CONNECTICUT RIVER

NEW HAMPSHIRE, VERMONT,
CONNECTICUT AND MASSACHUSETTS

REVIEW OF REPORTS ON FLOOD CONTROL

APPENDIX - VOLUME 2

1944

SECTION 5 - RESERVOIRS - DETAILS & ESTIMATES

UNITED STATES ENGINEER OFFICE
PROVIDENCE, RHODE ISLAND
28 FEBRUARY 1940
REVISED 18 DECEMBER 1944

REVIEW OF REPORTS ON SURVEYS OF THE CONNECTICUT RIVER AND TRIBUTARIES FOR FLOOD CONTROL

APPENDIX

VOLUME II

SECTION 5 - RESERVOIRS PAGES 163 - 431

UNITED STATES ENGINEER OFFICE

PROVIDENCE, RHODE ISLAND

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SECTION 5

RESERVOIRS - DETAILS AND ESTIMATES

RESERVOIR

SECTION 5

RESERVOIRS - DETAILS AND ESTIMATES

1. DATA AVAILABLE FOR DESIGN. - Topographic maps, river profiles, and site surveys were available. The principal geologic features have been determined by core borings and seismic investigations of a reconnaissance nature. Foundation characteristics were determined by drive sampling and by use of test pits and auger borings. These latter were also of value to determine the approximate location and quantity of borrow material for earth embankments. Samples have been tested in the District Soils Laboratory to determine the suitability of the material for embankment construction and to determine permeability, consolidation, and shear characteristics of the foundation strata. A description of soil classes and their limits as used in the Providence District are given in Table XXXVI, page 164 and Plate 14A, page 165. Sufficient data were available at all sites to develop preliminary designs for adequate estimates.

TABLE XXXVI

PROVIDENCE SOIL CLASSIFICATION
U. S. ENGINEER OFFICE
PROVIDENCE, R. I.

CLASS	DESCRIPTION OF MATERIAL
1	Clean Gravel. - Contains little coarse to medium sand.
2	Uniform Coarse to Medium Sand. - Contains little gravel and fine sand.
3	Variable - Graded from Gravel to Medium Sand. - Contains little fine sand.
4	Uniform Medium to Fine Sand. - Contains little coarse sand and coarse silt.
5	Variable - Graded from Gravel to Fine Sand. - Contains little coarse silt.
6	Uniform Fine Sand to Coarse Silt. - Contains little medium sand and medium silt.
7	Variable - Graded from Gravel to Coarse Silt. - Contains little medium silt.
8	Uniform Coarse to Medium Silt. - Contains little fine sand and fine silt.
9	Variable - Graded from Gravel to Medium Silt. - Contains little fine silt.
10	Uniform Medium to Fine Silt. - Contains little coarse silt and coarse clay. Possesses behavior characteristics of silt.
10 C	Uniform Medium Silt to Coarse Clay. - Contains little coarse silt and medium clay. Possesses behavior characteristics of clay.
11	Variable - Graded from Gravel or Coarse Sand to Fine Silt. - Contains little coarse clay.
12	Uniform Fine Silt to Medium Clay. - Contains little medium silt and fine clay(colloids). Possesses behavior characteristics of silt.
12 C	Uniform Clay. - Contains little silt. Possesses behavior characteristics of clay.
13	Variable - Graded from Coarse Sand to Clay. - Contains little fine clay (colloids). Possesses behavior characteristics of silt.
13 C	Variable Clay. - Graded from sand to fine clay (colloids). Possesses behavior characteristics of clay.

PROVIDENCE DISTRICT SOIL CLASSIFICATION

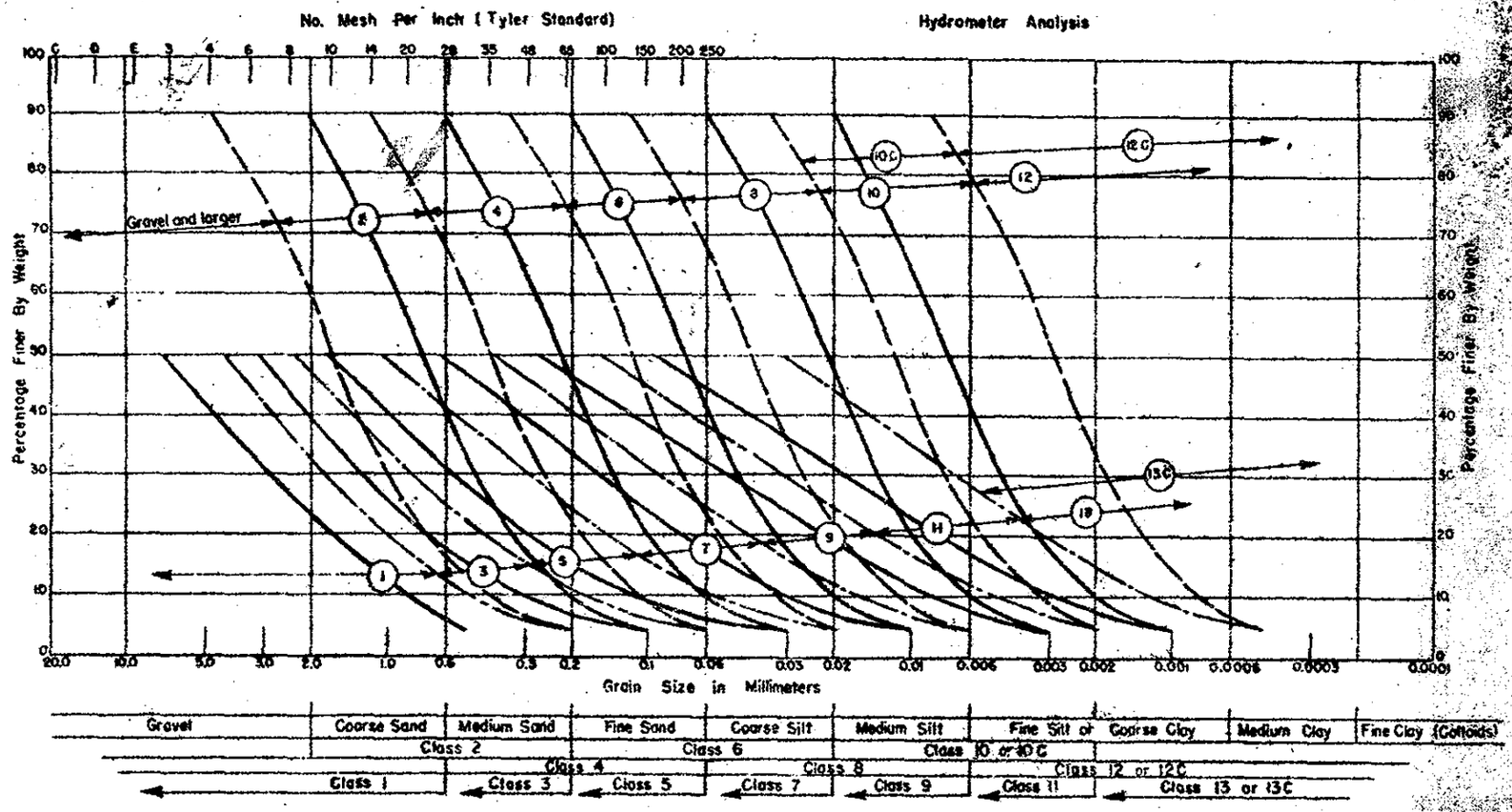


DIAGRAM SHOWING LIMITS OF SOIL CLASSES

2. BASIS OF ESTIMATES. - The cost of each dam has been estimated upon the basis of a preliminary design which will provide an economical and adequate construction for the particular site. Estimates of quantities have been made upon the basis of the adopted designs and foundation conditions. Rock and earth borrow, in all cases, is the volume required with some allowance for use of acceptable materials obtained from spillway and other structure excavations.

3. UNIT PRICES. - Unit prices are based upon construction costs for similar types of work in New England, particular use being made of cost data from work placed under construction in the Providence District during the past few years. In determing unit prices for borrow material, account has been taken of the fact that much of it occurs in relatively thin layers of glacial deposits containing boulders, the irregularity of such deposits, and the difficulty of transportation over rugged terrains. Unit prices vary depending upon the quantities involved, the conditions under which the work would be executed, and the availability and location of materials at each site. In most cases the sites are readily accessible by existing roads. Miscellaneous minor items of work, the caretaker's dwelling, and the access road costs are included in the lump sum applied as "Gatehouse and miscellaneous" in the cost estimate.

4. CONTINGENCIES, ENGINEERING AND OVERHEAD. - The construction costs as totaled from the individual items have been increased 20 percent to cover contingencies. This amount is considered necessary because of the preliminary character of the foundation explorations and the consequent possibility of subsequent design changes and construction difficulties. Engineering and overhead costs are estimated at 15 percent of the resultant construction costs.

5. RIGHTS-OF-WAY AND LAND. - The costs of rights-of-way and the damages which would result from the acquisition of lands and the construc-

tion of the dams have been estimated upon the basis of assessed valuations, field reconnaissance, and information secured from local authorities. Lands were estimated as sufficient for the construction of the dam, spillway, and appurtenant works, and for the adequate maintenance and operation of the dam. Land areas required for the reservoir were taken as those below the elevation of the spillway crest. The acreage used in the estimate for any reservoir was uniformly in excess of the net area of the reservoir at spillway elevation to allow for the usual exigencies of land acquisition. This is due to the fact that, in general, the taking lines follow the existing property lines. Frequently, the taking of such lands destroys the usefulness and value of the tract and the corresponding cost is as great as that of the whole tract. The land areas have been estimated with consideration given to the aforementioned facts. Any damage caused by flooding above the spillway elevation can be compensated for as special damages more economically than by purchase of the lands. Water rights have been estimated upon the basis of assessed valuations, allowing a reasonable increase. Purchase of existing water power interfered with has been based upon a value of $50.00 per water horse-power. Twenty percent has been added to allow for legal, overhead, and general expenses.

6. HIGHWAYS, RAILROAD, AND UTILITY RELOCATION. - The relocations and improvements proposed in this report are planned to conform as nearly as possible to the standards and requirements of the various state departments and other interested agencies. Where definite improvements over existing facilities are included, it is anticipated that the Federal Government will be credited with the additional cost of such items. The estimates are generally ample to provide for reasonable modifications. In view of the less complicated and more definite nature of the work, contingencies on highway, railroad, and utility relocations have been

estimated at 10 percent and engineering and overhead also at 10 percent.

7. BASIS OF ANNUAL COSTS. - Estimates are prepared on the basis that the United States will bear the costs of reservoirs, including construction, lands, easements, utility relocations, and maintenance. The tax loss on the properties occupied by the reservoir is the only non-Federal charge. This tax loss has been computed at 3 percent of the value of lands and improvements for projects located in Massachusetts, 2-1/2 percent for Connecticut, and 3-1/2 percent for New Hampshire and Vermont. Annual Federal carrying charges are computed upon the basis of interest at 3-1/2 percent per annum of the total Federal investment, which consists of the total capital cost plus interest during construction at 3 percent of the total capital cost for one-half of the estimated construction period when said period is two years or more. The total Federal investment, except for gates and machinery, has been amortized over a period of 50 years at 3-1/2 percent compounded annually. The gates and machinery costs have been amortized over a period of 20 years. Maintenance expenses have been computed upon the following basis for earth dams with annual charges, depending upon the amount of embankment quantities:

Up to 300,000 cu.yds.	- $ 500
300,000 to 500,000 cu.yds.	1,000
500,000 to 750,000 cu.yds.	1,500
750,000 to 1,000,000 cu.yds.	2,000
1,000,000 to 1,500,000 cu.yds.	2,500
1,500,000 to 2,000,000 cu.yds.	3,000
2,000,000 to 2,500,000 cu.yds.	3,500

Annual maintenance costs for gates and machinery have been estimated at 3 percent. For concrete dams, tunnels, walls, and other concrete structures the maintenance charges have been estimated at 1 percent of the costs of such dams or structures. For dams requiring gate operation a

charge of $1,500 per annum for an operator and $500 per annum for stand-by charges and expendable supplies has been applied. A general overhead charge of $3,000 for each dam has been included.

8. ALTERNATE LOCATION OF SITES. - The locations of dams as shown on the plans for each site are subject to change during the design studies.

9. DESCRIPTIVE DETAILS OF DAMS AND RESERVOIRS. - Descriptions of the proposed dam and reservoir projects, together with pertinent facts, are briefly set forth in the following paragraphs.

a. Knightville. - (1) General. - Knightville Reservoir, on the main stream of the Westfield River 27.8 miles above its junction with the Connecticut, is outlined on Plate No. 14. The dam is located just below the highway bridge, in the Village of Knightville, Massachusetts, and was completed in December 1941. The reservoir extends up the main stream about six miles, and up the Little River one mile, and lies in the Towns of Huntington and Chesterfield, in Hampshire County. The drainage area of 164 square miles is mostly rolling high land, deeply cut by streams, with some cultivation on the plateaus and in the bottom lands. The area and capacity curves are shown on Plate No. 14. The flood control storage capacity is equivalent to 4.5 inches of run-off from the drainage area, or 39,300 acre-feet at the spillway crest, excluding the conservation pool or future power storage. The reservoir area below the spillway crest elevation of 610.0 feet above mean sea level is approximately 960 acres, classified as follows:

(a)	Agricultural land	200 acres
(b)	Pasture land	200 acres
(c)	Wooded land	560 acres
(d)	Towns, etc.	29 sets of buildings. 2 cemeteries of 240 graves.

(2) Highways and roads. - Three and one-half miles of 24-foot bituminous macadam highway was relocated as indicated on Plate No. 14.

(3) Railroads. - No railroads were involved.

(4) Other public works. - None were involved.

(5) Dam. - A general plan of the dam and the geologic features are shown on Plates Nos. 15 and 16.

(a) Geology. - Steeply inclined beds of schist outcrop in the river and throughout the right abutment area. On the left bank the rock surface dips downward and passes beneath the left end of the dam at a depth of more than 30 feet below river level, or more than 170 feet below the ground surface. The overburden consists of a relatively impervious and compact mixture of sand, rock flour, gravel, and boulders.

(b) Available materials. - The principal source of hydraulic borrow was located above the left abutment. A supplementary source, composed of coarse material, was available in a terrace formation upstream from the left abutment. Rock fill for riprap and toe construction was obtained from the tunnel and spillway excavations, supplemented by boulders and cobbles from both hydraulic borrow areas.

(c) Dam and appurtenant works. - An earth dam built by the hydraulic-fill method, with a concrete spillway on the right bank, has been constructed. The length of the earth-fill section is 1,200 feet; the top at Elevation 630.0 is 160 feet above the stream bed, and allows freeboard of five feet above the maximum water surface. The outlet consists of a tunnel in the right bank.

(d) Embankment. - The hydraulic-fill earth dam has a 30-foot top width. The dam was built with an impervious core, with shoulders of sand, gravel, and cobbles. The core was keyed to the impervious foundation by a cut-off trench except where ledge was close to or at the surface, where a concrete key wall was used. The slopes of the earth section are 1 on 2-1/2 for the upper 15 feet and 1 on 3 for the remainder to the base. Such structure excavation as was suitable was used in the embankment. Both faces of the embankment were riprapped. A 70-foot high concrete wall extends across the main stream at the downstream toe of the dam.

