.E. ASST TO DIVISION ENGINEER

THAMES RIVER FLOOD CONTROL

FRENCH RIVER

PLAN AND PROFILE

FLOOD OF AUGUST 1955 - MILE 0 to 18.3

THAMES RIVER WATERSHED CONN., MASS. & R.I.

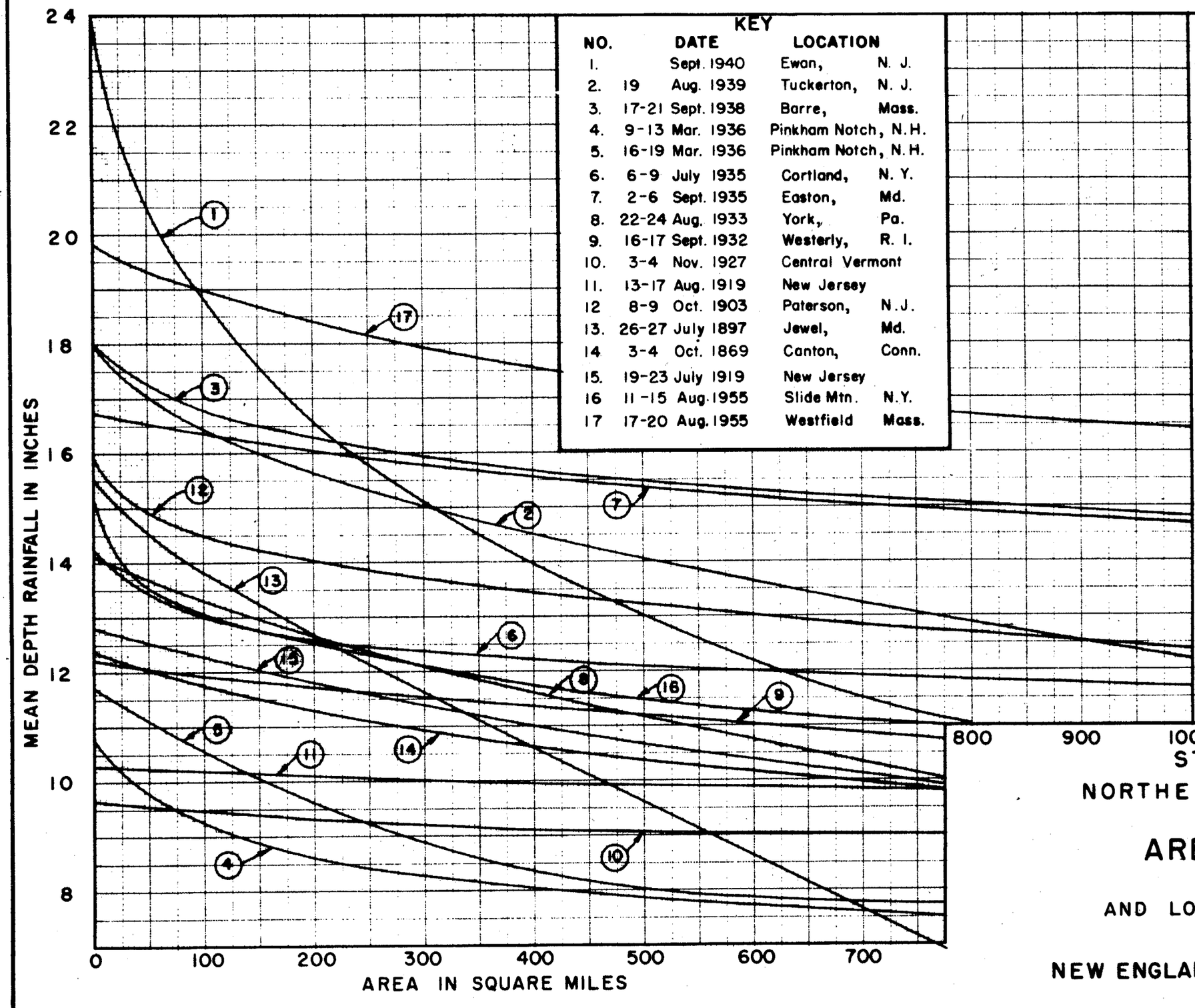
DATE JAN. 1958

SCALE: AS SHOWN

DRAWING NUMBER
TH-3-1034

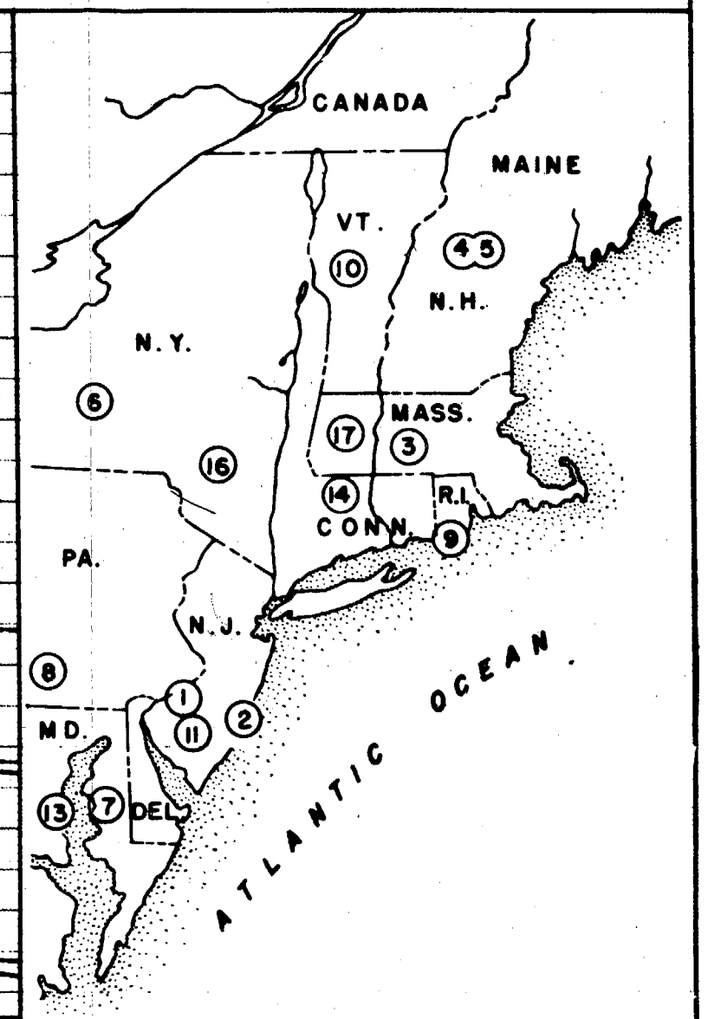
SHEET 1 OF 1

ACCOMPANY REPORT
DATED: 31 JANUARY 1958



KEY

NO.	DATE	LOCATION	
1.	Sept. 1940	Ewan,	N. J.
2.	19 Aug. 1939	Tuckerton,	N. J.
3.	17-21 Sept. 1938	Barre,	Mass.
4.	9-13 Mar. 1936	Pinkham Notch,	N.H.
5.	16-19 Mar. 1936	Pinkham Notch,	N.H.
6.	6-9 July 1935	Cortland,	N. Y.
7.	2-6 Sept. 1935	Easton,	Md.
8.	22-24 Aug. 1933	York,	Pa.
9.	16-17 Sept. 1932	Westerly,	R. I.
10.	3-4 Nov. 1927	Central Vermont	
11.	13-17 Aug. 1919	New Jersey	
12	8-9 Oct. 1903	Paterson,	N.J.
13.	26-27 July 1897	Jewel,	Md.
14	3-4 Oct. 1869	Canton,	Conn.
15.	19-23 July 1919	New Jersey	
16	11-15 Aug. 1955	Slide Mtn.	N.Y.
17	17-20 Aug. 1955	Westfield	Mass.



LOCATION OF STORM CENTERS

STORMS OF RECORD
NORTHEASTERN UNITED STATES

AREA-DEPTH CURVES

AND LOCATION OF STORM CENTERS

NEW ENGLAND DIVISION BOSTON, MASS.
JANUARY 1958

PLATE NO B-7

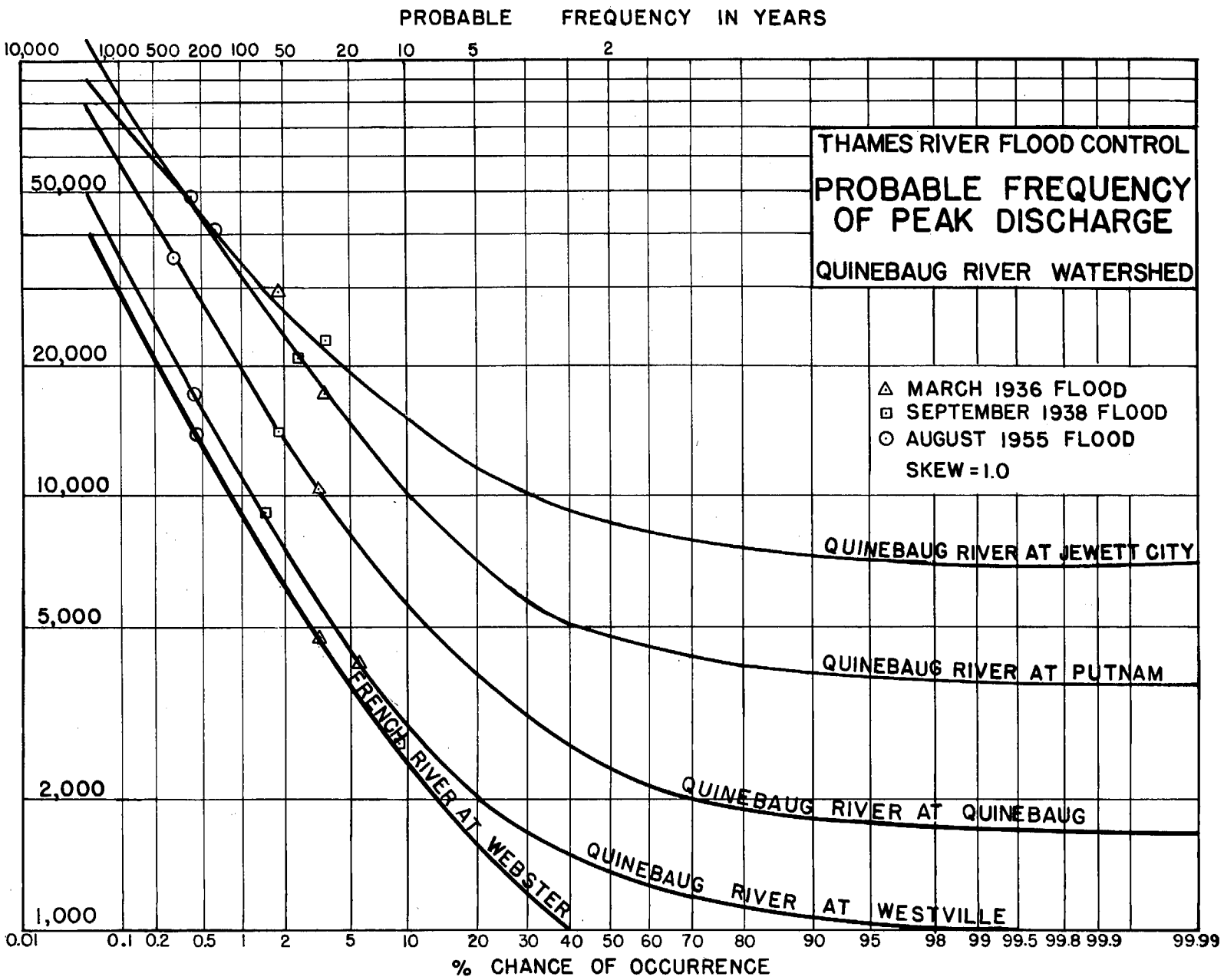
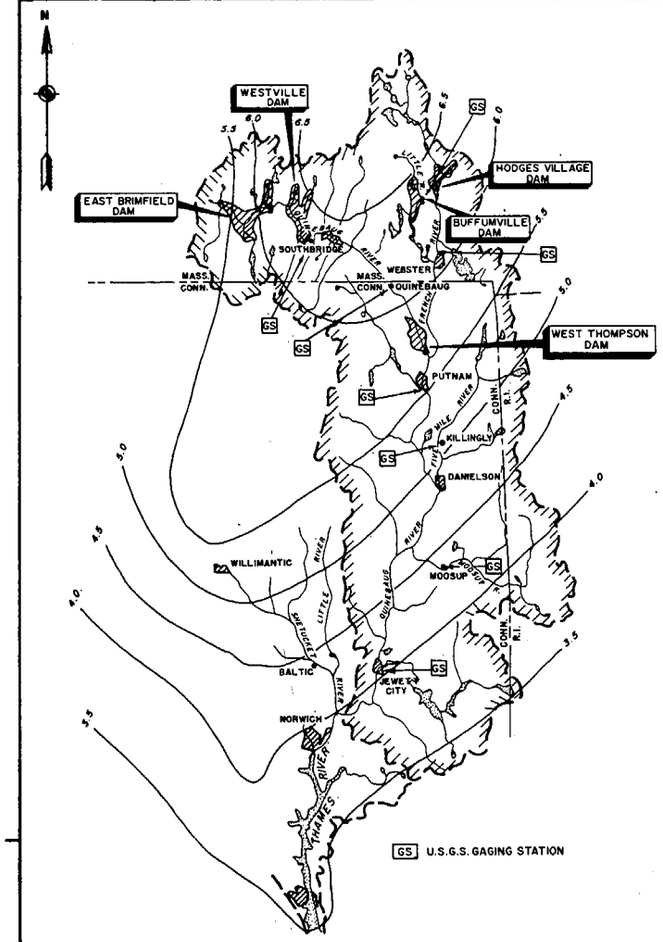
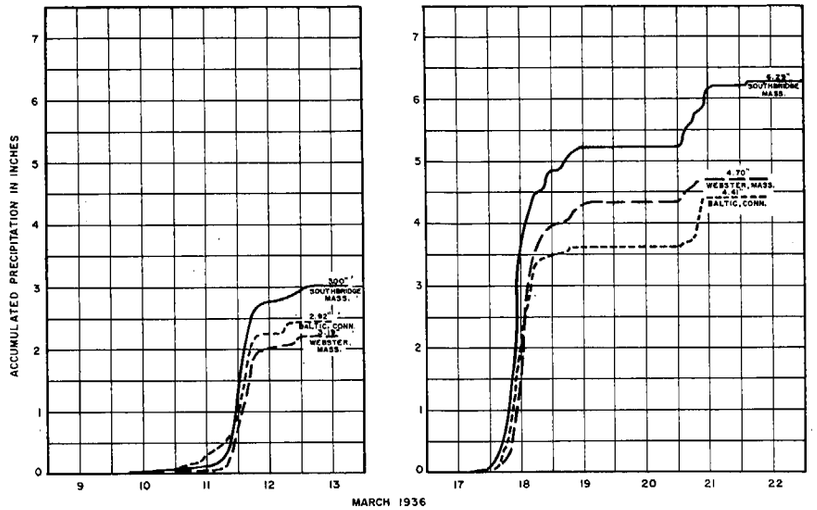

THAMES RIVER FLOOD CONTROL
PROBABLE FREQUENCY OF PEAK DISCHARGE
QUINEBAUG RIVER WATERSHED
MARCH 1936 FLOOD
SEPTEMBER 1938 FLOOD
AUGUST 1955 FLOOD
SKEW = 1.0
QUINEBAUG RIVER AT JEWETT CITY
QUINEBAUG RIVER AT PUTNAM
QUINEBAUG RIVER AT QUINEBAUG
QUINEBAUG RIVER AT WESTVILLE
FRENCH RIVER AT WEBSTER
PROBABLE FREQUENCY IN YEARS
10,000 1000 500 200 100 50 20 10 5 2
DISCHARGE C.F.S.
50,000
20,000
10,000
5,000
2,000
1,000
0.01 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.99
% CHANCE OF OCCURRENCE

PLATE NO. B-8

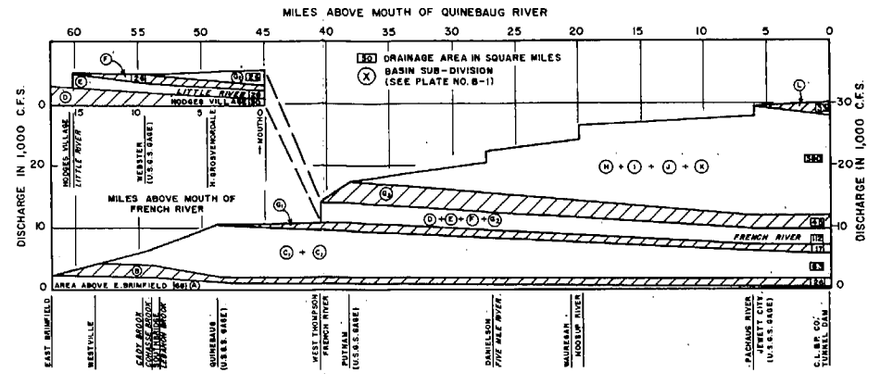


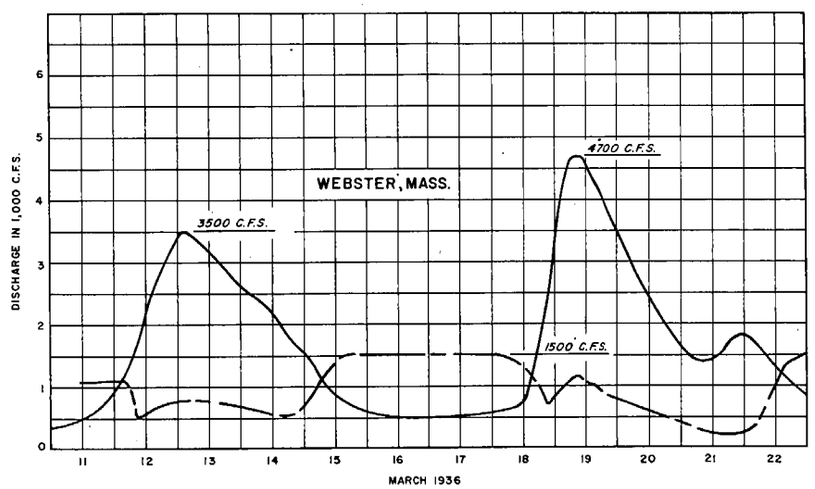
ISOHYETALS

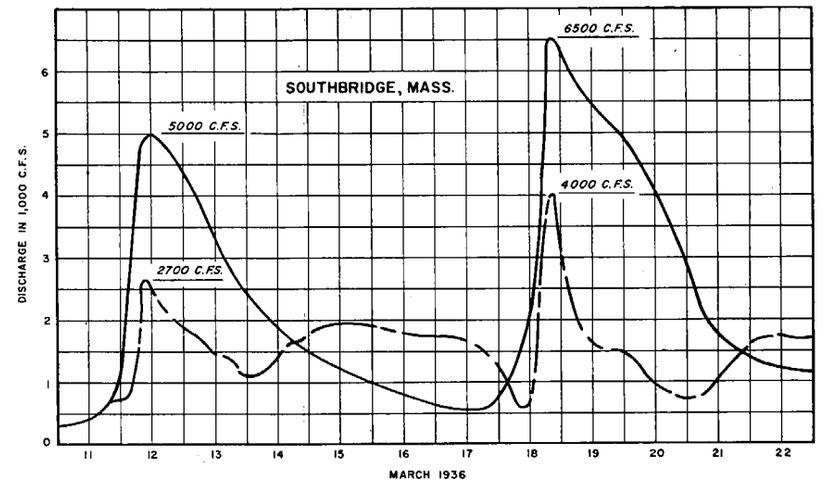
FOR STORM OF MARCH 17-19, 1936

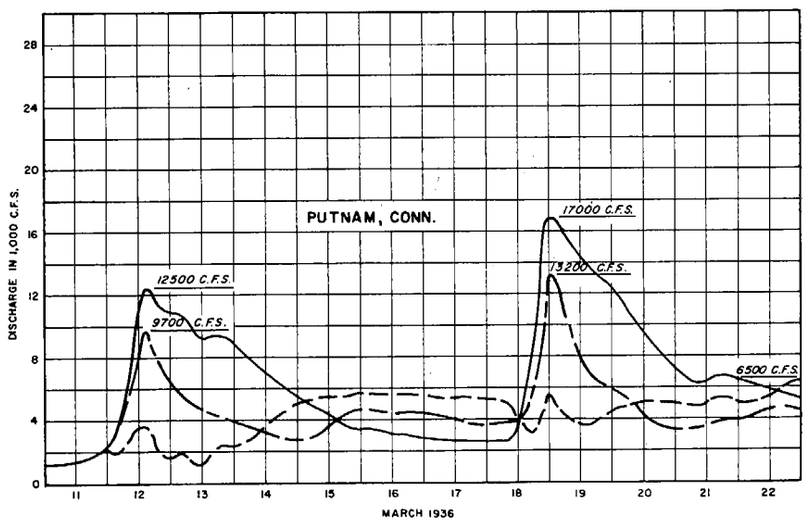


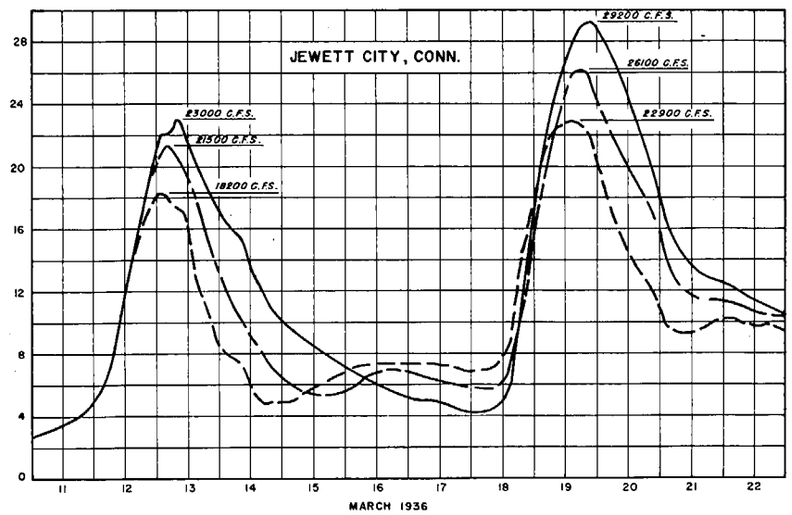
MASS RAINFALL CURVES











LEGEND

- NATURAL
- AUTHORIZED PLAN
- PROPOSED PLAN

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS

DR. BY | TR. BY S.J.C. | CK. BY

THAMES RIVER FLOOD CONTROL

FLOOD OF MARCH 1936

QUINEBAUG RIVER WATER SHED CONN. & MASS.

SUBMITTED BY: CHIEF HYD. & HYD. SECTION
APPROVED: CHIEF PLANN. & RPT. BRANCH
APPROVED: CHIEF ENGINEERING DIV.
APPROVED: LT. COL. C.E. ASST. TO DIVISION ENGINEER

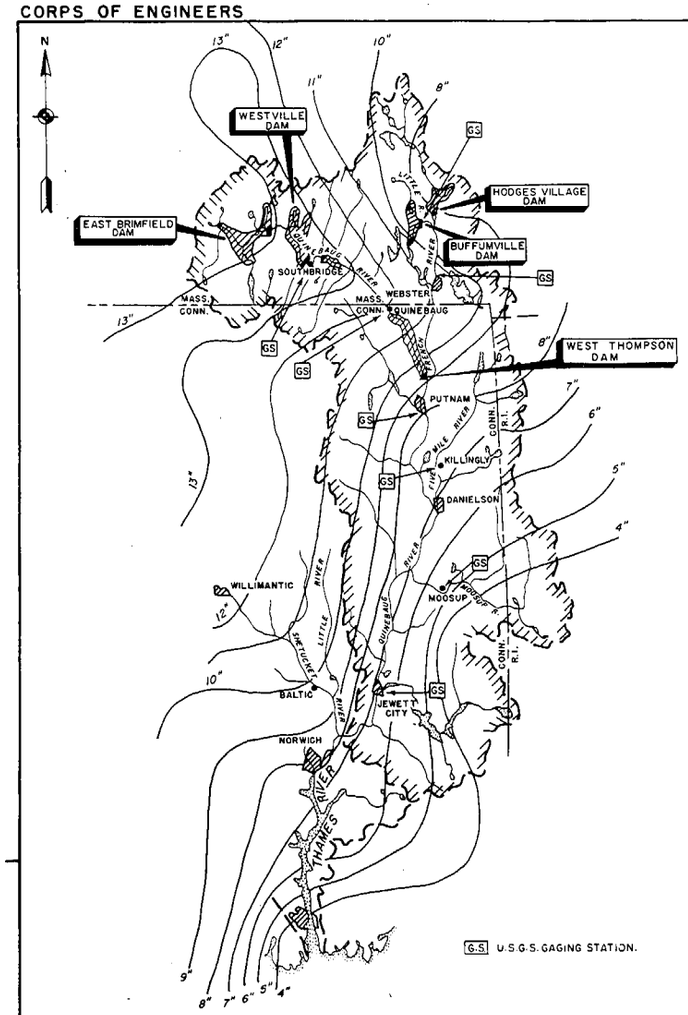
DATE JAN 1958

SCALE

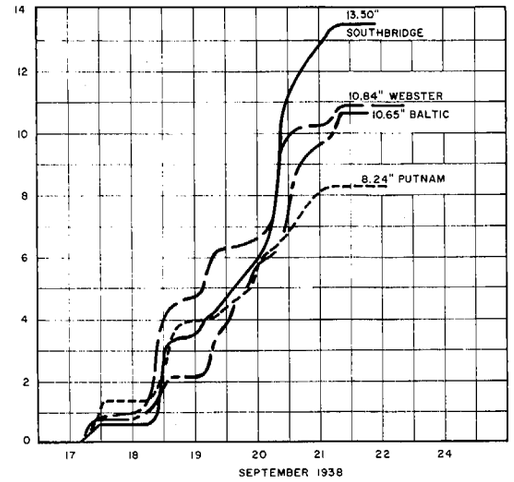
ACCOMPANY REPORT DATED: 31 JANUARY 1958

DRAWING NUMBER TH-3-1040

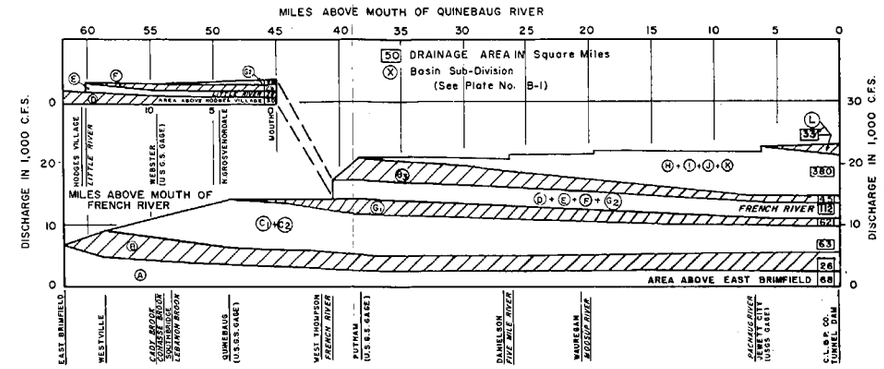
SHEET 1 OF 1

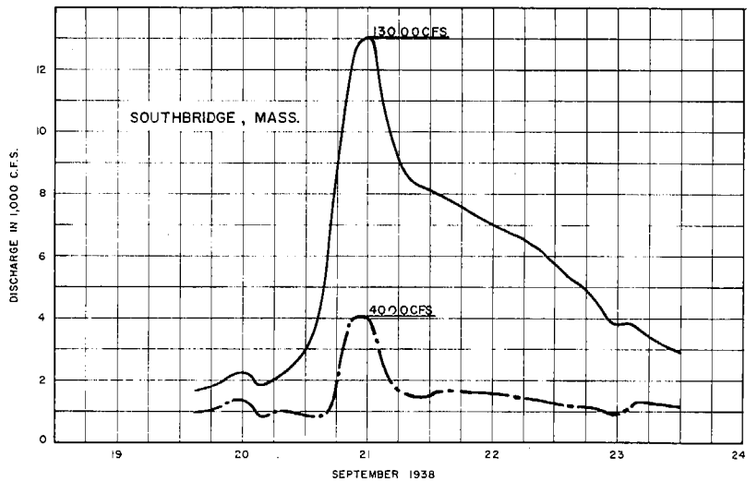


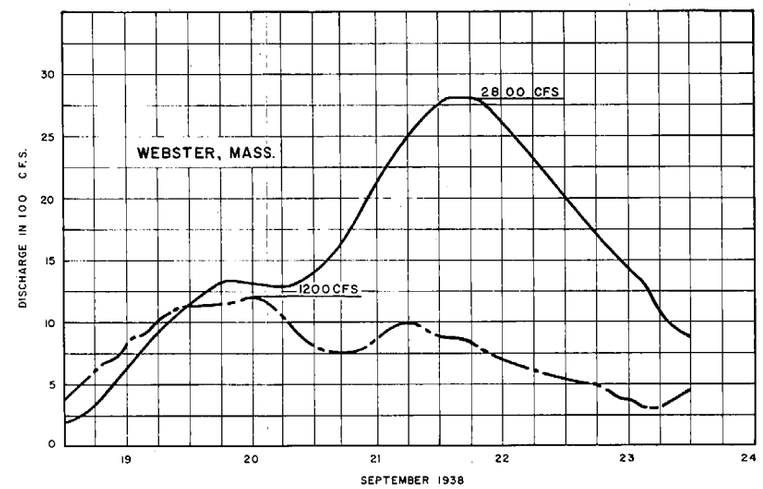
ISOHYETALS

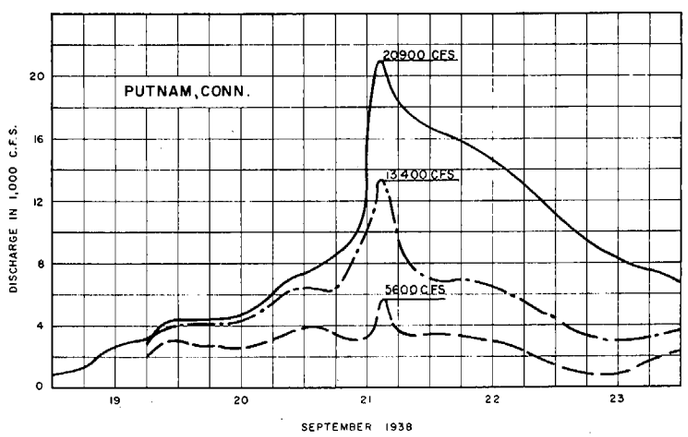


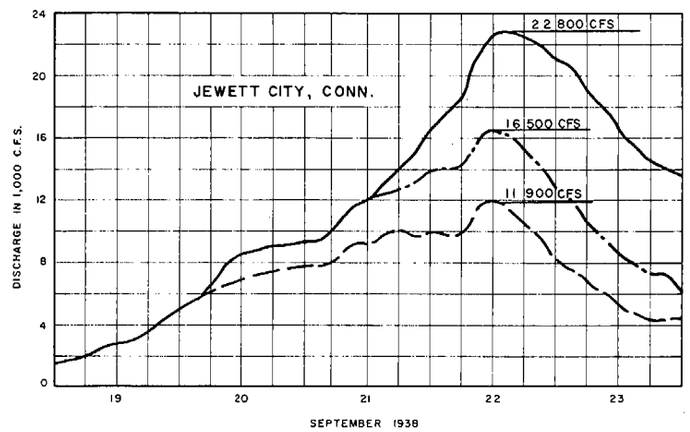
MASS. RAINFALL CURVES











NATURAL
AUTHORIZED PLAN
PROPOSED PLAN

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY | TR. BY S.J.C. | CK. BY

THAMES RIVER FLOOD CONTROL

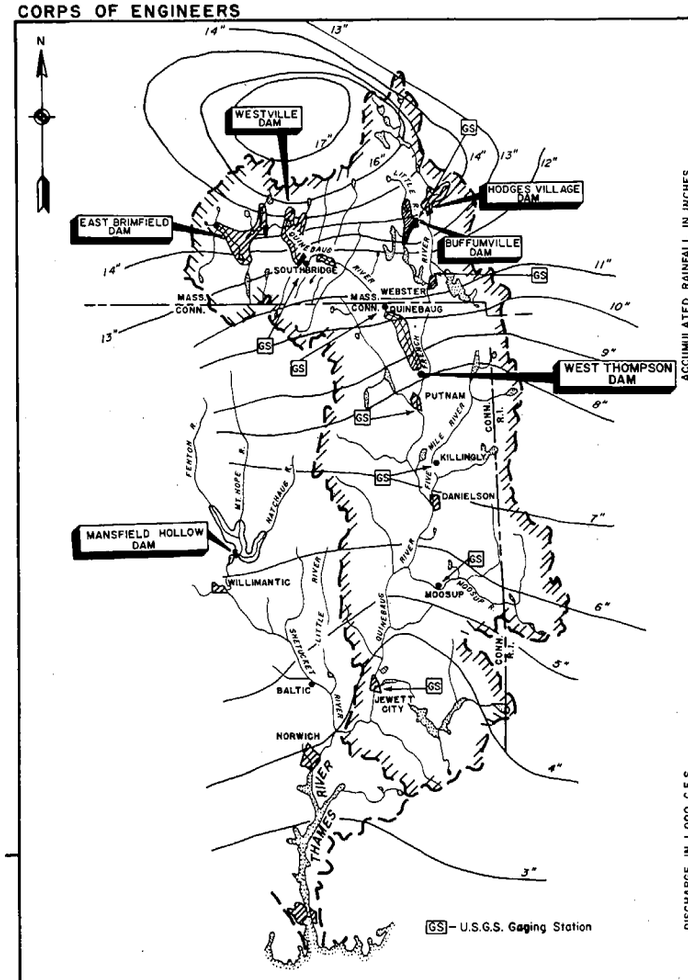
FLOOD OF SEPTEMBER 1938

QUINEBAUG RIVER WATERSHED CONN. & MASS.

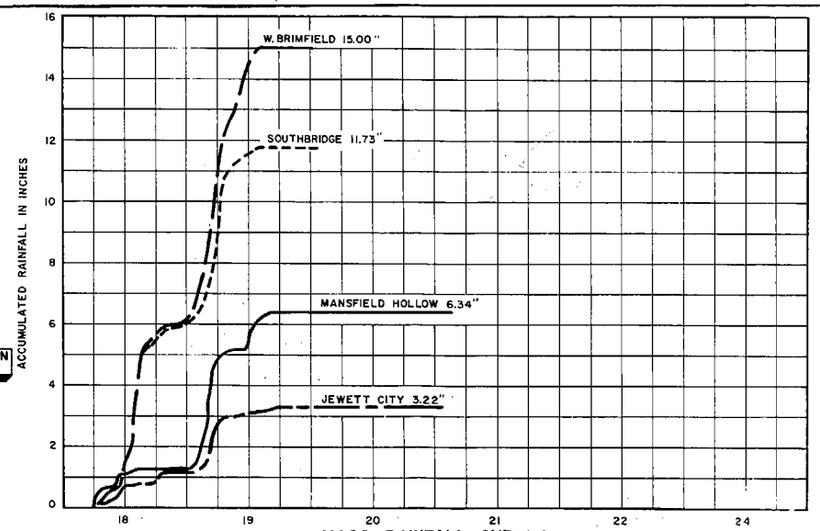
CHIEF HYD. & HYD. SECTION
SUBMITTED BY
CHIEF, PLANN. & REP. BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
LT. COL. C.E. ASST. TO DIVISION ENGINEER
DATE JAN. 1958.