(e) Spillway. - The spillway is a solid gravity concrete overflow section 400 feet long, with a crest at Elevation 610.0 which is 10.0 feet above design elevation for flood control storage. (See paragraph (j) following.) Under a 15-foot surcharge, the spillway will discharge the design flood of 87,500 cubic feet per second, or 534 cubic feet per second per square mile of drainage area controlled. The flood waters passing over the spillway will discharge into a rocky draw and return to the river below the toe of the dam. The spillway weir is separated from the earty dam by a concrete gravity retaining wall.

(f) Outlet. - The reservoir outlet consists of a 16-foot

diameter circular tunnel, excavated through ledge rock on the right bank, and was constructed to provide for diversion control during construction of the embankment and for reservoir control after completion of the dam. Control is accomplished by gates operated from a tower located at the intake end of the tunnel. Access to the tower is provided by a service bridge from the top of the dam. The discharge capacity with the pool at spillway crest elevation is 14,300 cubic feet per second.

(g) Plan of construction. - The outlet for diversion of the river, the concrete toe wall, and part of the retaining walls were constructed during the first season. Diversion of the river and hydraulicking the embankment was carried on during the second season. Completion of embankment and concrete structure was done during the third construction season. Construction was started September 1, 1939, and was completed December 13, 1941.

(h) Flood control storage. - The estimated costs of the reservoir as designed for flood control only were as follows:

(1)	Construction	$1,752,000
(2)	Relocation of railroads and utilities	None
(3)	Rights-of-way and land	91,000
(4)	Highway relocation	475,000
(5)	Grand total capital cost	2,318,000
(6)	Total annual cost	124,900

The dam was designed with the top at elevation 630.0 and with the spillway crest at elevation 610.0. At these elevations the reservoir would provide for 5.6 inches of run-off from the contributing drainage area or 49,000 acre feet, of which 39,300 acre feet or 4.5 inches of run-off is for flood control storage. The remainder is initially for use as a conservation pool and will ultimately be used for power storage.

(i) Conservation storage. - No permanent conservation storage was provided for or considered economically feasible.

(j) Power storage. - In order to comply with the request of the Federal Power Commission to make the dam adaptable for future power storage, the dam and spillway were built 10 feet higher than the proposed

flood control elevation, the intake tower was modified to provide the beginning of a power intake, and a short portion of tunnel for the future penstock was built. The additional 10 feet in height of spillway provides for the storage of an additional 1.1 inches of run-off from the contributing drainage area or 9,700 acre-feet. The flooded area at the spillway crest, elevation 610.0, will be 960 acres.

(k) Estimate of cost. - The costs for the initial construction of the Knightville Reservoir, including the adaptations for future power development at the site, are given in the following table: (For revised costs see Table XIII A on page 64.1 of the Report).

COST ESTIMATE OF KNIGHTVILLE RESERVOIR

INITIAL CONSTRUCTION - WITH ADAPTATIONS FOR FUTURE POWER DEVELOPMENT

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 8,100	
	Stream control			Lump sum	5,000	
	Earth excavation, common	75,000	cu.yd.	0.60	45,000	
	Earth excavation, borrow	1,060,000	cu.yd.	0.25	265,000	
	Rock excavation, open cut	66,000	cu.yd.	2.00	132,000	
	Rock excavation, tunnel	6,900	cu.yd.	9.00	62,100	
	Embankment, rolled	140,000	cu.yd.	0.55	77,000	
	Embankment, hydraulic	1,003,000	cu.yd.	0.20	200,600	
	Dumped rock	119,000	cu.yd.	0.30	35,700	
	Riprap, hand-placed	1,130	cu.yd.	6.00	6,800	
	Concrete, plain	37,300	cu.yd.	13.50	503,600	
	Concrete, reinforced	8,880	cu.yd.	18.50	164,300	
	Reinforcement steel	602,500	lb.	0.05	30,100	
	Gates and machinery			Lump sum	90,000	
	Gatehouse and miscellaneous			Lump sum	69,300	
	Bridges, service and road			Lump sum	25,000	
					1,719,600	
	Contingencies			10%	171,900	
					1,891,500	
	Engineering and overhead			15%	283,500	
	TOTAL					$2,175,000
2	Relocation of railroads and utilities					
3	Rights-of-way and land					
	Land	1,800	acres	Lump sum	46,000	
	Buildings purchased	29	sets	Lump sum	33,200	
	Cemetery relocation	240	graves	Lump sum	5,000	
	Water rights				None	
					84,200	
	Legal, overhead, and general expenses			20%	16,800	
	TOTAL					101,000
4	Highway relocation					
	State Highway 112 - 24-ft. bituminous macadam	3.5	mi.			
				Lump sum	267,500	
	Bridge			Lump sum	125,000	
					392,500	
	Contingencies			10%	39,300	
					431,800	
	Engineering and overhead			10%	43,200	
	TOTAL					475,000
5	Grand total capital cost					2,751,000

(1) Annual costs.

The estimated annual costs for the initial construction, including adaptations for future power development at the Knightville Reservoir, are given in the following table:

ESTIMATED ANNUAL COSTS OF KNIGHTVILLE RESERVOIR

INITIAL CONSTRUCTION - WITH ADAPTATIONS FOR FUTURE POWER DEVELOPMENT

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$2,751,000	
	Interest during construction ($2,751,000 x 0.03)	83,000	
	TOTAL (Federal investment)	2,834,000	
2	Federal annual charges		
	Interest . . . . . ($2,834,000 x 0.035). . . .	99,200	
	Amortization of obsolescence and depreciation		
	Earthwork and general. (1.265 x 1.03 x .0076 x $931,600)	9,200	
	Concrete . . . . . (1.265 x 1.03 x .0076 x 698,000)	6,900	
	Gates and machinery . (1.265 x 1.03 x .0354 x 90,000)	4,200	
	Railroads and utilities(- - - -)	None	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 84,200)	800	
	Highways . . . . . (1.21 x 1.03 x .0076 x 392,500)	3,700	
	Maintenance and operation		
	Embankment and general overhead.	5,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . (1.265 x 0.01 x $698,000) . . .	8,900	
	Gates and machinery . (1.265 x 0.03 x 90,000) . . .	3,300	
	TOTAL (Federal annual charges)		$ 143,700
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . ($79,200 x 0.03).	2,400	
	TOTAL (non-Federal annual charges)		2,400
	TOTAL ANNUAL COST (2 + 4)		146,100

b. Easthampton. - (1) General. - The Easthampton Reservoir, on the Manhan River, Massachusetts, 3 miles above the confluence with the Oxbow, an arm of the Connecticut River, is outlined on Plate No. 17. The dam site is located in the westerly part of Easthampton. The reservoir extends 5.5 miles upstream and lies in the Towns of Easthampton and Southampton, Hampshire County, Massachusetts. The drainage area of 68 square miles is hilly with mountainous area at the headwaters. Considerable farming is done on the hillsides and along the valley. The area and capacity curves are indicated on Plate No. 17. The flood control storage capacity will be equivalent to 6 inches of run-off from the drainage area or 21,800 acre-feet at the spillway crest. The reservoir area below the spillway crest elevation of 167.0 feet above mean sea leval will be approximately 1,210 acres, classified as follows:

(a) Agricultural land .... 520 acres of considerable value.

(b) Pasture land ..... 580 acres

(c) Wooded land ..... 100 acres

(d) Towns, etc. ..... 32 sets of buildings. No community centers.

(2) Highways and roads. - Fifteen hundred feet of 24-foot bituminous macadam highway will be relocated; 900 feet of 16-foot gravel road and 250 feet of 16-foot, 2,200 feet of 18-foot, and 1,500 feet of 20-foot bituminous macadam highway will be raised from 5 to 22 feet on their present location as indicated on Plate No. 17.

(3) Railroads. - One thousand feet of the New York, New Haven and Hartford Railroad single-track line will be raised on its present alinement as indicated on Plate No. 17.

(4) Other public works. - One mile of telephone and electric distribution lines will be relocated.

(5) Dam. - The general plan of the dam is shown on

Plate No. 18.

(a) Geology. - Slightly inclined strata of red sandstone outcrop on the right bank. The rock surface dips toward the northwest beneath the stream and the left bank. Overburden in the left abutment is composed of impervious fine sand and silt.

(b) Available materials. - Sand and silt are available upstream within one-half mile for the impervious rolled-fill section. Pervious materials, chiefly sand, are available upstream within one mile for pervious embankment construction. Acceptable concrete aggregates are available at commercial sources located within twenty miles.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main stream with a gravity section overflow weir in a saddle in the right abutment. An outlet is provided at the left end of the weir. The length of the earth fill will be 2,500 feet; the top at Elevation 182.0 will be 66 feet above the stream bed. This will allow a freeboard of 5 feet above the maximum water surface.

(d) Embankment. - The rolled-fill earth dam will have a 20-foot top width for 1,480 feet on the left abutment. The remainder of the dam will have a top width of 30 feet, and will carry a 24-foot highway which will approach from the left by means of a ramp on the abutment. The embankment will be built with an impervious core from top to bottom, keyed into the ground with a cut-off trench along the axis of the embankment. The impervious core will be backed by a pervious section on both upstream and downstream faces with outside slopes of 1 on 3 from the bottom to within 15 feet of the top; the upper 15 feet will be 1 on 2-1/2. The downstream toe will be of dumped

rock. The upstream face will be riprapped and the downstream face sodded and seeded.

(e) Spillway. - A concrete gravity weir, 270 feet long, will be constructed on rock on the right bank. A concrete-lined stilling basin below the weir will be provided before the discharge passes through the spillway channel into the river below the dam. With the crest at Elevation 167.0, the discharge capacity under a 10-foot surcharge, maximum flood level, will be 33,000 cubic feet per second or the equivalent of 485 cubic feet per second per square mile of drainage area controlled. A highway bridge will cross the stilling basin on the center line of the dam.

(f) Outlet. - A concrete intake and gate-operating tower will be provided in the right abutment, at the left end of the spillway weir. An open-cut channel at the discharge end will carry the water to the river channel below the dam. The discharge capacity with reservoir at spillway crest will be 3,470 cubic feet per second.

(g) Plan of construction. - It is proposed to construct the outlet and gate house simultaneously with the spillway excavation and placing of embankment on the left bank; the stream will then be diverted through the conduit and the embankment and spillway completed. The estimated time for construction will be 12 months or one construction season.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Easthampton Reservoir for flood control only are given in the following table:

COST ESTIMATE OF EASTHAMPTON RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 12,300	
	Stream control			Lump sum	15,000	
	Earth excavation, common	132,000	cu.yd.	0.40	52,800	
	Earth excavation, borrow	102,000	cu.yd.	0.30	30,600	
	Rock excavation, open cut	32,000	cu.yd.	2.30	73,600	
	Embankment, rolled	220,000	cu.yd.	0.20	44,000	
	Dumped rock	45,000	cu.yd.	0.30	13,500	
	Concrete, plain	20,500	cu.yd.	10.00	205,000	
	Concrete, reinforced	600	cu.yd.	18.00	10,800	
	Reinforcement steel	142,000	lb.	0.05	7,100	
	Gates and machinery			Lump sum	41,500	
	Gatehouse and miscellaneous			Lump sum	39,500	
					545,700	
	Contingencies			20%	109,100	
					654,800	
	Engineering and overhead			15%	98,200	
	TOTAL					$ 753,000
2	Relocation of railroads and utilities					
	Branch line, single-track, N.Y., N.H. and H. Railroad	0.2	mi.	Lump sum	17,800	
	Bridge			Lump sum	25,000	
	Telephone and electric distribution lines	1.5	mi.	Lump sum	1,000	
					43,800	
	Contingencies			10%	4,400	
					48,200	
	Engineering and overhead			10%	4,800	
	TOTAL					53,000
3	Rights-of-way and land					
	Land	1,200	acres	Lump sum	56,200	
	Buildings purchased	32	sets	Lump sum	96,000	
	Water rights, undeveloped			Lump sum	2,000	
					154,200	
	Legal, overhead, and general expenses			20%	30,800	
	TOTAL					185,000
4	Highway relocation					
	State highway 10,10-ft. bit.macadam	0.3	mi.	Lump sum	25,000	
	Local road - 20-ft. bit.macadam	0.3	mi.	Lump sum	35,000	
	Streets - Bit.macadam and gravel	0.7	mi.	Lump sum	38,400	
	Bridges	5		Lump sum	100,000	
					198,400	
	Contingencies			10%	19,800	
					218,200	
	Engineering and overhead			10%	21,800	
	TOTAL					240,000
5	Grand total capital cost					1,231,000

(1) Annual costs. - The estimated annual costs of the Easthampton Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF EASTHAMPTON RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5).	$1,231,000	
	Interest during construction.	None	
	TOTAL (Federal investment).	1,231,000	
2	Federal annual charges		
	Interest. . . . . .($1,231,000 x 0.035)	43,100	
	Amortization of obsolescence and depreciation		
	Earthwork and general . .(1.38 x .0076 x $281,300)	2,900	
	Concrete . . . . . .(1.38 x .0076 x 222,900)	2,300	
	Gates and machinery . . .(1.38 x .0354 x 41,500)	2,000	
	Railroads and utilities .(1.21 x .0076 x 43,800)	400	
	Rights-of-way and land. .(1.20 x .0076 x 154,200)	1,400	
	Highways . . . . . .(1.21 x .0076 x 198,400)	1,800	
	Maintenance and operation		
	Embankment and general overhead	3,500	
	Operator and expendable supplies.	2,000	
	Concrete . . . . . (1.38 x 0.01 x $222,900) . .	3,100	
	Gates and machinery(1.38 x 0.03 x 41,500) . .	1,700	
	TOTAL (Federal annual charges).		$ 64,200
3	Non-Federal investment.	None	
4	Non-Federal annual charges		
	Tax loss on land. . . . ($154,200 x 0.03)	4,600	
	TOTAL (non-Federal annual charges).		4,600
	TOTAL ANNUAL COST (2 + 4)		68,800

c. Fort Morrison. - (1) General. - The Fort Morrison Reservoir on the East Branch of North River, Massachusetts, 6.6 miles above its junction with the Deerfield River, is outlined on Plate No. 19. The dam site is located 1.2 miles upstream from Colrain. The reservoir extends upstream 2.5 miles, lying wholly in the Town of Colrain, Franklin County, Massachusetts. The drainage area of 48 square miles is very mountainous. Considerable farming is done along the river valley. The area and capacity curves are shown on Plate No. 19. The flood control storage capacity will be equivalent to 6.0 inches of run-off from the drainage area or 15,400 acre-feet at the spillway crest. The reservoir area below the spillway crest elevation of 711.0 feet above mean sea level will be approximately 400 acres, classified as follows:

(a)	Agricultural land	240 acres of fair value
(b)	Pastureland	100 acres
(c)	Wooded land	60 acres
(d)	Town, etc.	14 sets of buildings, the small community of Elm Grove.

(2) Highways and roads. - Two and seven tenth miles of 18-foot bituminous macadam highway and 0.6 mile of 14-foot gravel road will be relocated as indicated on Plate No. 19.

(3) Railroads. - No railroads are involved.

(4) Other public works. - Two and seven tenths miles of telephone and electric distribution lines will be relocated.

(5) Dam. - The general plan of the dam and the geological features are shown on Plates Nos. 20 and 21.

(a) Geology. - Determination of rock foundations on the left side were made by the seismic method. These investigations indicate that the rock surface is located at an average depth of approximately 18 feet. Schist outcrops on the hillside above the right abutment.

The overburden underlying the river and terrace on the right side is composed of pervious sand and gravel.

(b) Available materials. - Sand and gravel are available in terrace deposits on the right bank within one half mile upstream for use in pervious embankment construction. Impervious materials, chiefly fine sand and silt, are available in the upper portions of these same areas for construction of the impervious section. Rock for dumped rock on embankment slopes and for rock toes will be available from required excavations of the spillway and tunnel.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main channel, with a concrete side-channel spillway cut through rock in the left bank. The length of the earth fill will be 1400 feet; the top at Elevation 728.0 will be 113 feet above the stream bed, and will allow a freeboard of 5 feet above the maximum water surface. The outlet will consist of a tunnel excavated in rock in the left bank.

(d) Embankment. - The rolled-fill earth dam will have a 30-foot top width. The dam will be built with an impervious core, keyed to the rock foundation on the left bank by a cut-off trench. An impervious blanket will extend under the rest of the dam from the core to a point well beyond the upstream toe. The core will be backed on both upstream and downstream sides by a pervious section with outside slopes of 1 on 2-1/2 for the upper 15 feet and 1 on 3 for the remainder to the base. Structure excavation that is suitable will be used. Both faces of the embankment will be riprapped.

(e) Spillway. - A side-channel spillway, with a concrete weir 400 feet long, will be provided in the left bank. The discharge will be carried around the dam in a concrete-lined rock cut and returned to the stream with a free fall well below the toe. The spillway channel and weir will be separated from the earth dam by a concrete gravity

retaining wall. With the crest at Elevation 711.0, under a surcharge of 12 feet the spillway will discharge the design flood of 62,000 cubic feet per second or 1,290 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - The outlet will consist of a concrete-lined tunnel, 12 feet in diameter and 550 feet long, excavated through ledge rock in the left bank, and will provide for diversion control during construction and for reservoir control later. Control will be accomplished by gates operated from a tower located at the intake end of the tunnel. A service bridge will provide access from the top of the dam to the tower. An open channel cut in rock will carry the water to the water to the main channel below the dam. The discharge with the water surface at spillway crest elevation will be 6,380 cubic feet per second.

(g) Plan of construction. - It is proposed to construct the outlet and much of the embankment simultaneously with spillway excavation, then to divert the river through the outlet and complete the embankment and spillway. The construction period will be 18 months or two construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Fort Morrison Reservoir, for flood control only are given in the following table:

COST ESTIMATE OF FORT MORRISON RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 5,500	
	Stream control			Lump sum	5,000	
	Earth excavation, common	218,000	cu.yd.	0.40	87,200	
	Earth excavation, borrow	678,000	cu.yd.	0.35	237,300	
	Rock excavation, open cut	143,000	cu.yd.	2.00	286,000	
	Rock excavation, tunnel	5,500	cu.yd.	11.00	60,500	
	Embankment, rolled	876,000	cu.yd.	0.10	87,600	
	Dumped rock	208,000	cu.yd.	0.25	52,000	
	Concrete, plain	25,900	cu.yd.	10.00	259,000	
	Concrete, reinforced	5,300	cu.yd.	16.00	34,800	
	Reinforcement steel	660,000	lb.	0.05	33,000	
	Gates and machinery			Lump sum	85,000	
	Gatehouse and miscellaneous			Lump sum	48,700	
	Bridges, service and road			Lump sum	38,000	
					1,369,600	
	Contingencies			20%	273,900	
					1,643,500	
	Engineering and overhead			15%	246,500	
	TOTAL					$1,890,000
2	Relocation of railroads and utilities.					
	Telephone and electric distribution lines	2.7	mi.	Lump sum	2,500	
					2,500	
	Contingencies			10%	200	
					2,700	
	Engineering and overhead			10%	300	
	TOTAL					3,000
3	Rights-of-way and land					
	Land	450	acres	Lump sum	25,000	
	Buildings purchased	14	sets	Lump sum	81,300	
	Water rights, undeveloped			Lump sum	2,000	
					108,300	
	Legal, overhead, and general expenses			20%	21,700	
	TOTAL					130,000
4	Highway relocation					
	State Highway 112-18-ft. bit. macadam	2.7	mi.	Lump sum	135,000	
	Local road 14-ft. gravel	0.6	mi.	Lump sum	15,000	
	Bridge			Lump sum	21,000	
					171,100	
	Contingencies			10%	17,100	
					188,200	
	Engineering and overhead			10%	18,800	
	TOTAL					207,000
5	Grand total capital cost					$2,230,000

(1) Annual costs. -

The estimated annual costs of the Fort Morrison Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF FORT MORRISON RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$2,230,000	
	Interest during construction ($2,230,000 x 0.03) . .	67,000	
	TOTAL (Federal investment)	2,297,000	
2	Federal annual charges		
	Interest . . . . . ($2,297,000 x 0.035). . .	80,400	
	Amortization of obsolescence and depreciation		
	Earthwork and general. (1.38 x 1.03 x .0076 x $907,800)	9,800	
	Concrete . . . . . (1.38 x 1.03 x .0076 x 376,800)	4,100	
	Gates and machinery... (1.38 x 1.03 x .0354 x 85,000)	4,300	
	Railroads and utilities (1.21 x 1.03 x .0076 x 2,500)	0	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 108,300)	1,000	
	Highways . . . . . (1.21 x 1.03 x .0076 x 171,100)	1,600	
	Maintenance and operation		
	Embankment and general overhead.	5,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . (1.38 x 0.01 x $76,800) . .	5,200	
	Gates and machinery . . . (1.38 x 0.03 x 85,000) . .	3,500	
	TOTAL (Federal annual charges)		$117,400
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . . $108,300 x 0.03 . . .	3,300	
	TOTAL (non-Federal annual charges)		3,300
	TOTAL ANNUAL COST (2 + 4)		$120,700

d. West Brookfield. - (1) General. - The West Brookfield Reservoir, on the Quaboag River, 18.6 miles above its confluence with the Swift River to form the Chicopee River, Massachusetts, is outlined on Plate No. 22. The dam site is located in West Brookfield. The reservoir will extend up the Quaboag River 5.5 miles to the head of Quaboag Pond, 2.5 miles to the head of Quacumquasit Pond, 2 miles up Coys Brook, 2 miles up Dunn Brook, and 2.5 miles up the East Brookfield River. The reservoir will lie in the Towns of West Brookfield, Brookfield, East Brookfield, and Sturbridge, all in Worcester County, Massachusetts. The drainage area of 106 square miles is fairly flat and swampy with small hills and numerous lakes and ponds at the headwaters. The area and capacity curves are shown on Plate No. 22. The flood control storage capacity will be equivalent to 6.0 inches of run-off from the drainage area or 33,900 acre-feet at spillway crest. The reservoir area below the spillway crest elevation of 611.5 feet above mean sea level will be approximately 4,000 acres, classified as follows:

(a)	Agricultural lands	- 320 acres
(b)	Pasture land	- 390 acres
(c)	Wooded land	- 260 acres
(d)	Swamp land	- 2,270 acres
(e)	Ponds and lakes	- 760 acres
(f)	Towns, etc.	- 110 sets of buildings, one cemetery of 600 graves and portions of the villages of West Brookfield, Brookfield, and East Brookfield.

(2) Highways and roads. - One mile of 20-foot concrete highway, 1 mile of 18-foot bituminous macadam, and 1 mile of 16-foot bituminous macadam highway will be reconstructed as indicated on Plate No. 22.

(3) Railroads. - Five miles of the double-track Boston and Albany Railroad will require relocation as indicated on Plate No. 22.

(4) Other public works. - Seven miles of telephone, telegraph, and electric distribution lines will be relocated.

(5) Dam. - The general plan of the dam and the geologic features are indicated on Plates Nos. 23 and 24.

(a) Geology. - Bedrock is deeply buried beneath a glacial overburden of fine sand and interstratified silt and clay. The extent and behavior characteristics of these compressible sediments has not been developed fully. It is proposed to found the concrete spillway and retaining walls on these materials without any other support. Future modifications of this proposed design will depend upon more complete knowledge of the extent and behavior of the foundation materials.

(b) Available materials. - Fine sand and silt are available on the left bank above the valley bottom for impervious embankment construction. Pervious sand and gravel are also available on the left bank. Rock for toes and riprap is available only in boulder accumulations located in the higher ground on the left side.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend along the slope of the right bank with a gravity wall section weir across the main stream bed terminating in a short length of embankment on the left bank. The length of the earth fill will be 4,100 feet; the top at Elevation 626.0 will be 31 feet above the stream bed. This will allow a freeboard of 5 feet above the maximum water surface. An outlet will be provided at the right end of the weir.

(d) Embankment. - The earth fill will have a 20-foot top width. The dam will be built with an impervious core from top to bottom keyed into the ground with a cut-off trench along the axis of the dam. The impervious core will be backed by a pervious section on both upstream and downstream faces with outside slopes of 1 on 3 from the bottom to within 14.5 feet of the top; the upper 14.5 feet will be 1 on 2-1/2.

The upstream face will be riprapped and the downstream toe will be of dumped rock. A railroad stop-log structure, with base at Elevation 616.5, will be provided in the embankment, 1,300 feet east of the spillway.

(e) Spillway. - A concrete gravity weir, 430 feet long, with a concrete apron will be constructed across the stream and up the left bank. Steel sheet-piling will run under the length of the weir. Concrete gravity retaining walls at both ends of the spillway will be provided to support the embankment. With the crest at Elevation 611.5, under a surcharge of 9.5 feet, the spillway will discharge 31,000 cubic feet per second, which is the equivalent of 292 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - A concrete intake and gate-operating tower with mechanically operated gates will be provided at the right end of the spillway weir. The discharge with the water surface at spillway crest will be 3,260 cubic feet per second.

(g) Plan of construction. - It is proposed to divert the stream with cofferdams and build the outlet and left half of the spillway simultaneously with the embankment, then to divert the stream through the outlet and complete the spillway and embankment. The time estimated for construction is about 12 months or one long construction season.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the West Brookfield Reservoir for flood control are given in the following table:

COST ESTIMATE OF WEST BROOKFIELD RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$25,400	
	Stream control			Lump sum	10,000	
	Earth excavation, common	86,000	cu.yd.	0.40	34,400	
	Earth excavation, borrow	190,000	cu.yd.	0.35	66,500	
	Embankment, rolled	255,000	cu.yd.	0.20	51,000	
	Dumped rock	32,000	cu.yd.	1.80	57,600	
	Concrete, plain	4,000	cu.yd.	14.00	56,000	
	Concrete, reinforced	1,400	cu.yd.	18.00	25,200	
	Reinforcement steel	180,000	lb.	0.05	9,000	
	Sheet-piling	18,800	sq.ft.	1.25	23,500	
	Gates and machinery			Lump sum	70,000	
	Gatehouse and miscellaneous			Lump sum	31,600	
					460,200	
	Contingencies			20%	92,000	
					552,200	
	Engineering and overhead			15%	82,800	
	TOTAL					$635,000
2	Relocation of railroads and utilities					
	Main line, double track, B.&					
	Railroad	5.0	mi.	Lump sum	693,000	
	Telephone and electric distribution lines	7.0	mi.	Lump sum	7,800	
					700,800	
	Contingencies			10%	70,100	
					770,900	
	Engineering and overhead			10%	77,100	
	TOTAL					848,000
3	Rights-of-way and land					
	Land	4,100	acres	Lump sum	148,000	
	Buildings purchased	110	sets	Lump sum	253,700	
	Cemetery relocation	600	graves	Lump sum	55,000	
	Water rights, developed			Lump sum	5,000	
					461,700	
	Legal, overhead, and general expenses			20%	92,300	
	TOTAL					554,000
4	Highway relocation					
	State Highway 9, 20-ft. concrete	1.0	mi.	Lump sum	80,000	
	Local road, 18-ft. bit.macadam	1.0	mi.	Lump sum	53,000	
	Local road, 16-ft. bit.macadam	1.0	mi.	Lump sum	38,400	
	Overpass			Lump sum	60,000	
					231,400	
	Contingencies			10%	23,100	
					254,500	
	Engineering and overhead			10%	25,500	
	TOTAL					280,000
5	Grand total capital cost					2,317,000

(1) Annual costs. - The estimated annual costs of the West Brookfield Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF WEST BROOKFIELD RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$2,317,000	
	Interest during construction	0	
	TOTAL (Federal investment)	2,317,000	
2	Federal annual charges		
	Interest (2,317,000 x 0.035)	81,100	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x .0076 x $300,000)	3,200	
	Concrete (1.38 x .0076 x 90,200)	900	
	Gates and machinery (1.38 x .0354 x 70,000)	3,400	
	Railroads and utilities (1.21 x .0076 x 700,800)	6,400	
	Rights-of-way and land (1.20 x .0076 x 461,700)	4,200	
	Highways (1.21 x .0076 x 231,400)	2,100	
	Maintenance and operation		
	Embankment and general overhead	4,000	
	Operator and expendable supplies	2,000	
	Concrete (1.38 x 0.01 x $90,200)	1,200	
	Gates and machinery (1.38 x 0.03 x 70,000)	2,900	
	TOTAL (Federal annual charges)		$111,400
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land ($406,700 x 0.03)	12,200	
	TOTAL (non-Federal annual charges)		12,200
	TOTAL ANNUAL COST (2 + 4)		123,600

c. Barre Falls. - (1) General. - Barre Falls Reservoir on the Ware River 31.9 miles above its confluence with the Swift River, is outlined on Plate No. 25. The dam site is located at Barre Falls, Massachusetts. The reservoir will extend 2 miles up the northerly branch of the Ware River in the Towns of Barre and Hubbardston, Worcester County, and will also extend 3.4 miles up the southeasterly branch of the Ware River and 2 miles up Steven Brook, all in the Towns of Barre, Rutland, and Oakham, Worcester County, Massachusetts. The drainage area of 57 square miles is hilly, contains numerous ponds or lakes near the headwaters, and is very swampy and partially wooded. The area and capacity curves are shown on Plate No. 25. The flood control storage capacity will be equivalent to 8.0 inches of run-off from the drainage area above, or 24,300 acre-feet at the spillway crest. The reservoir area below the spillway crest elevation of 815.5 feet on the Metropolitan District Water Supply Commission datum, which is 6.05 feet below mean sea level, will be approximately 1450 acres, classified as follows:

(a)	Agricultural land . .	225 acres of poor quality
(b)	Wooded land	410 acres
(c)	Swamp land	815 acres
(d)	Towns, etc.	3 sets of buildings. No community centers in the area. One cemetery of 10 graves will need relocation.

All references to elevations in the Barre Falls description are on the Metropolitan District Water Supply Commission datum.

(2) Highways and roads. - Two miles of 14-foot gravel road will require relocation as indicated on Plate No. 25.

(3) Railroads. - No railroads are involved.

(4) Other public utilities. - No utilities are involved.

(5) Dam. - A general plan of the dam and the geological features are indicated on Plates Nos. 26 and 27.