ACCOMPANY REPORT
DATED: 31 JANUARY 1958

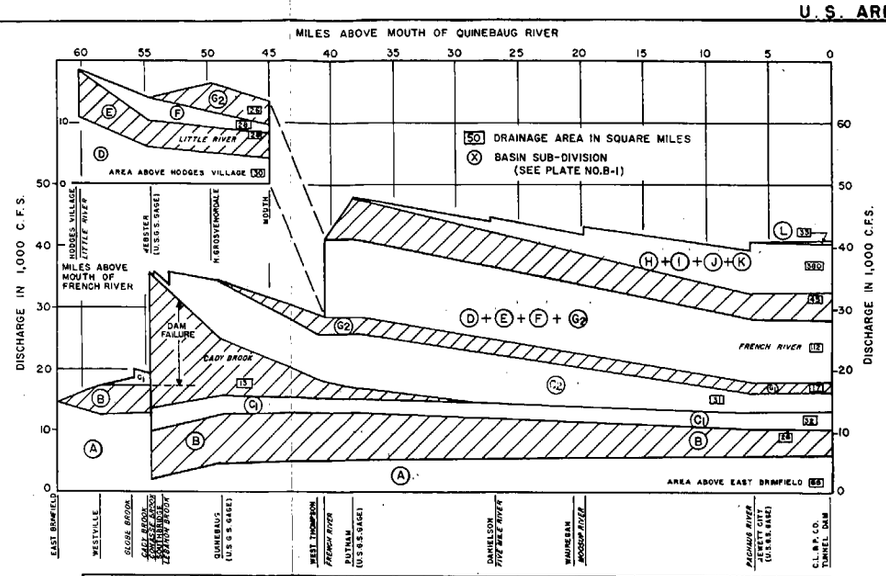
SCALE: AS SHOWN
DRAWING NUMBER
TH-3-1036
SHEET 1 OF 1

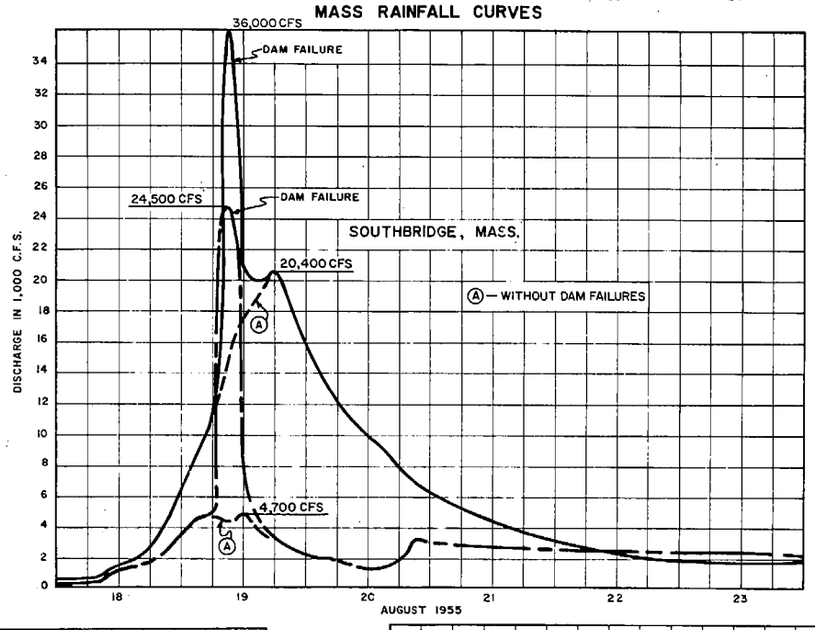


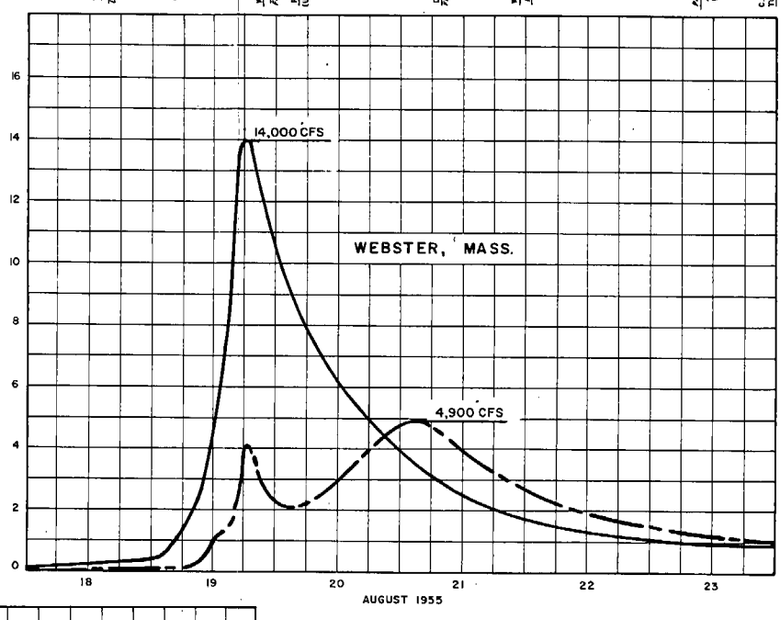
ISOHYETALS

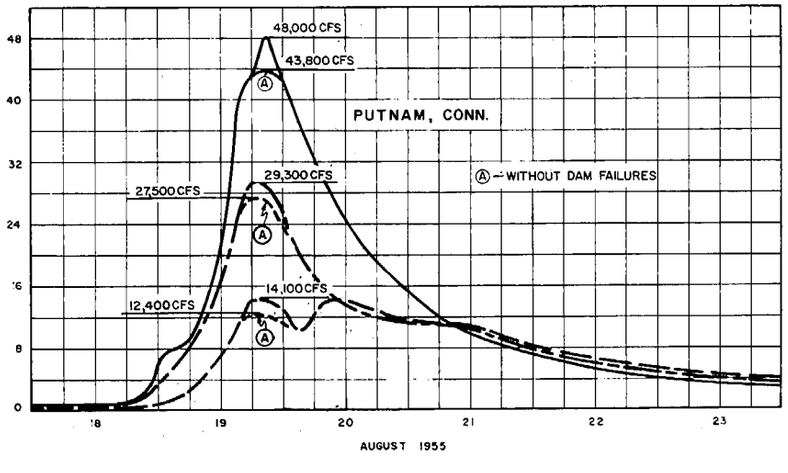


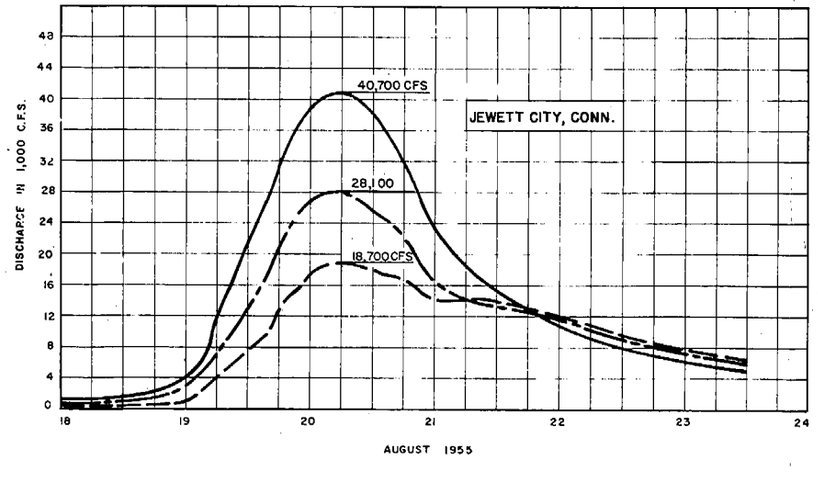
MASS RAINFALL CURVES











NATURAL
AUTHORIZED PLAN
PROPOSED PLAN

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON MASS

DR. BY | TR. BY S.J.C. | CK. BY

THAMES RIVER FLOOD CONTROL

FLOOD OF AUGUST 1955

QUINEBAUG RIVER WATERSHED CONN. & MASS.

CHIEF HYD. & HYD. SECTION
SUBMITTED BY
CHIEF PLANN. & R'T'S BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
LT. COL. C.E. ASST. TO DIVISION ENGINEER

DATE JAN 1958

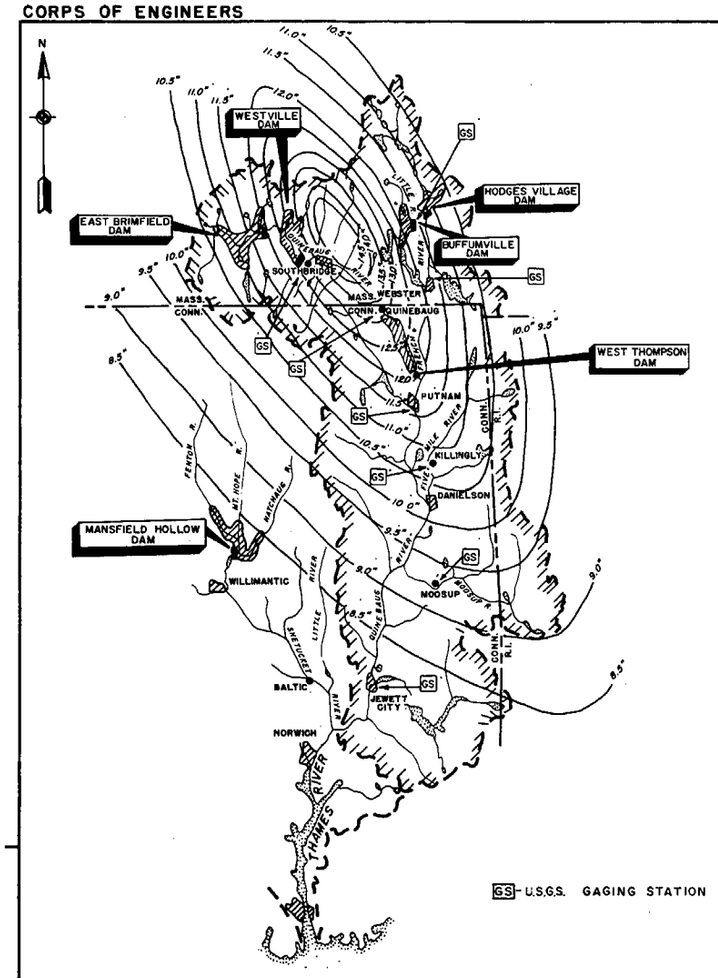
SCALE

ACCOMPANY REPORT
DATED: 31 JANUARY 1958

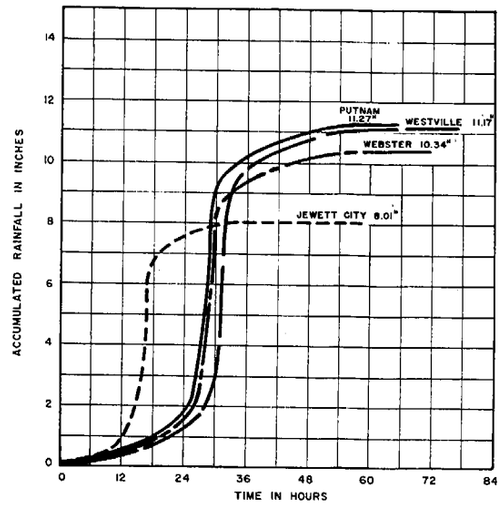
DRAWING NUMBER TH-3-1035

SHEET OF

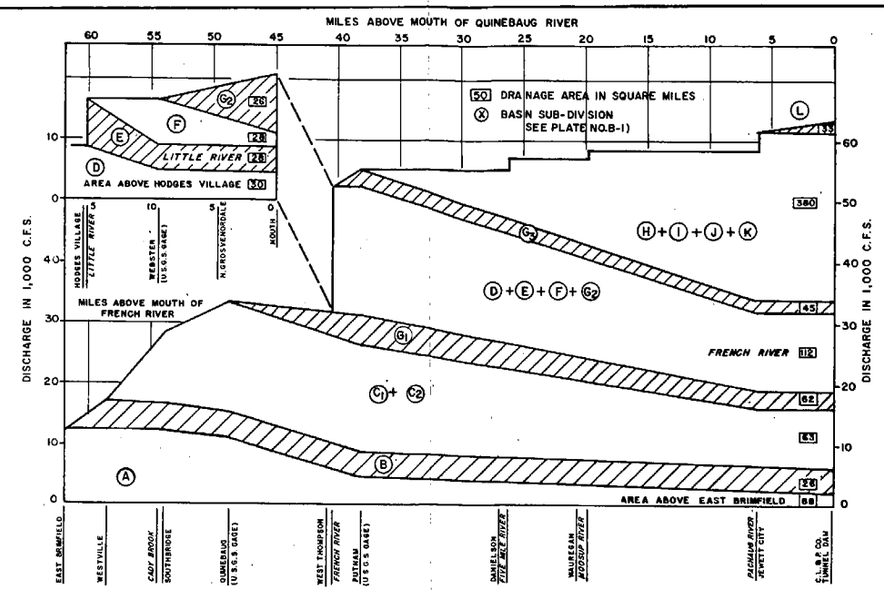
PLATE NO.B-11

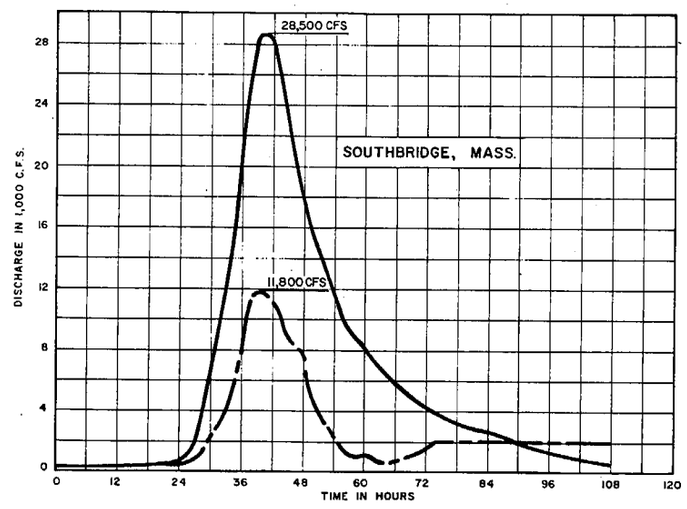


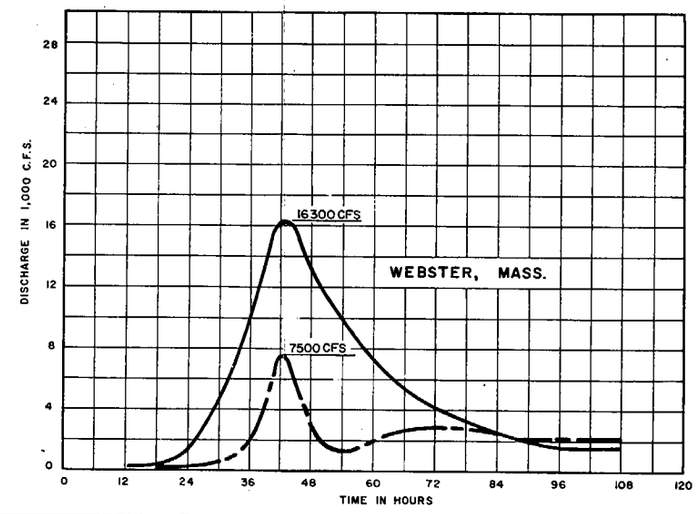
ISOHYETALS

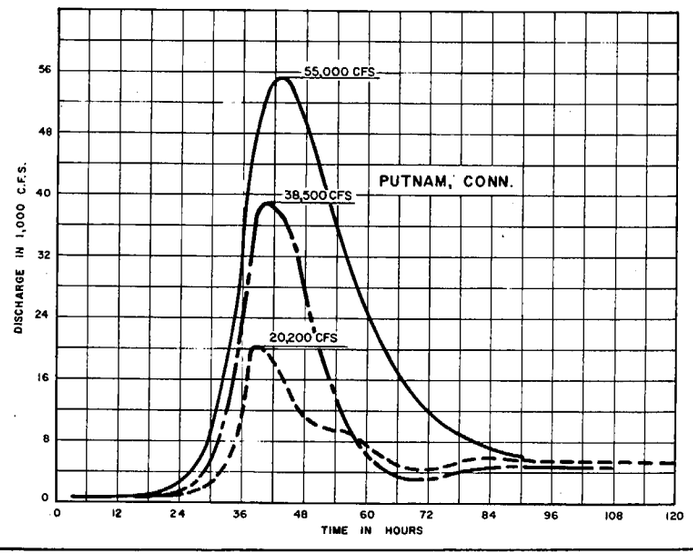


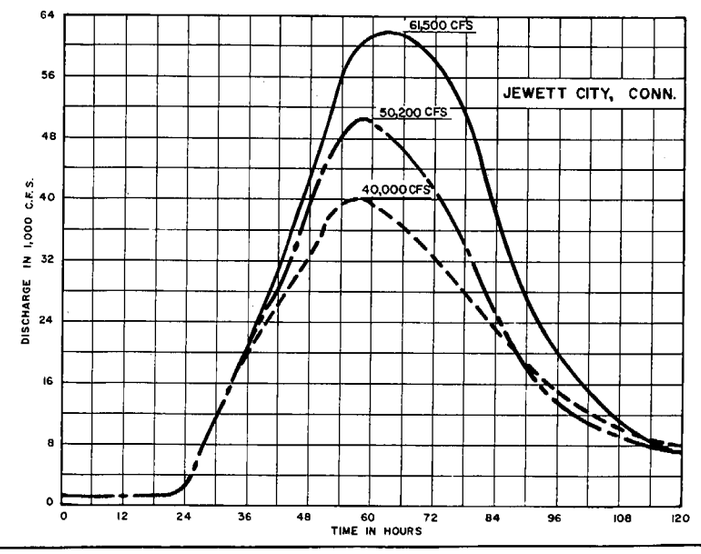
MASS RAINFALL CURVES











NATURAL
AUTHORIZED PLAN
PROPOSED PLAN

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY | TR. BY S.J.C. | CK. BY

THAMES RIVER FLOOD CONTROL

STANDARD PROJECT FLOOD

QUINEBAUG RIVER WATERSHED CONN. & MASS.

CHIEF HYD. & HYD. SECT.
SUBMITTED BY
CHIEF PLANN. & RPTS. BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
LT. COL. C.E. ASST. TO DIVISION ENGINEER

DATE JAN. 1958

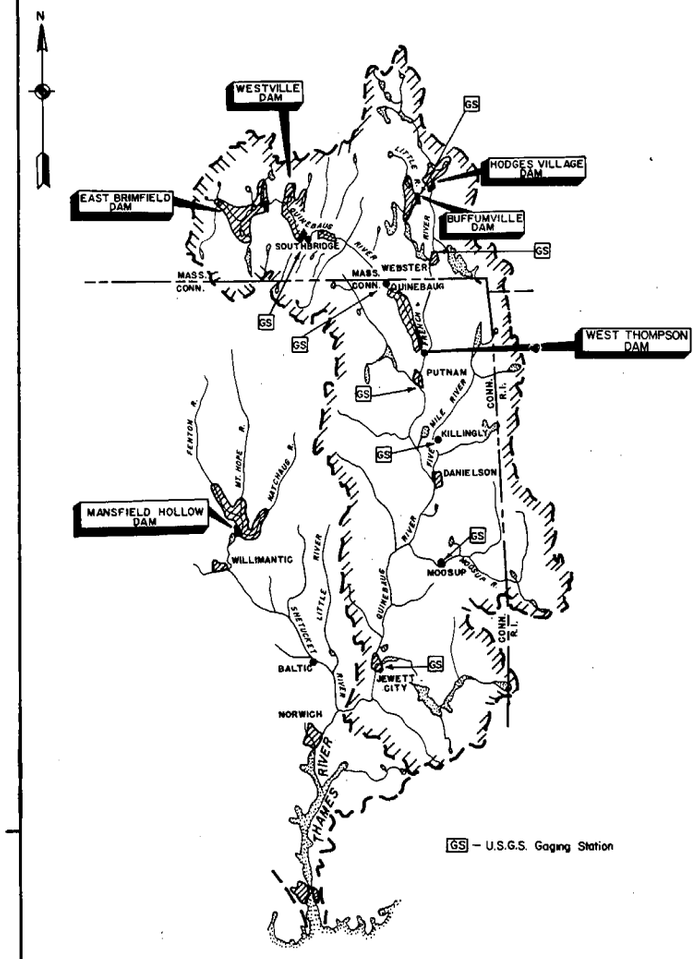
SCALE AS SHOWN

ACCOMPANY REPORT
DATED: 31 JANUARY 1958

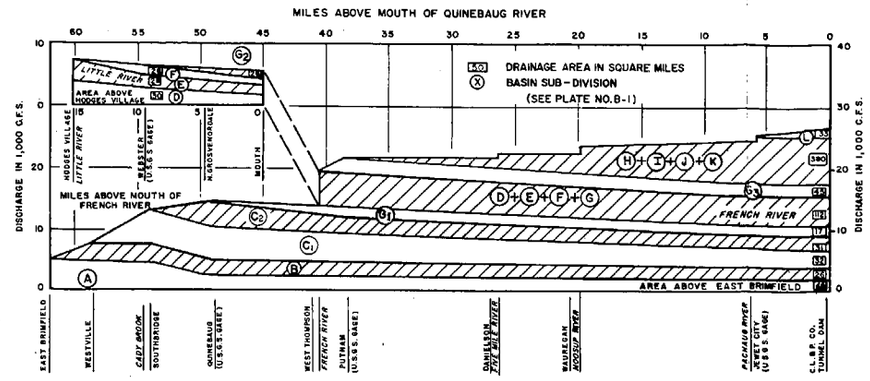
DRAWING NUMBER TH-3-1039

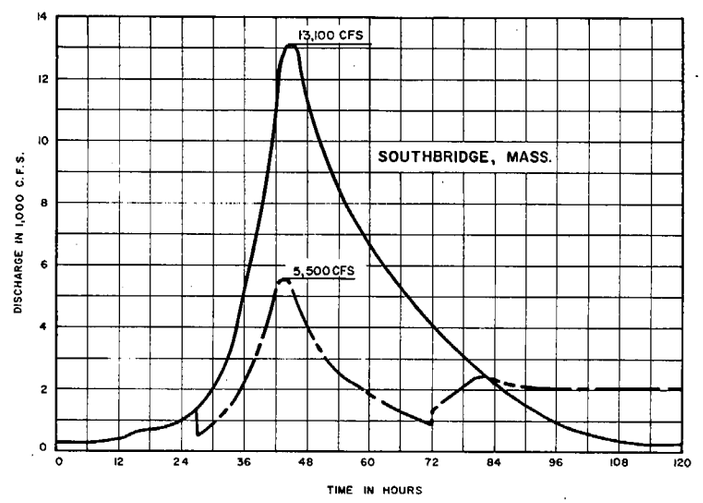
SHEET 1 OF 1

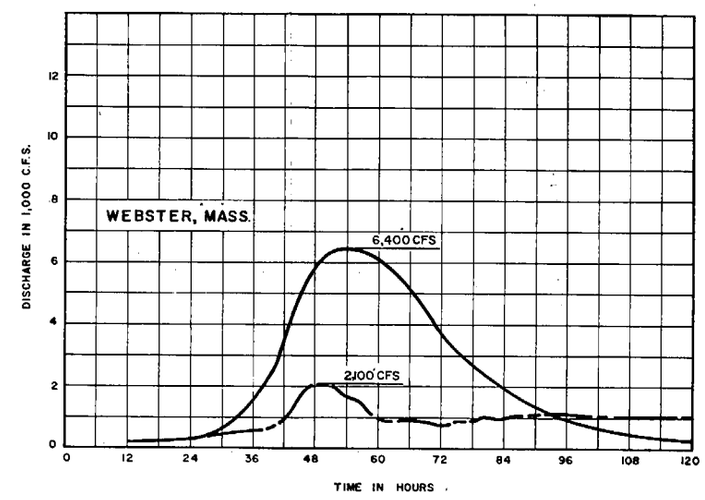
PLATE NO. B-12

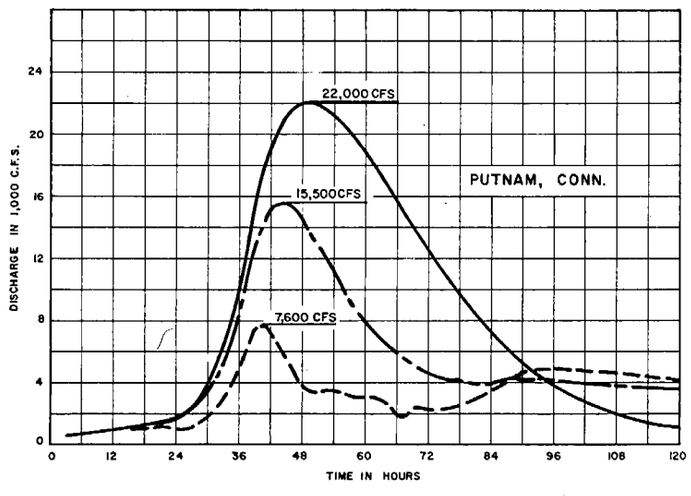


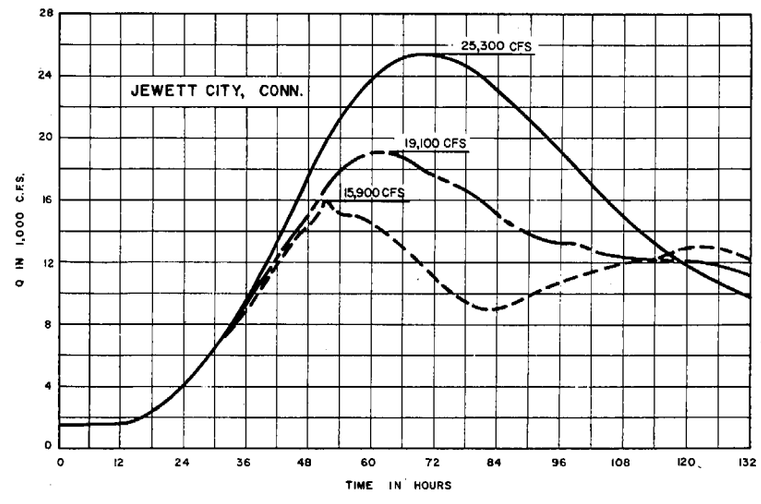
BASIN MAP











NATURAL
AUTHORIZED PLAN
PROPOSED PLAN

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY | TR. BY S.J.C. | CK. BY

THAMES RIVER FLOOD CONTROL

TYPICAL TRIBUTARY CONTRIBUTION FLOOD

QUINEBAUG RIVER WATERSHED CONN. & MASS.

CHIEF HYD. & HYD. SECTION — SUBMITTED BY — CHIEF PLAN & REP. BRANCH — APPROVED — CHIEF ENGINEERING DIV. — APPROVED — LT. COL. C.E. ASST. TO DIVISION ENGINEER

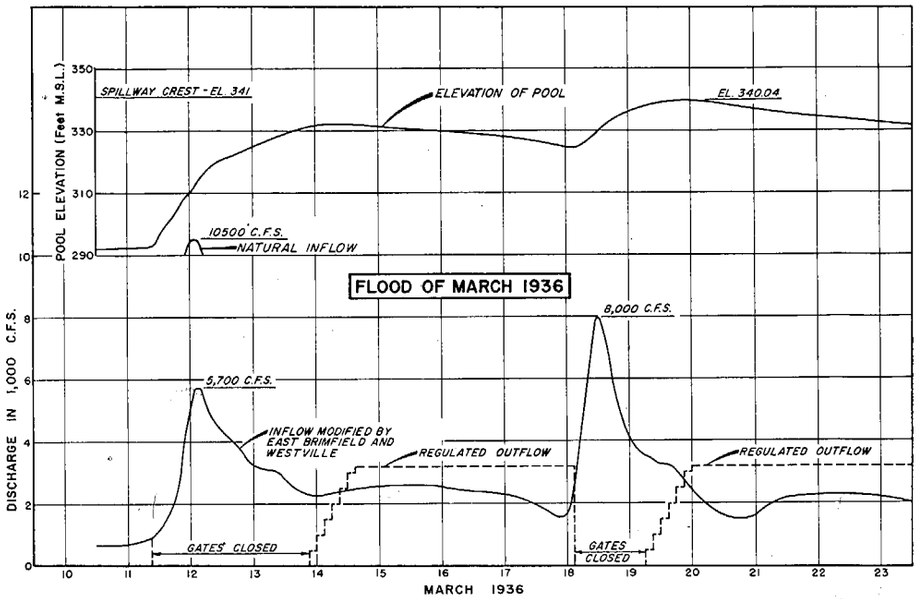
DATE JAN. 1958

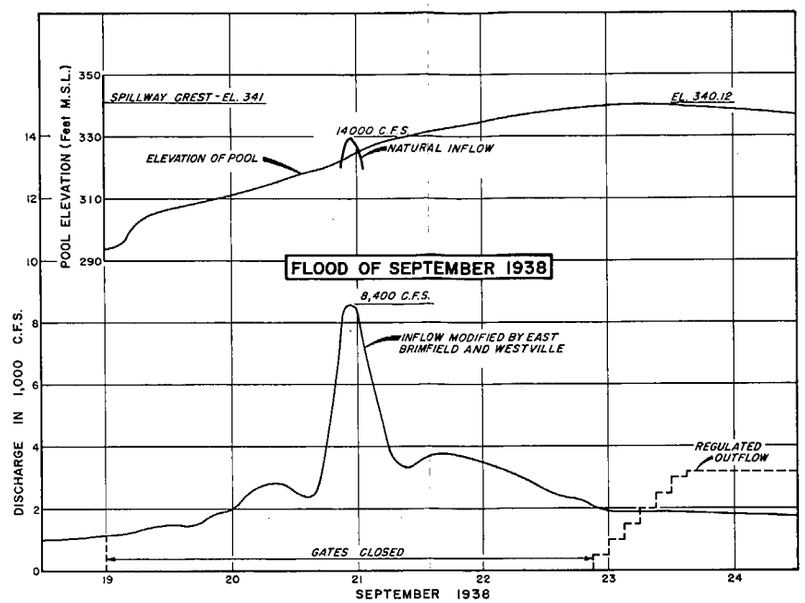
SCALE: AS SHOWN

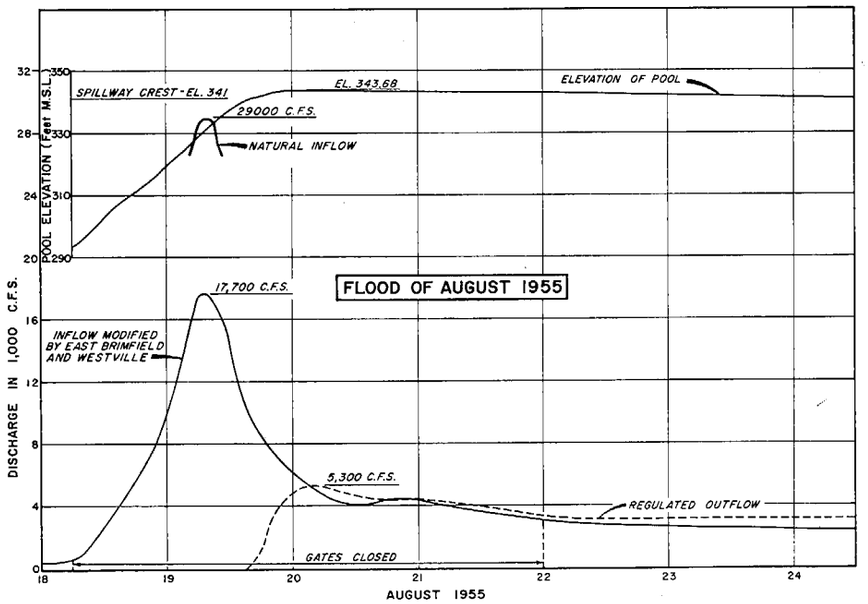
TO ACCOMPANY REPORT DATED: 31 JANUARY 1958

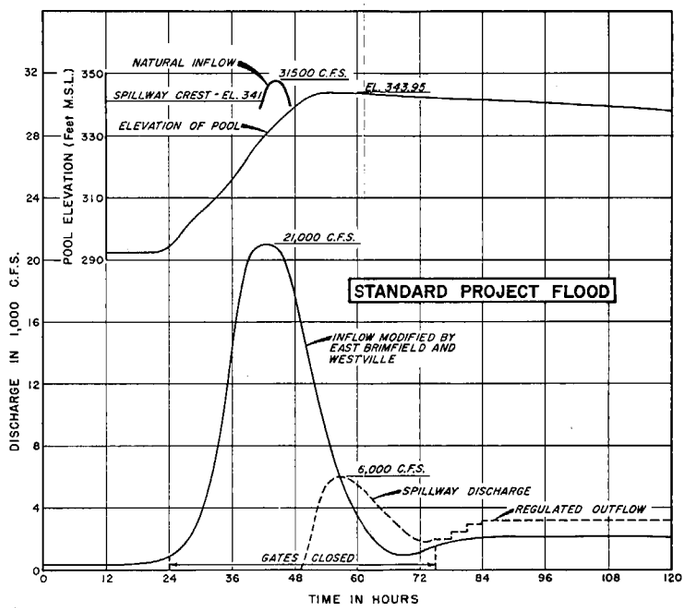
DRAWING NUMBER TH-3-1039

SHEET 1 OF 1









REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY | TR. BY M.S. | CK. BY

E. F. Chase
CHIEF HYD. & HYD. SECTION

SUBMITTED BY
N. T. Bonnyhall
CHIEF, PLANN. & REPORTS BRANCH

APPROVED
CHIEF, ENGINEERING DIV.

APPROVED
LT. COL. C.E. ASST. TO DIVISION ENGINEER

DATE JAN. 1958

THAMES RIVER FLOOD CONTROL

WEST THOMPSON RESERVOIR

FLOOD CONTROL REGULATION

QUINEBAUG RIVER WATERSHED CONN. & MASS.

SCALE: AS SHOWN

TO ACCOMPANY REPORT
DATED: 31 JANUARY 1958

DRAWING NUMBER
TH-3-1039
SHEET 1 OF 1

APPENDIX C

FLOOD LOSSES AND BENEFITS

APPENDIX C

FLOOD LOSSES AND BENEFITS

TABLE OF CONTENTS

Paragraph		Page
1	Damage Surveys	C-1
2	Loss Classification	C-1
3	Recurring and Preventable Losses	C-2
4	Annual Losses	C-5
5	Annual Benefits	C-5
6	Enhancement and Higher Utilization Benefits	C-7

TABLES

C-1	Description of Main Damage Reaches	C-3
C-2	Recurring and Preventable Losses - Flood of August 1955	C-4
C-3	Annual Losses and Benefits	C-6

PLATE

C-1	Typical Curves for Economic Analysis of Flood Control Reservoirs	

APPENDIX C

FLOOD LOSSES AND BENEFITS

1. Damage Surveys. - Detailed damage surveys were conducted in flood areas of the Thames River Basin immediately after the flood of August 1955. In view of unprecedented flood stages and damages, losses were referenced to 1955 stages. The results of this survey were correlated by an office review with data obtained after the 1936 and 1938 floods.

Damage surveys consisted, essentially, of a door-to-door inspection of the hundreds of residential, commercial, industrial, and other properties affected by flooding. Recorded information included extent of the areas flooded, descriptions of property, nature and amount of damages, depths of flooding, highwater references, and relationships to prior flood stages. Although damage estimates were furnished generally by property owners, these estimates were modified by investigators if owner evaluations appeared unreasonable. Sampling methods were used by investigators to estimate losses of small groups of similar residences which experienced the same depth of flooding. In order to reduce survey costs, central sources of information were used extensively. Valuable information was obtained from local and state officials and from utility companies that experienced damages in the Thames River Basin and other river basins in New England.

Sufficient data was obtained to derive losses for (1) the 1955 flood crest; (2) a stage three feet above the 1955 crest; (3) intermediate stages indicating sharp changes in stage-damage relationships; and (4) the stage at which damage begins referenced to the 1955 flood crest. Additional data was obtained for the purpose of evaluating enhancement or higher utilization of commercial and industrial space and land.

2. Loss Classification. - Flood loss information was recorded by type of loss and by location. Loss types used were urban (commercial, residential, public), industrial, rural, highway, railroad, and utility. Losses were recorded by reaches of the Quinebaug and French Rivers to provide a basis for later use in analyses of average annual losses and benefits.

Losses evaluated in the survey were the result of tangible, primary damages. Primary losses consist of physical losses such as damage to structures, equipment, stock, and costs of repair and clean-up; and non-physical losses such as unrecoverable loss of business, wages or production, increased cost of operation, cost of temporary facilities, and increased cost of shipment into, and out of, the flood areas.

Primary losses resulting from physical damage and a large part of the related non-physical loss were determined by direct inspection of property and evaluation of losses by property owners and field investigators. Where non-physical portions of primary losses could not be determined on the basis of available data, estimates were based upon the relationship between physical and non-physical losses for similar properties in the area.

Monetary evaluations were not made of secondary or of intangible damages. Secondary damages, incurred outside the immediate flood area, include such items as loss of utilities and transportation facilities, increased cost of travel and shipment of goods, and business losses. Intangible losses include items such as loss of life, hazards to health, and detrimental effects upon national security.

3. Recurring and Preventable Losses. - Under economic conditions existing in 1957, a recurrence of stages produced by flooding of the 1955 magnitude in the Quinebaug-French River system, including flooding in downstream areas around the Quinebaug-Shetucket-Thames River confluence, would cause a total loss estimated at over $55,550,000. Redevelopment planned for a portion of the flood area in Putnam would change the amount of the recurring loss, but data on the character of redevelopment is insufficient to permit a reasonable estimate of loss at this time. The existing Mansfield Hollow flood-control reservoir and the Norwich Channel improvement on the Willimantic-Shetucket River and operation of the four authorized flood-control reservoirs - Hodges Village and Buffumville projects in the French River system, East Brimfield and Westville projects on the Quinebaug River - would prevent $36,880,000 of the total recurring loss. Table C-1 presents a description of main damage zones in the Quinebaug-French system, and Table C-2 presents 1955 recurring losses that are preventable in each zone by combined operation of the authorized reservoir system after addition of the West Thompson Reservoir project.

TABLE C-1

DESCRIPTION OF MAIN DAMAGE REACHES

QUINEBAUG-FRENCH RIVER SYSTEM

River	Reach	Description
French	1	From Hodges Village and Buffumville dam sites to Mass.-Conn. state line
"	2	From state line to mouth of French River
Quinebaug	3	From East Brimfield dam site to Westville site
"	4	From Westville site to Mass.-Conn. state line
"	5	From state line to mouth of French River
"	6	From mouth of French to mouth of Five Mile River
"	7	From mouth of Five Mile River to mouth of Moosup River
"	8	From mouth of Moosup to mouth of Quinebaug
Shetucket	9	From mouth of Quinebaug to Laurel Hill bridge in Norwich
Thames	10	From Laurel Hill bridge to mouth of Thames River

TABLE C-2

RECURRING AND PREVENTABLE LOSSES
FLOOD OF AUGUST 1955
QUINEBAUG-FRENCH RIVER SYSTEM
(Losses at 1957 prices)

Reach	Recurring Losses	Losses Preventable by Authorized System	Losses Preventable by Auth. System Plus West Thompson
1	$11,340,000	$10,140,000	$10,140,000
2	4,550,000	3,330,000	3,330,000
3	1,760,000	1,720,000	1,720,000
4	19,600,000 (11,530,000)	12,250,000 (9,030,000)	12,250,000 (9,030,000)
5	250,000 (220,000)	50,000 (50,000)	50,000 (50,000)
6	10,600,000 (10,100,000)	2,930,000 (2,900,000)	8,230,000 (7,780,000)
7	3,040,000	2,660,000	3,030,000
8	900,000	840,000	900,000
9	1,930,000	1,390,000	1,820,000
10	1,580,000	1,570,000	1,580,000
TOTAL	$55,550,000 (46,950,000)	$36,880,000 (33,630,000)	$43,050,000 (39,380,000)

* Parentheses indicate losses without dam failure on Cady Brook

4. Annual Losses. - Estimated recurring flood losses on the Quinebaug and French Rivers were converted to annual losses for determining annual benefits to be used in economic evaluation of flood-control projects. Estimates of annual losses were derived by correlation of stage-damage, stage-discharge, discharge-frequency, and stage-frequency relationships to derive damage-frequency relationships in accordance with standard practices of the Corps of Engineers.

Natural annual losses in the Quinebaug-French River system, losses that would occur without flood protection, are approximately $2,135,000 at the 1957 price level. Of these losses, $1,400,000 occurs in the Quinebaug River and $735,000 on the French River. In areas of the Quinebaug River affected by operation of West Thompson Dam and Reservoir, natural annual losses are $844,000. After stage reductions by the authorized system, residual annual losses along the Quinebaug River are $262,000 and in the areas downstream from the Quinebaug-Shetucket confluence, $96,000. Typical curves used for computation of annual losses and benefits are shown on Plate C-1.

5. Annual Benefits. - The annual flood damage prevention benefits for the projects studied were determined by measuring the difference between the annual loss remaining in the project protection area after discharge or stage reductions by authorized projects and the annual loss remaining after modification of this loss by the combined effectiveness of the authorized projects and the project being studied. As a practical matter, all local protection projects studied, except for the left bank protection at Putnam, were eliminated from further study when it became evident that the annual loss remaining in the project protection areas was less than the anticipated annual cost of protection. Similarly, the annual loss remaining in Putnam after authorized reservoirs, plus one additional feasible reservoir on the Quinebaug, is less than estimated annual cost of protection.

The West Thompson Dam and Reservoir project, acting as an incremental unit with the authorized flood-control projects in the Thames River Basin, would provide annual flood damage prevention benefits of $229,000. Of this total, $202,000 would be realized along the Quinebaug River and $27,000 in the areas below the Quinebaug-Shetucket confluence.

The proposed local protection project at Putnam, acting after authorized reservoirs, would produce average annual flood damage prevention benefits of $56,000. Benefits after authorized reservoirs and the West Thompson project would be substantially less than the estimated cost of protection.

Table C-3 presents, by zones, the annual losses remaining after authorized projects, the annual losses remaining after the authorized projects plus the West Thompson project, and the benefits to West Thompson.

TABLE C-3

THAMES RIVER BASIN
ANNUAL LOSSES AND BENEFITS
(1957 price level)

Zone	River	Annual Losses Remaining After Authorized Projects	Annual Losses Remaining After Authorized Projects & West Thompson (1)	Benefits to West Thompson
1	French	$ 71,000	$ 71,000	$ 0
2	"	34,000	34,000	0
3	Quinebaug	0	0	0
4	"	76,000	76,000	0
5	"	5,000	5,000	0
6	"	241,000	50,000	191,000
7	"	11,000	1,000	10,000
8	"	5,000	4,000	1,000
9	Shetucket	42,000	28,000	14,000
10	Thames	54,000	41,000	13,000
		$539,000	$310,000	$229,000

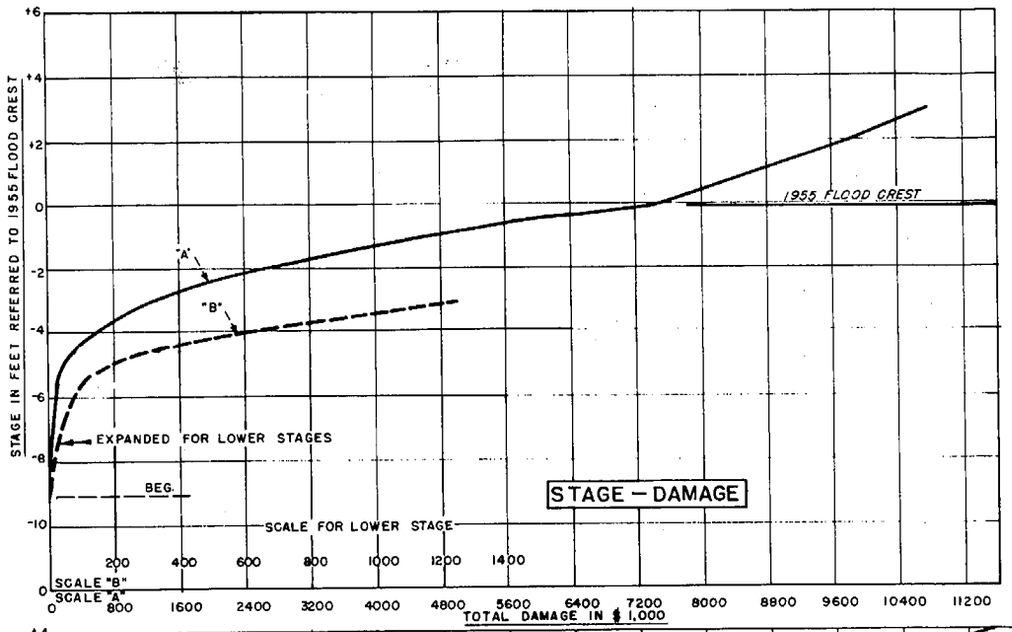
(1) Losses remaining are scattered and result largely from very rare floods

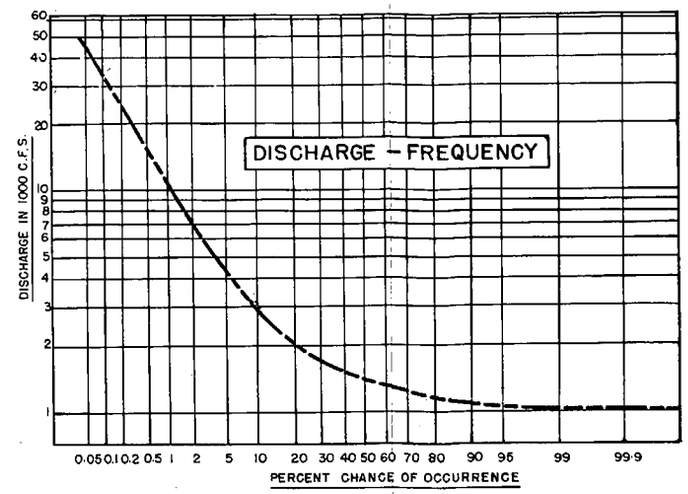
6. Enhancement and Higher Utilization Benefits. - An analysis of the flood problem along the Quinebaug River between West Thompson and Jewett City, Connecticut, revealed that some higher utilization of vacant and industrial, residential and commercial space would be encouraged by the construction of protective works which would augment the authorized system of reservoirs. Undeveloped land areas near the urban centers of Putnam, Danielson, and Jewett City would be available for development at such time as the general condition of the regional economy might warrant. The monetary value of such development over a period of years is not susceptible to evaluation at this time, but the increasing importance of the State in the manufacturing fields of airplane engines and parts, electrical and electronic goods, plastic and metals indicates that further development in this area could be anticipated with a substantially diminished threat of floods.

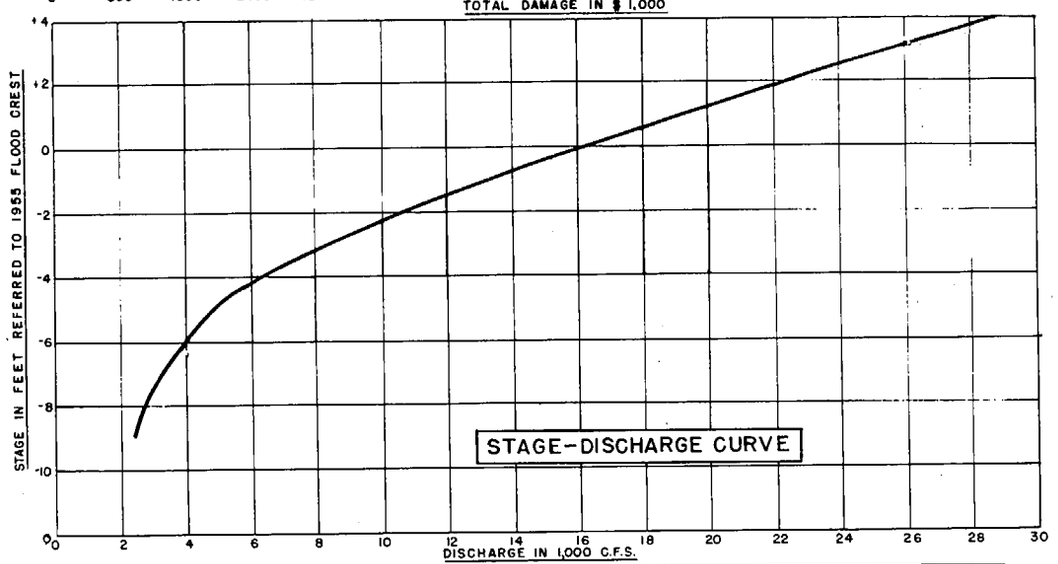
Within the corporate limits of Putnam, Plainfield and Jewett City, Connecticut, there are dwellings, stores, and industrial spaces which have been vacant since the August 1955 flood. The long flood history of these communities, climaxed by the devastating flood of 1955, has tended to discourage re-use or rental of these spaces.

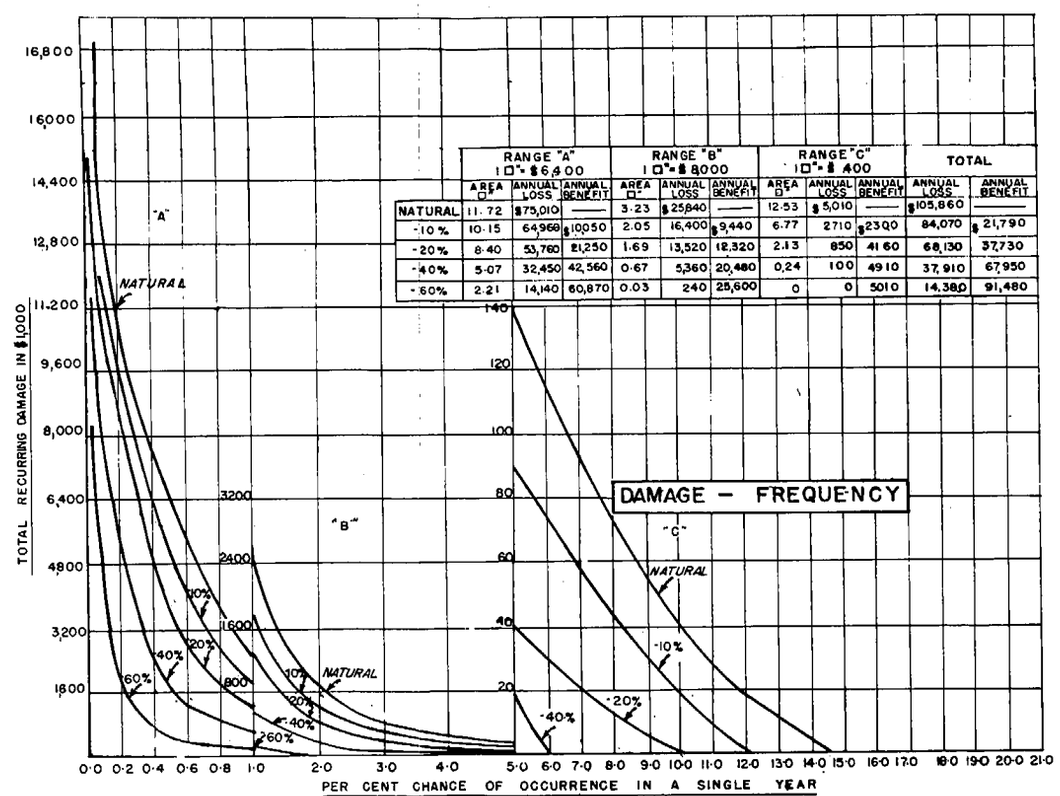
An investigation of the past, present, and potential use of vacant spaces in conjunction with a review of the general economic status of these communities was made to serve as the basis for determining higher utilization benefits. Data was obtained from responsible sources including local officials and merchants, property owners, tenants, the Redevelopment Agency of the city of Putnam, and the Connecticut Development Commission. The results of this study revealed that a definite need exists for use of some of the vacant properties within the flood plain, but it was not considered reasonable to assume that re-use was dependent on projects designed to supplement the effectiveness of authorized reservoirs.

In lieu of definitive enhancement benefits for space vacant since the August 1955 flood, recurring losses based on former use have been assigned where re-use would not be prohibited, to provide a fuller measure of the benefits to be anticipated with the provision of protective works.

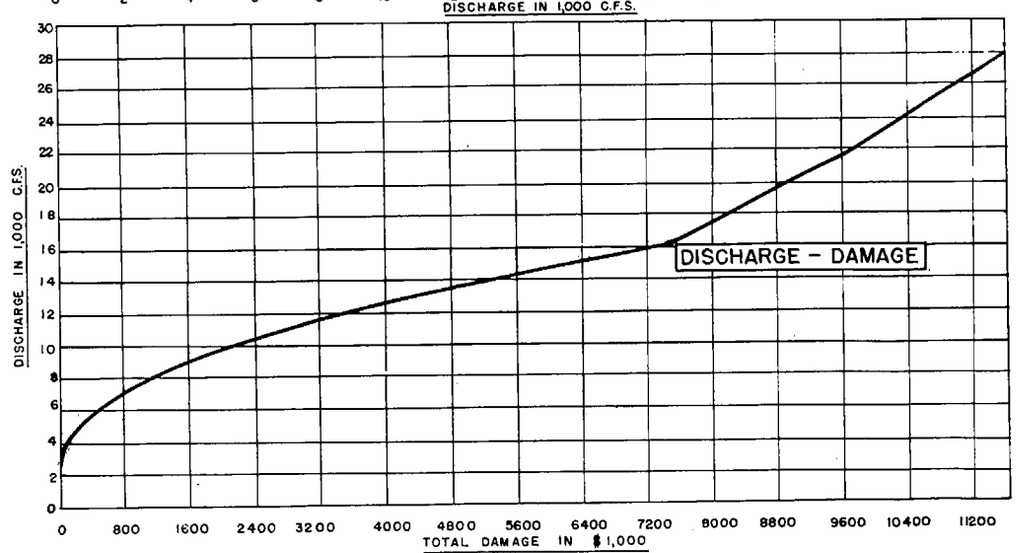


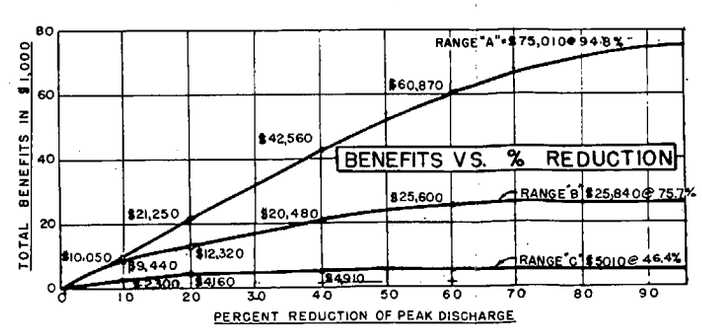






	RANGE "A" 1 □" = $6,400			RANGE "B" 1 □" = $8000			RANGE "C" 1 □" = $ 400			TOTAL	
	AREA □"	ANNUAL LOSS	ANNUAL BENEFIT	AREA □"	ANNUAL LOSS	ANNUAL BENEFIT	AREA □"	ANNUAL LOSS	ANNUAL BENEFIT	ANNUAL LOSS	ANNUAL BENEFIT
NATURAL	11.72	$75,010	—	3.23	$25,840	—	12.53	$5,010	—	$105,860	—
-10%	10.15	64,960	$10,050	2.05	16,400	$9,440	6.77	2710	$2300	84,070	$21,790
-20%	8.40	53,760	21,250	1.69	13,520	12,320	2.13	850	4160	68,130	37,730
-40%	5.07	32,450	42,560	0.67	5,360	20,480	0.24	100	4910	37,910	67,950
-60%	2.21	14,140	60,870	0.03	240	25,600	0	0	5010	14,380	91,480





TYPICAL CURVES
FOR ECONOMIC ANALYSIS
OF
FLOOD CONTROL RESERVOIRS

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

APPENDIX D

WEST THOMPSON DAM AND RESERVOIR

APPENDIX D

WEST THOMPSON DAM AND RESERVOIR

TABLE OF CONTENTS

Par.		Page
	A. INTRODUCTION	
1	Description	D-1
	B. GEOLOGY	
2	Regional Geology and Topography	D-1
3	Surficial and Subsurface Investigations	D-2
4	Surficial Geology	D-2
5	Foundation Conditions	D-3
	a. Overburden	D-3
	b. Bedrock	D-3
	c. Ground Water	D-3
6	Leakage Conditions in the Reservoir	D-3
7	Construction Materials	D-3
	a. Reconnaissance	D-3
	b. Pervious Materials	D-3
	c. Impervious Materials	D-4
	d. Rock Fill	D-4
	e. Concrete Aggregates	D-4
	C. REAL ESTATE	
8	Character of Reservoir	D-4
9	Taking	D-4
10	Mineral Rights	D-4
11	Water Rights	D-4
12	Gravel Pit	D-4
13	Severance Damage	D-4
14	Relocations	D-4
	a. Cemeteries	D-4
	b. Utilities	D-4
	c. Roads	D-5
15	Resettlement Costs	D-5
16	Acquisition Costs	D-5
17	Valuation	D-6
18	Salvage Value	D-7

Par.		Page
	D. RELOCATIONS	
19	Roads	D-7
20	Utilities	D-7
	E. COST ESTIMATES	
21	Basis of Estimates	D-7
22	Unit Prices	D-7
23	Contingencies, Engineering, and Overhead	D-8
24	Annual Charges	D-8
25	Cost Estimates	D-8

TABLES
(At End of Appendix)

D-1	First Cost	-West Thompson Dam and Reservoir
D-2	Annual Charges	- " " " " "

PLATE

D-1	West Thompson Dam - Geology

APPENDIX D

WEST THOMPSON DAM AND RESERVOIR

A. INTRODUCTION

1. Description. The West Thompson dam site is located on the Quinebaug River in the town of Thompson, Conn., approximately 2.0 miles upstream from Putnam and approximately 0.1 mile upstream from the confluence of the Quinebaug and French Rivers. The reservoir at spillway crest would be 5 miles long, lying entirely within the town of Thompson, and would have a surface area of 1,200 acres. The reservoir would have a capacity of 25,600 acre-feet of storage, all reserved for flood control, equivalent to 6.0 inches of runoff from the net drainage area of 80.0 square miles below the authorized Westville and East Brimfield flood control reservoirs. The limits of the reservoir are shown on Plate No. 3 of the report.

The dam, with top elevation of 361 feet, mean sea level datum, would be of earth-fill construction, approximately 2,400 feet long with a maximum height of 70 feet above the stream bed. A 400-foot long dike, with a maximum height of 24 feet, would be required across a saddle northeast of the dam. An L-shaped side channel spillway at elevation 341, mean sea level datum, 313 feet long, would be constructed in rock in the right abutment. The spillway is designed for a 15-foot surcharge. An 11-foot diameter, horseshoe shaped, reinforced concrete conduit, constructed at existing river level at the foot of the right abutment, would discharge into the spillway channel downstream from the dam. Control of flows through the conduit would be by means of three 5'x8' hydraulically operated gates.

Construction of the project is estimated to require 2 years. A general plan of the dam and appurtenant structures is shown on Plate No. 4 of the report.

B. GEOLOGY

2. Regional geology and topography. The region drained by the Quinebaug River and its tributaries lies entirely within the eastern part of the New England Upland. In the upland section, the Quinebaug flows through a region of moderate relief in relatively narrow, deep, steep-sided valleys. The topography of the entire region has been modified by glaciation. The tops of the hills have been rounded and scoured and the valleys deeply filled with glacial debris. The hills are generally blanketed with a thin veneer of glacial till and the valleys filled with deep deposits of outwash, in the form of relatively wide flood plains and terraces.

Bedrock outcrops frequently through the till on the hilltops and upper slopes. Rock is exposed in the valleys only where the streams have down-cut sufficiently to expose bedrock spurs along the flanks of the preglacial valleys.

The bedrock of the region consists of a series of Pre-Cambrian crystalline rocks, mostly gneisses and schists of the so-called Putnam Series. The folds trend generally north to south.

3. Surficial and subsurface investigations. Geological reconnaissance of the site was made to determine general foundation conditions, and the type and extent of subsurface explorations necessary for this stage of investigations.

Foundation explorations, consisting of 7 test borings and 1 test trench, were completed at the site. The borings were continuously drive-sampled in overburden and were diamond-drill cored where rock was encountered.

Overburden samples from borings and test trench were classified according to the Unified Soils Classification System. The classification of all overburden samples and a description of bedrock cores recovered from the borings are shown on Plate No. D-1.

4. Surficial geology. The Quinebaug River at the dam site flows through a relatively wide and flat flood plain. The valley section is deeply filled with relatively impervious glacial-lake deposits of sands and silts. The left abutment rises gradually from the flood plain and the bedrock surface is mantled by gradually thinning glacial till. The upper elevations are heavily wooded and covered with numerous large boulders with rock outcropping above the height of dam. The right abutment is formed in part by a small terrace remnant of outwash, which rises steeply from the flood plain, then falls away abruptly to the west to form a small saddle between it and the old valley wall. The upper right abutment rises steeply from the saddle and is mantled by a thin till cover and numerous large boulders and blocks. The nearest definable outcrops to centerline on this abutment occur several hundred feet upstream and downstream.

The dike site is located in a small saddle approximately 0.7 of a mile northeast of the dam site. A small swamp is located at the foot of the left abutment which rises sharply with rock outcropping frequently through the till cover. The right abutment is heavily wooded and rises sharply above the saddle with rock apparently deeply buried beneath the till.

5. Foundation conditions.

a. Overburden. The overburden in the valley section consists of a thin stratum of relatively pervious sands and gravels overlying relatively impervious, variably stratified gravelly silty sands and sandy silts extending to a thin till stratum overlying the bedrock.

A small terrace remnant of pervious outwash is found at the foot of the right abutment. To the west of this terrace, the right abutment rises sharply and consists of a thin cover of reworked till overlying a shallow bedrock surface. The left abutment rises gradually from the flood plain and, in the lower elevations, outwash, ranging from sandy gravels to fine sands, overlies the glacial till. On the higher elevations, the overburden is glacial till overlying a relatively shallow and rising rock surface.

b. Bedrock. The granitic, mica schist is generally light to dark gray, hard and relatively fresh. Garnet is disseminated throughout and in FD-6 a small talc zone was found. Granite zones were found throughout the cores.

Observations at scattered outcrops show the trend of the schist varies throughout the area. The dip of foliation ranges from nearly horizontal to vertical in outcrops and rock cores. Weathering is slight and occurs generally along open foliation planes and joints.

c. Ground water Levels of subsurface water as indicated by observations in borings during drilling operations are essentially at river level in the valley bottom. In the abutments, ground water is generally below the rock surface.

6. Leakage conditions in the reservoir. Leakage through the reservoir rim is precluded by high and wide valley walls of bedrock generally covered by till. The preglacial valley at the dam site is filled with relatively impervious material and it appears practicable to cut off the overlying pervious stratum.

7. Construction materials.

a. Reconnaissance of the reservoir area was made to determine the availability of materials for construction. A more detailed investigation would be required to determine actual quantity and characteristics of the materials but it is assumed that all requirements could be satisfied.

b. Pervious materials. Materials suitable for pervious are readily available in the reservoir within a 2-mile haul distance of the site. The pervious is found in form of several large glaciolacustrine terraces upstream from the site.

c. Impervious materials. Glacial till suitable for use as impervious is available from several areas within a mile haul of the dam site.

d. Rock fill. Rock from spillway and conduit excavations is suitable for use as rock fill. Additional rock can be obtained from several commercial quarries within a 15-mile haul distance of the site.

e. Concrete aggregates. There are several commercial aggregate plants in and around Putnam, Conn. Two of these sources have been tested previously for use in other civil works projects in the area.

C. REAL ESTATE

8. Character of reservoir. The reservoir area contains woodland, pastureland, tillable land, rich bottom land, and homesites.

9. Taking. The proposed taking will be in fee title for dam site and reservoir areas. It is estimated that 1,200 acres would be required at spillway crest elevation 341.

10. Mineral rights. A current field inspection revealed that no mining operations of minerals are apparent in the proposed taking except some sand and gravel operations.

11. Water rights. There are no apparent waterpower rights and none are included in this report.

12. Gravel pit. There are 2 commercially operated gravel pits within the reservoir area: one is located off Fabyan-Woodstock Road, the other is located off Blaine Road.

13. Severance damage. Experience in this type of acquisition has proven that severance damage occurs. Ownerships and parts of ownerships are usually left without access. Farms from which land has been acquired are, as a result of the taking, overimproved by excessive size of buildings. Since no maps showing property lines are available at this time, this damage is estimated.

14. Relocations.

a. Cemeteries. There are no cemeteries lying within the proposed reservoir area.

b. Utilities. It is proposed to relocate portions of existing roads. It is also planned to abandon a portion of certain roads. No additional acreage is included for utility relocation in this report as it is assumed that telephone and electric lines will be relocated along the road relocation.

c. Roads. Fabyan Road is to be relocated in 2 sections; portions of Ravenelle Road will be relocated. Portions of Blaine Road and Brickyard Road will be abandoned.

Harrisville Road, which passes through West Thompson, is to be cut off at the westerly border of the reservoir. At this time it is not definitely determined whether or not this road will be relocated or abandoned.

Approximately 14 acres would be required for road relocations, valued at $2,000. This amount is included in the relocations estimate.

15. Resettlement costs. Resettlement costs are based on recent experience for this type of property and are estimated as follows:

1 Farm	@	$1,000	$ 1,000
1 Church		1,000	1,000
32 Residences and outbuildings		600	19,200
1 Mill		1,000	1,000
1 Auto repair garage		1,000	1,000
1 Fire station		1,000	1,000
1 Antique shop		1,000	1,000
1 School		1,000	1,000
Estimated Resettlement Costs			$26,200
Processing resettlement of residential claims, 74 @ $75 each			5,550
Processing resettlement of commercial claims, 6 @ $150 each			900
Total Resettlement Costs			$32,650

16. Acquisition costs. There are estimated to be 80 ownerships involved in this taking. Costs of acquisition, based on a study of recent acquisition costs of this type, are as follows:

Surveys and mapping	$ 80	
Appraisals	125	
Title evidence	125	
Negotiations, closings, etc.	250	
	$580	
Division Office overhead	30	
Total acquisition cost per tract	$610	
80 ownerships @ $610 each		$48,800

17. Valuation. The valuation on property is based on the Market Data approach. Valuations reflected in this report are based on a study of recent sales in the area.

a. Improvements

1 Farm	$ 9,900	
1 Church	25,000	
32 Residences and outbuildings	247,625	
1 Mill	10,000	
1 Auto repair garage	4,300	
1 Fire station	7,000	
1 Antique shop	4,500	
1 School	10,000	
39 Improvements		$318,325

b. Land - Fee

Residential	35 acres	@	$2,000 =	$ 70,000
Industrial and commercial	10 "		4,000	40,000
Rich bottom land	230 "		200	46,000
Agriculture	315 "		100	31,500
Pasture	260 "		80	20,800
Woodland	150 "		50	7,500
Swamp	25 "		20	500
Developable	30 "		2,000	60,000
Gravel pit	5 "		1,000	5,000
River & ponds	125 "			0
Public roads	15 "			0
	1,200 acres			$281,300

c. Severance damage	25,000
d. Contingencies	93,925
e. Resettlement costs	32,650
f. Acquisition costs	48,800
Total Estimated Cost of Lands and Improvements	$800,000

18. Salvage value. For purposes of determining the net Federal investment, the salvage value of lands at the end of the economic life of the project (50 years) was estimated as follows. No salvage value was placed on land occupied by the dam and appurtenant structures.

Residential	35	acres	@ $500	=	$ 17,500
Industrial and commercial	10	"	500		5,000
Rich bottom land	205	"	200		41,000
Agriculture	315	"	100		31,500
Pasture	260	"	80		20,800
Woodland	124	"	50		6,200
Swamp	25	"	20		500
Developable	30	"	500		15,000
Gravel pit	5	"	500		2,500
	1,150	acres			$140,000

D. RELOCATIONS

19. Roads. Portions of 4 secondary roads which cross the reservoir will be abandoned. The West Thompson-Fabyan road, which parallels the Quinebaug River on the right (west) bank, will be relocated in 2 stretches in order to have the entire road above maximum reservoir elevation. The road between North Grosvenordale and Fabyan, which parallels the river on the left (east) bank, will require relocation in one stretch. Costs of road relocations are based on replacement in kind of existing facilities. Proposed road relocations are shown on Plate No. 3 of the report.

20. Utilities. Utilities requiring relocation consist of electric and telephone lines along existing roads which are to be relocated. Costs of utility relocations are included in the costs of road relocations.

E. COST ESTIMATES

21. Basis of estimates. Topographic maps of the U. S. Army Map Service were supplemented by field determination of centerline profiles of dam and dike. Foundation conditions were determined by core borings and field reconnaissance. Quantities of the principal construction items were estimated on the basis of a preliminary design which would provide safe structures for the given conditions and hydrologic criteria.

22. Unit prices. Unit prices are based on average bid prices, adjusted to 1957 price level for similar projects constructed or under construction in the New England Division. Minor items of work are included in the feature "Miscellaneous Items."

23. Contingencies, engineering and overhead. To cover contingencies, construction and relocations costs have been increased by 20 percent. Costs of engineering and design, and supervision and administration are estimated lump sums based on knowledge of the site and experience on similar projects.

24. Annual charges. The estimate for annual charges is based on a 2.5% interest rate. The cost of the project is amortized over an estimated 50-year useful economic life. Maintenance and operation costs are based on costs of similar projects in the New England Division. An allowance for replacement of items estimated to have a life less than the life of the project is included in the item "Major Replacements." The estimated annual tax loss on lands transferred to Federal ownership is included as a non-Federal annual charge and excludes tax loss on improvements.

25. Cost estimates. A breakdown of the major construction items together with their estimated costs is given in Table D-1. The breakdown of costs for lands and damages is given in paragraph 17 of this appendix (q.v.) and is summarized in Table D-1. Annual charges are given in Table D-2.