(a) Geology. - Rock is exposed in the stream bed and to a height of 10 feet above the stream on the left bank. The rock sur-

face slopes toward the east, rising to higher elevation beneath glacial overburden on the right side and falling off to lower elevations beneath an increasing thickness of fine and medium sand on the left side. A spillway channel will be excavated in schist and granite in the high right abutment. Rock is not available for foundations at either dike site, being buried beneath moderately pervious sand and gravel strata to depths ranging from 25 feet to 90 feet.

(b) Available materials. - Embankment materials, for placement against the upstream face of the rock fill at the dam, will be made available from required overburden excavation and from nearby areas. Pervious materials are located nearby, within one-half mile, and suitable impervious materials occur at a distance of approximately one mile. Embankment materials for dike construction are likewise available nearby.

(c) Dam and appurtenant works. - A dam of rolled-fill construction will extend across the main channel with the spillway located adjacent to the right end of the dam. With the top at Elevation 832.5, the dam will be 840 feet long and will rise 63.5 feet above the stream bed, allowing a freeboard of 5 feet above the maximum water surface. Three dikes, with top elevation at 832.5, will be constructed at the southwesterly end of the reservoir, having a total length of 2,640 feet and varying in height from 5 to 34 feet. A similar dike, 180 feet long, will be constructed near the left end of the dam. The outlet will consist of a reinforced concrete conduit in the right bank.

(d) Embankment. - The downstream half of the dam will be a heavy rock fill, the upstream face of which will be backed by gravel which in turn will be backed by a heavy impervious section from top to bottom, keyed into the ground by a cut-off trench. This impervious section will be backed with pervious material which will be riprapped.

The outside slopes, both upstream and downstream, will be 1 on 3 from the bottom to within 17 feet of the top, and the upper 17 feet will be 1 on 2-1/2. The top width of both dam and dikes will be 20 feet. The dikes will have the same slopes as the main dam but will be built with an impervious core from top to bottom with an impervious section extending upstream from the core under and well beyond the toe of the dike. The core will be backed by pervious material and both faces will be riprapped. The materials obtained from structure excavations will be utilized in the construction of the dam and dikes where suitable. A portion of the materials used in the embankments will be obtained from borrow pits.

(e) Spillway. - The spillway channel will be excavated in the rock on the right bank and will discharge into the river below the dam. A broad-crested overflow weir 265 feet long will be constructed on ledge at the head of the spillway with a crest at Elevation 815.5. The discharge under a 12-foot surcharge will be 33,000 cubic feet per second, or the equivalent of 579 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - A reinforced concrete conduit, 7.5 feet in diameter and 330 feet long, constructed on rock in the right bank, will provide for diversion control during construction and for reservoir control later. An intake and gate-operating tower at the upstream end of the conduit, containing mechanically-operated gates, will provide the control. A service bridge from the top of the dam will provide access to the tower. The discharge capacity of the conduit with the pool at spillway elevation will be 1,610 cubic feet per second.

(g) Plan of construction. - It is proposed to construct the outlet works, divert the stream, and then construct the embankment. The excavation and construction of the spillway and dikes

may proceed simultaneously with the aforementioned operations. The time estimated for construction is about 18 months or two construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation. - The State of Massachusetts has expressed a desire for 8,000 acre-feet of conservation storage, the equivalent of 2.6 inches of run-off, in the Barre Falls Reservoir for wild life, recreation, and pollution abatement. If this storage were provided, at the expense of local interests, the conservation pool level would be maintained by means of a siphon, at Elevation 802.0, flooding an area of 850 acres. To provide the flood control storage of 24,300 acre-feet, the spillway crest would be raised 5.5 feet to Elevation 821.0 and the top of the dam would be raised to Elevation 839.0. The reservoir at spillway crest would then flood an area of 1,850 acres, 400 acres in excess of the area flooded by the reservoir for flood control storage only. No change would be necessary in the general design of the dam and other appurtenances. The additional cost over and above the cost for flood control would be $157,000, with an annual cost of $8,100.

(j) Power storage. - No power storage for power development at the site is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Barre Falls Reservoir for flood control only are given in the following table:

COST ESTIMATE OF BARRE FALLS RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing.			Lump sum	$20,000	
	Stream control.			Lump sum	10,000	
	Earth excavation, common. . .	182,000	cu.yd.	0.40	72,800	
	Earth excavation, borrow. . .	134,000	cu.yd.	0.35	46,900	
	Rock excavation, open cut . .	110,000	cu.yd.	2.00	220,000	
	Embankment, rolled.	250,000	cu.yd.	0.20	50,000	
	Dumped rock	154,000	cu.yd.	0.20	30,800	
	Riprap, hand-placed	5,000	cu.yd.	3.50	17,500	
	Concrete, plain	1,950	cu.yd.	14.00	27,300	
	Concrete, reinforced.	1,800	cu.yd.	18.00	32,400	
	Reinforcement steel	144,000	lb.	0.05	7,200	
	Gates and machinery			Lump sum	36,500	
	Gatehouse and miscellaneous			Lump sum	42,700	
	Bridges, service and road			Lump sum	20,600	
					634,700	
	Contingencies			20%	127,000	
					761,700	
	Engineering and overhead.			15%	114,300	
	TOTAL. . . .					$876,000
2	Relocation of railroads and utilities . . .				None	
3	Rights-of-way and land					
	Land.	1,600	acres	Lump sum	22,300	
	Buildings purchased	3	sets	Lump sum	7,500	
	Cemetery relocation	10	graves	Lump sum	1,000	
					30,800	
	Legal, overhead, and general expenses . . .			20%	6,200	
	TOTAL. . . .					37,000
4	Highway relocation					
	Local roads - 14-ft. gravel . . .	2.0	mi.	Lump sum	43,000	
					43,000	
	Contingencies			10%	4,300	
					47,300	
	Engineering and overhead.			10%	4,700	
	TOTAL. . . .					52,000
5	Grand total capital cost					965,000

(1) Annual costs. - The estimated annual costs of the Barre Falls Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF BARRE FALLS RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$965,000	
	Interest during construction ($965,000 x 0.03). . . .	29,000	
	TOTAL (Federal investment).	994,000	
2	Federal annual charges		
	Interest. . . . . ($994,000 x 0.035). .	34,800	
	Amortization of obsolescence and depreciation		
	Earthwork and general(1.38 x 1.03 x .0076 x $531,300)	5,700	
	Concrete. . . . . .(1.38 x 1.03 x .0076 x 66,900)	700	
	Gates and machinery (1.38 x 1.03 x .0354 x 36,500)	1,800	
	Rights-of-way and land(1.20 x 1.03 x .0076 x 30,800)	300	
	Highways. . . . . .(1.21 x 1.03 x .0076 x 43,000)	400	
	Maintenance and operation		
	Embankment and general overhead	4,000	
	Operator and expendable supplies.	2,000	
	Concrete. . . . . (1.38 x 0.01 x 66,900)	900	
	Gates and machinery . . . . (1.38 x 0.03 x 36,500)	1,500	
	TOTAL (Federal annual charges).		$52,100
3	Non-Federal investment.	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . . ($29,800 x 0.03)	900	
	TOTAL (non-Federal annual charges).		900
	TOTAL ANNUAL COST (2 + 4)		53,000

f. Tully. - (1) General. - Tully Reservoir is outlined on Plate No. 28. The dam site is located on the Tully River, 3.9 miles above its junction with the Millers River, one mile above Fryville and 0.1 mile below a wooden highway bridge on the highway between Athol, Massachusetts and Keene, New Hampshire. The reservoir will extend upstream 6 miles, lying wholly in the Town of Royalston, Worcester County, Massachusetts. The spillway will project into the Town of Athol, Worcester County and the outlet channel will project into the Town of Orange, Franklin County. The drainage area of 50 square miles is hilly, partly wooded, and covered with brush. The area and capacity curves are shown on Plate No. 28. The flood control storage capacity will be equivalent to 8.3 inches of run-off from the drainage area or 22,150 acre-feet at the spillway crest. The reservoir area below the spillway crest elevation of 668.0 feet above mean sea level will be approximately 1,100 acres, classified as follows:

(a)	Agricultural land.	100 acres
(b)	Pasture land	100 acres
(c)	Wooded land.	670 acres
(d)	Swamp land	200 acres
(e)	Pond.	30 acres
(f)	Towns, etc.	No community center is within the area. 7 sets of buildings.

(2) Highways and roads. - Two and seven tenths miles of 16-foot gravel road will be relocated as indicated on Plate No. 28.

(3) Railroads. - No railroads are located within the area.

(4) Other public works. - Three and six tenths miles of telephone line and 2.7 miles of electric transmission line (steel tower) will be relocated.

(5) Dam. - A general plan of the dam and the geologic features are indicated on Plates Nos. 29 and 30.

(a) Geology. - On the left side, granite outcrops at the river and rises steeply toward the left abutment under a glacial overburden of sand, silt, gravel, and boulders. The rock surface on the right side dips steeply toward the north beneath compact and impervious sediments similar to those forming the overburden in the opposite abutment.

(b) Available materials. - Mixed deposits of sand, silt, and gravel, suitable for the impervious section, are available on the right bank upstream within one-half mile. Sand and gravel for pervious-embankment construction is available upstream on the right within one-half mile, also downstream on the left bank. Rock from rock excavations, supplemented by boulders, will be available for rock-fill embankment.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main stream with a tunnel in rock through the left bank. A spillway will be constructed on rock in a saddle located wouthead of the left abutment. The dam will be 1,500 feet long. The top at Elevation 684.0 will be 61 feet above the stream bed, and will allow a freeboard of 5.3 feet above the maximum water surface.

(d) Embankment. - The rolled-fill earth embankment will have a top width of 30 feet. The dam will be built with an impervious core from top to bottom, keyed into the ground with a cut-off trench along the axis of the dam. The impervious core will be backed with a pervious section on both faces. The upstream slope will be 1 on 3 from the bottom to the top of the dam and the downstream slope will be 1 on 2-1/2. Both slopes will be riprapped. The material for the embankment

will be obtained from borrow areas supplemented by suitable materials from the outlet and spillway channel excavations.

(e) Spillway. - A concrete spillway with an ogee-crested weir 255 feet long will be constructed across a gully southeast of the left abutment. With the crest at Elevation 668.0 and a 10.7-foot surcharge, the discharge capacity will be 31,800 cubic feet per second or 636 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - A 6-foot diameter concrete-lined tunnel, 296 feet long, constructed through rock in the left bank, will provide diversion control during construction and reservoir control later. The discharge capacity with the pool at spillway crest will be 1,100 cubic feet per second. Located at the upper end of the tunnel will be a tower from which the gates will be mechanically operated. It will be accessible by way of a service bridge connecting with the top of the dam.

(g) Plan of construction. - It is proposed first to construct the outlet works and prepare the ground for the embankment. The stream will then be diverted through the outlet, and the embankment will be constructed simultaneously with the spillway channel excavation. Finally, the spillway weir and the service bridge will be constructed. The time estimated for construction will be 16 months or two construction seasons.

(h) Flood control storage. - The estimated costs of the reservoir as designed for flood control only were as follows:

(1)	Construction.	$502,000
(2)	Relocation of railroad utilities.	31,000
(3)	Rights-of-way and land.	45,000
(4)	Highway relocation.	87,000
(5)	Grand total capital cost.	665,000
(6)	Total annual cost.	39,200

The dam was designed with the top at Elevation 684.0 and the spillway crest at Elevation 668.0.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - In order to provide for the request of the Federal Power Commission to install a portion of penstock and provide for adapting the dam to future power storage, the design of the dam was made such that it is suitable for being raised 36 feet and the spillway being relocated to a position suitable for the higher dam. The spillway design was also modified for penstock takeoff and power intake. If and when the spillway is raised 36 feet, in the future, it will provide for the storage of an additional 20.0 inches of run-off or 53,450 acre-feet.

(k) Estimate of cost. - The estimated costs of the Tully Reservoir for initial construction which includes the flood control dam with adaptations for future raising are as follows:

COST ESTIMATE OF TULLY RESERVOIR

INITIAL CONSTRUCTION WITH ADAPTATIONS FOR FUTURE RAISING

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 38,000	
	Stream control			Lump sum	4,000	
	Earth excavation, common	98,000	cu.yd.	0.40	39,200	
	Earth excavation, borrow	92,000	cu.yd.	0.32	29,400	
	Rock excavation, open cut	50,000	cu.yd.	2.30	115,000	
	Rock excavation, tunnel	600	cu.yd.	15.00	9,000	
	Embankment, rolled	134,000	cu.yd.	0.23	30,800	
	Dumped rock	59,000	cu.yd.	0.25	14,800	
	Concrete, plain	2,900	cu.yd.	14.00	40,600	
	Concrete, reinforced	1,150	cu.yd.	18.00	20,700	
	Reinforcement steel	90,000	lb.	0.05	4,500	
	Gates and machinery			Lump sum	31,000	
	Gatehouse and miscellaneous			Lump sum	36,000	
	Bridges, service and road			Lump sum	19,000	
					432,000	
	Contingencies			20%	86,000	
					518,000	
	Engineering and overhead			15%	78,000	
	TOTAL					$596,000
2	Relocation of railroads and utilities					
	Railroads				None	
	Telephone and electric distribution lines	3.0	mi.	Lump sum	1,500	
	Steel tower transmission line	2.7	mi.	Lump sum	24,100	
					25,600	
	Contingencies			10%	2,600	
					28,200	
	Engineering and overhead			10%	2,800	
	TOTAL					31,000
3	Rights-of-way and land					
	Land	1,100	acres	Lump sum	29,700	
	Buildings purchased	7	sets	Lump sum	7,800	
					37,500	
	Legal, overhead, and general expenses			20%	7,500	
	TOTAL					45,000
4	Highway relocation					
	Local road - 18-ft. bit. macadam	1.0	mi.	Lump sum	27,000	
	Local roads - 16-ft. gravel	2.5	mi.	Lump sum	44,900	
					71,900	
	Contingencies			10%	7,200	
					79,100	
	Engineering and overhead			10%	7,900	
	TOTAL					87,000
5	Grand total capital cost					759,000

(1) Annual costs. - The estimated annual costs for the initial construction of the Tully Reservoir are given in the following table:

ESTIMATED ANNUAL COSTS OF TULLY RESERVOIR

INITIAL CONSTRUCTION WITH ADAPTATIONS FOR FUTURE RAISING

Item No.	Item	Cost	Total cost
1	Federal Investment		
	Grand total capital cost (Item 5)	$759,000	
	Interest during construction ($759,000 x 0.03)	23,000	
	TOTAL (Federal investment)	782,000	
2	Federal annual charges		
	Interest (.....($782,000 x 0.035)	27,400	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.03 x .0076 x $335,200)	3,600	
	Concrete (1.38 x 1.03 x .0076 x 65,800)	700	
	Gates and machinery (1.38 x 1.03 x .0354 x 31,000)	1,600	
	Railroad and utilities (1.21 x 1.03 x .0076 x 25,600)	200	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 37,500)	400	
	Highways (1.21 x 1.03 x .0076 x 71,900)	700	
	Maintenance and operation		
	Embankment and general overhead	3,500	
	Operator and expendable supplies	2,000	
	Concrete (1.38 x 0.01 x $65,800)	900	
	Gates and machinery (1.38 x 0.03 x 31,000)	1,300	
	TOTAL (Federal annual charges)		$42,300
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land (.....($37,500 x 0.03)	1,100	
	TOTAL (non-Federal annual charges)		1,100
	TOTAL ANNUAL COST (2 + 4)		43,400