TABLE D-1

FIRST COST - WEST THOMPSON DAM AND RESERVOIR
(1957 Price Level)

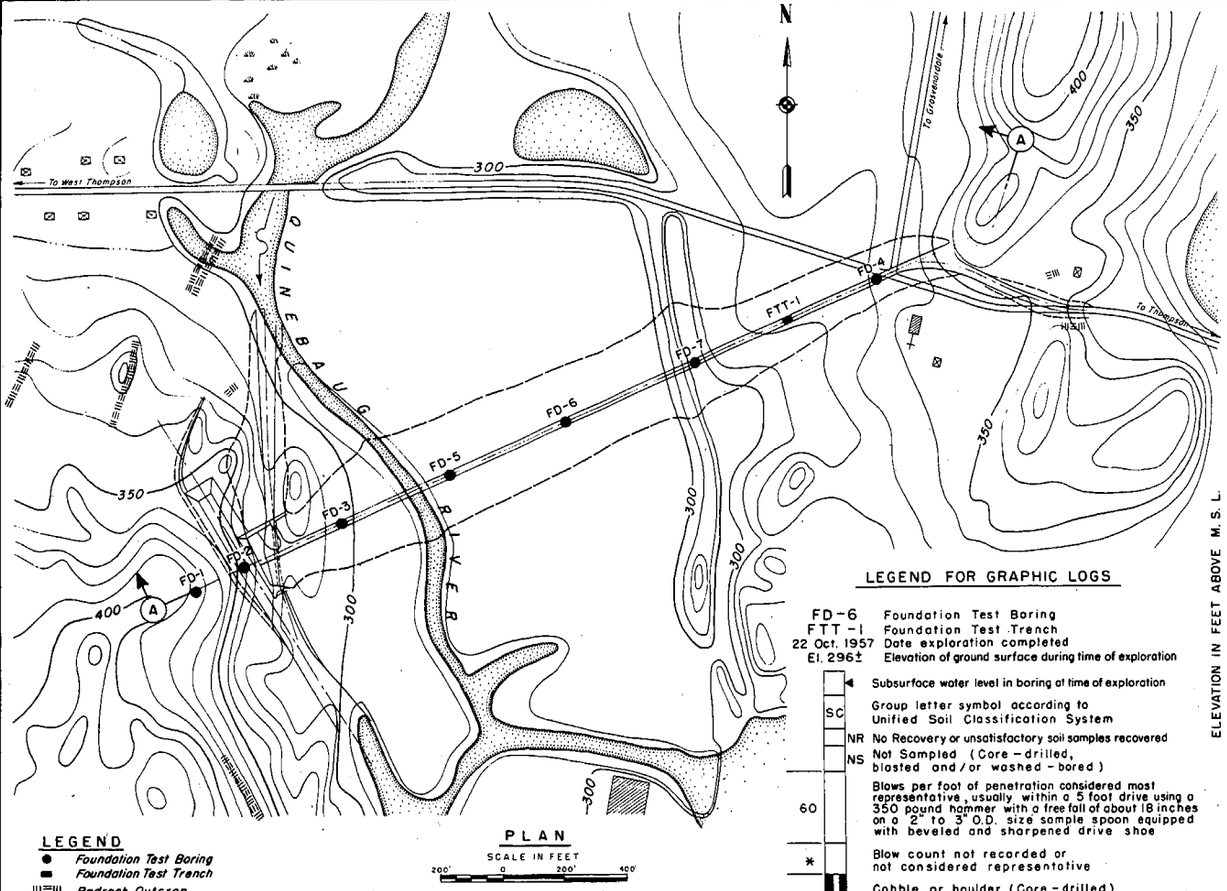
Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Lands and damages					
Land in fee	1,200	acre	L.S.	$281,300	
Improvements	39	parcel	L.S.	318,325	
Severance	L.S.			25,000	
Resettlement	L.S.			32,650	
Acquisition costs	L.S.			48,800	
Contingencies				93,925	
Total Lands and Damages Cost					$ 800,000
Relocations					
Roads	3	mile	L.S.	$286,000	
Contingencies				57,000	
Total Relocations Cost					343,000
Reservoir					
Clearing	160	acre	$350	$ 56,000	
Contingencies				11,000	
Total Reservoir Cost					67,000

Item	Estimated Quantity	Unit	Unit Price	Amount	Total
Dam					
Preparation of site	45	acre	500	$ 22,500	
Stream control	L.S.			25,000	
Earth excavation (common)	162,000	c.y.	0.60	97,200	
Earth excavation (borrow)	592,500	c.y.	0.60	355,500	
Rock excavation (open cut)	70,300	c.y.	3.00	210,900	
Embankment (rolled)	650,000	c.y.	0.30	195,000	
Select gravel	25,000	c.y.	1.50	37,500	
Rock fill	88,000	c.y.	0.60	52,800	
Concrete, mass	14,100	c.y.	30.00	423,000	
Concrete, reinforced	1,000	c.y.	60.00	60,000	
Gates and machinery	L.S.			120,000	
Operating house superstructure	1,600	c.f.	2.50	4,000	
Service bridge	1,350	s.f.	20.00	27,000	
Miscellaneous items				163,000	
Contingencies				358,600	
Total Dam Cost					$2,152,000
Buildings, grounds and utilities					
Utility building and garage	L.S.			$ 35,000	
Electric service lines	L.S.			5,000	
Plumbing and heating	L.S.			2,000	
Operator's quarters	L.S.			18,000	
Grading and landscaping	L.S.			2,000	
Contingencies				12,000	
Total Buildings, Grounds and Utilities Cost					74,000
Permanent operating equipment L.S.				$ 16,000	
Contingencies				3,000	
Total Permanent Operating Equipment Cost					19,000
Preauthorization studies					20,000
Engineering and design					318,000
Supervision and administration					237,000
Total Project First Cost					$4,030,000

TABLE D-2

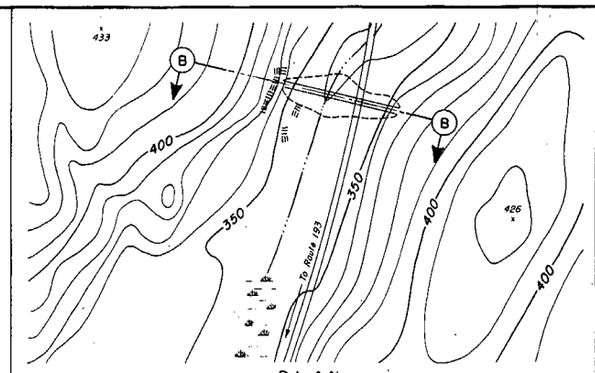
ANNUAL CHARGES - WEST THOMPSON DAM AND RESERVOIR
(1957 Price Level)

Federal investment		
Federal first cost	$4,030,000	
Interest during construction	100,000	
Gross Federal Investment	$4,130,000	
Salvage value of land	140,000	
Net Federal Investment	$3,990,000	
Annual charges		
Federal:		
Interest ($4,130,000 x 2.5%)	$ 103,300	
Amortization ($3,990,000 x 1.026%)	40,900	
Maintenance and operation	20,000	
Major replacements	2,000	
Total Federal Annual Charges		$166,200
Non-Federal:		
Loss of taxes on lands		10,000
Total Annual Charges		$176,200

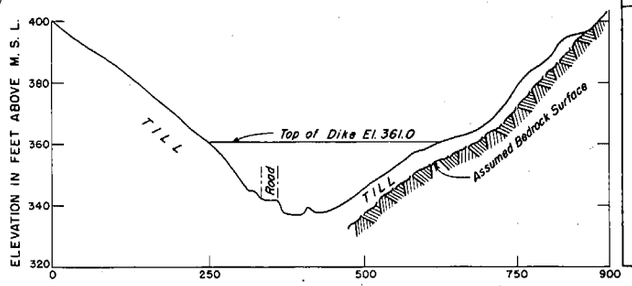


PLAN
SCALE IN FEET
200' 0 200' 400'

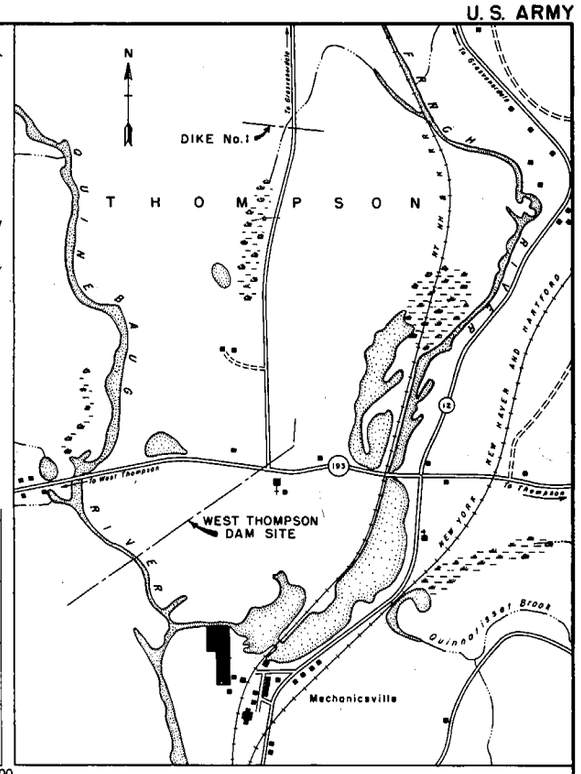
LEGEND
- Foundation Test Boring
- Foundation Test Trench
- Bedrock Outcrop



PLAN
SCALE IN FEET
200' 0 200' 400'



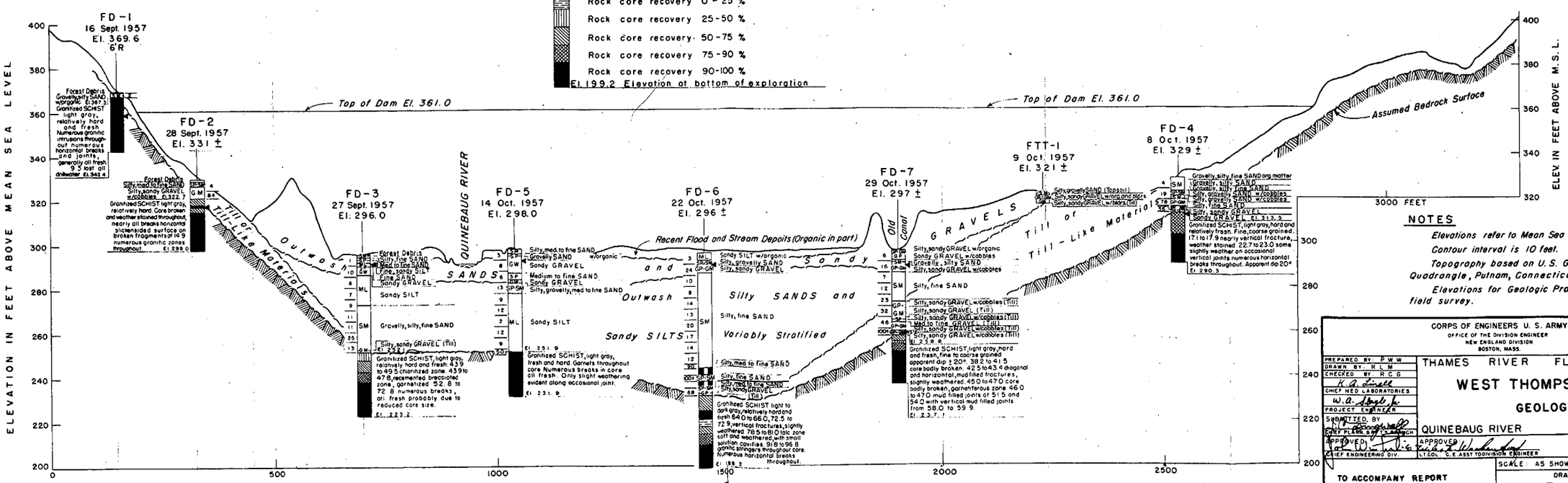
GEOLOGIC PROFILE, ℄ DIKE
(LOOKING DOWNSTREAM)



GENERAL LOCATION MAP
SCALE IN FEET
1000' 0 1000' 2000'

LEGEND FOR GRAPHIC LOGS

FD-6	Foundation Test Boring
FTT-1	Foundation Test Trench
22 Oct. 1957	Date exploration completed
El. 296±	Elevation of ground surface during time of exploration
◄	Subsurface water level in boring at time of exploration
SC	Group letter symbol according to Unified Soil Classification System
NR	No Recovery or unsatisfactory soil samples recovered
NS	Not Sampled (Core-drilled, blasted and/or washed-bored)
60	Blows per foot of penetration considered most representative, usually within a 5 foot drive using a 350 pound hammer with a free fall of about 18 inches on a 2" to 3" O.D. size sample spoon equipped with beveled and sharpened drive shoe
*	Blow count not recorded or not considered representative
	Cobble or boulder (Core-drilled)
	Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped)
El. 232.0	Elevation of bedrock surface
	Rock core recovery 0 - 25 %
	Rock core recovery 25-50 %
	Rock core recovery 50-75 %
	Rock core recovery 75-90 %
	Rock core recovery 90-100 %
El. 199.2	Elevation at bottom of exploration



GEOLOGIC - LOG PROFILE, DAM
(LOOKING UPSTREAM)

NOTES

Elevations refer to Mean Sea Level Datum.

Contour interval is 10 feet.

Topography based on U.S. Geological Survey Quadrangle, Putnam, Connecticut.

Elevations for Geologic Profiles are based on field survey.

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

PREPARED BY P.W.W.
DRAWN BY R.L.M.
CHECKED BY R.C.G.
CHIEF, MED. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANS & SPEC. BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
LT. COL. C.E. ASST. TO DIVISION ENGINEER

THAMES RIVER FLOOD CONTROL

WEST THOMPSON DAM

GEOLOGY

QUINEBAUG RIVER — CONNECTICUT

DATE JAN. 1958

TO ACCOMPANY REPORT DATED 31 JANUARY 1958

SCALE: AS SHOWN

DRAWING NUMBER TH-2-1056

SHEET 1 OF 1

APPENDIX E

RED BRIDGE DAM AND RESERVOIR

APPENDIX E

RED BRIDGE DAM AND RESERVOIR

TABLE OF CONTENTS

Par.		Page
	A. INTRODUCTION	
1	Description	E-1
	B. GEOLOGY	
2	Regional Geology and Topography	E-1
3	Surficial and Subsurface Investigations	E-2
4	Surficial Geology	E-2
5	Foundation Conditions	E-2
	a. Overburden	E-2
	b. Bedrock	E-3
	c. Ground Water	E-3
6	Leakage Conditions in the Reservoir	E-3
7	Construction Materials	E-3
	a. Pervious Materials	E-3
	b. Impervious Materials	E-3
	c. Rock Fill	E-3
	d. Concrete Aggregates	E-4
	C. REAL ESTATE	
8	Character of Reservoir	E-4
9	Taking	E-4
10	Mineral Rights	E-4
11	Water Rights	E-4
12	Gravel Pit	E-4
13	Severance Damage	E-4
14	Relocations	E-4
	a. Cemeteries	E-4
	b. Utilities	E-5
	c. Roads	E-5
15	Resettlement Costs	E-5
16	Acquisition Costs	E-5
17	Valuation	E-6
18	Potential Diked Areas	E-7
	a. Area "A"	E-7
	b. Area "B"	E-7
	c. Area "C"	E-8
19	Salvage Value	E-8

Par.		Page
	D. RELOCATIONS	
20	Roads	E-9
21	Utilities	E-10
22	Cemeteries	E-10
	E. COST ESTIMATES	
23	Basis of Estimates	E-10
24	Unit Prices	E-10
25	Contingencies, Engineering, and Overhead	E-10
26	Annual Charges	E-10
27	Cost Estimates	E-10
28	Dikes vs. Acquisition	E-11

TABLES
(At end of Appendix)

No.		Page
E-1	First Cost - Red Bridge Dam and Reservoir	E-12
E-2	Annual Charges - Red Bridge Dam and Reservoir	E-14

PLATES

E-1	Red Bridge Dam - Reservoir Map
E-2	" " " - General Plan
E-3	" " " - Geology

APPENDIX E

RED BRIDGE DAM AND RESERVOIR

A. INTRODUCTION

1. Description. The Red Bridge dam site is located on the Quinebaug River in the town of Thompson, Conn., approximately 5 miles upstream of Putnam and approximately 3 miles upstream of the confluence of the Quinebaug and French Rivers and the site of the recommended West Thompson dam. This project was studied as an alternative to the West Thompson project. The reservoir at spillway crest would be 6 miles long, lying within the towns of Thompson, Conn., and Dudley, Mass., and have a surface area of 1,100 acres. The reservoir would have a capacity of 24,700 acre-feet of storage, all reserved for flood control, equivalent to 6.0 inches of runoff from the net drainage area of 76.5 square miles below the authorized Westville and East Brimfield flood control reservoirs. The limits of the reservoir are shown on Plate No. E-1 of this appendix.

The dam, with top elevation of 390 feet, mean sea level datum, would be of earth-fill construction, approximately 1,140 feet long with a maximum height of 80 feet above the stream bed. An L-shaped side channel spillway at elevation 370 feet, mean sea level datum, 305 feet long, would be constructed in rock in the left abutment. The spillway is designed for a 15-foot surcharge. An 11-foot diameter, horseshoe shaped, reinforced concrete conduit, constructed at the foot of the right abutment, would discharge into the Quinebaug River immediately downstream from the dam. Control of flows through the conduit would be by means of 3-5'x8' hydraulically operated gates.

Construction of the project would require 2 years. A general plan of the dam and appurtenant structures is shown on Plate No. E-2 of this appendix.

B. GEOLOGY

2. Regional geology and topography. The region drained by the Quinebaug River lies entirely within the eastern part of the New England Upland. In the upland section, the Quinebaug River and its tributaries flow through an area of moderate relief in relatively narrow, deep, steep-sided valleys. The topography of the entire area has been modified by glaciation. The tops of hills have been rounded and the valleys scoured and filled with deep deposits of glacial till and outwash. The hills are generally blanketed with a thin veneer of glacial till, and the till in the valleys is overlain by thick deposits of outwash which form wide plains in the valley floors and terraces along the flanks of the valley. Bedrock outcrops frequently through the veneer of till on the hilltops and

upper slopes. In the valleys rock is exposed only where the streams have down-cut sufficiently to expose a bedrock spur on the flanks of the pre-glacial valleys.

The bedrock of the region consists of a series of Pre-Cambrian crystalline rocks, mostly gneisses and schists of the so-called Putnam Series. The folds trend generally north-south.

3. Surficial and subsurface investigations. Geological reconnaissance of the site was made to determine general foundation conditions, and the type and extent of subsurface explorations for this stage of investigations.

Foundation explorations consisting of 5 test borings and 1 test pit, located as shown on Plate No. E-3, were completed at the site. The borings were continuously drive-sampled in overburden. Where rock was encountered, the rock was diamond-drill cored.

Overburden samples from borings and test pit were classified according to the Unified Soils Classification System. The classification of all overburden samples and a description of bedrock cores recovered from the borings are shown on Plate No. E-3.

4. Surficial geology. At the site, the Quinebaug River flows through a relatively narrow flood plain consisting of thick outwash materials, sands and gravels overlying a thin strata of till. The proposed alignment takes advantage of a rock spur on the lower left abutment. From the flood plain, the left abutment rises sharply, and bedrock outcrops frequently through the thin till cover both upstream and downstream of the proposed centerline of the dam. The right abutment rises sharply above the river and is a bedrock feature covered by a thin mantle of till. No outcrops were noted on the right abutment except well above top of dam elevation. The bedrock at the site is a granitic schist of the Putnam Series generally believed to be Pre-Cambrian in age.

The relatively narrow flood plain is composed of deep pervious melt-water deposits of sand and gravel which fill the entire valley. Some superficial organic materials of recent deposition are found on the flood plain.

5. Foundation conditions.

a. Overburden. The overburden in the flood plain consists of thick variably stratified sands and gravels overlying a thin stratum of glacial till immediately above the bedrock surface. These stratified materials are extremely pervious and extend with reasonable continuity throughout the valley section.

On the left abutment overburden is generally only a few feet in thickness, except in shallow troughs in the existing bedrock surface.

The right abutment has a relatively thin mantle of till, which may be as great as 15 feet in depth, overlying the rock surface. The till here is overlain by surficial deposits of organic material and reworked till.

The arrangement of the various overburden materials in the foundations and the relation of each type of material with those adjacent and with the bedrock is shown in the geologic section on Plate No. E-3.

b. Bedrock. The granitic, biotite schist bedrock is generally dark gray, fine to coarse grained, hard and fresh. Quartz veins and granitic stringers occur throughout the rock.

Observations at the outcrops on the left abutment show the trend of the schist varies greatly within short distances with a range of N 40°E to N 15°W and dips westward. Outcrops and bedrock cores indicate variations in the dip of foliation from 30° to 90°. Weathering is slight and occurs along open foliation planes and joints.

c. Ground water. Levels of subsurface water as indicated by observations in borings during drilling operations are essentially at river level in the valley bottom. On the right abutment, ground water is well below the rock surface, although excavations may encounter water trapped in troughs in the rock surface or seasonal runoff from fissures in the rock. A similar situation is expected to exist on the left abutment.

6. Leakage conditions in reservoir. The high valley walls which completely enclose the reservoir are wide bedrock ridges generally covered by till so there is no possibility of leakage from the reservoir. The deep, pervious-filled, preglacial valley in bedrock at the dam site has been considered in the preliminary design for the dam.

7. Construction materials.

a. Pervious material. Material suitable for pervious is readily available in the reservoir within easy haul distance of the site. The pervious is found in the form of several large glaciolacustrine terraces. A more detailed investigation would be needed to determine quality and quantity, but it is assumed that all requirements could easily be satisfied.

b. Impervious materials. Suitable glacial till can be obtained from several drumlins located upstream of the dam site. Further investigation would be required to determine quantity and quality of material available.

c. Rock fill. Rock from spillway and conduit excavations is suitable for use as riprap. Additional rock could be secured from quarries opened at outcrop areas in the reservoir within 1 mile of the dam site or from several commercial quarries within a 15-mile haul distance of the site.

d. Concrete aggregates. Because of the relatively small quantity of concrete required for construction at this dam, only commercial aggregate sources have been considered. There are several established producers located in and around North Grosvenordale, Conn., within a 20-mile haul distance of the site. Two of these sources have previously been tested for use in other civil works projects in the area.

C. REAL ESTATE

8. Character of reservoir. The reservoir area contains woodland, pastureland, tillable land, rich bottom land, and homesites. The taking also includes farms, gas station, food store, post office, church parish hall, gravel pit, poultry farms, industrial buildings, 2 cemeteries, and a drive-in theatre.

9. Taking. The proposed taking will be in fee title for dam site and reservoir areas. The guide taking line is established at 370 feet above mean sea level and will include an estimated 1,370 acres of reservoir, borrow, and relocation areas.

10. Mineral rights. A current field inspection revealed that no mining operations of minerals are apparent in the proposed taking.

11. Water rights. Values of water rights are not known and no estimate is included in this report.

12. Gravel pit. There is 1 commercially operated gravel pit within the reservoir area off the Fabyan-Woodstock Road.

13. Severance damage. Experience in this type of acquisition has proven that severance damage occurs. Ownerships and parts of ownerships are usually left without access. Farms from which land has been acquired are, as a result of the taking, overimproved by excessive sized buildings. Since no maps showing property lines are available at this time, the damage is estimated.

14. Relocations.

a. Cemeteries. A current field inspection revealed that 2 cemeteries are located within the reservoir area:

The Fabyan Cemetery contains about 450 graves, approximately 100 of which are within the taking area. The other is the Coman family plot containing about 25 graves, all of which are within the acquisition area. Costs of cemetery relocations are included under the feature "Relocations" in the cost estimate (Table E-1).

Fabyan Cemetery	100 graves	$25,000
Coman Family Cemetery	25 graves	6,300
Total Estimated Cemetery Relocation Costs		$31,300

b. Utilities. It is proposed to relocate portions of existing roads including 2 locations on Fabyan Road. It is also proposed to abandon a portion of the Fabyan-Woodstock Road and a portion of the Red Bridge Road.

No additional acreage is included for utility relocations in this report, as it is assumed that telephone and electric utilities will be relocated along the road relocation.

c. Roads. Fabyan Road is to be relocated at 2 separate sections; approximately 20 acres in fee is included in this report for the road relocations.

15. Resettlement costs. Resettlement costs are based on recent experience for this type of property and are estimated as follows:

9 Farms	@	$1,000	=	$ 9,000
1 Food store and post office		1,000		1,000
1 Gasoline station		1,000		1,000
1 Church parish hall		1,000		1,000
99 Residences		600		59,400
1 Drive-in theatre		1,000		1,000
2 Mills		1,000		2,000
Total Estimated Resettlement Costs				$74,400
Processing resettlement of residential claims:				
144	@	$ 75	=	10,800
Processing resettlement of commercial claims:				
6	@	$ 150	=	900
Total Resettlement Costs				$86,100

16. Acquisition costs. There are estimated to be 150 ownerships involved in this taking. Costs of acquisition, based on a study of recent acquisition costs of this type, are as follows:

Surveys and mapping		$ 45	
Appraisals		100	
Title evidence		125	
Negotiations, closings		225	
		$ 495	
Division Office overhead		20	
Total Acquisition Cost Per Tract		$ 515	
150 Ownerships	@	$ 515 =	$77,250

17. Valuation. The valuation of property is based on the Market Data Approach. Valuations reflected in this report are based on the study of recent sales in the area.

A. Improvements

9 Farms	$133,300	
2 Mills	50,000	
1 Food store and post office	12,000	
1 Gasoline station	12,000	
1 Church parish hall	65,000	
99 Residences and outbuildings	712,100	
1 Drive-in theatre	50,000	
114 Improvements		$1,034,400

B. Land - Fee

Residential	60	acres	@ $2,000	=$120,000	
Industrial and commercial	15	"	4,000	60,000	
Rich bottom land	200	"	200	40,000	
Agriculture	300	"	100	30,000	
Pasture	400	"	80	32,000	
Woodland and brush	320	"	50	16,000	
Swamp	20	"	20	400	
Developable	50	"	2,000	100,000	
Gravel pit	5	"	1,000	5,000	
	1,370	acres			$ 403,400

C.	Severance Damage	25,000
D.	Contingencies	219,850
E.	Resettlement Costs	86,100
F.	Acquisition Costs	77,250
	Total Estimated Cost of Lands and Improvements	$1,846,000

18. Potential diked areas. Three developed areas, designated hereafter as Areas "A," "B," and "C," are located near the rim of the proposed reservoir and are topographically located so as to permit construction of dikes for protection against reservoir flooding in lieu of acquisition. Real estate costs of these parcels, for comparison with costs of protective works, are described in this paragraph.

a. Area "A," the Fabyan Cemetery, is located on Parker Road in Fabyan, Conn. It contains 449 graves, approximately 100 of which are within the taking area.

100 Graves	@	$250	= $25,000	
Contingencies			4,000	
Total Estimated Real Estate Costs - Area "A"				$29,000

b. Area "B" is a new development located on Route 131 in Fabyan, Conn.

(1) Resettlement costs. Resettlement costs are based on recent experience for this type of property and are estimated as follows:

12 Residences and outbuildings @ $600 =	$7,200

(2) Acquisition costs. There are estimated to be 12 ownerships involved in this taking. The costs are based on a study of recent acquisition costs of this type:

Surveys and mapping		$ 80		
Appraisals		125		
Title evidence		125		
Negotiations, closings		250		
		$580		
12 Ownerships	@	$580 =	$6,960	
Processing resettlement of residential claims:				
12	@	$ 75	900	
			$7,860	
Division Office overhead			280	
Total Estimated Acquisition Costs				$8,140

(3) Valuation. The valuation of property is based on the Market Data Approach. The valuations reflected in this report are based on the study of recent sales. The land and improvements within the flood area consist of the following:

Improvements		
12 Residences and outbuildings	$99,550	
Land - Fee		
Residential 6 acres @ $2,000	12,000	
		$111,550
(4) Contingencies		17,110
Total Estimated Real Estate Costs - Area "B"		$144,000

c. Area "C" is located on Route 131 in West Dudley, Mass., near the Massachusetts-Connecticut line.

(1) Resettlement costs. Resettlement costs are based on recent experience for this type of property and are estimated as follows:

20 Residences and outbuildings @ $600 = $12,000

(2) Acquisition costs. There are estimated to be 20 ownerships involved in this taking. These costs are based on a study of recent acquisition costs of this type.

Surveys and mapping	$ 80		
Appraisals	125		
Title evidence	125		
Negotiations, closings	250		
	$580		
20 Ownerships @	$580	=	$11,600
Processing resettlement of residential claims:			
20 @	$ 75		1,500
			$13,100
Division Office overhead			470
Total Estimated Acquisition Costs			$ 13,570

(3) Valuation. The valuation of property is based on the Market Data Approach. The valuations reflected in this report are based on the study of recent sales. The land and improvements within the flood area consist of the following:

Improvements		
20 Residences and outbuildings	$129,550	
Land - Fee		
Residential 7 acres @ $2,000	14,000	
		$143,550
(4) Contingencies		21,880
Total Estimated Real Estate Costs - Area "C"		$191,000

19. Salvage value. For purposes of determining the net Federal investment, the salvage value of lands at the end of the economic life of the project (50 years) was estimated as follows. No salvage value was placed on land occupied by the dam and appurtenant structures.

Residential	60	acres	@ $500	=	$ 30,000
Industrial and commercial	15	"	500		7,500
Rich bottom land	200	"	200		40,000
Agriculture	286	"	100		28,600
Pasture land	400	"	80		32,000
Woodland	320	"	50		16,000
Swamp	20	"	20		400
Developable	50	"	500		25,000
Gravel pit	5	"	500		2,500
	1,356	acres			$182,000

D. RELOCATIONS

20. Roads. Portions of 4 secondary roads which cross the reservoir will be abandoned. Route 131 will have to be raised in 1 section and relocated in a second section. A new bridge will also be required where the relocated Route 131 crosses the Quinebaug River near the Massachusetts-Connecticut line. The West Thompson-Fabyan road, along the right (west) bank of the Quinebaug will require relocation to a higher elevation in 2 stretches. Route 197 will be relocated to tie into the relocated Route 131 at West Dudley. Costs of road relocations are based on replacement in kind of existing facilities. Proposed road relocations are shown on Plate No. E-1 of this appendix.

21. Utilities. Utilities requiring relocations consist of electric and telephone lines along existing roads which are to be relocated. Costs of utility relocations are included in the costs of road relocations.

22. Cemeteries. Two cemeteries are located within the proposed reservoir area; the Coman family plot and the Fabyan Cemetery. The Coman family plot contains about 25 graves, all of which are within the acquisition area. The Fabyan Cemetery contains approximately 450 graves, of which about 100 are within the taking line. Consideration was given to constructing a low dike around this cemetery in lieu of removal and relocation (see paragraph 28 of this appendix.)

E. COST ESTIMATES

23. Basis of estimates. Topographic maps of the U.S. Army Map Service were supplemented by field determination of centerline profile of dam. Foundation conditions were determined by core borings and field reconnaissance. Quantities of the principal construction items were estimated on the basis of a preliminary design which would provide economical and safe structures for the given conditions and hydrologic criteria.

24. Unit prices. Unit prices are based on average bid prices, adjusted to 1957 price level for similar projects constructed or under construction in the New England Division. Minor items of work are included in the feature "Miscellaneous Items."

25. Contingencies, engineering, and overhead. To cover contingencies, construction, and relocations costs have been increased by 20%. Costs of engineering and design, and supervision and administration are estimated lump sums based on knowledge of the site and experience on similar projects.

26. Annual charges. The estimate for annual charges is based on a 2.5% interest rate. The cost of the project is amortized over an estimated 50-year useful economic life. Maintenance and operation costs are based on costs of similar projects in the New England Division. An allowance for replacement of items estimated to have a life less than the life of the project is included in the item "Major Replacements." The estimated annual tax loss on lands transferred to Federal ownership is included as a non-Federal annual charge and excludes tax loss on improvements.

27. Cost estimates. A breakdown of the major construction items together with their estimated costs is given in Table E-1. The breakdown of costs for lands and damages is given in paragraph 17 of this appendix (q.v.) and is summarized in Table E-1. Annual charges are given in Table E-2.

28. Dikes vs. acquisition. Three developed areas, designated hereafter as Areas "A," "B," and "C," are located near the perimeter of the reservoir and are so situated topographically as to be feasibly protected against reservoir flooding by dikes. Estimates of the cost of such protection are listed below, together with the estimated cost of acquiring the properties. (Paragraph 18 of this appendix includes brief descriptions of the areas.) An examination of this table indicates that, in all 3 cases, it is more economical to purchase the properties than to provide protection. The cost estimate in Table E-1, therefore, is based on acquisition of the properties and does not include costs of dikes.

Comparison of Dike Costs and Acquisition Costs

Area	Cost of Protection	Value of Property Protected
"A"	$45,000	$29,000
"B"	328,000	144,000
"C"	272,000	191,000

TABLE E-1

FIRST COST - RED BRIDGE DAM AND RESERVOIR
(1957 Price Level)

	Estimated Quantity	Unit	Unit Price	Amount	Total
Lands and Damages					
Land in fee	1,370	acre	L.S.	$ 403,400	
Improvements	114	parcel	L.S.	1,034,400	
Severance				25,000	
Resettlement costs				86,100	
Acquisition costs				77,250	
Contingencies				219,850	
Total Lands and Damages Cost					$1,846,000
Relocations					
Roads	4.4	mile	L.S.	656,900	
Cemeteries	125	graves	L.S.	31,300	
Contingencies				137,800	
Total Relocations Cost					826,000
Reservoir					
Clearing	100	acre	$350	35,000	
Contingencies				7,000	
Total Reservoir Cost					42,000
Dam					
Preparation of site	40	acre	$500	20,000	
Stream control	L.S.			25,000	
Earth excavation (common)	29,000	c.y.	0.70	20,300	
Earth excavation (borrow)	283,000	c.y.	0.60	169,800	
Rock excavation (open cut)	98,700	c.y.	3.00	296,100	
Embankment (rolled)	261,000	c.y.	0.30	78,300	
Rock fill (placing)	112,000	c.y.	0.60	67,200	
Concrete, mass	5,650	c.y.	35.00	197,750	
" reinforced	950	c.y.	60.00	57,000	
Gates and machinery	L.S.			120,000	
Operating house superstructure	1,600	c.f.	2.50	4,000	
Service bridge	1,560	s.f.	20.00	31,200	
Miscellaneous items				126,350	
Contingencies				243,000	
Total Dam Cost					$1,456,000

	Estimated Quantity	Unit Price	Amount	Total
Buildings, Grounds, and Utilities				
Utility building and garage	L.S.		$35,000	
Electric service lines	L.S.		5,000	
Plumbing and heating	L.S.		2,000	
Operator's quarters	L.S.		18,000	
Grading and landscaping	L.S.		2,000	
Contingencies			12,000	
Total Buildings, Grounds, and Utilities Cost				$ 74,000
Permanent Operating Equipment	L.S.		$16,000	
Contingencies			3,000	
Total Permanent Operating Equipment Cost				19,000
Preauthorization Studies				20,000
Engineering and Design				290,000
Supervision and Administration				217,000
Total Project First Cost				$4,790,000

TABLE E-2

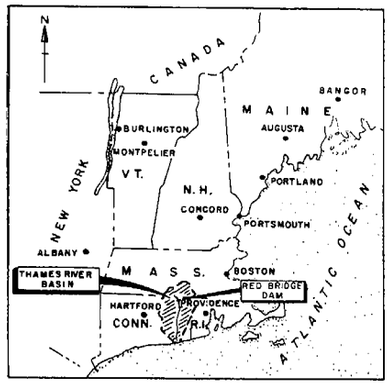
ANNUAL CHARGES - RED BRIDGE DAM AND RESERVOIR
(1957 Price Level)

FEDERAL INVESTMENT

Federal first cost	$4,790,000
Interest during construction	120,000
Gross Federal investment	4,910,000
Salvage value of land	182,000
Net Federal Investment	$4,728,000

ANNUAL CHARGES

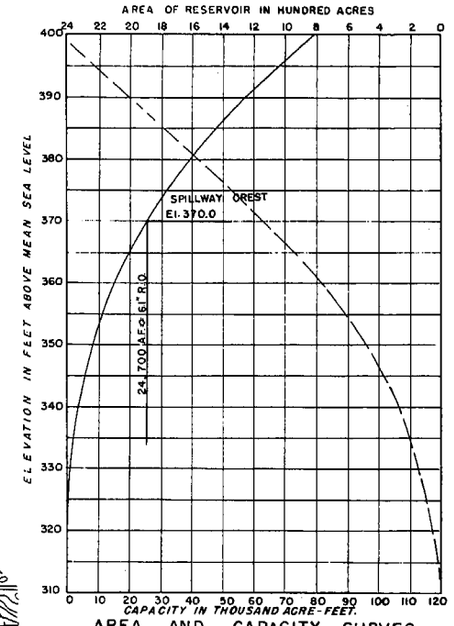
Federal		
Interest ($4,910,000 x 2.5%)	$ 122,800	
Amortization ($4,728,000 x 1.026%)	48,500	
Maintenance and operation	20,000	
Major replacements	2,000	
Total Federal Annual Charges		$193,300
Non-Federal		
Loss of taxes on lands		14,000
Total Annual Charges		$207,300



LOCATION MAP

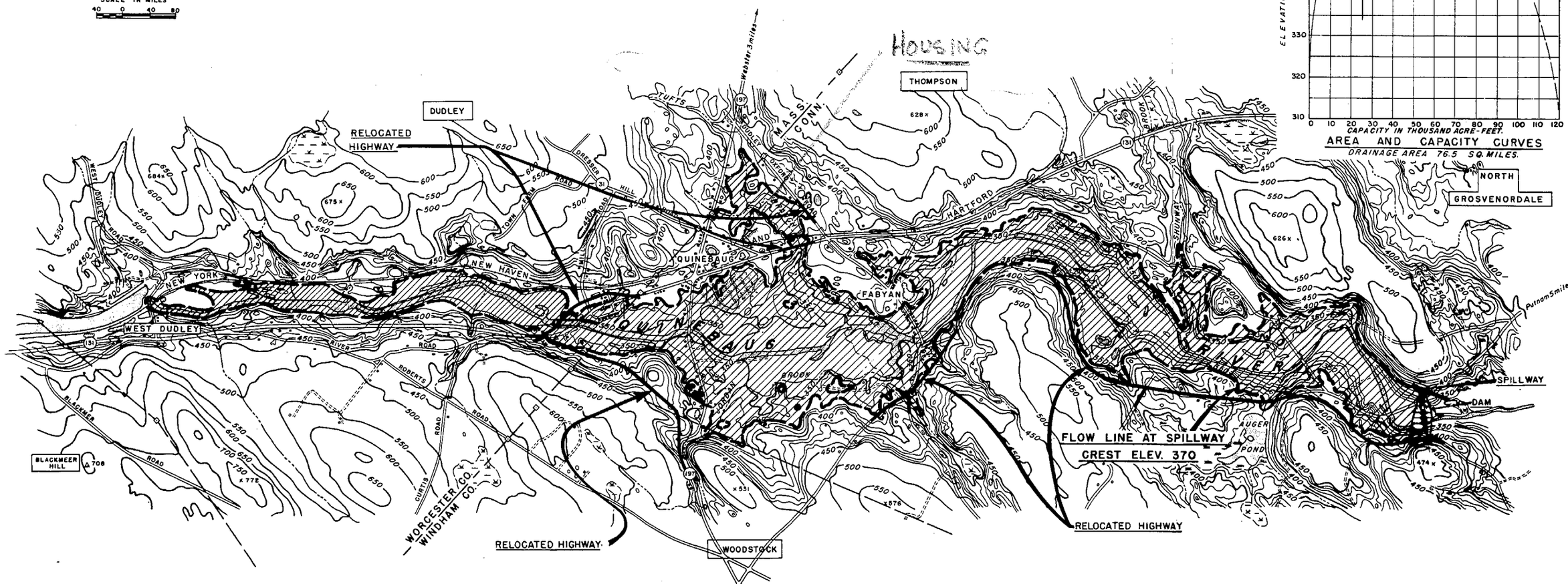
SCALE IN MILES

40 0 40 80



AREA AND CAPACITY CURVES

DRAINAGE AREA 76.5 SQ. MILES.



RESERVOIR PLAN

SCALE IN FEET

0 1000 2000 3000

LEGEND

- Existing gravel road
- Existing surfaced road
- State Boundary
- Reservoir at spillway crest, El. 370
- Raised or relocated road.

NOTES:

Elevations refer to Mean Sea Level Datum.
Contour interval equals ten feet up to 450 feet.
Fifty-foot interval above 450 feet.
Topography is based on U.S.G.S. Map.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY M.S. | TR. BY P.W.G. | CK. BY G.F.B.

THAMES RIVER FLOOD CONTROL

RED BRIDGE DAM

RESERVOIR MAP

QUINEBAUG RIVER MASS. & CONN.

PROJECT ENGINEER

SUBMITTED BY

CHIEF PLANN. & RPTS. BRANCH

APPROVED

CHIEF ENGINEERING DIV.

APPROVED

LT. COL. C.E. ASS'T. TO DIVISION ENGINEER

DATE JAN. 1958

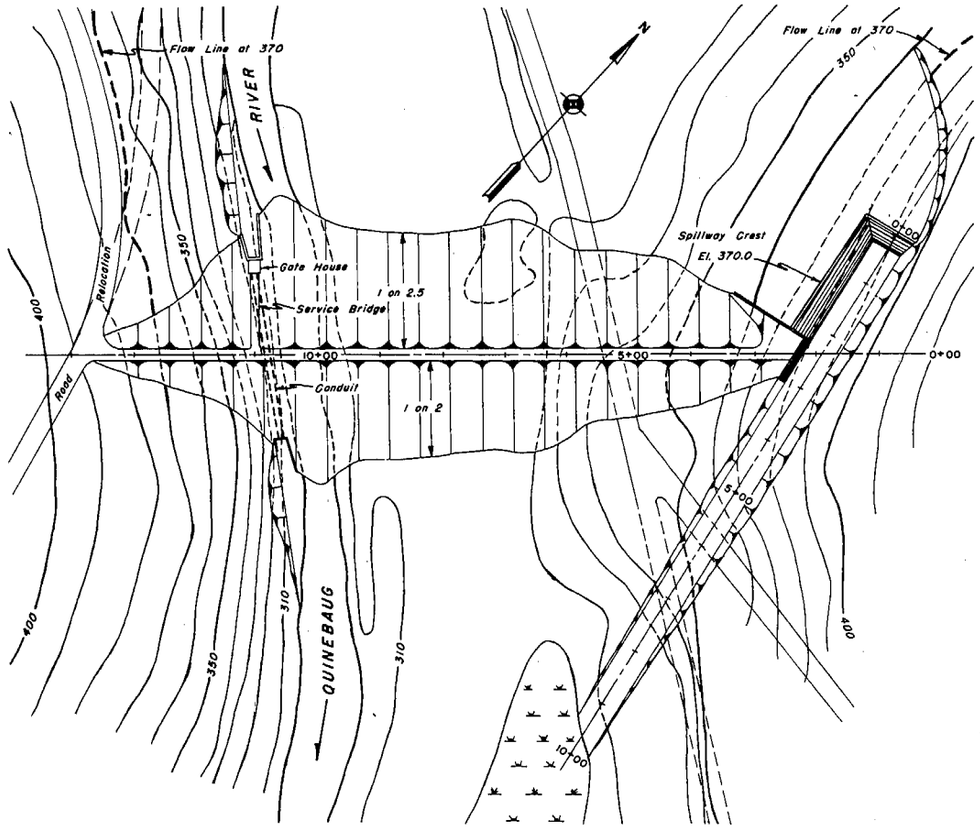
SCALE: AS NOTED.

TO ACCOMPANY REPORT DATED: 31 JANUARY 1958

DRAWING NUMBER TH-1-1382

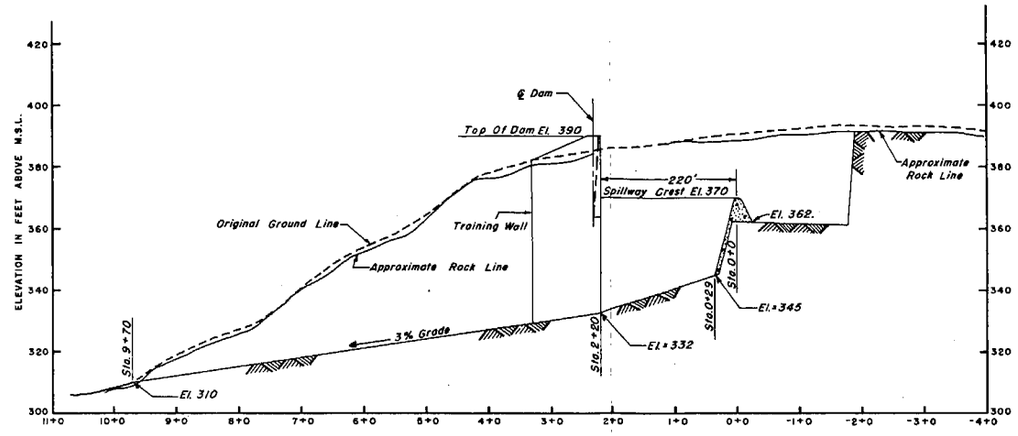
SHEET 1 OF 1

PLATE NO. E-1



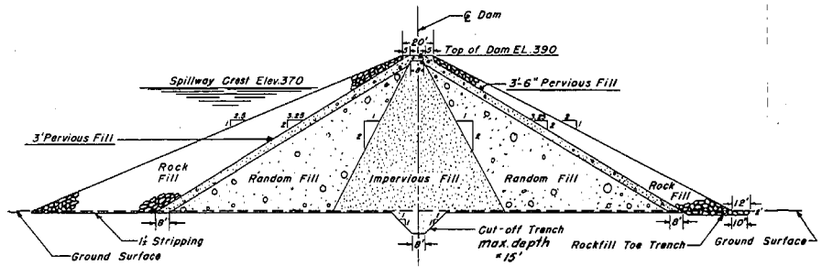
PLAN

SCALE: 1" = 100'



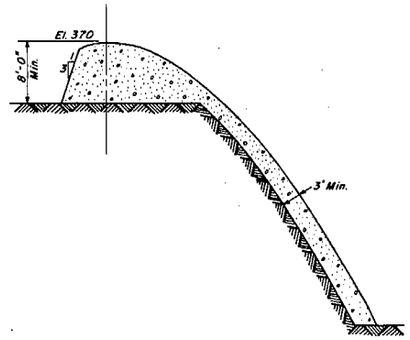
PROFILE ALONG ℄ SPILLWAY CHANNEL

SCALE: HOR. 1" = 100'
VERT. 1" = 20'



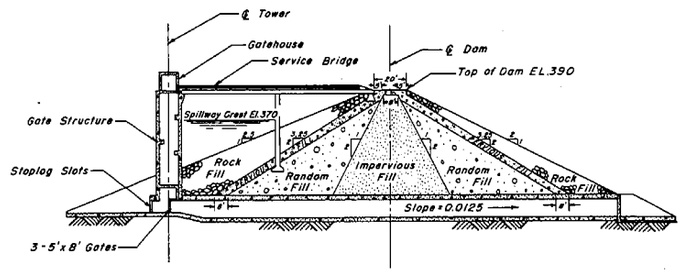
TYPICAL DAM SECTION

SCALE: 1" = 40'



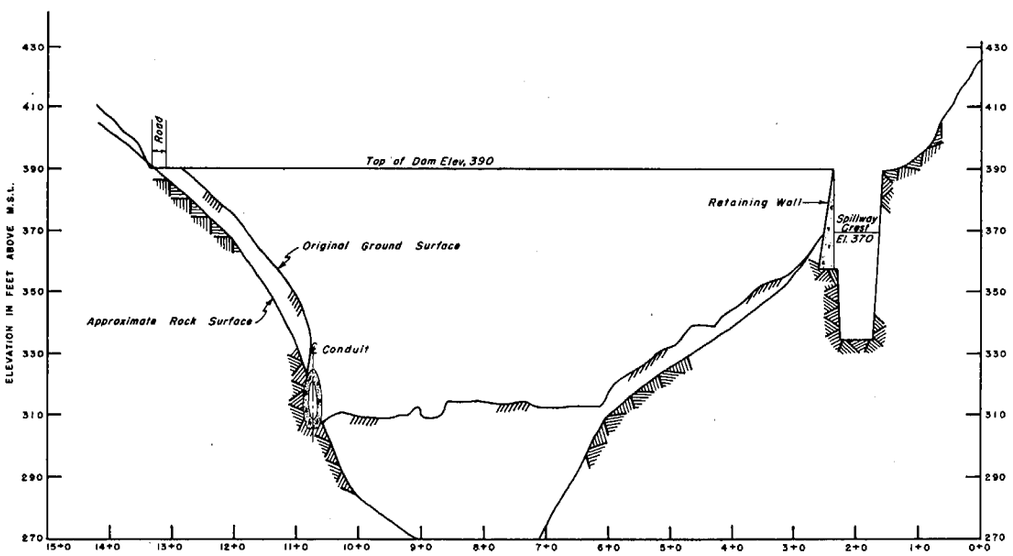
TYPICAL SPILLWAY SECTION

SCALE: 1/8" = 1'-0"



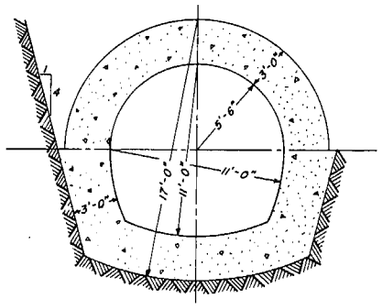
PROFILE ALONG ℄ OUTLET WORKS

SCALE: 1" = 40'



PROFILE ALONG ℄ DAM

SCALE: HOR. 1" = 100'
VERT. 1" = 20'



TYPICAL CONDUIT SECTION

SCALE: 1/4" = 1'-0"

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY	TR. BY	CK. BY
E.R.S.	M.S.	J.W.D.

PROJECT ENGINEER

SUBMITTED BY — CHIEF PLANN. & REPTS. BRANCH

APPROVED — CHIEF ENGINEERING DIV.

APPROVED — LT. COL. C.E. ASST. TO DIVISION ENGINEER

THAMES RIVER FLOOD CONTROL

RED BRIDGE DAM

GENERAL PLAN

QUINEBAUG RIVER MASS. & CONN.

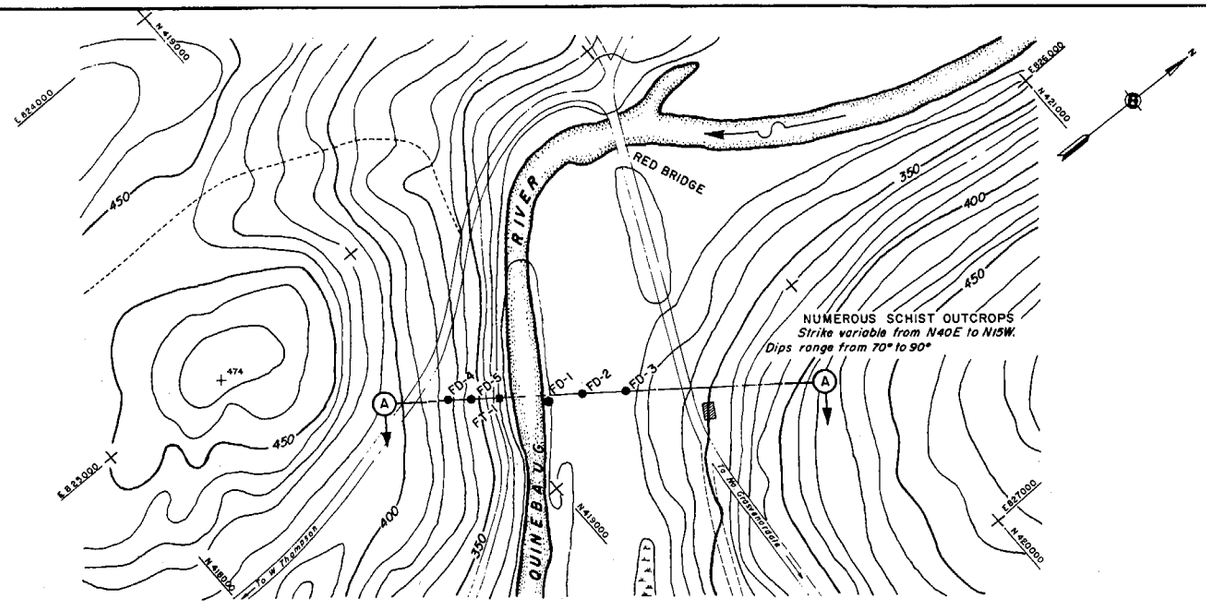
DATE JAN. 1958

SCALE: AS NOTED

DRAWING NUMBER TH-1-1383

SHEET 1 OF 1

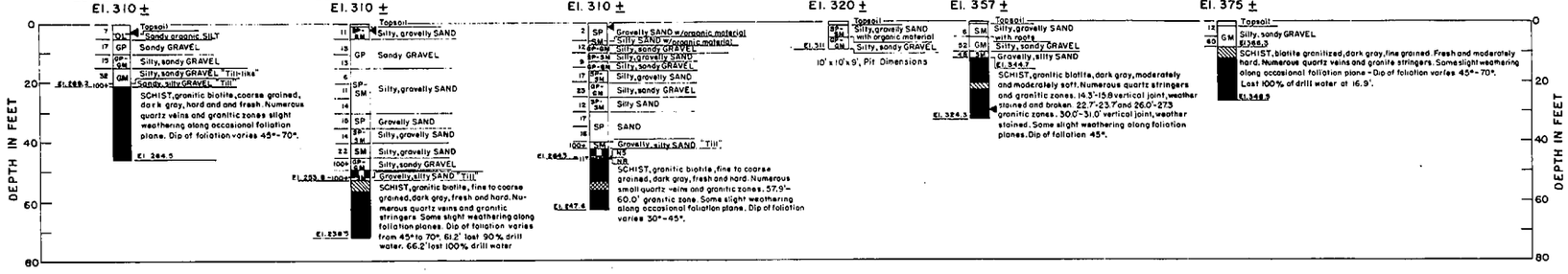
TO ACCOMPANY REPORT DATED: 31 JANUARY 1958



PLAN

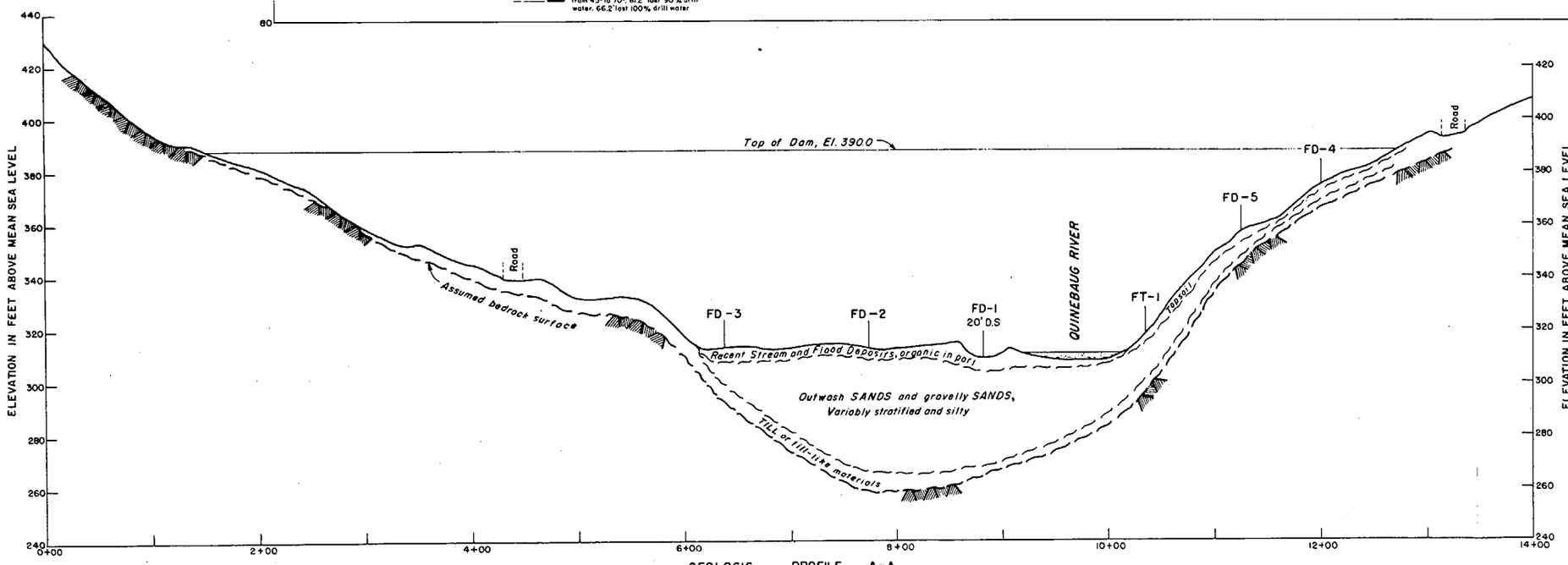
SCALE: 1" = 200'

200' 0 200' 400'



LEGEND FOR GRAPHIC LOGS

FD-1	Foundation Test Boring
FT-1	Foundation Test Pit
20'DS	Offset downstream from ℄ Profile.
17 DEC. 1956	Date exploration completed.
El. 310 ±	Elevation of ground surface, during time of exploration.
◄	Subsurface water level in boring, at time of exploration.
SM	Group letter symbol according to Unified Soil Classification System.
NR	No Recovery or unsatisfactory soil samples recovered.
NS	Not Sampled (Core-drilled, blasted and/or wash-bored).
23	Blows per foot of penetration considered most representative for each sample drive using a 350 pound hammer with free fall of about 18 inches on a 2" or 2½" O.D. size sample spoon equipped with a bevelled and sharpened drive shoe.
*	Blow count not recorded or not considered representative.
	Cobble or boulder (Core-drilled)
El. 264.3	Elevation of bedrock surface.
	Rock core recovery 0- 25%
	Rock core recovery 25- 50%
	Rock core recovery 50- 75%
	Rock core recovery 75- 90%
	Rock core recovery 90- 100%
El. 247.6	Elevation at bottom of exploration.



GEOLOGIC — PROFILE A-A

(LOOKING DOWNSTREAM)

NOTES

Elevations refer to Mean Sea Level Datum.

Contour interval is 10 feet.

Topography based on U.S. Geological Survey, Putnam Quadrangle, Connecticut.

Elevations for Geologic Profile are based on field survey.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

PREPARED BY: P.W.W.
DRAWN BY: R.A.W.
CHECKED BY: R.C.G.
CHIEF, N.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, ENGINEERING DIV.
APPROVED
CHIEF, ENGINEERING DIV.
APPROVED
LT. COL., CORPS OF ENGINEERS
ASST. TO DIVISION ENGINEER

THAMES RIVER FLOOD CONTROL

RED BRIDGE DAM

GEOLOGY

QUINEBAUG RIVER CONNECTICUT

DATE JAN. 1958

TO ACCOMPANY REPORT DATED 31 JAN. 1958

SCALES: AS SHOWN

DRAWING NUMBER TH-2-1057

SHEET OF

APPENDIX F

PUTNAM LOCAL PROTECTION

APPENDIX F

PUTNAM LOCAL PROTECTION

TABLE OF CONTENTS

Par.		Page
	A. PLANS STUDIED	
1	General	F-1
2	Lands and Damages	F-1
3	Relocations	F-1
	B. FOUNDATIONS AND MATERIALS	
4	Foundations	F-1
5	Materials	F-2
	C. COST ESTIMATES	
6	Basis of Estimates	F-2
7	Unit Prices	F-2
8	Contingencies, Engineering and Overhead	F-2
9	Local Costs	F-2
10	Basis of Annual Charges	F-2
11	Estimates of Cost	F-3

TABLES
(At End of Appendix)

	Title
F-1	Descriptions of Plans Studied
F-2	Protection with 4 Upstream Reservoirs
F-3	" " 5 " "
F-4A & 4B	First Cost and Annual Charges - Layout I - Left Bank
F-5A & 5B	" " " " " - " Ia- " "
F-6A & 6B	" " " " " - " I - Both Banks
F-7A & 7B	" " " " " - " Ia- " "
F-8A & 8B	" " " " " - " II - Left Bank
F-9A & 9B	" " " " " - " IIa " "
F-10A & 10B	" " " " " - " II - Both Banks
F-11A & 11B	" " " " " - " IIa- " "
F-12A & 12B	" " " " " - " IV " "
F-13A & 13B	" " " " " - " IVa- " "
F-14A & 14B	" " " " " - " VI - " "
F-15A & 15B	" " " " " - " VIa- " "

APPENDIX F

PUTNAM LOCAL PROTECTION

A. PLANS STUDIED

1. General. Local protection plans studied for Putnam, Connecticut, consisted of dikes and floodwalls, individually and in various combinations with channel rectification and modification of the three existing dams. These plans considered protection against the standard project flood modified by the authorized reservoirs, with and without the proposed West Thompson Reservoir or its alternative, Red Bridge. The layout numbers with the suffix "a" are based on a reservoir system containing the proposed reservoir.

Only one plan, identified as "Layout I - Left Bank," would be economically justified. It is based on a reservoir system excluding the proposed reservoir and would provide for the construction of dikes and flood walls along the east (left) bank of the Quinebaug River.

The various plans studied are briefly described in Table F-1. Pertinent data is given in Tables F-2 and F-3. General plans for the various layouts studied are shown on Plates F-1 and F-2.

2. Lands and Damages. The economically justified plan would involve a small amount of land-taking as would the other plans having no channel improvement. The plans containing channel improvement would involve the acquisition of one of the Belding-Heminway Company buildings.

3. Relocations. Construction of the economically justified plan would require minor modification of existing utilities. The effect on existing facilities would also be minor for other plans except those identified as Layout II or IIa. These latter plans include extensive channel improvement requiring the replacement of the Pomfret Street bridge.

B. FOUNDATIONS AND MATERIALS

4. Foundations. Field reconnaissance disclosed that the area is generally sands and gravels except for rock outcroppings in the river bed. No unusual excavation or foundation problems are anticipated.

5. Materials. Earth fill materials of various types, rock, and concrete aggregate are readily available within the general area. For those plans where channel improvement is involved, random and pervious fills and dumped rock would be obtained, to the extent available, from required channel excavations.

C. COST ESTIMATES

6. Basis of Estimates. The costs of local protection for Putnam have been estimated on the basis of a design which would provide safe structures for the given conditions. Quantities have been estimated on the basis of net outlines of the proposed design and foundation requirements. Earthwork items include borrow and allow for stripping borrow areas, spoil, loss from borrow to fill, and compactions in fill. Dumped rock estimates provide for swell from borrow excavation to fill. Consideration was given to utilizing, wherever possible, materials from required excavations in lieu of borrow materials.

7. Unit Prices. Unit prices are based on average bid prices for similar projects constructed or under construction in the same general region. The adopted unit prices are adjusted to the 1957 price level and include minor items of work which do not appear in the cost estimates.

8. Contingencies, Engineering, and Overhead. Estimates of basic costs have been increased by 20 percent to cover contingencies. The costs for engineering and overhead are estimated lump sums based on knowledge of the site and experience on similar projects.

9. Local Costs. The cost of lands, easements, and rights-of-way would be a local responsibility in accordance with Section 3 of the Flood Control Act of 1936. The responsibility for the relocation or modification of transportation facilities and utilities would also rest with local interests. In addition, local interests would be required to hold and save the United States free from damages due to the construction works and maintain and operate the project after completion.

10. Basis of Annual Charges. Estimates of Federal annual charges comprise the interest on the investment plus an amount required to amortize the investment over a period of 50 years. The investment represents the first cost plus interest accrued during the estimated construction period. An interest rate of 2.5 percent was used in computing annual charges. Non-Federal interest and amortization charges were computed in the same manner.

Non-Federal annual charges include, in addition to interest and amortization charges, amounts for maintenance and operation. The estimated annual cost for maintenance and operation of the project is based on knowledge of the site and on similar projects in New England. An allowance, expressed on an annual basis, is also made for the interim replacement of major equipment. No allowance is made for tax loss on lands removed from taxation since, for local protection projects, the loss of taxable lands will be offset by the increase in the value of protected property.

11. Estimates of Cost. Detailed estimates of cost of the various plans studied are given in Tables F-4 through F-15. A summary of economic data is contained in Table 8 of the main report.

TABLE F-1

PUTNAM LOCAL PROTECTION
DESCRIPTIONS OF PLANS STUDIED

Layout I and Ia

Protection on right bank from Pomfret Street to high ground upstream from Providence Street; protection on left bank from Arch Street to high ground upstream from Providence Street and dike and stoplog structure at railroad cut upstream from Providence Street.

Layout II and IIa

Protection for the same areas as Layout I; includes channel improvement from below Arch Street to above Providence Street, modifications to 3 existing dams, and dikes and flood walls similar to Layout I.

Layout IV and IVa

Same as Layout II except protection and channel improvement extend only from Pomfret Street to upstream from Providence Street.

Layout VI and VIa

Same as Layout II except protection and channel improvement extend only upstream from Providence Street; modification of only one dam is involved.

Note: Layout numbers without suffix "a" indicate plans designed for protection against standard project flood modified by 4 authorized upstream reservoirs.

Layout numbers with suffix "a" indicate plans designed for protection against standard project flood modified by 4 authorized upstream reservoirs and proposed West Thompson or alternative Red Bridge.

TABLE F-2

PERTINENT DATA
PUTNAM LOCAL PROTECTION
WITH 4 UPSTREAM RESERVOIRS

AREA			LAYOUT I Right Bank	LAYOUT I Left Bank	LAYOUT II Right Bank	LAYOUT II Left Bank	LAYOUT IV Right Bank	LAYOUT IV Left Bank	LAYOUT VI Right Bank	LAYOUT VI Left Bank
	DOWNSTREAM FROM POMFRET ST.									
	Area Protected	-Acres		50		50				
A	Earth Dikes	-Length in Ft		2,900		2,900				
		-Max Ht " "		17		18				
	Concrete Walls	-Length in Ft		400		200				
		-Max Ht " "		17		13				
	Stoplog Structures	-Number		2		1				
B	POMFRET ST. TO PROVIDENCE ST.									
	Area Protected	-Acres	18	24	18	24	18	24		
	Earth Dikes	-Length in Ft	2,300	2,400	2,100	2,300	2,100	2,300		
		-Max Ht " "	18	12	15	12	15	12		
	Concrete Walls	-Length " "	700	900		350		350		
		-Max Ht " "	16	21		8		8		
	Stoplog Structures	-Number	1	1	1	1	1	1		
C	UPSTREAM FROM PROVIDENCE ST.									
	Area Protected	-Acres	10	1	10	1	10	1	10	1
	Earth Dikes	-Length in Ft	1,300	350	500		500		500	
		-Max Ht " "	12	14	7		7		7	
	Concrete Walls	-Length " "		300						
		-Max Ht " "		30						
	RAILROAD CUTOFF									
	Area Protected	-Acres		20		20		20		20
	Earth Dikes	-Length in Ft		500		470		470		470
		-Max Ht " "		14		5		5		5
	Stoplog Structures	-Number		3		3-or sandbag openings		3-or sandbag openings		3-or sandbag openings
	PUMPING STATIONS		1	1	1	1	1			
	Number of Pumps		3	3	3	3	3			
	Size	-Inches	24	36	16	20	16			
	Total Capacity	-GPM	30,900	75,300	20,700	32,700	20,700			
	Design Head	-Feet	18	20	10	20	10			
	CHANNEL IMPROVEMENTS									
	Length	-Feet	-- None --		-- 5,900 --		-- 2,400 --		-- 900 --	
	DAM MODIFICATIONS		None		3		3		1	
	Cargill Falls Dam	-Gate Size & Type			120'x20' rolling gate		120'x20' rolling gate			
	Metal Sellings "	" " " "			120'x20' rolling gate		120'x20' rolling gate			
	Belding-Heminway"	" " " "			120'x20' rolling gate		120'x20' rolling gate		120'x20' rolling gate	

TABLE F-3

PERTINENT DATA
PUTNAM LOCAL PROTECTION
WITH 5 UPSTREAM RESERVOIRS

AREA			LAYOUT I-a		LAYOUT II-a		LAYOUT IV-a		LAYOUT VI-a	
			Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank
	DOWNSTREAM FROM POMFRET ST.									
	Area Protected	-Acres		50		50				
A	Earth Dikes	-Length in Ft		2,800		2,900				
		-Max Ht " "		12		11				
	Concrete Walls	-Length " "		300		250				
		-Max Ht " "		6		5				
	Stoplog Structures	-Number		1		1				
B	POMFRET ST. TO PROVIDENCE ST.									
	Area Protected	-Acres	18	24	18	24	18	24		
	Earth Dikes	-Length in Ft	2,300	2,300	2,200	1,850	2,200	1,850		
		-Max Ht " "	12	8	10	7	10	7		
	Concrete Walls	-Length " "	600	300		100		100		
		-Max Ht " "	6	16		4		4		
	Stoplog Structures	-Number	1	1	1	1	1	1		
C	UPSTREAM FROM PROVIDENCE ST.									
	Area Protected	-Acres	10	1	10	1	10	1	10	1
	Earth Dikes	-Length in Ft	700	300	500		500		500	
		-Max Ht " "	6	8	4		4		7	
	Concrete Walls	-Length " "		300						
		-Max Ht " "		18						
	RAILROAD CUTOFF									
	Area Protected	-Acres		20		20		20		20
	Earth Dikes	-Length in Ft		470		470		470		470
		-Max Ht " "		7		3		3		3
	Stoplog Structures	-Number		3		3-sand-bag openings only		3-sand-bag openings only	sandbag openings only	3-
	PUMPING STATIONS									
	Number of Pumps		1	1	1	1	1			
	Size	-Inches	3	3	3	3	3			
	Total Capacity	-GPM	24	20	14	20	14			
	Design Head	-Feet	31,500	22,800	20,100	22,800	20,100			
			13	13	5	13	5			
	CHANNEL IMPROVEMENTS									
	Length	-Feet	-- None	--	-- 5,900	--	-- 2,400	--	-- 900	--
	DAM MODIFICATIONS		None		(3)		(3)		(1)	
	Cargill Falls Dam	-Gate Size & Type			120'x20' rolling gate		120'x20' rolling gate			
	Metal Sellings	" " " " "			120'x20' rolling gate		120'x20' rolling gate			
	Belding-Heminway	" " " " "			120'x20' rolling gate		120'x20' rolling gate		120'x20' rolling gate	

TABLE F-4A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT I
(Left Bank)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Preparation of Site	11	A.	$220.00	$ 2,400
Earthwork				
Stripping	16,000	C.Y.	1.00	16,000
Random Fill	89,000	C.Y.	1.00	89,000
Impervious	28,000	C.Y.	1.10	30,800
Gravel	4,700	C.Y.	2.75	12,925
Topsoil	6,800	C.Y.	3.30	22,440
Seeding	11	A.	550.00	6,100
Dumped Rock	4,800	C.Y.	5.50	26,400
Floodwalls and Stoplogs				
Concrete	2,400	C.Y.	80.00	192,000
Excavation	3,100	C.Y.	2.20	6,820
Sheeting	30,000	S.F.	2.20	66,000
Stoplogs	2,400	S.F.	27.50	66,000
Drainage Facilities	1	Job	L.S.	181,000
Pumping Station (Arch St.)	1	Job	L.S.	188,000
Miscellaneous			L.S.	11,200
Subtotal				$ 917,000
Contingencies				183,000
Subtotal				$1,100,000
Preauthorization Studies				2,000
Engineering and Design				130,000
Supervision and Administration				98,000
Total Federal First Cost				$1,330,000
Non-Federal First Cost				
Lands, Easements & R/W				2,000
Relocations				10,000
Total Non-Federal First Cost				$ 12,000

TABLE F-4B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES
(1957 Price Level)

LAYOUT I
(Left Bank)

FEDERAL INVESTMENT

Federal First Cost	$ 1,330,000	
Interest during construction	33,000	
Total Federal Investment	$ 1,363,000	

FEDERAL ANNUAL CHARGES

Interest	$ 34,100	
Amortization	14,000	
Total Federal Annual Charges		$ 48,100

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 12,000	
Interest during construction	-	
Total Non-Federal Investment	$ 12,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 300	
Amortization	100	
Maintenance and Operation	3,000	
Major Replacements	1,000	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		4,400
Total Annual Charges		$ 52,500

TABLE F-5A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT 1a
(Left Bank)

Description	Quantity	Unit	Unit Price		Amount
Federal First Cost					
Preparation of Site	7	A.	$220.00	$	1,500
Earthwork					
Stripping	10,700	C.Y.	1.00		10,700
Random Fill	23,000	C.Y.	1.00		23,000
Impervious	21,000	C.Y.	1.10		23,100
Gravel	2,500	C.Y.	2.75		6,900
Topsoil	4,800	C.Y.	3.30		15,840
Seeding	7	A.	550.00		3,900
Dumped Rock	2,500	C.Y.	5.50		13,800
Floodwalls and Stoplogs					
Concrete	600	C.Y.	80.00		48,000
Excavation	1,300	C.Y.	2.20		2,900
Sheeting	12,000	S.F.	2.20		26,400
Stoplogs	900	S.F.	27.50		24,800
Drainage Facilities	1	Job	L.S.		112,200
Pumping Station (Arch St.)	1	Job	L.S.		90,000
Miscellaneous	-	-	L.S.		10,000
Subtotal				$	413,000
Contingencies					83,000
Subtotal				$	496,000
Preauthorization Studies					1,000
Engineering and Design					59,000
Supervision and Administration					44,000
Total Federal First Cost				$	600,000
Non-Federal First Cost					
Lands, Easements & R/W				$	2,000
Relocations					10,000
Total Non-Federal First Cost				$	12,000

TABLE F-5B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES
(1957 Price Levels)

LAYOUT 1a
(Left Bank)

FEDERAL INVESTMENT

Federal First Cost	$ 600,000	
Interest during construction	15,000	
Total Federal Investment	$ 615,000	

FEDERAL ANNUAL CHARGES

Interest	$ 15,400	
Amortization	6,300	
Total Federal Annual Charges		$ 21,700

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 12,000	
Interest during construction	-	
Total Non-Federal Investment	$ 12,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 300	
Amortization	100	
Maintenance and Operation	3,000	
Major Replacements	500	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		3,900
Total Annual Charges		$ 25,600

TABLE F-6A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT I
(Both Banks)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Preparation of Site	16	A.	$220.00	$ 3,500
Earthwork				
Stripping	24,600	C.Y.	1.00	24,600
Random Fill	137,000	C.Y.	1.00	137,000
Impervious	44,000	C.Y.	1.10	48,400
Gravel	7,100	C.Y.	2.75	19,500
Topsoil	10,200	C.Y.	3.30	33,700
Seeding	16	A.	550.00	8,800
Dumped Rock	6,300	C.Y.	5.50	34,700
Floodwalls and Stoplogs				
Concrete	3,500	C.Y.	80.00	280,000
Excavation	4,900	C.Y.	2.20	10,800
Sheeting	43,000	S.F.	2.20	94,600
Stoplogs	2,800	S.F.	27.50	77,000
Drainage Facilities	1	Job	L.S.	269,400
Pumping Stations				
Arch St.	1	Job	L.S.	188,000
Church St.	1	Job	L.S.	110,000
Miscellaneous			L.S.	10,000
Subtotal				$1,350,000
Contingencies				270,000
Subtotal				$1,620,000
Preauthorization Studies				2,000
Engineering and Design				194,000
Supervision and Administration				144,000
Total Federal First Cost				$1,960,000
Non-Federal First Cost				
Lands, Easements & R/W				3,000
Relocations				10,000
Total Non-Federal First Cost				$ 13,000

TABLE F-6B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES
(1957 Price Levels)

LAYOUT I
(Both Banks)

FEDERAL INVESTMENT

Federal First Cost	$ 1,960,000	
Interest during construction	49,000	
Total Federal Investment	$ 2,009,000	

FEDERAL ANNUAL CHARGES

Interest	$ 50,200	
Amortization	20,600	
Total Federal Annual Charges		$ 70,800

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 13,000	
Interest during construction	-	
Total Non-Federal Investment	$ 13,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 300	
Amortization	100	
Maintenance and Operation	3,500	
Major Replacements	1,500	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		5,400
Total Annual Charges		$ 76,200

TABLE F-7A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT 1a
(Both Banks)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Preparation of Site	11	A.	$220.00	$ 2,400
Earthwork				
Stripping	16,300	C.Y.	1.00	16,300
Random Fill	39,000	C.Y.	1.00	39,000
Impervious	34,000	C.Y.	1.10	37,400
Gravel	7,200	C.Y.	2.75	19,800
Topsoil	6,800	C.Y.	3.30	22,400
Seeding	11	A.	550.00	6,100
Dumped Rock	3,400	C.Y.	5.50	18,700
Floodwalls and Stoplogs				
Concrete	1,300	C.Y.	80.00	104,000
Excavation	2,400	C.Y.	2.20	5,300
Sheeting	12,000	S.F.	2.20	26,400
Stoplogs	1,050	S.F.	27.50	28,900
Drainage Facilities	1	Job	L.S.	221,300
Pumping Stations				
Arch St.	1	Job	L.S.	90,000
Church St.	1	Job	L.S.	110,000
Miscellaneous			L.S.	10,000
Subtotal				$758,000
Contingencies				152,000
Subtotal				$910,000
Preauthorization Studies				1,000
Engineering and Design				108,000
Supervision and Administration				81,000
Total Federal First Cost				$1,100,000
Non-Federal First Cost				
Lands, Easements & R/W				$ 2,000
Relocations				10,000
Total Non-Federal First Cost				$ 12,000

TABLE F-7B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES
(1957 Price Level)

LAYOUT Ia
(Both Banks)

FEDERAL INVESTMENT

Federal First Cost	$ 1,100,000	
Interest during construction	28,000	
Total Federal Investment	$ 1,128,000	

FEDERAL ANNUAL CHARGES

Interest	$ 28,200	
Amortization	11,600	
Total Federal Annual Charges		$ 39,800

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 12,000	
Interest during construction	-	
Total Non-Federal Investment	$ 12,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 300	
Amortization	100	
Maintenance and Operation	3,500	
Major Replacements	1,000	
Net Loss of Taxes	-	
Total Non-Federal Annual Charges		4,900
Total Annual Charges		$ 44,700

TABLE F-8A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT II
(Left Bank)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Preparation of Site	9	A.	$220.00	$ 2,000
Earthwork				
Stripping	13,000	C.Y.	1.00	13,000
Random Fill	75,000	C.Y.	1.00	(1)
Impervious	25,000	C.Y.	1.10	27,500
Gravel	4,000	C.Y.	2.75	11,000
Topsoil	6,000	C.Y.	3.30	19,800
Seeding	9	A.	550.00	5,000
Dumped Rock	4,300	C.Y.	(2)	(2)
Floodwalls and Stoplogs				
Concrete	500	C.Y.	80.00	40,000
Excavation	1,000	C.Y.	2.20	2,200
Sheeting	12,000	S.F.	2.20	26,400
Stoplogs	1,200	S.F.	27.50	33,000
Drainage Facilities	1	Job	L.S.	107,700
Pumping Station (Arch St.)	1	Job	L.S.	90,000
Channel Work				
Earth Excavation	174,000	C.Y.	2.00	348,000
Rock Excavation	87,000	C.Y.	11.00	957,000
Rolling Gates (3)	1	Job	L.S.	1,050,000
Miscellaneous			L.S.	10,000
Subtotal				$2,742,000
Contingencies				548,000
Subtotal				$3,290,000
Preauthorization Studies				2,000
Engineering and Design				394,000
Supervision and Administration				294,000
Total Federal First Cost				$3,980,000
Non-Federal First Cost				
Land, Easements & R/W				$ 100,000
Relocations				260,000
Total Non-Federal First Cost				$ 360,000

(1) Random fill taken from channel improvement excavation and cost thereof is included in the "Channel Earth Excavation" cost.