(m) Estimate of cost. - The estimated additional costs of the Tully Reservoir for the future raising to provide 54,000 acre feet of power storage at the site, exclusive of any power plant installations, are as follows:

ESTIMATE OF ADDITIONAL COST OF RAISING TULLY RESERVOIR TO INCLUDE POWER STORAGE

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 8,500	
	Earth excavation, common	95,000	cu.yd.	0.40	38,000	
	Earth excavation, borrow	558,000	cu.yd.	0.33	184,000	
	Rock excavation, open cut	46,000	cu.yd.	2.30	106,000	
	Embankment, rolled	682,000	cu.yd.	0.13	88,600	
	Dumped rock	87,400	cu.yd.	0.30	26,200	
	Concrete, plain	8,400	cu.yd.	13.00	109,000	
	Concrete, reinforced	7,400	cu.yd.	16.00	118,000	
	Reinforcement steel	614,000	lb.	0.05	30,600	
	Gates and machinery			Lump sum	167,000	
	Gatehouse and miscellaneous			Lump sum	56,000	
					931,900	
	Contingencies			20%	186,400	
					1,118,300	
	Engineering and overhead			15%	167,700	
	TOTAL					$1,286,000
2	Relocation of railroads and utilities					
	Telephone and electric distribution lines	3.5	mi.	Lump sum	1,800	
	Steel tower transmission line	1.2	mi.	Lump sum	13,000	
					14,800	
	Contingencies			10%	1,500	
					16,300	
	Engineering and overhead			10%	1,700	
	TOTAL					18,000
3	Rights-of-way and land					
	Land	600	acres	Lump sum	40,000	
	Buildings purchased	3	sets	Lump sum	5,000	
	Cemetery relocation	100	graves	Lump sum	10,000	
					55,000	
	Legal, overhead, and general expenses			20%	11,000	
	TOTAL					66,000
4	Highway relocation					
	Local road - 18-ft.bit.macadam	0.1	mi.	Lump sum	6,500	
	Local road - 16-ft.gravel	0.7	mi.	Lump sum	15,000	
					21,500	
	Contingencies			10%	2,100	
					23,600	
	Engineering and overhead			10%	2,400	
	TOTAL					26,000
5	Grand total capital cost					1,396,000

(n) Annual costs. -

The estimated additional annual costs for the future raising of the Tully Reservoir to provide power storage, exclusive of power plant installation, are given in the following table:

ESTIMATED ADDITIONAL ANNUAL COSTS OF RAISING TULLY RESERVOIR TO INCLUDE POWER STORAGE

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5).	$1,396,000	
	Interest during construction ($1,396,000 x 0.03)	42,000	
	TOTAL (Federal investment)	1,438,000	
2	Federal annual charges		
	Interest ($1,438,000 x 0.035).	50,300	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.03 x .0076 x $507,300)	5,500	
	Concrete . . . (1.38 x 1.03 x .0076 x 257,600)	2,800	
	Gates and machinery (1.38 x 1.03 x .0354 x 167,000)	8,400	
	Railroads and utilities (1.21 x 1.03 x .0076 x 14,800)	100	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 55,000)	500	
	Highways . . . (1.21 x 1.03 x .0076 x 21,500)	200	
	Maintenance and operation		
	Embankment and general overhead.	1,500	
	Concrete . . . (1.38 x .01 x $257,600)	3,600	
	Gates and machinery (1.38 x 0.03 x 167,000)	6,900	
	TOTAL (Federal annual charges)		$79,800
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . . ($45,000 x 0.03).	1,400	
	TOTAL (non-Federal annual charges)		1,400
	TOTAL ANNUAL COST (2 + 4)		81,200

g. Birch Hill. - (1) General. - The Birch Hill Reservoir, on the Millers River, Massachusetts, 27.3 miles above its junction with the Connecticut, is outlined on Plate No. 31. The dam is located 1.3 miles northeast of South Royalston and was completed in May 1942. The Reservoir is in the Towns of Royalston, Winchendon, and Templeton, in Worcester County, Massachusetts. The net drainage area of 155 square miles is mostly brush and second-growth timber. The area and capacity curves are shown on Plate No. 31. As designed, the flood control storage capacity is equivalent to 6.0 inches of run-off from the net drainage area, or 49,900 acre-feet at spillway crest. The reservoir area of 3,200 acres below the spillway crest elevation of 852.0 feet above mean sea level is classified as follows:

(a) Agricultural land..... 190 acres

(b) Pasture land..... 760 acres of fair value

(c) Wooded land..... 2,200 acres

(d) Towns, etc..... 150 sets of buildings, 1 church, and a small part of the village of Baldwinsville.

(2) Highways and roads. - The relocation of six miles of 20-foot bituminous macadam highway and the improvement of 1.5 miles of 16-foot gravel road as indicated on Plate No. 31, remain to be completed.

(3) Railroads. - Three and two-tenths miles of double-track main line of the Fitchburg Division of the Boston and Maine Railroad have been relocated along the southern edge of the reservoir and cross over an arm of the reservoir extending to Baldwinsville.

(4) Other public works. - Three miles of telephone and electric distribution lines and 1.2 miles of high-power transmission (steel tower) line have been relocated. At Waterville dike, protection has been provided for a sewage disposal plant owned by the Town of Winchendon.

(5) Dam. - A general plan of the dam and the geologic features are indicated on Plates Nos. 32 and 33.

(a) Geology. - The only surface exposures of bedrock are located high above the dam in both abutments. In the left abutment, schist and granite occur at a depth of approximately 25 feet beneath an impervious overburden of compact sand, gravel, and silt. Rock in the right abutment occurs at a depth of approximately 20 feet beneath an overburden similar to that in the opposite abutment. Numerous boulders occur both on the surface and in the overburden. The discharge channel was excavated in granite and weathered schist in the right abutment. A concrete spillway on shallow-seated rock was built in a natural saddle adjacent to the west side of the hill forming the right abutment.

(b) Available materials. - A large portion of the impervious and random materials required were obtained from excavation of the discharge channel. Pervious materials were available upstream within one-half mile. Rock for riprap and toes was available from rock excavations and from bouldery accumulations on the surface and in the overburden.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction extends across the Millers River with the main spillway in a natural saddle in the right bank. Three other spillways are located adjacent to the main spillway. The earth dam is approximately 1,400 feet long; the top at elevation 864.0 is 56 feet above the river bed. A freeboard of 5 feet has been allowed above maximum water surface.

(d) Embankment. - The rolled-earth embankment has a top width of 25 feet. An impervious blanket extends upstream from the core of the dam to 200 feet beyond the toe of the dam; the core

is backed by random and pervious shoulders, the upstream outer slope is 1 on 3 up to 12 feet from the top, and the upper 12 feet is 1 on 2-1/2; the downstream slope is 1 on 2-1/2 from base to top; was obtained from borrow pits after the suitable material from structure excavations had been utilized.

(e) Spillway. - The spillway weir consists of two concrete overflow sections, separated by a natural knoll, and a short weir closing an abandoned railroad cut, all constructed on solid rock in the right bank. The main spillway length is 720 feet, the adjacent spillway 170 feet, and the small one 30 feet. The crests of all three are at Elevation 852.0 with a total discharge capacity under a 7-foot surcharge, maximum flood level, of 56,600 cubic feet per second, or the equivalent of 365 cubic feet per second per square mile of net drainage area controlled. The freeboard of 5 feet will be above the 7-foot surcharge.

(f) Outlet. - The outlet works consist of an open-cut intake channel 1,500 feet long, with a bottom width of 70 feet, partly in earth and partly in rock; a reinforced-concrete gate structure with a brick operating house directly above and all constructed on solid rock; and an open cut outlet channel 1,150 feet long, with a bottom width of 70 feet. The intake and gate-operating tower, located at the north or right end of the dam, contains gates mechanically controlled from the operating house above. Access to the house is across the dam. The discharge capacity, with the pool at spillway elevation, is 10,500 cubic feet per second, with all the gates open.

(g) Construction procedure. - The construction of the outlet works, part of the spillway weirs, the preparation of the foundation for the dam were accomplished during the first construction season. In the second season, the stream was diverted, the dam was built, and the spillways were completed. The required time for construction was about 18 months or two construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The costs of the Birch Hill Reservoir as initially estimated for flood control only are given in the following table: (For revised costs, see Table XIII A on page 64.1 of the Report).

COST ESTIMATE OF BIRCH HILL RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing.			Lump sum	$12,000	
	Stream control.			Lump sum	10,000	
	Earth excavation, common.	200,000	cu.yd.	0.42	84,000	
	Earth excavation, borrow.	140,000	cu.yd.	0.35	49,000	
	Rock excavation, open cut	56,300	cu.yd.	2.55	143,600	
	Embankment, rolled. . . .	250,000	cu.yd.	0.15	37,500	
	Dumped rock	38,000	cu.yd.	0.75	28,500	
	Riprap, hand-placed . . .	2,800	cu.yd.	3.50	9,800	
	Concrete, plain	10,000	cu.yd.	13.50	135,000	
	Concrete, reinforced. . .	2,520	cu.yd.	18.65	47,000	
	Reinforcement steel . . .	191,300	lb.	0.05	9,600	
	Gates and machinery			Lump sum	78,000	
	Gatehouse and miscellaneous			Lump sum	67,500	
					711,500	
	Contingencies			10%	71,100	
					782,600	
	Engineering and overhead.			15%	117,400	
	TOTAL					$900,000
2	Relocation of railroads and utilities					
	Main line, double track, Fitchburg Division of B. & M. R. R. . . .	3.2	mi.	Lump sum	740,500	
	Telephone and telegraph lines	3.0	mi.	Lump sum	2,000	
	Steel tower transmission lines	2.0	mi.	Lump sum	20,000	
	Dike protection, sewage disposal plant.			Lump sum	30,000	
					792,500	
	Contingencies			10%	79,300	
					871,800	
	Engineering and overhead.			10%	87,200	
	TOTAL					959,000
3	Rights-of-way and land					
	Land.	3,000	acres	Lump sum	45,000	
	Buildings purchased	157	sets	Lump sum	508,300	
	Cemetery relocation	200	graves	Lump sum	10,000	
	Water rights, developed			Lump sum	25,000	
					588,300	
	Legal, overhead, and general expenses .			20%	117,700	
	TOTAL					706,000
4	Highway relocation					
	U.S. Highway 202, 20-foot bituminous macadam.	6.0	mi.	Lump sum	273,600	
	Local roads, 16-foot gravel .	1.5	mi.	Lump sum	90,000	
					363,600	
	Contingencies			10%	36,400	
					400,000	
	Engineering and overhead.			10%	40,000	
	TOTAL					440,000
5	Grand total capital cost.					3,005,000

(1) Annual costs. - The estimated annual costs of the Birch Hill Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF BIRCH HILL RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$3,005,000	
	Interest during construction ($3,005,000 x 0.03)	90,000	
	TOTAL (Federal investment).	3,095,000	
2	Federal annual charges		
	Interest. . . . . .($3,095,000 x 0.035)	108,300	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.265 x 1.03 x .0076 x $441,900)	4,400	
	Concrete. . (1.265 x 1.03 x .0076 x 191,600)	1,900	
	Gates and machinery (1.265 x 1.03 x .0354 x 78,000)	3,600	
	Railroads and utilities (1.21 x 1.03 x .0076 x 792,500)	7,500	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 588,300)	5,500	
	Highways. . (1.21 x 1.03 x .0076 x 363,600)	3,400	
	Maintenance and operation		
	Embankment and general overhead	3,500	
	Operator and expendable supplies.	2,000	
	Concrete. . . . . (1.265 x 0.01 x $191,600)	2,400	
	Gates and machinery (1.265 x 0.03 x 78,000)	3,000	
	TOTAL (Federal annual charges).		$145,500
3	Non-Federal investment.	None	
4	Non-Federal annual charges		
	Tax loss on land. . . . . ($578,300 x 0.03)	17,300	
	TOTAL (non-Federal annual charges).		17,300
	TOTAL ANNUAL COST (2 + 4)		162,800

h. Lower Naukeag. - (1) General. - Lower Naukeag Reservoir is outlined on Plate No. 34. The dam site is located on Millers River, 41.7 miles above its junction with the Connecticut River, 1.5 miles north of North Ashburnham Station, and 0.1 mile above a bridge across Millers River. The reservoir will consist of two branches, of which one branch will extend 2.0 miles upstream along the Millers River, and another branch, including Lower Naukeag Lake, will extend about two miles upstream from the dam site. Water rights of the existing development are vested in the Winchendon Electric Light and Power Company. The reservoir will lie in the Town of Ashburnham, with a small portion in the Town of Winchendon, all in Worcester County, Massachusetts. The drainage area of 20.0 square miles is mostly hilly, covered with second-growth timber and brush. The area and capacity curves are shown on Plate No. 34. The flood control storage capacity will be equivalent to 8.0 inches of run-off from the drainage area, or 8,500 acre-feet at spillway crest. The reservoir area below the spillway crest elevation of 1075.5 feet above mean sea level will be approximately 1000 acres, classified as follows:

(a) Agricultural land ..... 50 acres

(b) Pasture land ..... 50 acres

(c) Wooded land ..... 360 acres

(d) Swamp land ..... 240 acres

(e) Lake ..... 300 acres

(f) Towns, etc. ..... No towns are within the area. One set of farm buildings and 44 cottages, scattered on the shores of Lower Naukeag Lake.

(2) Highways and roads. - One mile of 14-foot gravel road will be relocated and 0.2 mile of 16-foot gravel road will be raised on its present alinement as indicated on Plate No. 34.

(3) Railroads. - No railroads are located within the area.

(4) Other public works. - The existing low dam, now owned by the Winchendon Electric Light and Power Company, will be acquired. One-half mile of telephone and electric distribution line will be relocated.

(5) Dam. - A general plan of the dam and dikes and the geologic features are shown on Plates Nos. 35 and 36.

(a) Geology. - At the dam, granite and schist occur on the left bank to a height of 3 feet above the river. The rock surface dips slightly toward the west, passing beneath the stream at a depth of approximately 5 feet. Both abutments are formed in an impervious overburden. The rock floor at the Sherberts Mill dike site is situated at a depth of 10 feet below the stream. A pervious overburden occurs on the left bank and an impervious overburden on the right.

(b) Available materials. - Materials for the impervious rolled-fill sections, at both the dam and the nearby Sherberts Mill dike, may be obtained upstream within one-half mile. Sand and gravel for pervious embankment construction are available downstream within one-half mile. Materials similar to those named above are available near the Pole Street dike site for both pervious and impervious embankment. A portion of the rock fill required for riprap may be obtained from rock excavations and boulders.