(2) Dumped rock taken from channel improvement excavation and cost thereof is included in the "Channel Rock Excavation" cost.

TABLE F-8B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES
(1957 Price Level)

LAYOUT II
(Left Bank)

FEDERAL INVESTMENT

Federal First Cost	$ 3,980,000	
Interest during construction	100,000	
Total Federal Investment	$ 4,080,000	

FEDERAL ANNUAL CHARGES

Interest	$ 102,000	
Amortization	41,900	
Total Federal Annual Charges		$ 143,900

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 360,000	
Interest during construction	9,000	
Total Non-Federal Investment	$ 369,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 9,200	
Amortization	3,800	
Maintenance and Operation	6,000	
Major Replacements	5,000	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		24,000
Total Annual Charges		$ 167,900

TABLE F-9A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT IIa
(Left Bank)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Preparation of Site	6	A.	$220.00	$ 1,300
Earthwork				
Stripping	7,500	C.Y.	1.00	7,500
Random Fill	16,000	C.Y.	(1)	(1)
Impervious	21,000	C.Y.	1.10	23,100
Gravel	2,500	C.Y.	2.75	6,900
Topsoil	2,600	C.Y.	3.30	8,600
Seeding	6	A.	550.00	3,300
Dumped Rock	2,100	C.Y.	(2)	(2)
Floodwalls and Stoplogs				
Concrete	300	C.Y.	80.00	24,000
Excavation	400	C.Y.	2.20	900
Sheeting	12,000	S.F.	2.20	26,400
Stoplogs	500	S.F.	27.50	13,800
Drainage Facilities	1	Job	L.S.	96,200
Pumping Station (Arch St.)	1	Job	L.S.	90,000
Channel Work				
Earth Excavation	174,000	C.Y.	2.00	348,000
Channel Rock Excavation	87,000	C.Y.	11.00	957,000
Rolling Gates (3)	1	Job	L.S.	1,050,000
Miscellaneous			L.S.	10,000
Subtotal				$2,667,000
Contingencies				533,000
Subtotal				$3,200,000
Preauthorization Studies				2,000
Engineering and Design				383,000
Supervision and Administration				285,000
Total Federal First Cost				$3,870,000
Non-Federal First Cost				
Lands, Easements & R/W				$ 100,000
Relocations				260,000
Total Non-Federal First Cost				$ 360,000

(1) Random fill taken from channel improvement excavation and cost thereof is included in the "Channel Earth Excavation" cost.

(2) Dumped rock taken from channel improvement excavation and cost thereof is included in the "Channel Rock Excavation" cost.

TABLE F-9B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES
(1957 Price Level)

LAYOUT IIa
(Left Bank)

FEDERAL INVESTMENT

Federal First Cost	$ 3,870,000	
Interest during construction	97,000	
Total Federal Investment	$ 3,967,000	

FEDERAL ANNUAL CHARGES

Interest	$ 99,200	
Amortization	40,700	
Total Federal Annual Charges		$ 139,900

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 360,000	
Interest during construction	9,000	
Total Non-Federal Investment	$ 369,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 9,200	
Amortization	3,800	
Maintenance and Operation	6,000	
Major Replacements	5,000	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		24,000
Total Annual Charges		$ 163,900

TABLE F-10A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT II
(Both Banks)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Preparation of Site	13	A.	$220.00	$ 2,900
Earthwork				
Stripping	18,300	C.Y.	1.00	18,300
Random Fill	103,000	C.Y.	(1)	(1)
Impervious	37,000	C.Y.	1.10	40,700
Gravel	5,900	C.Y.	2.75	16,200
Topsoil	8,500	C.Y.	3.30	28,100
Seeding	13	A.	550.00	7,200
Dumped Rock	5,400	C.Y.	(2)	(2)
Floodwalls and Stoplogs				
Concrete	500	C.Y.	80.00	40,000
Excavation	1,000	C.Y.	2.20	2,200
Sheeting	12,000	S.F.	2.20	26,400
Stoplogs	1,500	S.F.	27.50	41,300
Drainage Facilities		Job	1	154,700
Pumping Station				
Arch St.	1	Job	L.S.	90,000
Church St.	1	Job	L.S.	95,000
Channel Work				
Earth Excavation	174,000	C.Y.	2.00	348,000
Rock Excavation	87,000	C.Y.	11.00	957,000
Rolling Gates (3)	1	Job	L.S.	1,050,000
Miscellaneous			L.S.	10,000
Subtotal				$2,928,000
Contingencies				585,000
Subtotal				$3,513,000
Preauthorization Studies				2,000
Engineering and Design				421,000
Supervision and Administration				314,000
Total Federal First Cost				$4,250,000
Non-Federal First Cost				
Lands, Easements & R/W				$ 100,000
Relocations				260,000
Total Non-Federal First Cost				$ 360,000

(1) Random fill taken from Channel Improvement Excavation and cost thereof is included in the "Channel Earth Excavation" cost.

(2) Dumped Rock taken from channel improvement excavation and cost thereof is included in the "Channel Rock Excavation" cost.

TABLE F-10B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES

LAYOUT II
(Both Banks)

FEDERAL INVESTMENT

Federal First Cost	$ 4,250,000	
Interest during construction	106,000	
Total Federal Investment	$ 4,356,000	

FEDERAL ANNUAL CHARGES

Interest	$ 108,900	
Amortization	44,700	
Total Federal Annual Charges		$ 153,600

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 360,000	
Interest during construction	9,000	
Total Non-Federal Investment	$ 369,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 9,200	
Amortization	3,800	
Maintenance and Operation	6,500	
Major Replacements	5,500	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		25,000
Total Annual Charges		$ 178,600

TABLE F-11A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT IIa
(Both Banks)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Preparation of Site	9	A.	$220.00	$ 2,000
Earthwork				
Stripping	11,500	C.Y.	1.00	11,500
Random Fill	26,000	C.Y.	(1)	(1)
Impervious	31,000	C.Y.	1.10	34,100
Gravel	3,800	C.Y.	2.75	10,500
Topsoil	4,000	C.Y.	3.30	13,200
Seeding	9	A.	550.00	5,000
Dumped Rock	2,900	C.Y.	(2)	(2)
Floodwalls and Stoplogs				
Concrete	300	C.Y.	80.00	24,000
Excavation	400	C.Y.	2.20	900
Sheeting	12,000	S.F.	2.20	26,400
Stoplogs	650	S.F.	27.50	17,900
Drainage Facilities	1	Job	L.S.	142,500
Pumping Stations				
Arch Street	1	Job	L.S.	90,000
Church Street	1	Job	L.S.	95,000
Channel Work				
Earth Excavation	174,000	C.Y.	2.00	348,000
Rock Excavation	87,000	C.Y.	11.00	957,000
Rolling Gates (3)	1	Job	L.S.	1,050,000
Miscellaneous	1	L.S.		10,000
Subtotal				$2,838,000
Contingencies				568,000
Subtotal				$3,406,000
Preauthorization Studies				2,000
Engineering and Design				408,000
Supervision and Administration				304,000
Total Federal First Cost				$4,120,000
Non-Federal First Cost				
Lands, Easements & R/W				$ 100,000
Relocations				260,000
Total Non-Federal First Cost				$ 360,000

(1) Random fill taken from channel improvement excavation and cost thereof is included in the "Channel Earth Excavation" cost.

(2) Dumped rock taken from channel improvement excavation and cost thereof is included in the "Channel Rock Excavation" cost.

TABLE F-11B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES
(1957 Price Level)

LAYOUT IIa
(Both Banks)

FEDERAL INVESTMENT

Federal First Cost	$ 4,120,000	
Interest during construction	103,000	
Total Federal Investment	$ 4,223,000	

FEDERAL ANNUAL CHARGES

Interest	$ 105,600	
Amortization	43,300	
Total Federal Annual Charges		$ 148,900

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 360,000	
Interest during construction	9,000	
Total Non-Federal Investment	$ 369,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 9,200	
Amortization	3,800	
Maintenance and Operation	6,500	
Major Replacements	5,500	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		25,000
Total Annual Charges		$ 173,900

TABLE F-12A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT IV
(Both Banks)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Preparation of Site	10	A.	$220.00	$ 2,200
Earthwork				
Stripping	9,100	C.Y.	1.00	9,100
Random Fill	45,700	C.Y.	(1)	(1)
Impervious	19,700	C.Y.	1.10	21,700
Gravel	3,000	C.Y.	2.75	8,300
Topsoil	3,900	C.Y.	3.30	12,900
Seeding	10	A.	550.00	5,500
Dumped Rock	2,400	C.Y.	(2)	(2)
Floodwalls and Stoplogs				
Concrete	85	C.Y.	80.00	6,800
Excavation	140	C.Y.	2.20	308
Sheeting	25,000	S.F.	2.20	55,000
Stoplogs	800	S.F.	27.50	22,000
Drainage Facilities	1	Job	L.S.	92,200
Pumping Station (Church St.)	1	Job	L.S.	95,000
Channel Work				
Earth Excavation	70,000	C.Y.	2.00	140,000
Rock Excavation	55,000	C.Y.	11.00	605,000
Rolling Gates (3)	1	Job	L.S.	1,050,000
Miscellaneous			L.S.	10,000
Subtotal				2,136,000
Contingencies				427,000
Subtotal				2,563,000
Preauthorization Studies				2,000
Engineering & Design				306,000
Supervision & Administration				229,000
Total Federal First Cost				$3,100,000
Non-Federal First Cost				
Lands, Easements & R/W				$ 100,000
Relocations				10,000
Total Non-Federal First Cost				$ 110,000

(1) Random fill taken from channel improvement excavation and cost thereof is included in the "Channel Excavation" cost.

(2) Dumped rock taken from channel improvement excavation and cost thereof is included in the "Channel Rock Excavation" cost.

TABLE F-12B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES
(1957 Price Level)

LAYOUT IV
(Both Banks)

FEDERAL INVESTMENT

Federal First Cost	$ 3,100,000	
Interest during construction	78,000	
Total Federal Investment	$ 3,178,000	

FEDERAL ANNUAL CHARGES

Interest	$ 79,500	
Amortization	32,600	
Total Federal Annual Charges		$ 112,100

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 110,000	
Interest during construction	3,000	
Total Non-Federal Investment	$ 113,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 2,800	
Amortization	1,200	
Maintenance and Operation	6,000	
Major Replacements	5,000	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		15,000
Total Annual Charges		$ 127,100

TABLE F-13A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT IVa
(Both Banks)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Preparation of Site	7	A.	$220.00	$ 1,500
Earthwork				
Stripping	5,900	C.Y.	1.00	5,900
Random Fill	11,400	C.Y.	(1)	(1)
Impervious	15,300	C.Y.	1.10	16,800
Gravel	2,000	C.Y.	2.75	5,500
Topsoil	1,900	C.Y.	3.30	6,300
Seeding	7	A.	550.00	3,900
Dumped Rock	1,300	C.Y.	(2)	(2)
Floodwalls and Stoplogs				
Concrete	50	C.Y.	80.00	4,000
Excavation	40	C.Y.	2.20	88
Sheeting	3,000	S.F.	2.20	6,600
Stoplogs	380	S.F.	27.50	10,450
Drainage Facilities	1	Job	L.S.	84,900
Pumping Station (Church St.)	1	Job	L.S.	95,000
Channel Work				
Earth Excavation	70,000	C.Y.	2.00	140,000
Rock Excavation	55,000	C.Y.	11.00	605,000
Rolling Gates (3)	1	Job		1,050,000
Miscellaneous		Job		10,000
Subtotal				$2,046,000
Contingencies				409,000
Subtotal				$2,455,000
Preauthorization Studies				2,000
Engineering & Design				294,000
Supervision & Administration				219,000
Total Federal First Cost				$2,970,000
Non-Federal First Cost				
Lands, Easements & R/W				$ 100,000
Relocations				10,000
Total Non-Federal First Cost				$ 110,000

(1) Random fill taken from channel improvement excavation and cost thereof is included in the "Channel Earth Excavation" cost.

(2) Dumped rock taken from channel improvement excavation and cost thereof is included in the "Channel Rock Excavation" cost.

TABLE F-13B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES
(1957 Price Level)

LAYOUT IVa
(Both Banks)

FEDERAL INVESTMENT

Federal First Cost	$ 2,970,000	
Interest during construction	74,000	
Total Federal Investment	$ 3,044,000	

FEDERAL ANNUAL CHARGES

Interest	$ 76,100	
Amortization	31,200	
Total Federal Annual Charges		$ 107,300

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 110,000	
Interest during construction	3,000	
Total Non-Federal Investment	$ 113,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 2,800	
Amortization	1,200	
Maintenance and Operation	6,000	
Major Replacements	5,000	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		15,000
Total Annual Charges		$ 122,300

TABLE F-14A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT VI
(Both Banks)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Preparation of Site	1.5	A.	$220.00	300
Earthwork				
Stripping	1,000	C.Y.	1.00	1,000
Random Fill	3,100	C.Y.	(1)	(1)
Impervious	3,300	C.Y.	1.10	3,600
Gravel	500	C.Y.	2.75	1,400
Topsoil	450	C.Y.	3.30	1,500
Seeding	1.5	A.	550.00	800
Floodwalls and Stoplogs				
Concrete	100	C.Y.	80.00	8,000
Excavation	100	C.Y.	2.20	200
Sheeting	500	S.F.	2.20	1,100
Stoplogs	250	S.F.	27.50	6,900
Drainage Facilities	1	Job	L.S.	1,200
Channel Work				
Earth Excavation	12,000	C.Y.	2.00	24,000
Rock Excavation	30,000	C.Y.	11.00	330,000
Rolling Gate	1	Job	L.S.	375,000
Miscellaneous			L.S.	4,000
Subtotal				$ 759,000
Contingencies				151,000
Subtotal				$ 910,000
Preauthorization Studies				1,000
Engineering and Design				109,000
Supervision and Administration				80,000
Total Federal First Cost				$1,100,000
Non-Federal First Cost				
Lands, Improvements & R/W				$ 100,000
Relocations				1,000
Total Non-Federal First Cost				$ 101,000

(1) Random fill taken from channel improvement excavation and cost thereof is included in the "Channel Excavation" cost.

(2) Dumped rock taken from channel improvement excavation and cost thereof is included in the "Channel Rock Excavation" cost.

TABLE F-14B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES

LAYOUT VI
(Both Banks)

FEDERAL INVESTMENT

Federal First Cost	$ 1,100,000	
Interest during construction	28,000	
Total Federal Investment	$ 1,128,000	

FEDERAL ANNUAL CHARGES

Interest	$ 28,200	
Amortization	11,600	
Total Federal Annual Charges		$ 39,800

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 101,000	
Interest during construction	3,000	
Total Non-Federal Investment	$ 104,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 2,600	
Amortization	1,100	
Maintenance and Operation	2,000	
Major Replacements	1,500	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		7,200
Total Annual Charges		$ 47,000

TABLE F-15A

PUTNAM, CONN. LOCAL PROTECTION

FIRST COST
(1957 Price Level)

LAYOUT VIa
(Both Banks)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Preparation of Site	1.5	A.	$220.00	$ 300
Earthwork				
Stripping	900	C.Y.	1.00	900
Random Fill	600	C.Y.	(1)	(1)
Impervious	2,900	C.Y.	1.10	3,200
Gravel	300	C.Y.	2.75	800
Topsoil	200	C.Y.	3.30	700
Seeding	1.5	A.	550.00	800
Floodwalls and Stoplogs				
Concrete	100	C.Y.	80.00	8,000
Excavation	100	C.Y.	2.20	200
Sheeting	500	S.F.	2.20	1,100
Channel Work				
Channel Excavation	12,000	C.Y.	2.00	24,000
Channel Ledge Excavation	30,000	C.Y.	11.00	330,000
Rolling Gates	1	Job	L.S.	375,000
Miscellaneous			L.S.	5,000
Subtotal				750,000
Contingencies				150,000
Subtotal				$900,000
Preauthorization Studies				1,000
Engineering and Design				108,000
Supervision and Administration				81,000
Total Federal First Cost				$1,090,000
Non-Federal First Cost				
Lands, Improvements & R/W				$ 100,000
Relocations				1,000
Total Non-Federal First Cost				$ 101,000

(1) Random fill taken from channel improvement excavation and cost thereof is included in the "Channel Earth Excavation" cost.

TABLE F-15B

PUTNAM, CONN. LOCAL PROTECTION

ANNUAL CHARGES

LAYOUT VIa
(Both Banks)

FEDERAL INVESTMENT

Federal First Cost	$ 1,090,000	
Interest during construction	27,000	
Total Federal Investment	$ 1,117,000	

FEDERAL ANNUAL CHARGES

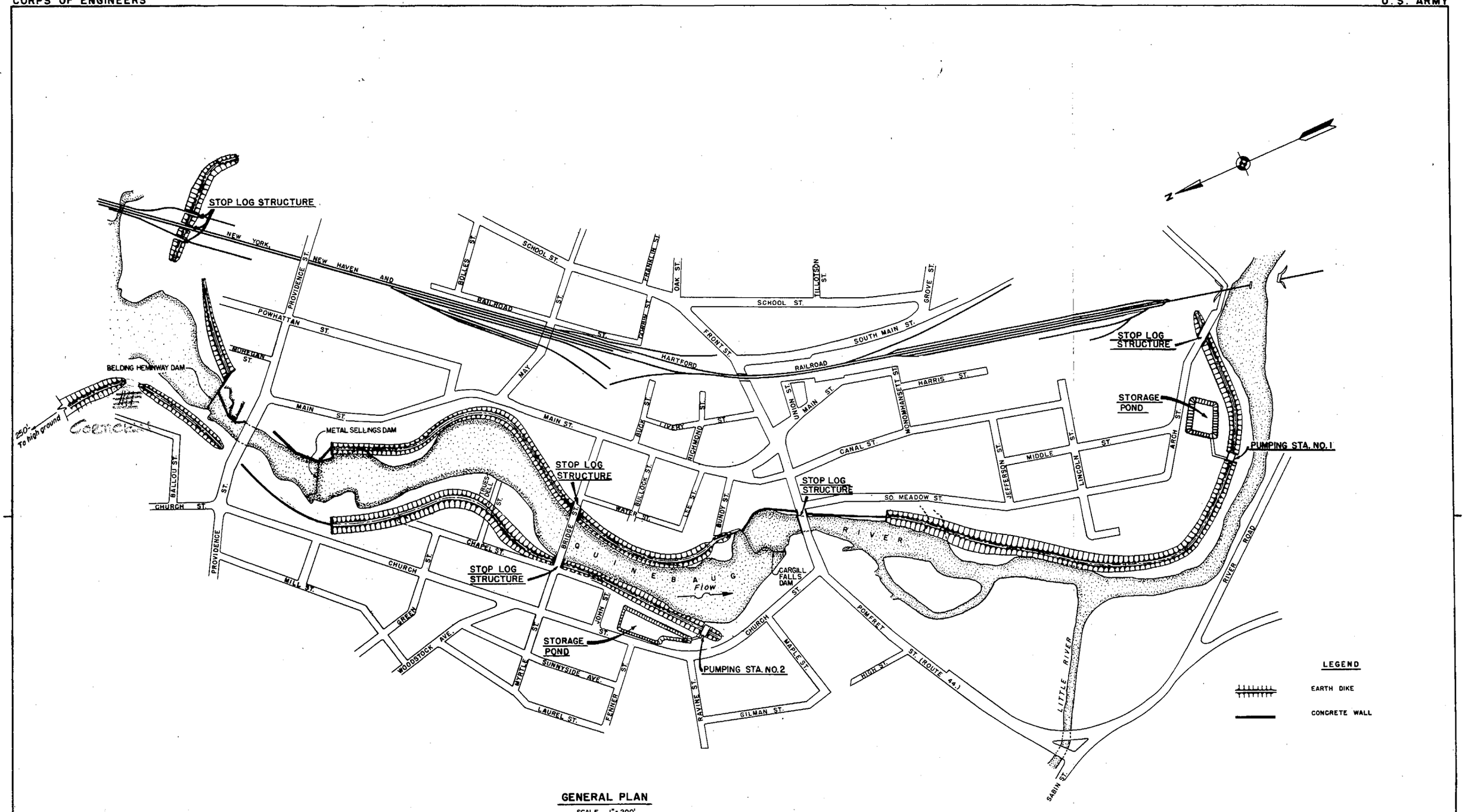
Interest	$ 27,900	
Amortization	11,500	
Total Federal Annual Charges		$ 39,400

NON-FEDERAL INVESTMENT

Non-Federal First Cost	$ 101,000	
Interest during construction	3,000	
Total Non-Federal Investment	$ 104,000	

NON-FEDERAL ANNUAL CHARGES

Interest	$ 2,600	
Amortization	1,100	
Maintenance and Operation	2,000	
Major Replacements	1,500	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		7,200
Total Annual Charges		$ 46,600



GENERAL PLAN

SCALE 1" = 200'

200 0 200 400 FT.

NOTES:

Plan No. I provides for dikes and flood walls, but with no channel improvement.

Layout without suffix "a" is based on requirements after 4 authorized reservoirs.

Layout with suffix "a" is based on requirements after 4 authorized reservoirs and proposed West Thompson Reservoir

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY	TR. BY	CK. BY
P.A.D.	M.W.B.	J.W.D.

PROJECT ENGINEER

SUBMITTED BY: CHIEF PLANN. & REP. BRANCH

APPROVED: CHIEF ENGINEERING DIV.

APPROVED: LT. COL. C.E. ARBT TO DIVISION ENGINEER

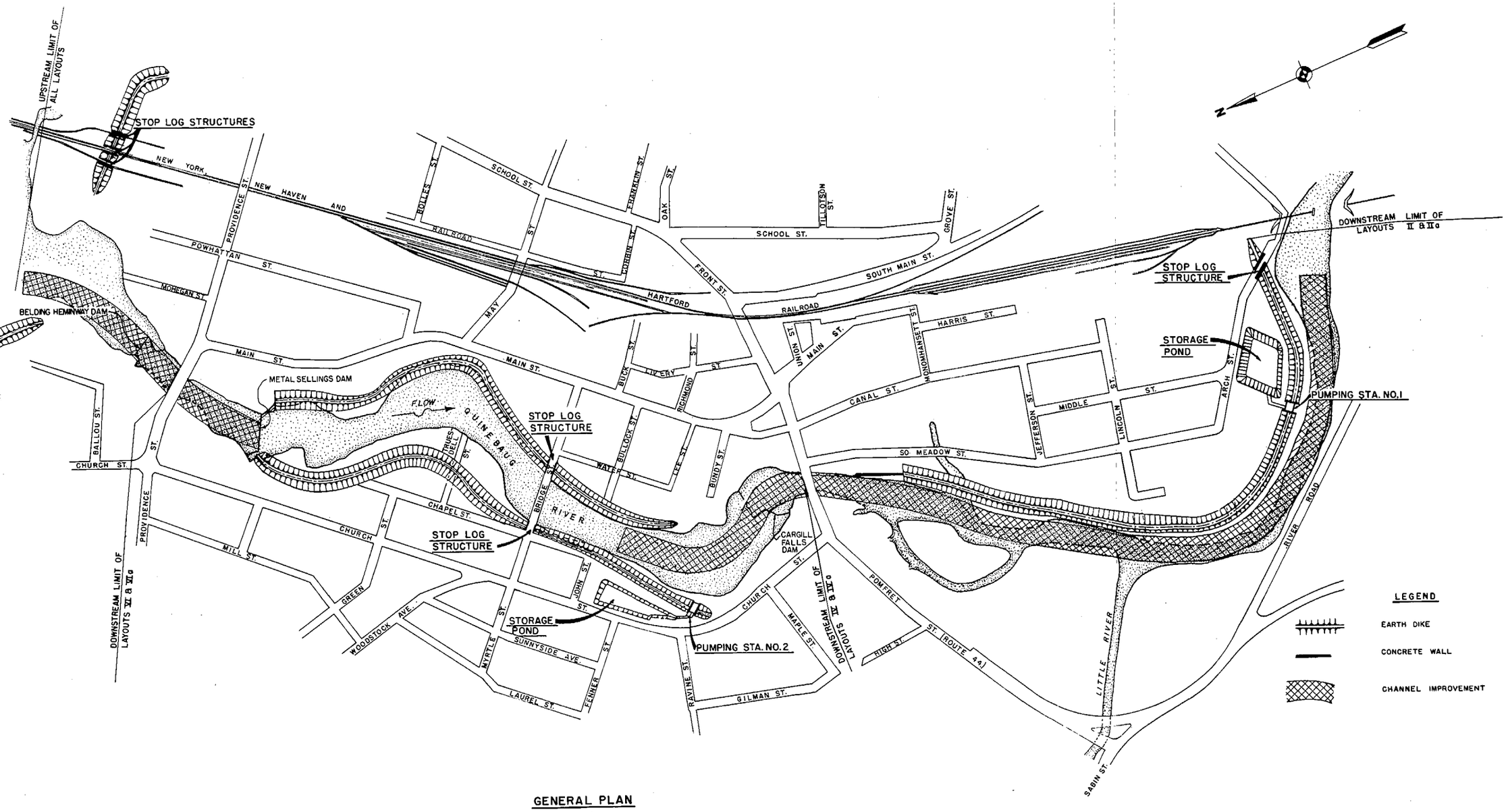
THAMES RIVER FLOOD CONTROL
PUTNAM, CONN.
FLOOD PROTECTION STUDY
PLAN NO. I
QUINEBAUG RIVER CONN.

DATE JAN. 1958

SCALE: 1" = 200'

TO ACCOMPANY REPORT
DATED: 31 JANUARY 1958

DRAWING NUMBER
TH-1-1386
SHEET 1 OF 1



GENERAL PLAN

SCALE 1" = 200'

200 0 200 400 FT.

LEGEND

- EARTH DIKE
- CONCRETE WALL
- CHANNEL IMPROVEMENT

NOTES

Plan No.2 provides for dikes, flood walls, channel widening and deepening, and modifications to existing dams.

Layouts without suffix "a" are based on requirements after 4 authorized reservoirs.

Layouts with suffix "a" are based on requirements after 4 authorized reservoirs and proposed West Thompson Reservoir

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON MASS.

DR BY P.A.D. TR BY M.W.B. CK BY J.W.D.

PROJECT ENGINEER

SUBMITTED BY CHIEF PLANN. & REP. BRANCH

APPROVED CHIEF ENGINEERING DIV.

APPROVED LT. COL. C.E. ASST TO DIVISION ENGINEER

THAMES RIVER FLOOD CONTROL

PUTNAM, CONN.

FLOOD PROTECTION STUDY PLAN NO. 2

QUINEBAUG RIVER CONN.

DATE JAN. 1958

SCALE: 1" = 200'

TO ACCOMPANY REPORT DATED: 31 JANUARY 1958

DRAWING NUMBER TH-1-1387

SHEET 1 OF 1

APPENDIX G

OTHER PROJECTS STUDIED

APPENDIX G

OTHER PROJECTS STUDIED

Par.	TABLE OF CONTENTS	Page
1	General	G-1
2	Southbridge, Mass.	G-1
3	Grosvenordale, Conn.	G-1
4	Killingly, Conn.	G-2
5	Plainfield, Conn.	G-2
6	Cost Estimates	G-2

TABLES
(At End of Appendix)

	Southbridge Local Protection	
G-1A	First Cost	G-3
G-1B	Annual Charges	G-4
	Grosvenordale Local Protection	
G-2A	Dam Modification - First Cost	G-5
G-2B	" " - Annual Charges	G-6
G-3A	Flood Wall (Alt) - First Cost	G-7
G-3B	" " " - Annual Charges	G-8
	Killingly Local Protection	
G-4A	First Cost	G-9
G-4B	Annual Charges	G-10
	Plainfield Local Protection	
G-5A	First Cost	G-11
G-5B	Annual Charges	G-12

PLATES

G-1	Southbridge, Mass.
G-2	Grosvenordale, Conn.
G-3	Killingly, Conn.
G-4	Plainfield, Conn.

APPENDIX G

OTHER PROJECTS STUDIED

1. General. Five flood control projects were studied in addition to the West Thompson and Red Bridge Reservoirs and the various local protection plans for Putnam. None of these five is economically justified at this time. Two other small projects in Massachusetts, along Cady Brook in Southbridge and the French River in Leicester, will be considered under authority of Section 205 of the 1948 Flood Control Act, as amended.

The five projects studied are all of the local protection type. Two of these projects are alternative protection in Grosvenordale, Connecticut. The other three would provide protection along McKinstry Brook in Southbridge, Massachusetts, and along the Quinebaug River in Killingly (Rogers) and Plainfield (Wauregan), Connecticut. Estimates of first cost and annual charges are given in the tables at the end of this appendix.

2. Southbridge, Massachusetts. A channel improvement along McKinstry Brook in Southbridge was investigated. The brook drains an area of 8.0 square miles and enters the Quinebaug River from the north, 0.6 miles above the center of Southbridge. The channel is badly clogged with debris, trees, and brush from its lower end upstream to the Plimpton Street area. During the design flood, a recurring August 1955 flood, the brook would flood overbank to a depth of 5 to 6 feet from its mouth upstream to Pleasant Street bridge. This depth would be increased to between 10 and 12 feet in the Plimpton Street area upstream from Pleasant Street bridge. Because of the heavily developed condition of the area, a rectangular concrete-lined channel would be the most feasible means of providing flood protection. The channel would be 2,000 feet long and 30 feet wide. The location of this project is shown on Plate No. G-1.

The total estimated first cost of this project is $382,000. Resulting annual charges of $13,900 for a project to protect an area with residual annual losses of $4,500 precludes economic justification. Summaries of first costs and annual charges are given in Table G-1.

3. Grosvenordale, Connecticut. A large industrial plant and a residential section along Route 12 in the Grosvenordale section of Thompson were flooded during the August 1955 and previous floods. This flooding results from overflow of a local mill pond on the French River. Protection against the standard project flood modified by the authorized reservoirs can be provided by modifying the dam at the pond outlet. This modification would involve the reconstruction of the top portion of the dam to provide for a 7-foot high bascule gate. The length of the gate would be 100 feet. This project is shown on Plate No. G-2.

The total estimated first cost of this modification is $163,000. Resulting annual charges of $7,800 for a project to protect an area with residual annual losses of $4,500 precludes economic justification. Summaries of first costs and annual charges are given in Table G-2.

An alternative, more costly, solution would be to construct a flood wall from the east (left) abutment of the dam upstream to high ground. The wall would be 2,000 feet long and would have an average height of 7 feet above ground. The total estimated first cost of this flood wall is $340,000. Resulting annual charges are estimated at $12,300. Summaries of first costs and annual charges are given in Table G-3.

4. Killingly, Connecticut. Damages in the village of Rogers in Killingly are caused by floodwaters overtopping the non-overflow sections of a local dam on the Quinebaug River. Raising the dam 2 to 3 feet over a distance of 250 feet would provide protection against overtopping by the standard project flood modified by the authorized reservoirs and the proposed West Thompson Reservoir. This project is shown on Plate No. G-3.

The cost estimates for this project are $9,000 for first cost and $400 for annual charges. Benefits are estimated at $150 annually. The project would have a benefit-cost ratio of 0.37 to 1.0. Summaries of first costs and annual charges are given in Table G-4.

5. Plainfield, Connecticut. The Wauregan Mills in the village of Wauregan have been badly damaged by past floods on the Quinebaug River. A low dike would protect this plant against the standard project flood modified by the authorized reservoirs and the proposed West Thompson Reservoir. The dike would be 1,300 feet long and would have an average height of 9 feet above ground. This project is shown on Plate No. G-4.

The cost estimates for this project are $57,000 for first cost and $1,900 for annual charges. Benefits are estimated at $700 annually. The project would have a benefit-cost ratio of 0.33 to 1.0. Summaries of first costs and annual charges are given in Table G-5.

6. Cost Estimates. The basis of estimates, unit prices, and other cost factors are discussed in Section C of Appendix F. The various components comprising the estimates of annual charges are also discussed in Appendix F.

TABLE G-1A

SOUTHBRIDGE LOCAL PROTECTION
McKINSTRY BROOK
FIRST COST
(1957 Price Level)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Channel Excavation	10,000	c.y.	$2.00	$ 20,000
Gravel Fill	6,000	c.y.	2.75	16,500
Reinforced Concrete	3,600	c.y.	60.00	216,000
Subtotal				$252,500
Contingencies				50,500
Subtotal				$303,000
Preauthorization Studies				1,000
Engineering and Design				48,000
Supervision and Administration				28,000
Total Federal First Cost				$380,000
Non-Federal First Cost				
Lands, Easements and Rights-of-Way				$ 1,000
Relocations				1,000
Total Non-Federal First Cost				$ 2,000

TABLE G-1B

SOUTHBRIDGE LOCAL PROTECTION
McKINSTRY BROOK
ANNUAL CHARGES
(1957 Price Level)

FEDERAL INVESTMENT		
Federal First Cost	$ 380,000	
Interest during construction	5,000	
Total Federal Investment	$ 385,000	
FEDERAL ANNUAL CHARGES		
Interest	$ 9,600	
Amortization	4,000	
Total Federal Annual Charges		$13,600
NON-FEDERAL INVESTMENT		
Non-Federal First Cost	$ 2,000	
Interest during construction	-	
Total Non-Federal Investment	$ 2,000	
NON-FEDERAL ANNUAL CHARGES		
Interest and Amortization	$ 100	
Maintenance and Operation	200	
Major Replacements	0	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		300
Total Annual Charges		$ 13,900

TABLE G-2A

GROSVENORDALE LOCAL PROTECTION
DAM MODIFICATION
FIRST COST
(1957 Price Level)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Masonry Excavation	200	c.y.	$10.00	$ 2,000
Reinforced Concrete	20	c.y.	70.00	1,400
Gate	1	Job	L.S.	105,000
Subtotal				$ 108,400
Contingencies				21,600
Subtotal				$ 130,000
Preauthorization Studies				1,000
Engineering and Design				20,000
Supervision and Administration				12,000
Total Federal First Cost				$ 163,000
Non-Federal First Cost				None

TABLE G-2B

GROSVENORDALE LOCAL PROTECTION
DAM MODIFICATION
ANNUAL CHARGES
(1957 Price Level)

FEDERAL INVESTMENT		
Federal First Cost	$ 163,000	
Interest during construction	2,000	
Total Federal Investment	$ 165,000	
FEDERAL ANNUAL CHARGES		
Interest	$ 4,100	
Amortization	1,700	
Total Federal Annual Charges		$5,800
NON-FEDERAL INVESTMENT		
Non-Federal First Cost	$ 0	
Interest during construction	0	
Total Non-Federal Investment	0	
NON-FEDERAL ANNUAL CHARGES		
Interest	$ 0	
Amortization	0	
Maintenance and Operation	200	
Major Replacements	1800	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		2,000
Total Annual Charges		$7,800

TABLE G-3A

GROSVENORDALE LOCAL PROTECTION
FLOOD WALL (ALTERNATIVE)
FIRST COST
(1957 Price Level)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Earth Excavation	3,700	c.y.	$2.40	$ 8,900
Reinforced concrete	2,700	c.y.	80.00	216,000
Subtotal				$ 224,900
Contingencies				44,100
Subtotal				$ 269,000
Preauthorization studies				1,000
Engineering and Design				43,000
Supervision and Administration				25,000
Total Federal First Cost				$ 338,000
Non-Federal First Cost				
Lands, Easements, and Rights of Way				$ 1,000
Relocations				1,000
Total Non-Federal First Cost				$ 2,000

TABLE G-3B

GROSVENORDALE LOCAL PROTECTION
FLOOD WALL (ALTERNATIVE)
ANNUAL CHARGES
(1957 Price Levels)

FEDERAL INVESTMENT		
Federal First Cost	$338,000	
Interest during construction	2,000	
Total Federal Investment	$340,000	
FEDERAL ANNUAL CHARGES		
Interest	$ 8,500	
Amortization	3,500	
Total Federal Annual Charges		$12,000
NON-FEDERAL INVESTMENT		
Non-Federal First Cost	$ 2,000	
Interest during construction	-	
Total Non-Federal Investment	$ 2,000	
NON-FEDERAL ANNUAL CHARGES		
Interest and Amortization	$ 100	
Maintenance and Operation	200	
Major Replacements	0	
Net Loss of Taxes	0	
Total Non-Federal Annual Charges		300
Total Annual Charges		$12,300

TABLE G-4A

KILLINGLY (ROGERS) LOCAL PROTECTION
FIRST COST
(1957 Price Level)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Earth Excavation	100	c.y.	$1.00	$ 100
Random Fill	200	c.y.	1.00	200
Impervious Fill	180	c.y.	1.10	200
Gravel	35	c.y.	2.75	100
Topsoil	30	c.y.	3.30	100
Reinforced concrete	60	c.y.	70.00	4,200
Subtotal				$4,900
Contingencies				1,100
Subtotal				$6,000
Preauthorization Studies				500
Engineering and Design				1,000
Supervision and Administration				500
Total Federal First Cost				$8,000
Non-Federal First Cost				
Lands, Easements, and Rights-of-Way				$1,000
Relocations				0
Total Non-Federal First Cost				$1,000

TABLE G-4B

KILLINGLY (ROGERS) LOCAL PROTECTION
ANNUAL CHARGES
(1957 Price Levels)

FEDERAL INVESTMENT		
Federal First Cost	$ 8,000	
Interest during construction	-	
Total Federal Investment	$ 8,000	
FEDERAL ANNUAL CHARGES		
Interest	$ 200	
Amortization	80	
Total Federal Annual Charges		$ 280
NON-FEDERAL INVESTMENT		
Non-Federal First Cost	$ 1,000	
Interest during construction	-	
Total Non-Federal Investment	$ 1,000	
NON-FEDERAL ANNUAL CHARGES		
Interest and Amortization	$ 40	
Maintenance and Operation	80	
Major Replacements	-	
Net Loss of Taxes	-	
Total Non-Federal Annual Charges		120
Total Annual Charges		$ 400

TABLE G-5A

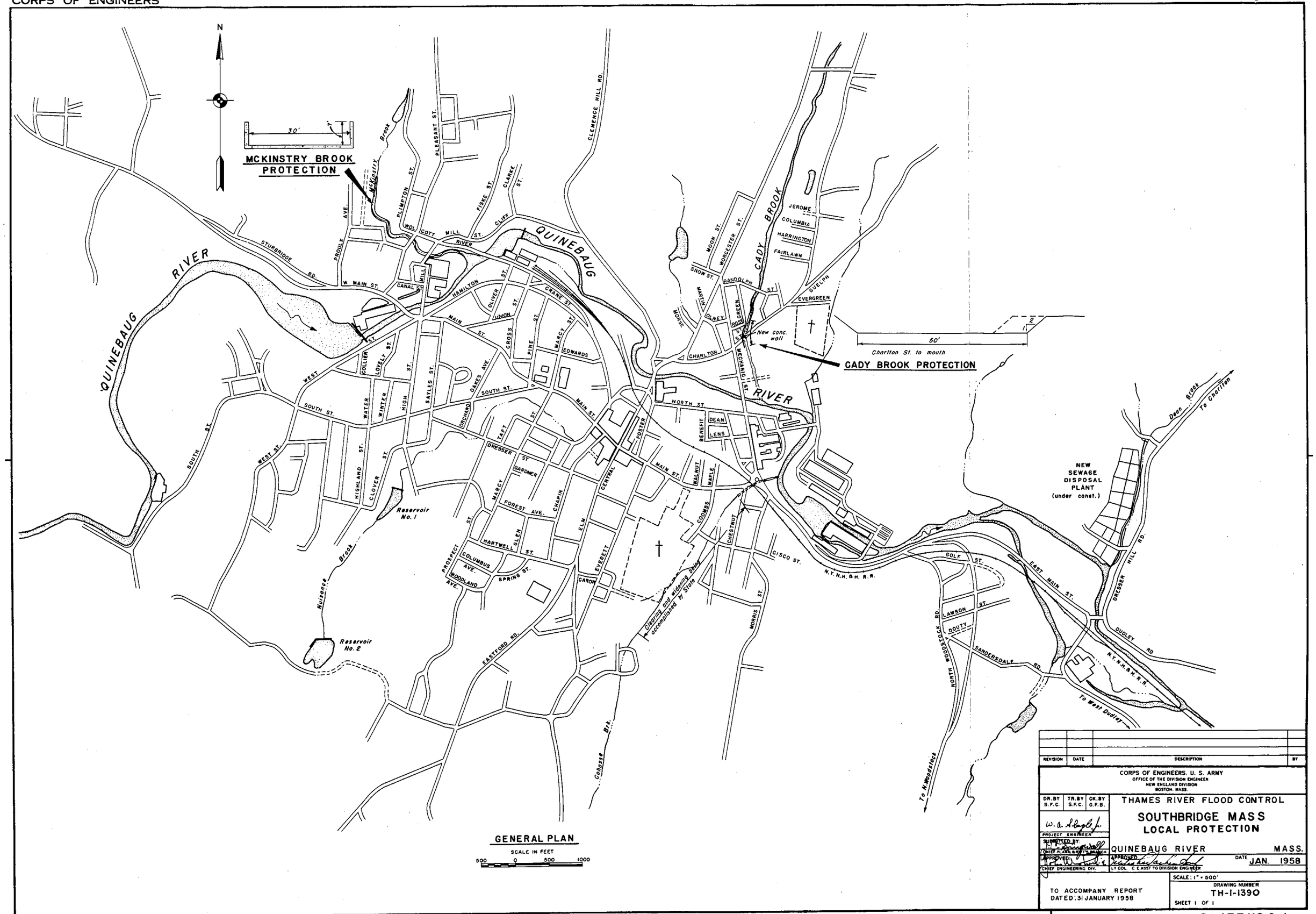
PLAINFIELD (WAUREGAN) LOCAL PROTECTION
FIRST COST
(1957 Price Level)

Description	Quantity	Unit	Unit Price	Amount
Federal First Cost				
Earth Excavation	2,700	c.y.	1.00	$2,700
Random Fill	10,500	c.y.	1.00	10,500
Impervious Fill	5,600	c.y.	1.10	6,200
Dumped Rock	1,150	c.y.	5.50	6,300
Gravel	800	c.y.	2.75	2,200
Topsoil	1,100	c.y.	3.30	3,600
Drainage Facilities	1	job	L.S.	3,500
Subtotal				$35,000
Contingencies				7,000
Subtotal				$42,000
Preauthorization Studies				500
Engineering and Design				6,500
Supervision and Administration				4,000
Total Federal First Cost				$53,000
Non-Federal First Cost				
Lands, Easements, and Rights-of-Way				$ 1,000
Relocations				3,000
Total Non-Federal First Cost				$ 4,000

TABLE G-5B

PLAINFIELD (WAUREGAN) LOCAL PROTECTION
ANNUAL CHARGES
(1957 Price Level)

FEDERAL INVESTMENT		
Federal First Cost	$ 53,000	
Interest during construction	-	
Total Federal Investment	$ 53,000	
FEDERAL ANNUAL CHARGES		
Interest	$ 1,300	
Amortization	500	
Total Federal Annual Charges		$1,800
NON-FEDERAL INVESTMENT		
Non-Federal First Cost	$ 4,000	
Interest during construction	-	
Total Non-Federal Investment	$ 4,000	
NON-FEDERAL ANNUAL CHARGES		
Interest and Amortization	$ 100	
Maintenance and operation	200	
Major Replacements	-	
Net Loss of Taxes	-	
Total Non-Federal Annual Charges		300
Total Annual Charges	$	$2,100



REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS. U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY	TR. BY	CK. BY
S.F.C.	S.F.C.	G.F.B.

PROJECT ENGINEER

SUBMITTED BY: CHIEF PLANN. & REPORTS BRANCH

APPROVED: CHIEF ENGINEERING DIV.

APPROVED: LT COL. C E ASST TO DIVISION ENGINEER

THAMES RIVER FLOOD CONTROL

SOUTHBRIDGE MASS
LOCAL PROTECTION

QUINEBAUG RIVER MASS.

DATE JAN. 1958

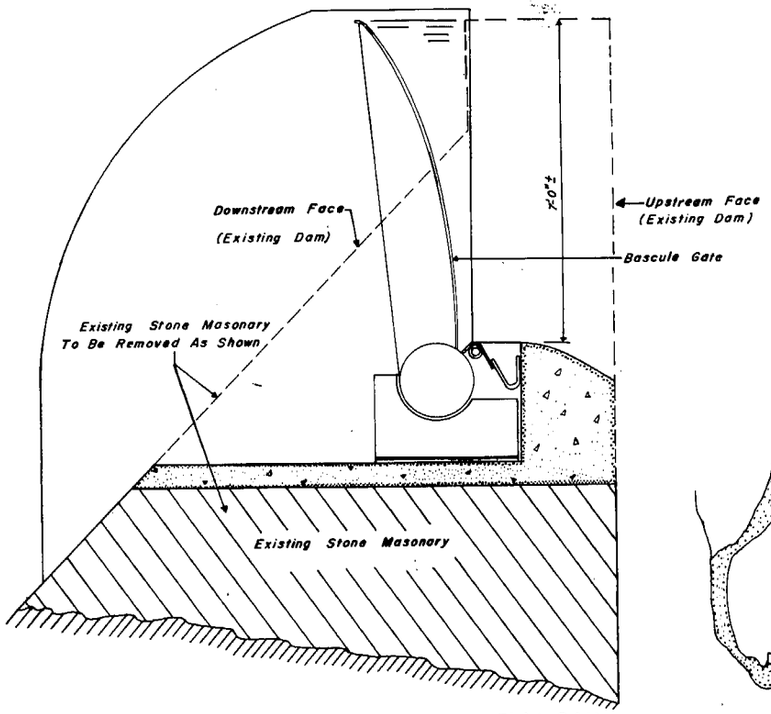
SCALE: 1" = 500'

DRAWING NUMBER TH-1-1390

SHEET 1 OF 1

TO ACCOMPANY REPORT DATED: 31 JANUARY 1958

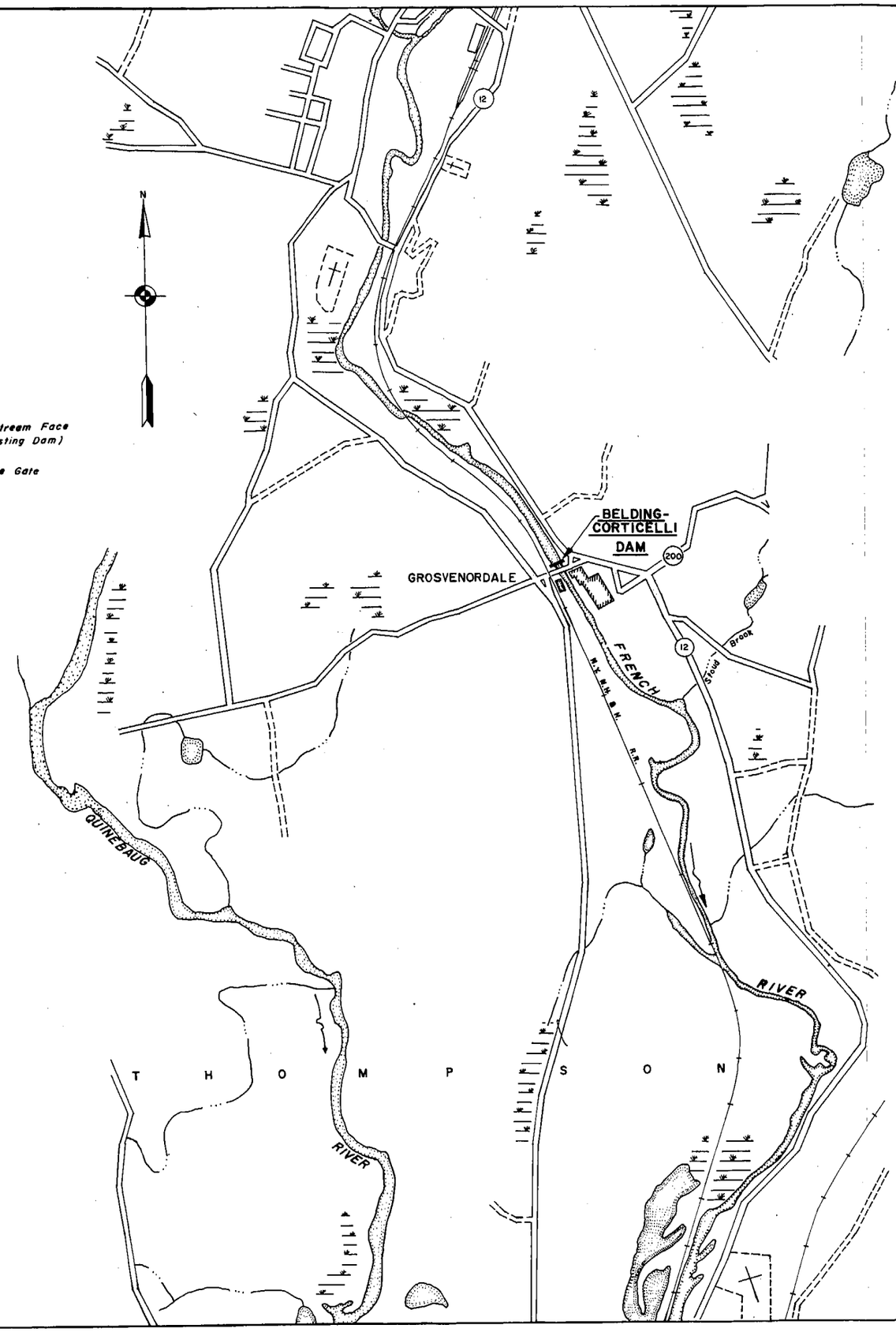
PLATE NO. G-1

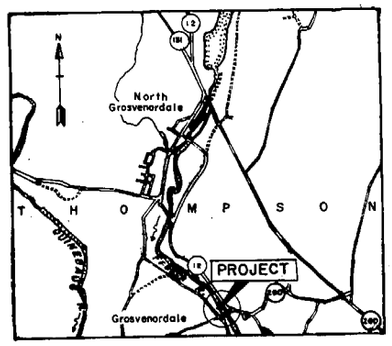


ALTERATIONS TO EXISTING BELDING-CORTICELLI DAM

AT GROSVENORDALE, CONN.

(NOT TO SCALE)





LOCATION MAP

SCALE IN MILES

½ 0 ½ 1 MI.

SCALE 1" = 500'

500' 0 500' 1000'

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS

DR. BY	TR. BY	CK. BY
P.A.D.	G.W.S.	G.F.B.

PROJECT ENGINEER

SUBMITTED BY: CHIEF, PLANS & REPORTS BRANCH

APPROVED: CHIEF ENGINEERING DIV.

THAMES RIVER FLOOD CONTROL

GROSVENORDALE, CONN.

LOCAL PROTECTION

FRENCH RIVER CONN.

APPROVED: LT. COL. C.E. ASST. TO DIVISION ENGINEER

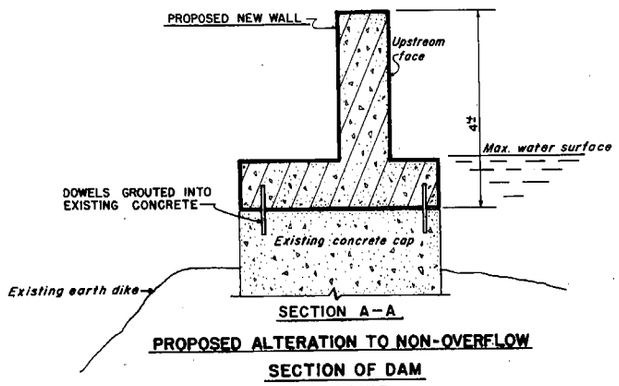
DATE JAN. 1958

SCALE: AS NOTED

TO ACCOMPANY REPORT
DATED: 31 JANUARY 1958

DRAWING NUMBER
TH-1-1388

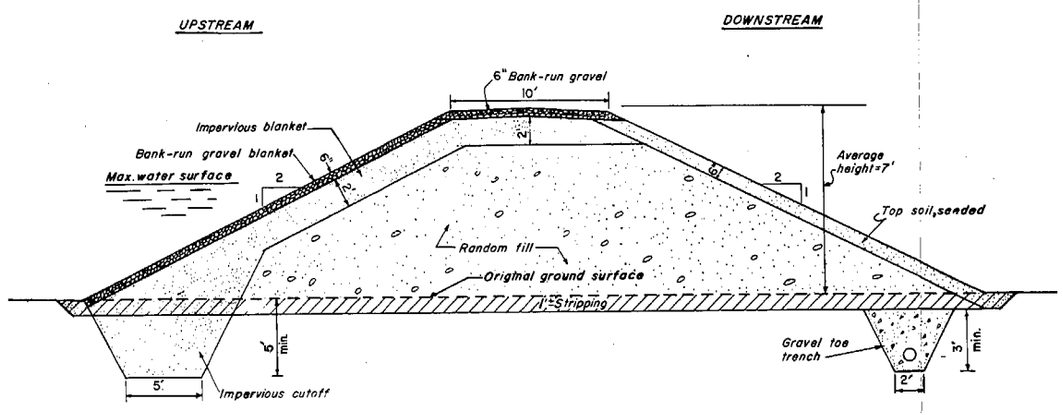
SHEET 1 OF 1



SECTION A–A

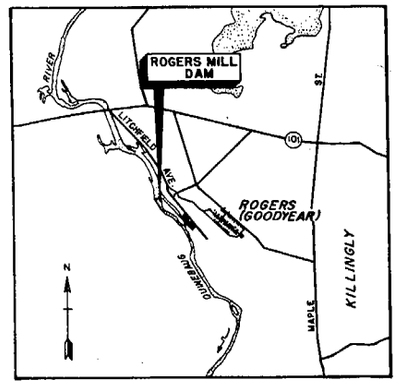
PROPOSED ALTERATION TO NON-OVERFLOW SECTION OF DAM

NOT TO SCALE



TYPICAL SECTION OF DIKE

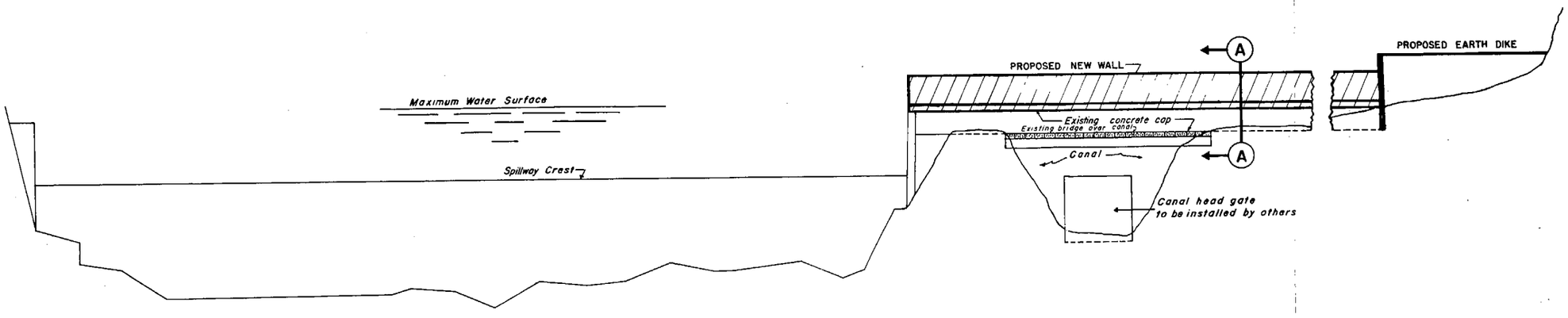
NOT TO SCALE



LOCATION MAP

SCALE IN MILES

½ 0 ½ MI.



DOWNSTREAM ELEVATION

NOT TO SCALE

MODIFICATIONS TO EXISTING ROGERS DAM

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS. U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON MASS

DR. BY	TR. BY	CK. BY
P.A.D.	M.W.B.	G.F.B

W. A. Sleyb, Jr.
PROJECT ENGINEER

SUBMITTED BY
CHIEF, PLANN. & REPORTS BRANCH

APPROVED
CHIEF ENGINEERING DIV.

THAMES RIVER FLOOD CONTROL
KILLINGLY, CONN.
LOCAL PROTECTION
ROGERS
QUINEBAUG RIVER CONN.

APPROVED
LT. COL. C.E. ASST TO DIVISION ENGINEER

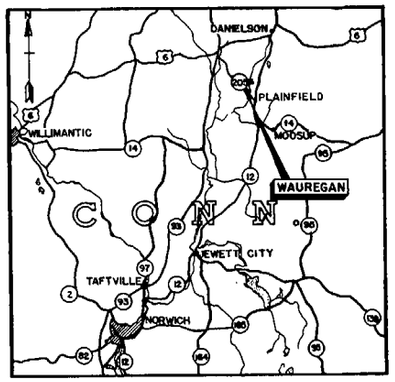
DATE JAN. 1958

TO ACCOMPANY REPORT
DATED 31 JANUARY 1958

SCALE: AS NOTED

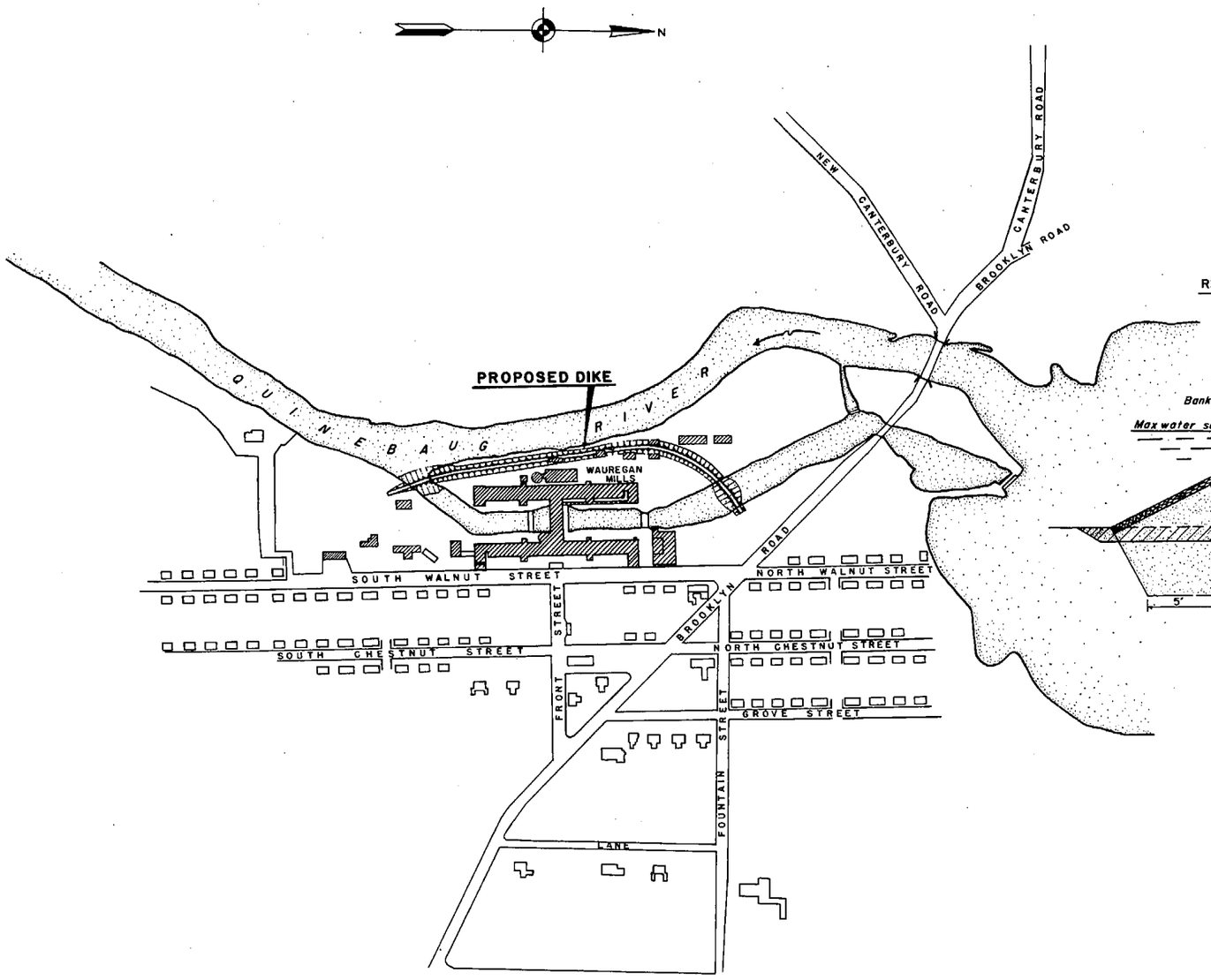
DRAWING NUMBER
TH-1-1385

SHEET: OF 1



LOCATION MAP

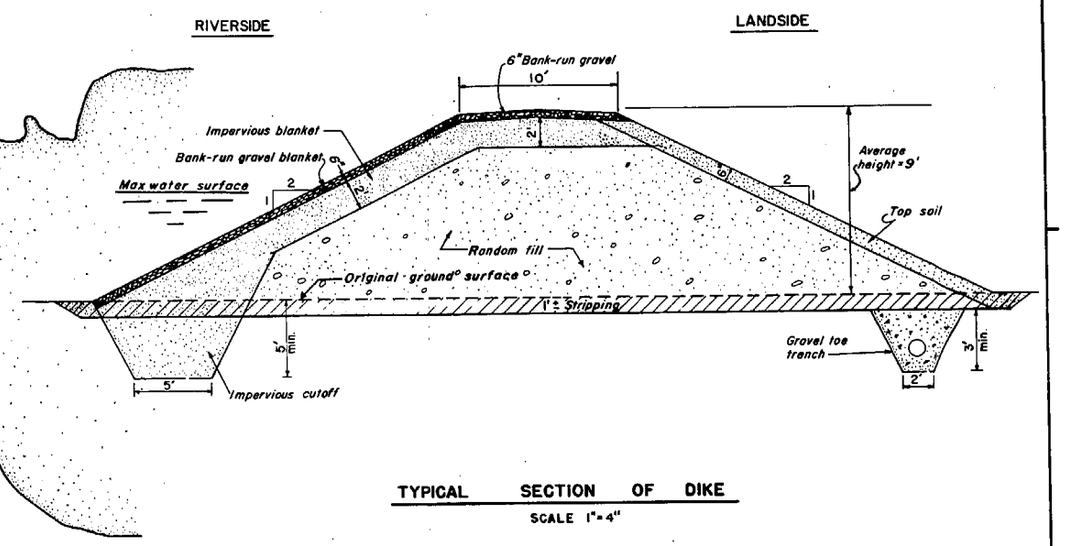
SCALE IN MILES



GENERAL PLAN

SCALE 1"=200'

200' 0 200' 400'



TYPICAL SECTION OF DIKE

SCALE 1"=4"

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS. U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DR. BY P.A.D. | TR. BY M.W.B. | CK. BY G.F.B.

THAMES RIVER FLOOD CONTROL
PLAINFIELD, CONN.
LOCAL PROTECTION
WAUREGAN
QUINEBAUG RIVER CONN.

W. A. Slagle, Jr.
PROJECT ENGINEER
SUBMITTED BY
CHIEF PLANN. & RPT. BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
LT. COL. C.E. ASST. TO DIVISION ENGINEER

DATE JAN. 1958

TO ACCOMPANY REPORT
DATED: 31 JANUARY 1958

SCALE: AS NOTED
DRAWING NUMBER TH-1-1384
SHEET 1 OF 1

PLATE NO. G-4

APPENDIX H

HYDROELECTRIC POWER STUDIES

APPENDIX H

HYDROELECTRIC POWER STUDIES

TABLE OF CONTENTS

Par.		Page
1	General	H-1
2	Site	H-1
3	Reservoir Capacity	H-1
4	Plans Studied	H-1
	a. Alternate 1	H-1
	b. " 2	H-1
	c. " 3	H-2
5	Economic Analysis	H-2
	a. Alternate 1	H-2
	b. " 2	H-2
	c. " 3	H-2
6	Conclusions	H-3

TABLES

	Alternate 1	
H-1	Power Plant Data Sheet	H-4
H-2	Hydroelectric Power Project Estimate	H-5
	Alternate 2	
H-3	Power Plant Data Sheet	H-6
H-4	Hydroelectric Power Project Estimate	H-7
	Alternate 3	
H-5	Power Plant Data Sheet	H-8
H-6	Hydroelectric Power Project Estimate	H-9

PLATE

H-1 West Thompson Dam - Flood Control and Power Study

APPENDIX H

HYDROELECTRIC POWER STUDIES

1. General. Studies were made of 3 multiple-purpose projects (flood control and power) in lieu of a single-purpose flood control project at West Thompson, Conn. The studies were made in sufficient detail to substantiate the conclusions reached.

2. Site. The site selected for study - the same as the recommended West Thompson flood control dam site - is located on the Quinebaug River in the town of Thompson, immediately upstream from the mouth of the French River and approximately 2 miles upstream from Putnam. The drainage area at the site is 173.5 square miles, of which approximately 93.5 square miles would be controlled by the authorized East Brimfield and Westville flood control projects. The location of the site is shown on Plate H-1.

3. Reservoir capacity. The maximum water surface selected for the dual-purpose project was elevation 370 m.s.l. Additional power storage could be used to increase the minimum dependable flow but was not practicable due to excessive property damage in the reservoir area above the selected elevation. The pool thus created would provide 25,600 acre-feet of flood control storage between elevations 358 and 370, equivalent to 6 inches of runoff on the net drainage area of 80 square miles below the authorized East Brimfield and Westville flood control reservoirs; 44,600 acre-feet of usable power storage between elevations 358 and 320; and 7,600 acre-feet of dead storage below elevation 320. The limits of the pools are shown on Plate No. H-1. The conservation storage would provide a minimum dependable flow of 155 cubic feet per second. Load factors of approximately 50% and 10% were used for generating facilities at the site. Two alternative power station locations were investigated.

4. Plans studied.

a. Alternate 1 - Station at dam site - 50% load factor. With an average net head of 54 feet, it would be possible to install a single 2500 horsepower Kaplan turbine direct-connected to a 1500 KVA generator. The average annual output of this plant would be approximately 7.7 million kilowatt-hours. The release of storage would also provide energy at downstream existing plants estimated to be about 3 million kilowatt-hours annually. The plant would have an annual capacity factor of about 73% and a dependable load factor of 51%. Any further peaking is considered undesirable, since existing downstream plants use the water for process purposes as well as for power. A summary of pertinent data is given in Table H-1.

b. Alternate 2 - Station below Putnam - 10% load factor. An average net head of 108 feet could be developed with a power station on the left bank of the Quinebaug River downstream of the center of Putnam. A 16-foot diameter penstock, approximately 13,500 feet in length with a

simple surge tank near the station, would be required. With the minimum dependable flow of 155 cubic feet per second and a dependable load factor of 8.2%, a single 28,000 horsepower Francis turbine direct-connected to an 18,750 KVA generator could be installed. The average annual station output of this plant would be approximately 17,500,000 kwh with an annual capacity factor of about 13%. A summary of pertinent data is given in Table H-3.

c. Alternate 3 - Station at dam site - 10% load factor. An average net head of 62 feet could be developed with a power station at the dam. With a minimum dependable flow of 155 cubic feet per second, and a dependable load factor of 9.5%, a single 12,500 horsepower propeller turbine direct-connected to a 9,375 KVA generator could be installed. The average annual station output of this plant would be 10,500,000 kwh with an annual capacity factor of 16%. A summary of pertinent data is given in Table H-5.

The release of storage would not provide downstream energy in either Alternate 2 or Alternate 3 since utilization of released flow could be provided only by reregulation.

5. Economic analysis.

a. Alternate 1. The estimated first cost of the power features only, exclusive of the allocable costs of dam, reservoir, real estate and relocations, is $536,000 or $447 per kilowatt of installed capacity. The annual costs, including the cost of taxes foregone on an equivalent steam-electric plant, are estimated to be $67,100. Estimated annual benefits, based on a value of $25.00 per kilowatt of installed capacity and 3.3 mills per kilowatt-hour for both the at-site and downstream energy, are $65,300, resulting in a benefit-cost ratio of 0.97 to 1 for power costs only. Summaries of first costs and annual charges are given in Table H-2.

b. Alternate 2. The estimated first cost of the power features for this alternative, exclusive of the allocable costs of dam, reservoir, real estate, and relocations, is $11,867,000, or approximately $790 per kilowatt of installed capacity. The annual costs, including the cost of taxes foregone on an equivalent steam-electric plant, are estimated to be $735,500. Estimated annual benefits, based on at-site values of $25.00 per kilowatt of installed capacity and 3.3 mills per kilowatt hour, are $432,750, resulting in a benefit-cost ratio of 0.59 to 1 for power costs only. Summaries of first costs and annual charges are given in Table H-4.

c. Alternate 3. The estimated first cost of the power features for this alternative is $2,143,000 or $286 per kilowatt of installed capacity. The annual costs, including the cost of taxes foregone on an equivalent steam-electric plant, are estimated to be $254,300. Estimated annual benefits, based on values described above, are $222,150, resulting

in a benefit-cost ratio of 0.87 to 1 for power costs only. Summaries of first costs and annual charges are given in Table 6.

6. Conclusions. Based on the foregoing assumptions and design criteria, it is concluded that a multiple-purpose project on the Quinebaug River near Putnam is not economically feasible at this time. The New York Regional Office of the Federal Power Commission was furnished the results of these studies and has concurred in the conclusions reached (see Exhibits 1 and 2 of Appendix I).

TABLE H-1

POWER PLANT DATA SHEET

ALTERNATE 1

PROJECT West Thompson CAPACITY 1200 K.W.

RIVER BASIN Thames RIVER Quinebaug

OUTPUT 7,700,000 K.W.H. ANNUAL CAPACITY FACTOR 73.2%

DEPENDABLE CAPACITY 1200 K.W. At 51.0 % LOAD FACTOR

AT SITE STORAGE 44,600 A.F. = 1,943 MILLION CU.FT.

DEPENDABLE MIN. FLOW AT SITE 155 CU.FT.PER SEC.

DRAINAGE AREA 173.5 SQ.MI.

GROSS HEAD 68.0 FT. GROSS HEAD AT MAX. DRAWDOWN 30.0 FT.

AV. NET HEAD 54.0 FT. CRITICAL HEAD 40.2 FT.

GENERATOR CAPACITY 1500 KVA 1200 KW AT 80 % PF.

TURBINE 2500 H.P. MAX. AT 54.0 FT. HEAD TYPE Kaplan

EFF. AT RATED KW GENERATOR 94.4% TURBINE 91.5% OVERALL 86.4 %

DISCHARGE AT RATED KW & 54.0 FT. HEAD 304 C.F.P.S.

TABLE H-2

HYDROELECTRIC POWER PROJECT ESTIMATE
ALTERNATE 1
(1,200 KW)

ESTIMATED FIRST COST

Item	Unit	Quantity	Unit Cost	Amount
Intake, Gates and Racks	ea.	2	$ 20,000	$ 40,000
Powerhouse Substructure	c.y.	1,000	100	100,000
Powerhouse Superstructure	c.f.	28,000	1.50	42,000
Turbine and Governors	ea.	1	110,000	110,000
Generators and Excieters	ea.	1	40,000	40,000
Accessory Electric Equip.	L.S.			10,000
Misc. Power Plant Equip.	L.S.			10,000
Roads and Grounds	L.S.			5,000
Subtotal				357,000
Contingencies				71,000
Subtotal				428,000
Engineering and Design				68,000
Subtotal				496,000
Supervision and Administration				40,000
Total				$536,000

NOTE: Does not include Dam and Reservoir Costs

ESTIMATED ANNUAL CHARGES

Public Financing

1.	Total Investment		
	a. First Cost to Constructing Agency		$536,000
	b. Interest During Construction		13,000
	c. Total Investment		549,000
2.	Annual Charges		
	a. Interest and Amortization		19,800
	b. Maintenance and Operation		
	(1) 1,200 kw at $25 /kw.	$30,000	
	(2) Major Replacements	2,900	
	Total Maintenance and Operation		32,900
	c. In Lieu of Taxes(1)		14,400
	Total Annual Charges - Public Financing		$67,100

(1) Alternative Steam Plant 1,200 kw @ $200 = $240,000
Taxes on Alternative @ 6% = $ 14,400

TABLE H-3

POWER PLANT DATA SHEET

ALTERNATE 2

PROJECT West Thompson CAPACITY 15,000 K.W.

RIVER BASIN Thames RIVER Quinebaug

OUTPUT 17,500,000 K.W.H. ANNUAL CAPACITY FACTOR 13.3 %

DEPENDABLE CAPACITY 15,000 K.W. At 8.2 % LOAD FACTOR

UPSTREAM STORAGE 44,600 A.F. = 1,943 MILLION CU. FT.