(c) Dam and appurtenant works. - The dam and dikes will consist of rolled-fill earth embankments. The dam across Millers River will contain the spillway and conduit. The total length of this dam will be 470 feet, the length of earth fill being 150 feet, outlet section 20 feet, and concrete spillway 300 feet. The present outlet of Lower Naukeag Lake will be blocked by a dike at Sherberts Mill, 2,000 feet south of the dam on the Millers River. The maximum height of the

dike will be 41 feet and the length 800 feet. The low ground west of Lower Waukeag Lake will be protected by a dike starting at a point 3,000 feet southeast of Sherberts Mill and following Pole Street in a southeasterly direction for a distance of 4,650 feet. The maximum height of this dike will be 15 feet and the average height 8.5 feet. The top of dam and dikes will be at elevation 1,085.5, or 30 feet above the stream-bed elevation at the dam on the Millers River. This will allow a freeboard of 5 feet above maximum water surface.

(d) Embankment. - The rolled-fill earth embankment of the main dam and Sherberts Mill dike will have a 20-foot top width. The embankments will be built with an impervious core from top to bottom, keyed into the ground with a cut-off trench along the axis of the embankment. The impervious core will be backed with a pervious section on both faces, the outside slope of the upstream side will be 1 on 3 from the bottom to within 10 feet of the top, and 1 on 2-1/2 for the remaining 10 feet; the downstream side will be 1 on 4 from the bottom to within 10 feet of the top, and 1 on 3 for the remaining 10 feet. The upstream slope will be hand-placed riprap. A pervious toe drain will be provided. The material for the embankments will be obtained from borrow. The Pole Street dike will be similar in section to the Sherberts Mill dike, except that the slopes will be 1 on 2-1/2 on the upstream side and 1 on 4 on the downstream side from top to bottom.

(e) Spillway. - The spillway will be a concrete gravity overflow weir with a concrete apron constructed in the dam across Millers River. With the crest at Elevation 1,075.5 and a 5-foot surcharge, the discharge capacity will be 13,000 cubic feet per second, or 650 cubic feet per second per square mile of drainage area controlled. The outlet will be constructed adjacent to the spillway, and concrete abutment walls will separate the spillway and outlet sections from the earth sections. During spillway operation, the water will be discharged immediately after leaving the spillway weir without damage to the embankment.

(f) Outlet. - The outlet will consist of an approach channel and a discharge channel with two 3-foot by 6-foot rectangular conduits, 25 feet long, located in the base at the right end of the spillway weir. Control will be accomplished by mechanically-operated gates from a concrete intake and gate-operating tower. The discharge capacity with pool at spillway crest will be 890 cubic feet per second. A reinforced-concrete stilling basin will be constructed at the discharge end, returning the water to the river with less than scouring velocity.

(g) Plan of construction. - It is proposed first to construct the outlet, including the abutments and spillway weir, at the dam on the Millers River and prepare the ground for the embankment simultaneously with the Pole Street dike. The stream will then be diverted through the outlet and the embankment completed. Lower Naukeag Lake may be lowered before construction of Sherberts Mill dike, and the present gate at the outlet of the lake kept closed long enough to construct the bottom part of the dike. The outlet of the lake will then be diverted through the gully to the Millers River and the embankment completed. It is estimated that a construction period of 12 months, or one working season, will be required.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation. - The State of Massachusetts has expressed a desire for 4,000 acre-feet of conservation storage, equivalent to 3.7 inches of run-off from the contributing drainage area, in the Lower Naukeag Reservoir for wild life, recreation, and pollution abatement. If this storage were provided, at the expense of local interests, the conservation pool level would be maintained, by means of a siphon, at Elevation 1071, occupying an area of 830 acres. To provide

the flood control storage of 8,500 acre-foot, the spillway crest would be raised 3.5 foot to elevation 1079.0 and the top of the dam to Elevation 1089.0. The reservoir at spillway crest would then occupy an area of 1,160 acres, 160 acres in excess of the area occupied by the reservoir for flood control storage only. No change would be necessary in the general design of the dam and other appurtenances. The additional cost over and above the cost for flood control would be $112,000, with an annual cost of $5,000.

(j) Power storage. - No storage for power development at the site is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Lower Naukeag Reservoir for flood control only are given in the following table:

COST ESTIMATE OF LOWER NAUKEAG RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$37,000	
	Stream control			Lump sum	3,000	
	Earth excavation, common	50,000	cu.yd.	0.40	20,000	
	Earth excavation, borrow	93,000	cu.yd.	0.30	27,900	
	Rock excavation, open cut	3,000	cu.yd.	2.30	6,900	
	Embankment, rolled	126,000	cu.yd.	0.30	37,800	
	Dumped rock	14,000	cu.yd.	1.35	18,900	
	Concrete, plain	4,800	cu.yd.	14.00	67,200	
	Concrete, reinforced	800	cu.yd.	18.00	14,400	
	Reinforcement steel	150,000	lbs.	0.05	7,500	
	Gates and machinery			Lump sum	25,000	
	Gatehouse and miscellaneous			Lump sum	35,800	
					301,400	
	Contingencies			20%	60,300	
					361,700	
	Engineering and overhead			15%	54,300	
	TOTAL					$416,000
2	Relocation of railroads and utilities					
	Railroads				None	
	Telephone and electric distribution lines	1.0	mi.	Lump sum	800	
					800	
	Contingencies			10%	100	
					900	
	Engineering and overhead			10%	100	
	TOTAL					1,000
3	Rights-of-way and land					
	Land	1,050	acres	Lump sum	24,000	
	Buildings purchased	45	sets	Lump sum	49,300	
	Water rights, developed			Lump sum	5,000	
					78,300	
	Legal, overhead, and general expenses			20%	15,700	
	TOTAL					94,000
4	Highway relocation					
	Local road, 14-ft. gravel	1.0	mi.	Lump sum	14,000	
	Local road, 16-ft. gravel	0.2	mi.	Lump sum	6,500	
	Bridge			Lump sum	10,000	
					30,500	
	Contingencies			10%	3,100	
					33,600	
	Engineering and overhead			10%	3,400	
	TOTAL					37,000
5	Grand total capital cost					548,000

(1) Annual costs. - The estimated annual costs of the Lower Naukeag Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF LOWER NAUKEAG RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$548,000	
	Interest during construction	None	
	TOTAL (Federal investment)	548,000	
2	Federal annual charges		
	Interest . . . . . ($548,000 x 0.035).	19,200	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x .0076 x $187,300)	2,000	
	Concrete . . . . . (1.38 x .0076 x 89,100)	900	
	Gates and machinery. . (1.38 x .0354 x 25,000)	1,200	
	Railroads and utilities(1.21 x .0076 x 800)	0	
	Rights-of-way and land (1.20 x .0076 x 78,300)	700	
	Highways . . . . . (1.21 x .0076 x 30,900)	300	
	Maintenance and operation		
	Embankment and general overhead	3,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . (1.38 x 0.01 x $89,100)	1,200	
	Gates and machinery. . (1.38 x 0.03 x 25,000)	1,000	
	TOTAL (Federal annual charges)		$32,000
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . ($78,300 x 0.03).	2,400	
	TOTAL (non-Federal annual charges)		2,400
	TOTAL ANNUAL COST (2 + 4).		34,400

i. Honey Hill. - (1) General. - The Honey Hill Reservoir, on the South Branch of the Ashuelot River, New Hampshire, 5.6 miles above its junction with the Ashuelot River, is outlined on Plate No. 37. The dam site is located one mile west of East Swanzey, New Hampshire. The reservoir will extend 2.0 miles upstream on the South Branch, 3.0 miles upstream on Martin Brook, 1.0 mile upstream on Falls Brook, and 2.5 miles upstream on Perry Brook, all in the Town of Swanzey, except the upper 0.5 mile on Martin Brook which lies in the Town of Richmond. The entire reservoir will be in Cheshire County, New Hampshire. The drainage area of 70 square miles is hilly to mountainous and heavily wooded. Considerable farming is done along the river valleys. The area and capacity curves are shown on Plate No. 37. The flood control storage capacity will be equivalent to 7.0 inches of run-off from the drainage area or 26,200 acre-feet at the spillway crest. The reservoir area below the spillway crest elevation of 520.0 feet above mean sea level will be approximately 1,360 acres, classified as follows:

(a) Agricultural land ... 340 acres of fair value

(b) Pasture land ..... 360 acres

(c) Wooded land ..... 610 acres

(d) Swamp land ..... 750 acres

(e) Towns, etc. ..... 50 sets of buildings and 1 school. A portion of East Swanzey.

(2) Highways and roads. - Two and one-half miles of 16-foot bituminous macadam highway will be relocated and 3.1 miles of 16-foot bituminous macadam road will be improved as indicated on Plate No. 37.

(3) Railroads. - No railroads are involved.

(4) Other public works. - Six miles of telephone and electric distribution lines will be relocated.

(5) Dam. - A general plan of the dam is shown on Plate No. 38.

(a) Geology. - Bedrock is not exposed at the site. The right abutment, in which the spillway and conduit will be located, is formed in an overburden of sand and gravel. The left abutment is likewise formed in a relatively impervious overburden of sand and silt.

(b) Available materials. - A portion of the embankment materials required may be obtained from excavations for spillway, conduit, and exploration trench. Additional pervious materials are available upstream within one-half mile. Sand and silt are also available upstream for impervious embankment construction.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend from the left bank across the main stream and valley with an overflow weir in the right abutment. The length of the earth fill will be 2,130 feet; the top at Elevation 535.0 will be 65 feet above the stream bed. This will allow a freeboard of 5 feet above the maximum water surface.

(d) Embankment. - The earth fill will have a 20-foot top width. The dam will be built with an impervious core from top to bottom keyed into the ground with a cut-off trench along the axis of the embankment. The impervious core will be backed by a pervious section on both upstream and downstream faces with outside slopes of 1 on 3 from the bottom to within 15 feet of the top; the upper 15 feet will be 1 on 2-1/2. The upstream face will be riprapped and the downstream toe will be of dumped rock.

(e) Spillway. - A concrete overflow weir, 280 feet long, will be constructed in the right abutment on sand and gravel. Steel sheet-piling will extend under the length of the weir. A concrete gravity retaining wall will protect the embankment at the spillway. A reinforced concrete spillway channel and stilling basin will return the discharge to the main channel below the dam. With the crest at Elevation 520.0 the

discharge capacity under a 10-foot surcharge, maximum flood level, will be 34,000 cubic feet per second or the equivalent of 486 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - The outlet will consist of a 10-foot diameter reinforced concrete conduit, 365 feet long, located in the right bank, and will provide for diversion control during construction and for reservoir control later. Control will be accomplished by gates operated from a tower located at the intake end of the tunnel. A service bridge will provide access from the tower to the top of the dam. A concrete stilling basin will be provided at the discharge end of the conduit. The discharge capacity with pool at spillway elevation will be 3,100 cubic feet per second.

(g) Plan of construction. - It is proposed to construct the outlet and intake tower simultaneously with spillway excavation and much of the embankment; the stream will then be diverted through the conduit and the embankment and spillway completed. The estimated time for construction is 18 months or two construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Honey Hill Reservoir for flood control only are given in the following table:

COST ESTIMATE OF HONEY HILL RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 43,000	
	Stream control			Lump sum	8,000	
	Earth excavation, common	306,000	cu.yd.	0.40	122,400	
	Earth excavation, borrow	400,000	cu.yd.	0.35	140,000	
	Embankment, rolled	600,000	cu.yd.	0.10	60,000	
	Dumped rock	66,000	cu.yd.	1.80	118,800	
	Riprap, hand-placed	2,100	cu.yd.	5.00	10,500	
	Concrete, plain	3,950	cu.yd.	14.00	55,300	
	Concrete, reinforced	17,750	cu.yd.	16.00	284,000	
	Reinforcement steel	656,000	lb.	0.05	32,800	
	Sheet-piling	13,600	sq.ft.	1.25	17,000	
	Gates and machinery			Lump sum	54,000	
	Gatehouse and miscellaneous			Lump sum	51,200	
	Bridges, service and road			Lump sum	16,000	
					1,013,000	
	Contingencies			20%	202,600	
					1,215,600	
	Engineering and overhead			15%	182,400	
	TOTAL					$1,398,000
2	Relocation of railroads and utilities					
	Telephone and electric distribution lines	5.8	mi.	Lump sum	4,100	
					4,100	
	Contingencies			10%	400	
					4,500	
	Engineering and overhead			10%	500	
	TOTAL					5,000
3	Rights-of-way and land					
	Land	2,000	acres	Lump sum	46,700	
	Buildings purchased	50	sets	Lump sum	145,000	
	Water rights, developed			Lump sum	10,000	
					201,700	
	Legal, overhead, and general expenses			20%	40,300	
	TOTAL					242,000
4	Highway relocation					
	Local roads, 16-ft. bituminous macadam	5.8	mi.	Lump sum	200,600	
	Bridges	2		Lump sum	39,000	
					239,600	
	Contingencies			10%	24,000	
					263,600	
	Engineering and overhead			10%	26,400	
	TOTAL					290,000
5	Grand total capital cost					1,935,000

(1) Annual costs. - The estimated annual costs of the Honey Hill Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF HONEY HILL RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$1,935,000	
	Interest during construction ($1,935,000 x 0.03)	58,000	
	TOTAL (Federal investment).	1,993,000	
2	Federal annual charges		
	Interest. . . . . .($1,993,000 x 0.035)	69,800	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.03 x .0076 x $586,900)	6,300	
	Concrete. . .(1.38 x 1.03 x .0076 x 372,100)	4,000	
	Gates and machinery (1.38 x 1.03 x .0354 x 54,000)	2,700	
	Railroads and utilities (1.21 x 1.03 x .0076 x 4,100)	0	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 201,700)	1,900	
	Highways. . .(1.21 x 1.03 x .0076 x 239,600)	2,300	
	Maintenance and operation		
	Embankment and general overhead	4,500	
	Operator and expendable supplies.	2,000	
	Concrete. . . . . .(1.38 x 0.01 x $372,100)	5,100	
	Gates and machinery .(1.38 x 0.03 x 54,000)	2,200	
	TOTAL (Federal annual charges).		$100,800
3	Non-Federal investment.	None	
4	Non-Federal annual charges		
	Tax loss on land. . . . . .($201,700 x 0.035)	7,100	
	TOTAL (non-Federal annual charges).		7,100
	TOTAL ANNUAL COST (2 + 4)		107,900

j. Otter Brook. - (1) General. - The Otter Brook Reservoir, on Otter Brook, New Hampshire, 4.9 miles above its junction with the Ashuelot River, is outlined on Plate No. 39. The dam site is located 2.5 miles north of South Keene, New Hampshire. The reservoir will extend upstream 2.5 miles largely in the Town of Keene and with a small portion in the Town of Roxbury, all in Cheshire County, New Hampshire. The drainage area of 47 square miles is very hilly and partly wooded. Considerable farming is carried on in the valley. The area and capacity curves are shown on Plate No. 39. The flood control storage capacity will be equivalent to 7.0 inches of run-off from the drainage area or 17,500 acre-feet at the spillway crest. The reservoir area below the spillway crest elevation at 771.5 feet above mean sea level, will be 350 acres, classified as follows:

(a) Agricultural land ... 120 acres of poor quality

(b) Pasture land ..... 70 acres

(c) Wooded land ..... 140 acres

(d) Swamp land ..... 20 acres

(e) Towns, etc. ..... 8 sets of buildings

(2) Highways and roads. - One and one-half miles of 16-foot gravel road and 1.6 miles of 20-foot bituminous macadam highway will be relocated as indicated on Plate No. 39.