DEPENDABLE MIN. FLOW AT SITE 155 CU. FT. PER SEC.

DRAINAGE AREA 173.5 SQ. MI.

GROSS HEAD 138 FT. GROSS HEAD AT MAX. DRAWDOWN 100 FT.

AV. NET HEAD 107.6 FT. CRITICAL HEAD 86.1 FT.

GENERATOR CAPACITY 18,750 KVA 15,000 KW AT 80 % P.F.

TURBINE 28,000 H.P. MAX. AT 107.6 FT. HEAD TYPE Francis

EFF. AT RATED KW GENERATOR 96% TURBINE 91% OVER-ALL 87.3 %

DISCHARGE AT RATED KW & 107.6 FT. HEAD 1,890 C.F.P.S.

PENSTOCK DIAM. 16 FT. LENGTH 13,500 FT. MATERIAL Steel

SURGE TANK DIAM. 95 FT. HEIGHT 100 FT. TYPE Simple

TABLE H-4

HYDROELECTRIC POWER PROJECT ESTIMATE
ALTERNATE 2
(15,000 KW)

ESTIMATED FIRST COST

Item	Unit	Quantity	Unit Cost	Amount
Intake, Gates and Racks	ea.	2	$130,000	$ 260,000
Penstock	l.f.	13,500	400	5,400,000
Surge Tank	ea.	1	500,000	500,000
Penstock Valves	ea.	1	180,000	180,000
Powerhouse Substructure	c.y.	6,900	100	690,000
Powerhouse Superstructure	c.f.	325,000	1.50	487,500
Turbines and Governors	ea.	1	375,000	375,000
Generators and Exciters	ea.	1	465,000	465,000
Accessory Electric Equip	L.S.		50,000	50,000
Misc. Power Plant Equip	L.S.		100,000	100,000
Roads and Grounds	L.S.		10,000	10,000
Subtotal				8,517,500
Contingencies				1,703,500
Subtotal				10,221,000
Engineering and Design				767,000
Subtotal				10,988,000
Supervision and Administration				879,000
Total				$11,867,000

NOTE: Does not include Dam and Reservoir Costs

ESTIMATED ANNUAL CHARGES

Public Financing

1. Total Investment		
a. First Cost to Constructing Agency		$11,867,000
b. Interest During Construction		593,000
c. Total Investment		12,460,000
2. Annual Charges		
a. Interest and Amortization		448,600
b. Maintenance and Operation		
(1) 15,000 kw at $ 6 /kw	$90,000	
(2) Major Replacements	16,900	
Total Maintenance and Operation		106,900
c. In Lieu of Taxes(1)		180,000
Total Annual Charges - Public Financing		$735,500

(1) Alternative Steam Plant 15,000 kw @ $200 = $3,000,000
Taxes on Alternative @ 6% = $ 180,000

TABLE H-5

POWER PLANT DATA SHEET

ALTERNATE 3

PROJECT West Thompson CAPACITY 7,500 K.W.

RIVER BASIN Thames RIVER Quinebaug

OUTPUT 10,500,000 K.W.H. ANNUAL CAPACITY FACTOR 16%

DEPENDABLE CAPACITY 7,500 K.W. At 9.5 % LOAD FACTOR

UPSTREAM STORAGE 44,600 A.F. = 1,943 MILLION CU. FT.

DEPENDABLE MIN. FLOW AT SITE 155 CU. FT. PER SEC.

DRAINAGE AREA 173.5 SQ. MI.

GROSS HEAD 68.0 FT. GROSS HEAD AT MAX. DRAWDOWN 30 FT.

AV. NET HEAD 62.7 FT. CRITICAL HEAD 54.3 FT.

GENERATOR CAPACITY 9,375 KVA 7,500 KW AT 80 % PF.

TURBINE 12,500 H.P. MAX. AT 62.7 FT. HEAD TYPE Propeller

EFF. AT RATED KW GENERATOR 95% TURBINE 91.5% OVER-ALL 87 %

DISCHARGE AT RATED KW & 62.7 FT. HEAD 1,625 C.F.P.S.

TABLE H-6

HYDROELECTRIC POWER PROJECT ESTIMATE

ALTERNATE 3
(7,500 KW)

ESTIMATED FIRST COST

Item	Unit	Quantity	Unit Cost	Amount
Intake, Gates and Racks	ea.	2	$ 90,000	$ 180,000
Powerhouse Substructure	c.y.	3,000	100	300,000
Powerhouse Superstructure	c.f.	87,000	1.50	130,500
Turbines and Governors	ea.	1	435,000	435,000
Generators and Exciters	ea.	1	332,000	332,000
Accessory Electric Equip.	L.S.			50,000
Misc. Power Plant Equip.	L.S.			100,000
Roads and Grounds	L.S.			10,000
Subtotal				1,537,000
Contingencies				307,500
Subtotal				1,845,000
Engineering and Design				140,000
Subtotal				1,985,000
Supervision and Administration				158,000
Total				$2,143,000

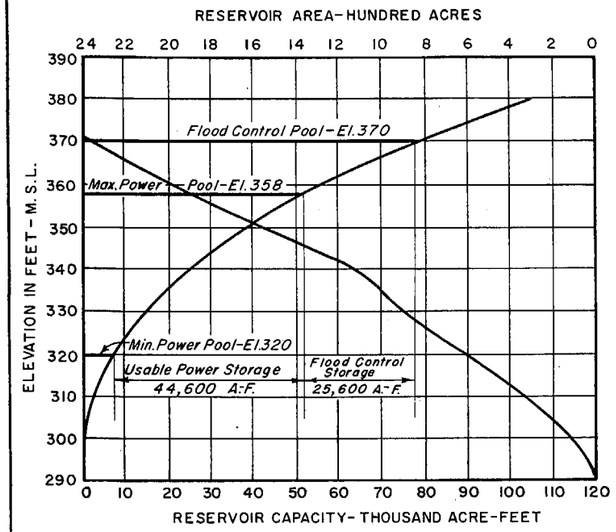
NOTE: Does not include Dam and Reservoir Costs

ESTIMATED ANNUAL CHARGES

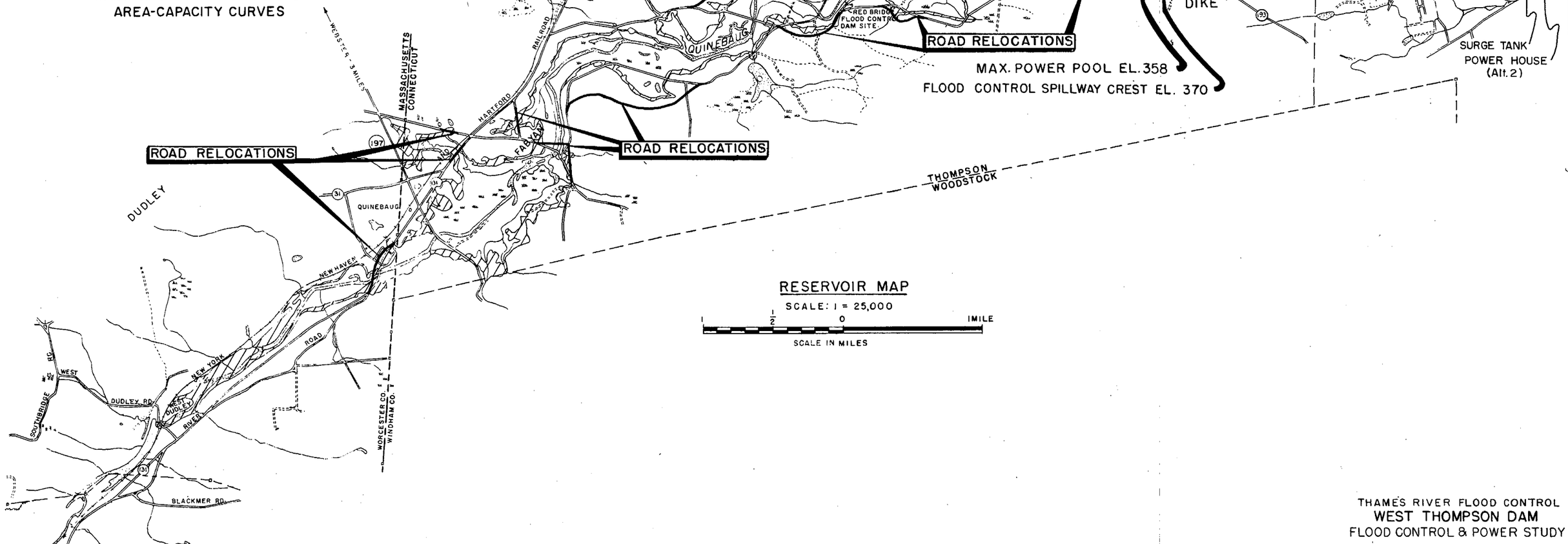
Public Financing

1. Total Investment			
a. First Cost to Constructing Agency			$2,143,000
b. Interest During Construction			107,000
c. Total Investment			2,250,000
2. Annual Charges			
a. Interest and Amortization			81,000
b. Maintenance and Operation			
(1) 7,500 kw at $9 /kw		$67,500	
(2) Major Replacements		15,800	
Total Maintenance and Operation			83,300
c. In Lieu of Taxes(1)			90,000
Total Annual Charges - Public Financing			$254,300

(1) Alternative Steam Plant 7,500 kw @ $200 = $1,500,000
Taxes on Alternative @ 6% = $ 90,000



AREA-CAPACITY CURVES



THAMES RIVER FLOOD CONTROL
WEST THOMPSON DAM
FLOOD CONTROL & POWER STUDY

APPENDIX I

LETTERS OF COMMENT AND CONCURRENCE

APPENDIX I

LETTERS OF COMMENT AND CONCURRENCE

TABLE OF CONTENTS

Exhibit No.	Agency	Letter dated
1	Federal Power Commission	Dec 20, 1957
2	" " "	Aug 9, 1957
3	U. S. Fish & Wildlife Service	Feb 11, 1958
4	" " " "	Jan 30, 1957
5	U. S. Bureau of Public Roads	Nov 27, 1957
6	" " " "	Jan 28, 1957
7	Conn. Water Resources Comm.	Oct 22, 1957
8	Conn. Flood Control & Water Policy Comm. (now Water Resources Comm.)	Jan 9, 1957
9	Conn. Board of Fisheries & Game	Dec 12, 1956
10	Conn. State Highway Dept	Dec 17, 1957
11	Mass. Dept of Public Works	Jun 28, 1957
12	N.E.D. to Dept of Public Works	Mar 13, 1957
13	Mass. " " " "	Jan 7, 1957

FEDERAL POWER COMMISSION
REGIONAL OFFICE
139 CENTRE STREET, NEW YORK 13, N. Y.

December 20, 1957

The Division Engineer
Corps of Engineers, U. S. Army
New England Division
150 Causeway Street
Boston 14, Massachusetts

Subject: Memorandum Report on Power Study,
West Thompson Dam, Quinebaug River,
Connecticut

Dear Sir:

Pursuant to your request we have reviewed the subject report transmitted with your letter of November 15, 1957 and concur in your findings that the multiple-purpose development of the West Thompson site for power and flood control is not economically feasible at this time.

We are pleased to note that your further studies of this site, as suggested in our letter of August 9, 1957, indicate that the site appears to be more favorable for flood control only than the site previously considered by your office upstream at Red Bridge, and will be recommended in your forthcoming report. It is our opinion that the West Thompson site is best adapted to any comprehensive plan for the development of the water resources of the Quinebaug River basin.

Sincerely yours,

John H. Spellman

John H. Spellman
Deputy Regional Engineer

EXHIBIT I

FEDERAL POWER COMMISSION
REGIONAL OFFICE
139 CENTRE STREET, NEW YORK 13, N. Y.

August 9, 1957

The Division Engineer
Corps of Engineers, U. S. Army
150 Causeway Street
Boston 14, Massachusetts

Dear Sir:

Reference is made to your letter of June 17, 1957 transmitting copy of a memorandum report summarizing the results of your investigation of the possible multiple-purpose development of a potential site on the Quinebaug River above Putnam, Connecticut. Pursuant to your request, there is presented in the following our comments thereon.

The site is located on the Quinebaug River in the Town of Thompson immediately upstream of its confluence with the French River and about three miles downstream of the proposed Red Bridge site currently under consideration for flood control. The drainage area at this point is 173.5 square miles of which about 93.5 square miles would be controlled by the authorized East Brimfield and Westville flood control projects. The plan of development considered would provide 25,600 acre-feet of flood control storage and 44,600 acre-feet of usable power storage. Installed capacity amounts to 1200 kilowatts capable of generating about 7.7 million kilowatt-hours of average annual energy. It was also estimated that release of storage would result in increased energy output at existing downstream hydroelectric plants, amounting to about 3.0 million kilowatt-hours annually.

The estimated first cost of the power features, exclusive of dam and reservoir costs properly chargeable to power, is given in the report as $800,000 and the annual cost as $74,600. With estimated annual power benefits of $65,200, the benefit-cost ratio amounts to 0.88 to 1.0. In view of the unfavorable results of the economic analysis, it is concluded that development of the site for power and flood control is not economically feasible at this time. It was therefore recommended that no further studies be made of the site at this time.

EXHIBIT 2

This office concurs in your findings with respect to the feasibility of developing the relatively small amount of power available with the power plant located at the site and designed for high load factor operation. In the plan considered by our staff, the power plant would be located downstream near the mouth of Muddy Brook below Putnam. A penstock about 9,500 feet in length would convey water from the reservoir to the plant under a gross head of about 140 feet. The plant would be designed for peaking use with an installed capacity of about 15,000 kilowatts. A reregulating pond could be provided by raising or reconstructing the existing dam at Danielson.

It is realized that from an economic and practical point of view this suggested plan could only be carried out in the future when redevelopment of existing plants in the Putnam area might be under consideration as well as the need for additional conservation storage for water supply and stream flow regulation. As pointed out in your report, raising of the proposed reservoir level at the Red Bridge site initially or in the future is precluded by excessive property damage in the reservoir area. Such does not appear to be the case at the lower site which could be constructed initially for flood control to about elevation 340, with provisions made for future raising to about elevation 370.

Based on our review of your memorandum report and upon preliminary staff studies of the Red Bridge site and its alternative, it is concluded that the latter is best adapted to a comprehensive plan for the development of the water resources of the Quinebaug River and therefore merits your further consideration before a final selection of a site for the proposed flood control project is made.

Sincerely yours,

D. J. Wait
Regional Engineer

By John H. Spellman
Acting

REGION 5

NEW ENGLAND STATES
NEW YORK
PENNSYLVANIA
NEW JERSEY
DELAWARE
WEST VIRGINIA

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
OFFICE OF REGIONAL DIRECTOR
BLAKE BUILDING
BOSTON 11, MASSACHUSETTS

IN REPLY REFER TO:

February 11, 1958

Division Engineer
New England Division
U.S. Corps of Engineers
150 Causeway Street
Boston 14, Massachusetts

Dear Sir:

Reference is made to your letter of October 4, 1957 in which you requested comments from this office in relation to the West Thompson Flood Control Reservoir, Connecticut, proposed as a possible alternate to the Red Bridge project, Thompson, Connecticut, and Dudley, Massachusetts.

The West Thompson Flood Control Reservoir Dam would be located on the Quinebaug River one and one-half miles above Putnam, Connecticut, one-quarter mile upstream from the mouth of the French River, and three and one-half miles downstream from proposed Red Bridge Dam. At the spillway crest elevation of 341 feet the reservoir would pond an area of 1,200 acres and would inundate approximately six and one-half miles of the Quinebaug River. The reservoir site, located in a region of moderately high populations, has about 30 homesites within the proposed maximum flowline. Bottomland in the lower mile or more of the reservoir site consists primarily of pasture with some cultivated land. On the sloping uplands and the bottomlands in the upper portions of the reservoir site the vegetative types consist of marsh, bottomland brush, upland brush, old fallow fields, mixed second-growth woodland, and mature solid stands of white pine. Young white pine are scattered throughout much of the mixed woodland on the slopes.

Game species inhabiting the reservoir area are pheasants, cotton-tail rabbits, gray squirrels, ruffed grouse, and woodcock. Pheasant hunting is particularly popular in the area and pheasants are stocked annually in the vicinity of the reservoir site by the State Board of Fisheries and Game. The diversity of land-use types within and adjacent to the reservoir site provides good habitat for the resident game species. Completion of the project would adversely affect wildlife to a moderate degree as a result of periodic flooding of habitat. Pheasants and cotton-tail rabbits would suffer the greatest losses.

EXHIBIT 3

The Quinebaug River is polluted by industrial and domestic wastes and the value of the fishery resources within the proposed reservoir site are very low. Tributaries entering the Quinebaug River in the reservoir area are small and have little or no fishery resources. Retardation of flood waters might have a beneficial effect on the poor fishery habitat downstream from the dam through reduction of scouring action on the stream bottom.

Existing maps and engineering data for the proposed West Thompson project are preliminary. However, the topographic and vegetative characteristics of the reservoir site appear to offer good to excellent possibilities for development for upland game and/or waterfowl. It is of foremost interest that an estimated 800 acres might be taken in fee and could, therefore, be available for development. For example, a pool held at the dam at elevation 300 feet (mean sea level datum) would inundate about 160 acres. Maximum depth of the pool would be 10 feet and a considerable portion of the pool would be less than 4 feet deep. This pool would utilize only 2.2% of the proposed reservoir storage capacity, the amount of water the reservoir would receive from an 0.15-inch rainfall. A pool of this type would have considerable value to waterfowl and other wildlife, particularly in conjunction with development of bordering uplands. Further, there exists the possibility that at some future time, following pollution abatement, such a pool might develop a fishery resource. The possibility pointed out above is mentioned at this time so that fish and wildlife development potentials may be considered in the early stages of project planning.

The State Board of Fisheries and Game is particularly interested in the section of the Quinebaug River Valley in which this proposed project is located since it is good open-land wildlife habitat. Habitat areas of this type are relatively scarce in this region and are highly important since they can provide excellent hunting opportunities. The Board would like to know, at the earliest possible date, just what lands will be acquired in fee and on which lands flowage easements will be obtained. They are interested in obtaining, through acquisition or lease, rights for public hunting on flowage easement lands.

The Connecticut Board of Fisheries and Game has a long-range program to develop the fish and game resources of this drainage system. Restoration of anadromous, or sea-run, fish will undoubtedly comprise a major element in this over-all development program. However, there are several substantial impediments to a restoration program, such as pollution and existing dams not equipped with fishways. In view of the magnitude of restoration problems already present, together with the anticipated location of the West Thompson Project in the upper waters of the basin, no positive recommendations concerning a fish passage device are indicated at this time. When various existing problems are solved the situation at West Thompson will require re-examination and it is possible that alterations in project operations together with a fish-passage facility, might be requested.

It is recommended:

(1) That the following language be incorporated in the recommendations of the report of the Division Engineer of the Corps of Engineers: That additional detailed studies of fish and wildlife resources be conducted, as necessary, after the project is authorized, in accordance with Section 2 of the Act of August 14, 1946 (60 Stat.1080); and such reasonable modifications be made in the authorized project facilities as may be agreed upon by the Director of the Fish and Wildlife Service and the Chief of Engineers, for the preservation and propagation of fish and wildlife resources.

(2) That the following language be incorporated in the report of the Divisional Engineer, Corps of Engineers: That Federal lands and project waters in the project area be open to free use for hunting and fishing so long as title to the lands and structures remains in the Federal Government, except for sections reserved for safety, efficient operation, or protection of public property.

(3) That the following language be incorporated in the reports of the Divisional Engineer, Corps of Engineers: That leases of Federal land in the project area reserve the right of free public access for hunting and fishing.

(4) The Report of the Divisional Engineer, Corps of Engineers, should include the preservation and propagation of fish and wildlife resources among the purposes for which the project is to be authorized.

This office welcomes the opportunity to comment on this project during the preliminary planning stage. Detailed reports will be prepared when required by your office.

Sincerely yours,

E. W. Bailey
Acting Regional Director

REGION 5

NEW ENGLAND STATES
NEW YORK
PENNSYLVANIA
NEW JERSEY
DELAWARE
WEST VIRGINIA

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

OFFICE OF REGIONAL DIRECTOR
BLAKE BUILDING
BOSTON 11, MASSACHUSETTS

IN REPLY REFER TO:

January 30, 1957

Division Engineer
New England Division
Corps of Engineers
150 Causeway Street
Boston 14, Massachusetts

Dear Sir:

Reference is made to your letter of 18 December 1956 in which you requested comments from this office in relation to the Red Bridge Flood Control Reservoir in Thompson, Connecticut and Dudley, Massachusetts.

The Red Bridge Flood Control Reservoir would be located on the Quinebaug River five miles above Putnam, Connecticut and three and three-quarters miles upstream from the mouth of the French River. At the spillway crest elevation of 370 feet the reservoir would pond an area of 1,125 acres. At the same pool elevation the reservoir would inundate a total of six and a quarter miles of the Quinebaug River upstream from the dam site, with the major portion of the pool located in Connecticut. While the site is situated in a well populated region, the area within the proposed flowline includes few homesites or farmsteads. While there are a few areas of bottomland brush, marshland and old fields within the site, the major part is about evenly divided between agricultural lands and second-growth woodlands with a fair amount of coniferous tree species.

The pheasant is a popular game species in the area and both states carry out pheasant stocking within the immediate vicinity of the site. Cottontail rabbits, gray squirrels, ruffed grouse and woodcock range over portions of the site. Since the scattered agricultural lands are divided and dissected by woodland and other cover types, the area represents good to excellent habitat for several of the above game species. Slight damages to wildlife may be expected as a result of assumed periodic flooding.

The Quinebaug River is polluted by industrial and domestic wastes and the fishery values of the river are negligible at the present time. The tributaries of the river which occur within the reservoir site have slightly higher fishery values than the river itself, but utilization is low. It is anticipated that fishery losses from periodic flooding will probably be low under present conditions.

EXHIBIT 4

There are two sites which represent opportunities for the creation of permanent pools. A pool at the dam site at an elevation of 330 feet would inundate about 195 acres and utilize about five percent of the total reservoir storage capacity. While approximately 65 acres of this pool would be ten or more feet deep the remainder would be less than ten feet deep. With further investigation it may be possible to determine a pool elevation below the 330 foot contour which would provide a maximum amount of shoal waters which could have significant wildlife values. The other possible site for a pool is on the main stream just above the bridge at Fabyan, Connecticut, approximately three miles upstream from the reservoir dam site. There is at present an existing low dam just above this bridge. A pool elevation at 350 feet would cover about 199 acres with water ten feet deep or less and utilize about four percent of the total storage capacity of the reservoir. Since most of the area which would be included in this pool is relatively flat, a shallow pool could develop significant wildlife values. These possibilities for the creation of permanent pools are pointed out at this time due to the desirability of their being considered in early planning stages. It is probable that the full value of such pools for all types of recreational uses, including fishing and hunting, may not be realized at this site until such time as the pollution of the river is abated. Both states would desire public access for the purpose of hunting and fishing on the site. The State of Connecticut has advised us of its desire to learn in advance how the federal agency proposes to gain control of project lands to the end that if hunting and fishing rights are not vested in the federal agency the state may consider their acquisition.

The State of Connecticut Board of Fisheries and Game has a long-range program to develop the fish and game resources of this drainage system. Restoration of anadromous, or sea-run, fish will undoubtedly comprise a major element in this over-all development program. However, there exist several substantial impediments to a restoration program, such as pollution and dams not equipped with fishways. In view of the magnitude of restoration problems already present, together with the anticipated location of the Red Bridge Project in the upper waters of the basin, no positive recommendations concerning a fish passage device are indicated at this time. When various existing problems are solved the situation at Red Bridge will require re-examination and it is possible that alterations in project operations, together with a fish-passage facility, might be required.

In addition to the general considerations outlined above, certain specific recommendations are indicated in regard to this project.

(1) Additional detailed studies be conducted, as necessary, after the project is authorized, in accordance with Section 2 of the Act of August 14, 1946 (60 Stat. 1080); and such reasonable modifications be made in the authorized project facilities as may be agreed upon by the Director of the Fish and Wildlife Service and the Chief of Engineers, for the preservation and propagation of fish and wildlife resources.

(2) Federal lands and project waters in the project area be open for free use for hunting and fishing as long as title to the lands and structures remains in the Federal Government, except for sections reserved for safety, efficient operation, or protection of public property.

(3) Leases of Federal land in the project area reserve the right of free public use of such land for hunting and fishing.

(4) The report of the District Engineer include the preservation and propagation of fish and wildlife resources among the purposes for which the project is to be authorized.

This office welcomes the opportunity to comment on these projects during preliminary planning stages. Detailed reports will be prepared when required by your office.

Sincerely yours,

D. R. Gascoyne
Regional Director

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

500 Capitol Avenue
Hartford 6, Conn.

November 27, 1957

Mr. John Wm. Leslie, Chief
Engineering Division
Corps of Engineers, U. S. Army
150 Causeway Street
Boston 14, Mass.

Dear Mr. Leslie:

RE: Your file No. NEDGW

Thank you for your letter of October 4, 1957 enclosing a map showing an alternate to the Red Bridge project at West Thompson, Connecticut. Our comments with respect to this alternate flood control dam and its affects on Federal-aid highways in the area are as follows:

(1) There are three Federal-aid routes within the limits of your map in the town of Thompson, namely,

FA Secondary Route 195 - Connecticut
Route 193 beginning at Mechanicsville on Conn. Route 12 and running northeasterly to the Conn.-Mass. Stateline

FA Secondary Route 196 - Connecticut
Route 131 beginning near North Grosvenordale on Conn. Route 12 and running northwesterly to the Conn.-Mass. Stateline

FA Primary Route 4 - Connecticut
Route 12 running north-south through Thompson.

(2) On the basis of your map, none of these existing Federal-aid routes will be affected by the proposed flood control projects. Although the State is planning a relocation of FAP Route 4 through Thompson, the new location will probably be further east from its present location in the direction away from the Quinebaug River.

EXHIBIT 5

Of course we cannot speak for the State or the Town with respect to the affects of the dam on any of the non-Federal-aid highways in the area. Perhaps you have already communicated with the Town and the State in connection with these local roads.

We hope this information will be of value to you.

Very truly yours,

Leo Grossman

Leo Grossman
Division Engineer

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

500 Capitol Avenue
Hartford 6, Conn.

January 28, 1956

Mr. John Wm. Leslie, Acting Chief Engineering Division
Corp of Engineers, U. S. Army
Office of the Division Engineer
150 Causeway Street
Boston 14, Mass.

Dear Sir:

RE: Your file No. NEDGW

In response to your letter of December 18 requesting our comments regarding the proposed dam at Red Bridge just upstream of Putnam, Connecticut, we submit the following comments:

(1) We have discussed the proposed project with the State and from an inspection of the maps sent us with your letter, it seems that the effect on Federal-aid highways of the proposed dam is small. The only effect seems to be on Connecticut Route 131(Federal-aid Secondary Route 196) just northwest of its intersection with Dudley Oxford Road. Probably some minor amount of grading for approximately 400 or 500 feet will raise this section of roadway above the water level.

(2) The State has advised us that since Route 131 is presently considered adequate, they do not plan any improvements or re-allocations in the vicinity of the dam in the foreseeable future.

If you should have specific questions not covered by our above comments, please advise and we shall attempt to answer them. We have not attempted to make comments regarding non-Federal aid highways affected by the dam since normally we have no authority over such highways.

Very truly yours,

Leo Grossman

Leo Grossman
District Engineer

EXHIBIT 6

STATE OF CONNECTICUT
WATER RESOURCES COMMISSION
STATE OFFICE BUILDING HARTFORD 15, CONNECTICUT

October 22, 1957

Division Engineer
Corps of Engineers, U.S. Army
New England Division
150 Causeway Street
Boston 14, Massachusetts

Re: Quinebaug River Flood Control
West Thompson Dam

Dear Sir:

Reference is made to your letter of September 19, 1957 requesting comments on your study of the West Thompson site as an alternate to the Red Bridge site for a flood control dam on the Quinebaug River in the Town of Thompson.

It appears that, from a flood control point of view, our comments on the Red Bridge site apply equally well to the West flows at Putnam and simplify the problems of providing local protection structures at Putnam and other towns along the Quinebaug River.

The West Thompson site requires a longer and probably more expensive dam; however, it is recognized that reduction in other costs such as those for real estate may compensate for greater construction costs.

The Commission considers a fifth dam above Putnam an important and desirable element in providing flood control for the Quinebaug Valley and in particular the City of Putnam and will support the solution which is more economical and suitable.

Without more details, the construction of an economic dual purpose hydropower - flood control reservoir at this site appears questionable. In any case it is our hope that consideration of power development will not delay your preparation of a report and recommendations on flood control for Putnam.

We will appreciate your keeping us informed as these alternate reservoir plans are developed.

Very truly yours,

William S. Wise

William S. Wise
Director

WSW/CJP/p

EXHIBIT 7

STATE OF CONNECTICUT
FLOOD CONTROL AND WATER POLICY COMMISSION
STATE OFFICE BUILDING HARTFORD 15, CONNECTICUT

January 9, 1957

Division Engineer
Corps of Engineers, U. S. Army
New England Division
150 Causeway Street
Boston 14, Massachusetts

Attention: John W. Leslie
Acting Chief, Engineering Division

Dear Sir:

Reference is made to your letter of December 21, 1956 requesting our comments on the proposed dam at Red Bridge on the Quinebaug River in the Town of Thompson.

We have realized the difficulty of providing satisfactory local protection through the Town of Putnam through our work on the setting of stream encroachment lines within the town. The information obtained in this work and the conclusions from conferences with engineers in your office indicate that even with the construction of the four authorized dams on the Upper Quinebaug and French Rivers the residual flood through Putnam would be so large that local protective works would be most difficult and costly.

The construction of a dam at Red Bridge, of the type outlined in your letter, would so reduce the residual flows that local works could provide a high degree of flood protection to Putnam at a reasonable cost. We have expressed willingness in conference with personnel of your office and at a public hearing to construct certain local works within the limit of our available funds. The carrying out of this work would be quite feasible if the Red Bridge Dam became an authorized project so that we could base the design of such local protective works upon the probability of its future construction. Without the Red Bridge Dam any local works to prevent damaging flows through the railroad cut would cause flood flows in the main channel greater than any which have occurred to date without reservoir protection. If Red Bridge Dam were authorized we probably could provide protection against a flood slightly higher than the residual which could occur after it was constructed, thus providing a fairly high degree of flood protection in the interim of time until the final completion of the Red Bridge Dam.

EXHIBIT 8

This project, therefore, is important in our plans to provide flood protection for Putnam. We would strongly favor the construction of this project and we hope that the comments we make above will be taken into consideration in viewing the economic feasibility of this project. Furthermore, the dislocation of property within the reservoir area will be a minimum in relation to the benefits to be derived.

We are advised that the officials of the City of Putnam are also interested in seeing this project become part of the Thames River comprehensive plan, and know that they have so expressed themselves at public hearings. Although the problems of communities downstream from Putnam are not as much affected because damage was not as extensive during the recent floods, there seems to be no doubt that it would be logical to also provide protection against flood damage which may occur in future storms at these downstream localities. We feel that if local protective work cannot be designed on a reasonable basis in Putnam without the Red Bridge Dam project then the same would also apply to downstream communities.

Very truly yours,

FLOOD CONTROL AND WATER POLICY COMMISSION

By William S. Wise
William S. Wise, Executive Secretary

WSW:JJC/jb

STATE OF CONNECTICUT
BOARD OF FISHERIES AND GAME
2 WETHERSFIELD AVENUE · HARTFORD, CONNECTICUT

ADDRESS ALL MAIL TO
STATE OFFICE BUILDING, HARTFORD 15

December 12, 1956

Division Engineer
Corps of Engineers, U.S. Army
Office of the Division Engineer
New England Division
150 Causeway Street
Boston 14, Massachusetts

Dear Sir:

Reference is made to notice of public hearing on Quinebaug and French Rivers dated 16 November 1956.

This agency has a long-range hope that pollution abatement and construction of adequate fishways in Connecticut and Massachusetts will restore important runs of anadromous fishes to the Thames River drainage system. Our chief concern in any of the flood control works to be considered in accordance with the subject notice is that no impassable barrier to the migration and free passage of such fishes be created.

Very truly yours,

Lyle M. Thorpe
Director

LMT/ln

EXHIBIT 9

STATE OF CONNECTICUT
STATE HIGHWAY DEPARTMENT
STATE OFFICE BUILDING · HARTFORD 15, CONNECTICUT

P. O. Box 2188
Hartford, Connecticut
December 17, 1957

Division Engineer
New England Division
Corps of Engineers, U.S. Army
150 Causeway Street
Boston 14, Massachusetts

Re: Quinebaug River Flood Control
West Thompson Dam

Dear Sir:

This will confirm telephone conversation of this date between Mr. Slagle of your office and Dr. Robert A. Norton, Hydraulics Engineer for the Connecticut Highway Department, concerning the proposed flood control dam on the Quinebaug River at West Thompson, as submitted to the Water Resources Commission by your letter of 19 September 1957.

The U.S. Geological Survey topographic map, Putnam Quadrangle, edition of 1945, indicates that Route 193 passes through the reservoir site just north of the proposed dam. Records of the State Highway Department have been checked and this section of highway is not part of the State System. Route 193 begins at the junction with Route 12 and proceeds east and north to the Massachusetts State Line.

It is noted that the proposed spillway crest is at Elevation 341 and that the bridge over the Quinebaug on Route 197 could possibly be affected if the flow over the spillway is of any great depth. It is considered that, before final plans for the West Thompson site are completed, the grades of Route 197 in the vicinity of the Quinebaug River should be checked to insure that backwater from the reservoir will not flood the highway.

Very truly yours,

NEWMAN E. ARGRAVES
State Highway Commissioner

By Ernest T. Perkins
Ernest T. Perkins
Assistant Chief Engineer

EXHIBIT 10

The Commonwealth of Massachusetts

Department of Public Works

Division of Waterways

100 Nashua Street, Boston 14

June 28, 1957

Division Engineer
Corps of Engineers
150 Causeway St.
Boston, Mass.

Dear Sir:

Reference is made to your letter of March 13 relative to the proposed Red Bridge flood control dam and reservoir on the Quinebaug River.

In particular regard to the houses in Dudley, Mass, where we have asked your office for an investigation of a dike in lieu of removing the houses we feel that there is more involved than costs. Insofar as the entire benefit from this proposed reservoir is in the State of Connecticut we believe that the additional cost should be included in the cost of the reservoir borne by the Corps of Engineers or by the State of Connecticut.

Very truly yours,

Rodolphe G. Bessette

RODOLPHE G. BESSETTE
Director, Division of Waterways

EXHIBIT 11

COPY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
150 CAUSEWAY STREET
BOSTON 14. MASS.

ADDRESS REPLY TO:
DIVISION ENGINEER

REFER TO FILE NO.
NEDGW

13 March 1957

Mr. Rodolphe G. Bessette
Director, Division of Waterways
Department of Public Works
100 Nashua Street
Boston 14, Massachusetts

Dear Mr. Bessette:

Reference is made to your letter of January 7 relative to the proposed Red Bridge flood control dam and reservoir on the Quinebaug River above Putnam, Connecticut.

In accordance with your suggestion, this office has investigated the feasibility of protecting the houses in the Dudley area with a dike in lieu of purchasing and removing those structures within the reservoir area. Preliminary studies indicate that a dike with necessary drainage facilities would cost approximately $272,000. Appraisers from this office have visited the area and estimate that the current market value of the property thus protected, including acquisition and resettlement costs, is $190,000. Sketches showing the alternative solutions are inclosed. Costs of necessary relocation of Route 131 and a new bridge over the Quinebaug River are approximately the same in either case and are not included in the above figures.

It would therefore appear to be more economical to purchase the property than to provide the necessary protection. However, if the Commonwealth or responsible local interests are willing to contribute the additional cost for the dike protection, this fact will be taken into consideration by this office. Your comments would be appreciated.

FOR THE DIVISION ENGINEER:

Very truly yours,

/s/ Byron G. Belote

BYRON G. BELOTE
Lt. Colonel, Corps of Engineers
Assistant Division Engineer

Incls-2 Sketches,
Area "C"

COPY

EXHIBIT 12

The Commonwealth of Massachusetts

Department of Public Works

100 Nashua Street, Boston 14

January 7, 1957

Brigadier General Robert J. Fleming, Jr.
Division Engineer, New England Division
Corps of Engineers
150 Causeway Street
Boston, Massachusetts

Dear Sir:

Reference is made to a letter from your Division, dated December 27, 1956, regarding the proposed Red Bridge flood control reservoir on the Quinebaug River.

It would appear that the only serious objection that may be raised in the Commonwealth would be the removal of 16 dwelling houses in the Town of Dudley. Fifteen of these buildings are concentrated in a small area, and it is urged that the Corps of Engineers investigate the feasibility of protecting the area with a dike.

Very truly yours,

RODOLPHE G. BESSETTE
Director, Division of Waterways

EXHIBIT 13