(3) Railroads. - No railroads are involved.

(4) Other public works. - Three miles of telephone lines will be relocated.

(5) Dam. - A general plan of the dam and the geologic features are indicated on Plates Nos. 40 and 41.

(a) Geology. - Rock either is exposed at the surface or lies at shallow depth below the surface throughout the right abutment. The spillway and conduit will be constructed in rock on this

side. The left abutment is formed in a relatively impervious glacial formation composed of mixed sand, silt, gravel, and few cobbles and boulders. This overburden ranges in thickness adjacent to the river to approximately 100 feet beneath the east end of the dam.

(b) Available materials. - A rolled-earth embankment is proposed. Impervious materials are available on the left bank within one-half mile. Pervious materials are available in the higher ground on the left bank within one-half mile and also upstream in the valley bottom.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main stream with an open spillway excavated in the right abutment. The dam will be 1100 feet long; the top at Elevation 786.5 will be 122.5 feet above stream bed. This will allow a freeboard of 5 feet above the maximum water surface. The outlet will consist of a reinforced concrete conduit on rock in the right bank.

(d) Embankment. - The rolled-fill embankment will have 30-foot top width. The dam will be built with an impervious core from top to bottom keyed into the ground on the left bank by a cut-off trench along the axis of the dam. The core will be keyed into the rock on the right bank by a concrete key wall along the axis of the dam. The core will be backed by pervious material which in turn will be covered with rock fill. The outside slopes of the embankment will be 1 on 3 from the bottom to within 15 feet of the top, the upper 15 feet being 1 on 2-1/2.

(e) Spillway. - An overflow concrete weir, 220 feet long, will extend across the spillway excavated in the right bank. The weir will be on the extension of the center line of the dam and separated from the dam by a concrete retaining wall. The discharge

capacity, with the weir crest at Elevation 771.5 and a surcharge of 10 feet, will be 25,000 cubic feet per second or the equivalent of 532 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - A 6-foot diameter reinforced-concrete conduit, 700 feet long, located in the right bank, will provide diversion control during construction and reservoir control later. An intake and gate-operating tower, containing mechanically operated gates, located at the upstream end of the conduit will provide the control. Access to the tower will be by means of a bridge from the top of the dam. The discharge capacity with the pool at spillway elevation will be 1,350 cubic feet per second.

(g) Plan of construction. - It is proposed to build the outlet works first, then divert the stream and build the dam and spillway simultaneously. The estimated construction period is 18 months or two construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Otter Brook Reservoir for flood control only are given in the following table:

COST ESTIMATE OF OTTER BROOK RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing.			Lump sum	$ 9,700	
	Stream control.			Lump sum	10,000	
	Earth excavation, common.	73,000	cu.yd.	0.40	29,200	
	Earth excavation, borrow.	685,000	cu.yd.	0.30	205,500	
	Rock excavation, open cut	136,000	cu.yd.	2.00	272,000	
	Embankment, rolled. . . .	740,000	cu.yd.	0.10	74,000	
	Dumped rock	190,000	cu.yd.	0.25	47,500	
	Concrete, plain	3,800	cu.yd.	14.00	53,200	
	Concrete, reinforced. . .	3,700	cu.yd.	18.00	66,600	
	Reinforcement steel . . .	296,000	lb.	0.05	14,800	
	Gates and machinery			Lump sum	36,000	
	Gatehouse and miscellaneous			Lump sum	53,300	
	Bridges, service and road			Lump sum	55,000	
					923,800	
	Contingencies			20%	185,400	
					1,112,200	
	Engineering and overhead.			15%	166,800	
	TOTAL					$1,279,000
2	Relocation of railroads and utilities					
	Telephone and electric distribution lines	3.0	mi.	Lump sum	2,500	
					2,500	
	Contingencies			10%	200	
					2,700	
	Engineering and overhead.			10%	300	
	TOTAL					3,000
3	Rights-of-way and land					
	Land.	400	acres	Lump sum	8,500	
	Buildings purchased	8	sets	Lump sum	22,300	
	Water rights, developed			Lump sum	5,000	
					35,800	
	Legal, overhead, and general expenses .			20%	7,200	
	TOTAL					43,000
4	Highway relocation					
	State Highway 9, 20-foot, bituminous macadam.	1.6	mi.	Lump sum	96,000	
	Local road, 16-foot, gravel. .	1.5	mi.	Lump sum	44,400	
	Small bridges			Lump sum	10,000	
					150,400	
	Contingencies			10%	15,000	
					165,400	
	Engineering and overhead.			10%	16,600	
	TOTAL					182,000
5	Grand total capital cost.					1,507,000

(1) Annual costs. - The estimated annual costs of the Otter Brook Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF OTTER BROOK RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$1,507,000	
	Interest during construction ($1,507,000 x 0.03)	45,000	
	TOTAL (Federal investment).	1,552,000	
2	Federal annual charges		
	Interest. . . . . .($1,552,000 x 0.035)	54,300	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.03 x .0076 x 756,200)	8,200	
	Concrete. . . .(1.38 x 1.03 x .0076 x 134,600)	1,500	
	Gates and machinery (1.38 x 1.03 x .0354 x 36,000)	1,800	
	Railroads and utilities (1.21 x 1.03 x .0076 x 2,500)	0	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 35,800)	300	
	Highways. . . .(1.21 x 1.03 x .0076 x 150,400)	1,400	
	Maintenance and operation		
	Embankment and general overhead	5,000	
	Operator and expendable supplies.	2,000	
	Concrete . . . . . (1.38 x 0.01 x $134,600)	1,800	
	Gates and machinery. . (1.38 x 0.03 x 36,000)	1,500	
	TOTAL (Federal annual charges).		$77,800
3	Non-Federal investment.	None	
4	Non-Federal annual charges		
	Tax loss on land. . . . . ($35,800 x 0.035)	1,300	
	TOTAL (non-Federal annual charges).		1,300
	TOTAL ANNUAL COST (2 + 4)		79,100

k. Surry Mountain. - (1) General. - Surry Mountain Reservoir, on the Ashuelot River, 34.6 miles above its junction with the Connecticut, is outlined on Plate No. 42. The dam is located five miles northwest from Keene, New Hampshire, and was completed in June 1942, and the reservoir extends 4 miles upstream, all lying in the Town of Surry, in Cheshire County. The drainage area of 100 square miles is hilly to mountainous. At the headwaters the hills flatten out, embracing a number of scattered ponds. The hilltops are mostly wooded, but the hillsides and valleys are farmed. The area and capacity curves are shown on Plate No. 42. The flood control storage capacity is equivalent to 6.1 inches of run-off from the drainage area, or 32,500 acre-feet at the spillway crest. The reservoir area below the spillway crest elevation of 550.0 feet above mean sea level is 970 acres, classified as follows:

(a)	Agricultural land	500 acres of considerable value.
(b)	Pasture land	120 acres.
(c)	Wooded land	350 acres.
(d)	Towns, etc.	8 sets of buildings in the village of Surry.

(2) Highways and roads. - Approximately three miles of 18-foot bituminous macadam highway has been relocated as indicated on Plate No. 42.

(3) Railroads. - No railroads are involved.

(4) Other public works. - Approximately three miles of telephone and electric distribution lines and 1.2 miles of electric (steel-tower) transmission line have been relocated.

(5) Dam. - The general plan of the dam and the geologic features are indicated on Plates Nos. 43 and 44.

(a) Geology. - In the right abutment, granite rises high above the spillway elevation, under a shallow cover of sand and silt.

The rock surface dips towards the east beneath the flood plain to a maximum depth of approximately 95 feet below river level. It rises again in the left abutment under a compact and impervious overburden of gravel, sand, and boulders, approximately 100 feet thick. Deposits of interstratified silt and clay occur beneath the flood plain together with coarser sediments. The spillway and outlet conduit were excavated in granite in the right abutment.

(b) Available materials. - Gravel and sand suitable for pervious rolled-fill construction were available north and east of the dam. Impervious and random materials were also available on the east side. Rock for riprap and toes was available from excavations of spillway and conduit.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction with a side-channel spillway on the right bank has been constructed. The total length of the dam is 1,670 feet with the top at elevation 568.0, or 86 feet above the stream bed. This allows a freeboard of 8 feet above the maximum water surface.

(d) Embankment. - The earth-fill dam has a 30-foot top width. It consists of an impervious core from top to bottom, keyed into the ground with a cut-off trench along the axis of the dam. The side slopes of the impervious core are approximately 1 on 2. The core is backed by a pervious section on both upstream and downstream faces, the outside slope of each is 1 on 5 from bottom to elevation 520.0, 1 on 3 to elevation 550.0, and the upper 18 feet is 1 on 2.1 approximately. Dumped rock has been placed on both upstream and downstream faces. A rock-filled trench along the downstream toe provides drainage. The materials obtained from the structure excavations were used in the embankment where suitable, the remainder of embankment material being obtained from borrow pits.

(e) Spillway. - An open side-channel spillway in the right abutment, with a low concrete weir 337.5 feet long, will carry the

flood waters around the embankment, discharging them at a point 1200 feet below the downstream toe. With the permanent crest at Elevation 550.0, the discharge capacity under a 10-foot surcharge will be 40,900 cubic feet per second, or the equivalent of 409 cubic feet per second per square mile of drainage area controlled. The 8-foot freeboard will be above the 10-foot surcharge.

(f) Outlet. - A 10-foot diameter concrete-lined tunnel through rock in the right abutment, 383 feet long, provided for stream diversion during the construction of the embankment, is now used for reservoir control. The capacity under maximum operating head (spillway crest) is approximately 3,650 cubic feet per second. The discharge is controlled by gates mechanically operated through a shaft from the control house above. The outlet discharges into the spillway channel. Access to the house is provided by a bridge over the spillway channel.

(g) Plan of construction. - During the first construction season the outlet was constructed and the ground prepared for the earth fill. The stream was diverted through the outlet, and a portion of the embankment was built simultaneously with the spillway during the second season. Construction was started August 23, 1939 and was completed in June 1942.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The costs of the Surry Mountain Reservoir as initially for flood control only are given in the following table: (For revised costs see Table XIII A on page 64.1 of the Report.)

COST ESTIMATE OF SURRY MOUNTAIN
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total Cost
1	Construction					
	Clearing			Lump sum	$16,000	
	Stream control			Lump sum	8,000	
	Earth excavation, common	132,000	cu.yd.	0.40	52,800	
	Earth excavation, borrow	750,000	cu.yd.	0.30	225,000	
	Rock excavation, open cut	111,000	cu.yd.	2.00	222,000	
	Rock escavation, tunnel and shaft	3,500	cu.yd.	12.00	42,000	
	Embankment, rolled	860,000	cu.yd.	0.08	68,800	
	Dumped rock	134,000	cu.yd.	0.20	26,800	
	Concrete, plain	10,300	cu.yd.	10.00	103,000	
	Concrete, reinforced	5,000	cu.yd.	12.00	60,000	
	Reinforcement steel	560,000	lb.	0.05	28,000	
	Sheet-piling					
	Gates and machinery			Lump sum	71,000	
	Gatehouse and miscellaneous			Lump sum	15,000	
					938,400	
	Contingencies			20%	187,700	
					1,126,100	
	Engineering and overhead			15%	168,900	
	TOTAL					$1,295,000
2	Relocation of railroads and utilities					
	Telephone and transmission pole lines	1.2	mi.	Lump sum	1,400	
	Steel tower transmission line	3.0	mi.	Lump sum	30,000	
					31,400	
	Contingencies			10%	3,100	
					34,500	
	Engineering and overhead			10%	3,500	
	TOTAL					38,000
3	Rights-of-way and land					
	Land	1,800	acres	Lump sum	95,000	
	Buildings purchased	20	sets	Lump sum	63,300	
					158,300	
	Legal, overhead, and general expenses			20%	31,700	
	TOTAL					190,000
4	Highway relocation					
	Local road - 18-ft. bit. macadam	1.2	mi.	Lump sum	80,200	
					80,200	
	Contingencies			10%	8,000	
					88,200	
	Engineering and overhead			10%	8,800	
	TOTAL					97,000
5	Grand total capital cost					1,620,000

(1) Annual costs. - The estimated annual costs of the Surry Mountain Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF SURRY MOUNTAIN RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$1,620,000	
	Interest during construction ($1,620,000 x 0.03)	49,000	
	TOTAL (Federal investment)	1,669,000	
2	Federal annual charges		
	Interest . . . . . ($1,669,000 x 0.035) . . .	58,400	
	Amortization of obsolescence and depreciation		
	Earthwork and general. (1.38 x 1.03 x .0076 x $676,400)	7,300	
	Concrete . . . . . (1.38 x 1.03 x .0076 x 191,000)	2,100	
	Gates and machinery. . (1.38 x 1.03 x .0354 x 71,000)	3,600	
	Railroads and utilities(1.21 x 1.03 x .0076 x 31,400)	300	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 158,300)	1,500	
	Highways . . . . . (1.21 x 1.03 x .0076 x 80,200)	800	
	Maintenance and operation		
	Embankment and general overhead	5,000	
	Operator and expendable supplies	2,000	
	Concrete . . . . . (1.38 x 0.01 x $191,000). . . .	2,600	
	Gates and machinery . (1.38 x 0.03 x 71,000). . . .	2,900	
	TOTAL (Federal annual charges)		$ 86,500
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . ($158,300 x 0.035).	5,500	
	TOTAL (non-Federal annual charges)		5,500
	TOTAL ANNUAL COST (2 + 4)		92,000

1. Claremont. - (1) General. - The Claremont Reservoir, on the Sugar River, New Hampshire, 7.1 miles above its junction with the Connecticut River, is outlined on Plate No. 45. The dam site is located one mile southeast from Claremont, New Hampshire; and the reservoir will extend upstream 4.5 miles, lying for the most part in the Town of Claremont, a small portion lying in the Town of Newport, all in Sullivan County. The drainage area of 245 square miles is hilly with a few sharp peaks. At the headwaters are a number of ponds. Considerable farming is done on the hillsides and along the valley. The area and capacity curves are shown on Plate No. 45. The flood control storage capacity will be equivalent to 6 inches of run-off from the drainage area or 78,400 acre-feet at the spillway crest. The reservoir area below the spillway crest elevation of 630.0 feet above mean sea level will be approximately 1,500 acres, classified as follows:

(a)	Agricultural land	660 acres
(b)	Pasture land	700 acres
(c)	Wooded land	100 acres
(d)	Swamp land	40 acres
(e)	Towns, etc.....	56 sets of buildings, small community of Puckershire.

(2) Highways and roads. - Two and one-tenth miles of 18-foot concrete, 4 miles of bituminous macadam, and 2 miles of 16-foot gravel highways will require relocation as indicated on Plate No. 45.

(3) Railroads. - Four miles of single-track railroad, a branch line of the Boston and Maine Railroad, will require relocation as shown on Plate No. 45.

(4) Other public works. - Seven and three-tenths miles of telephone and electric distribution lines will require relocation.

(5) Dam. - The general plan of the dam and the geologic features are indicated on Plates Nos. 46 and 47.

(a) Geology. - A low hill, rising approximately 50 feet above pool level, forms the right abutment. Crumpled mica schist, overlain by an impervious mixture of sand, silt, gravel, and boulders, lies more than 100 feet beneath the summit of this hill. Rock is located under the middle portion of the flood plain, which is 1,200 feet wide, at a depth of approximately 120 feet below the river. From this low point in the floor, rock rises in a hill forming the left abutment, where it is overlain by an impervious overburden. A major portion of the valley overburden consists of interstratified silt and clay.

(b) Available materials. - Extensive deposits of fine-grained materials, suitable for an impervious section, are available on the hillside adjacent to the left abutment. Rock from spillway and tunnel excavations may be used for riprap protection. Sand and gravel deposits occur in the valley bottom, within one-half mile upstream and downstream. These may be used for pervious embankment construction.

(c) Dam and appurtenant works. - An earth dam of rolled filled construction will extend across the main stream, with a side-channel spillway cut into the left bank at the south end of the dam. The length of the earth fill will be 2,600 feet; the top at Elevation 650.0 will be 125 feet above the stream bed. This will allow a freeboard of 5 feet above the maximum water surface.

(d) Embankment. - The earth fill will have a 30-foot top width. The dam will be built with an impervious core from top to bottom keyed into the ground with a cut-off trench along the axis of the embankment. The impervious core will be backed by a pervious section on both faces, which in turn will be riprapped, with outside slopes of 1 on 3 from the bottom to within 15 feet of the top, the upper 15 feet being 1 on 2-1/2. A rock-filled trench will be constructed along the downstream toe. Materials for the embankment will

for the most part be obtained from borrow pits. Structure excavations will be utilized where suitable. Both upstream and downstream faces on the slopes will be riprapped.

(e) Spillway. - A saddle spillway with concrete ogee weir, 400 feet long, will be constructed in the rock ledge on the right bank. The spillway channel will carry the flood discharge around the dam and into the river. With the crest at Elevation 630.0, the discharge capacity under a 15-foot surcharge, maximum flood level, will be 87,100 cubic feet per second or the equivalent of 355 cubic feet per second per square mile of gross drainage area controlled. The freeboard of 5 feet will be above the 15-foot surcharge.

(f) Outlet. - A concrete-lined tunnel, 14 feet in diameter and 1100 feet long, constructed through rock in the left bank, will provide for diversion-control during the construction of the embankment and for reservoir control later. The discharge with pool at spillway elevation will be 8,900 cubic feet per second. At the entrance of the tunnel a concrete intake and gate-operating tower will be provided containing mechanically operated gates for controlling the discharge. A service bridge will provide access to the gate house from the top of the dam. A reinforced concrete stilling basin will be provided at the discharge end, returning the water to the river channel below the toe of the embankment.

(g) Plan of construction. - It is proposed first to construct the outlet and gate house; the stream will then be diverted through the tunnel and the earth embankment will be built simultaneously with the spillway excavation, leaving an opening at the existing river channel for flood discharge during the major part of the construction period. The estimated time for construction is 30 months or 3 construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Claremont Reservoir for flood control only are given in the following table:

COST ESTIMATE OF CLAREMONT RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 8,900	
	Stream control			Lump sum	15,900	
	Earth excavation, common	609,000	cu.yd.	0.40	243,600	
	Earth excavation, borrow	1,628,000	cu.yd.	0.30	488,400	
	Rock excavation, open cut	369,000	cu.yd.	1.80	664,200	
	Embankment, rolled	2,182,000	cu.yd.	0.10	218,200	
	Dumped rock	526,000	cu.yd.	0.10	52,600	
	Concrete, plain	24,720	cu.yd.	10.00	247,200	
	Concrete, reinforced	7,000	cu.yd.	16.00	112,000	
	Reinforcement steel	1,112,000	lb.	0.05	55,600	
	Gates and machinery			Lump sum	103,000	
	Gatehouse and miscellaneous			Lump sum	45,400	
	Bridges, service and road			Lump sum	43,000	
					2,297,100	
	Contingencies			20%	459,400	
					2,756,500	
	Engineering and overhead			15%	413,500	
	TOTAL					$3,170,000
2	Relocation of railroads and utilities					
	Branch line - B&M RR - Single track	3.2	mi.	Lump sum	550,000	
	Bridge - Sugar River			Lump sum	25,000	
	Viaduct	0.85	mi.	Lump sum	360,000	
	Telephone and electric distribution lines	7.3	mi.	Lump sum	5,500	
					940,500	
	Contingencies			10%	94,000	
					1,034,500	
	Engineering and overhead			10%	103,500	
	TOTAL					1,138,000
3	Rights-of-way and land					
	Land	1,800	acres	Lump sum	164,700	
	Buildings purchased	56	sets	Lump sum	200,000	
	Water rights, undeveloped			Lump sum	2,000	
					366,700	
	Legal, overhead, and general expenses			20%	73,300	
	TOTAL					440,000
4	Highway relocation					
	State Hwys. 11 & 103 - 18-ft. concrete	2.1	mi.	Lump sum	200,000	
	Local road - 18-ft. bit. macadam.	4.0	mi.	Lump sum	91,000	
	Local road - 16-ft. gravel	2.0	mi.	Lump sum	49,500	
					340,500	
	Contingencies			10%	34,000	
					374,500	
	Engineering and overhead			10%	37,500	
	TOTAL					412,000
5	Grand total capital cost					5,160,000

(1) Annual costs. - The estimated annual costs of the Claremont Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF CLAREMONT RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5).	$5,160,000	
	Interest during construction ($5,160,000 x 0.045). . .	232,000	
	TOTAL (Federal investment)	5,392,000	
2	Federal annual charges		
	Interest . . . . . ($5,392,000 x 0.035).	188,700	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.045 x .0076 x $1,779,300)	19,500	
	Concrete . . . . . .(1.38 x 1.045 x .0076 x 414,800)	4,500	
	Gates and machinery .(1.38 x 1.045 x .0354 x 103,000)	5,300	
	Railroads & utilities (1.21 x 1.045 x .0076 x 940,500)	9,000	
	Rights-of-way & land (1.20 x 1.045 x .0076 x 366,700)	3,500	
	Highways . . . . . .(1.21 x 1.045 x .0076 x 340,500)	3,300	
	Maintenance and operation		
	Embankment and general overhead	6,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . (1.38 x 0.01 x $414,800). . .	5,700	
	Gates and machinery. . (1.38 x 0.03 x 103,000). . .	4,300	
	TOTAL (Federal annual charges)		$252,300
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . ($366,700 x 0.035).	12,800	
	TOTAL (non-Federal annual charges)		12,800
	TOTAL ANNUAL COST (2 + 4)		265,100

m. West Canaan. - (1) General. - West Canaan Reservoir, on the Mascoma River, New Hampshire, 19.5 miles above its junction with the Connecticut River, is outlined on Plate No. 48. The dam site is located 1.5 miles east of West Canaan, New Hampshire. The reservoir will extend upstream on the Mascoma River 4 miles to Canaan Center, and up the Indian River 3 miles to the village of Canaan, all in the Town of Canaan, in the County of Grafton. The drainage area of 80 square miles is hilly to mountainous farm land and woods. The area and capacity curves are shown on Plate No. 48. The flood control and conservation storage capacity will be equivalent to 12.5 inches of run-off from the drainage area above, or 53,500 acre-feet at spillway crest. The reservoir area below the spillway crest elevation of 910.0 feet above mean sea level will be approximately 1,900 acres, classified as follows:

(a) Agricultural land ..... 280 acres

(b) Pasture land ..... 240 acres

(c) Wooded land ..... 930 acres

(d) Swamp land ..... 450 acres

(e) Towns, etc. ..... 21 sets of buildings.

(2) Highways and roads. - Four miles of 20-foot bituminous macadam highway will be relocated as indicated on Plate No. 48.

(3) Railroads. - Six miles of the Concord Division of the Boston and Maine Railroad (single track) will be relocated as indicated on Plate No. 48.

(4) Other public works. - Ten miles of telephone, telegraph, and electric distribution lines will be relocated.

(5) Dam. - A general plan of the dam is shown on Plate No. 49.

(a) Geology. - Little is definitely known of the subsurface conditions. The river has cut deeply into glacial deposits, and

the location of the rock floor is uncertain. The overburden on both banks is composed of fine and medium sand and silt. Coarser sand and gravel occur upstream. Numerous large boulders are accumulated in the stream bed, on the valley slopes, and in the higher ground on either side.

(b) Available materials. - Pervious and impervious materials are available upstream on the left bank. As the location of both spillway and conduit is in overburden, the only source of rock for riprap and toes is in surface and stream accumulations of boulders in addition to those obtained from excavations.

(c) Dam and appurtenant works. - A dam of rolled-fill construction will extend across the main channel with a broad-crested weir spillway in the right abutment. The length of the earth fill will be 660 feet; the top at Elevation 927.0 will be 79 feet above the stream bed, and will allow a freeboard of 5 feet above the maximum water surface. The outlet will consist of a concrete conduit in the left bank.

(d) Embankment. - The rolled-fill earth dam will have a 25-foot top width. The dam will be built with an impervious core extending from top to bottom, keyed into the foundation with a cut-off trench along the axis of the dam. The core will be backed on both upstream and downstream sides by a pervious section with outside slopes of 1 on 2-1/2 for the upper 15 feet and 1 on 3 for the remainder to the base. The upstream face of the embankment will be riprapped and the downstream toe of dumped rock will provide for drainage. Structure excavation that is suitable will be used for the embankment.

(e) Spillway. - The spillway will consist of a broad-crested concrete weir 275 feet long in the form of an arc at the right end of the embankment. Steel sheet-piling will run under the length of

the weir and a short distance under the axis of the embankment. The discharge will be carried around the dam in a reinforced concrete channel, which will converge to 100 feet wide below the weir, terminating in a stilling basin well below the dam. The spillway weir will be separated from the embankment by a concrete gravity retaining wall. With the pool at crest Elevation 910.0 with a surcharge of 12 feet, the spillway will discharge the design flood of 34,100 cubic feet per second or 426 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - The outlet will consist of a reinforced concrete conduit 10 feet in diameter and 425 feet long in the left bank, and will provide for diversion control during construction of the embankment and for reservoir control later. Control will be accomplished by gates operated from a tower located at the intake end of the conduit. A service bridge will provide access from the top of the dam to the tower. The discharge capacity with the reservoir at spillway elevation will be 3,520 cubic feet per second.

(g) Plan of construction. - It is proposed to construct the outlet, excavate the spillway, and begin construction of the embankment simultaneously. The river will then be diverted through the outlet and the embankment and spillway completed. The time estimated for construction is 36 months or three long construction seasons.

(h) Flood control storage. - The estimated costs of the reservoir as designed for flood control only were as follows:

(1)	Construction	$ 968,000
(2)	Relocation of railroad and utilities	930,000
(3)	Rights-of-way and land	82,000
(4)	Highway relocation	260,000
(5)	Grand total capital cost	2,240,000
(6)	Total annual costs	114,600

The dam was designed with the top at Elevation 916.0 and the spillway at Elevation 899.0. At these elevations the reservoir would provide for 8.0 inches of run-off or 34,100 acre-feet of flood control storage. The area flooded at spillway crest would be 1600 acres.

(i) Conservation storage. - Conservation for downstream power benefits has been found economically feasible for immediate development. The conservation pool will be maintained by means of a siphon at Elevation 888.0, flooding an area of 1220 acres. This will provide for 4.5 inches of run-off or 19,400 acre-feet of conservation storage. The additional cost of providing storage for conservation over and above the cost for flood control will be $280,000, with an annual cost of $13,800.

(j) Power storage. - No power storage for power development at the site is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs for the construction of the West Canaan reservoir, including both flood control and conservation storage, are given in the following table:

COST ESTIMATE OF WEST CANAAN RESERVOIR
INCLUDING FLOOD CONTROL AND CONSERVATION STORAGE

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 86,000	
	Stream control			Lump sum	8,000	
	Earth excavation, common	250,000	cu.yd.	0.40	100,000	
	Earth excavation, borrow	35,000	cu.yd.	0.30	10,500	
	Embankment, rolled	235,000	cu.yd.	0.20	47,000	
	Dumped rock	26,000	cu.yd.	1.80	46,800	
	Concrete, plain	22,500	cu.yd.	10.00	225,000	
	Concrete, reinforced	3,200	cu.yd.	18.00	57,600	
	Reinforcement steel	920,000	lb.	0.05	46,000	
	Sheet-piling	14,000	sq.ft.	1.25	17,500	
	Gates and machinery			Lump sum	60,000	
	Gatehouse and miscellaneous			Lump sum	33,700	
	Bridges, service and road			Lump sum	30,000	
					768,100	
	Contingencies			20%	153,600	
					921,700	
	Engineering and overhead			15%	138,300	
	TOTAL					$1,060,000
2	Relocation of railroads and utilities					
	Main line - single track					
	Boston & Maine Railroad	5.8	mi.	Lump sum	696,000	
	Structures			Lump sum	103,000	
	Telephone and electric distribution lines	10.1	mi.	Lump sum	10,900	
					809,900	
	Contingencies			10%	81,000	
					890,900	
	Engineering and overhead			10%	89,100	
	TOTAL					980,000
3	Rights-of-way and land					
	Land	2,000	acre	Lump sum	27,000	
	Buildings purchased	21	sets	Lump sum	51,300	
	Cemetery relocation				None	
	Water rights, developed			Lump sum	5,000	
	Water rights, undeveloped				None	
					83,300	
	Legal, overhead, and general expenses			20%	16,700	
	TOTAL					100,000
4	Highway relocation					
	State Highway 14 - 20-foot bituminous macadam	4.1	mi.	Lump sum	234,000	
	Bridges	2		Lump sum	35,100	
	Reservoir crossing			Lump sum	45,000	
					314,100	
	Contingencies			10%	31,400	
					345,500	
	Engineering and overhead			10%	34,500	
	TOTAL					380,000
5	Grand total capital cost					2,520,000

(1) Annual costs. - The estimated annual costs of the West Canaan Reservoir including flood control and conservation storage are given in the following table:

ESTIMATED ANNUAL COSTS OF WEST CANAAN RESERVOIR
INCLUDING FLOOD CONTROL AND CONSERVATION STORAGE

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5).	$2,520,000	
	Interest during construction . .($2,520,000 x 0.03)	76,000	
	TOTAL (Federal investment)	$2,596,000	
2	Federal annual charges		
	Interest . . . . . ($2,596,000 x 0.035)	90,900	
	Amortization of obsolescence and depreciation		
	Earthwork and general ((1.38 x 1.03 x .0076 x $379,500)	4,100	
	Concrete . . . . (1.38 x 1.03 x .0076 x 328,600)	3,500	
	Gates and machinery (1.38 x 1.03 x .0354 x 60,000)	3,000	
	Railroads and utilities (1.21 x 1.03 x .0076 x 809,900)	7,700	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 83,300)	800	
	Highways . . . . (1.21 x 1.03 x .0076 x 314,100)	3,000	
	Maintenance and operation		
	Embankment and general overhead.	3,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . .(1.38 x 0.01 x 328,600)	4,500	
	Gates and machinery . . .(1.38 x 0.03 x 60,000)	2,500	
	TOTAL (Federal annual charges)		$125,500
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . . .($83,300 x 0.035)	2,900	
	TOTAL (non-Federal annual charges)		2,900
	TOTAL ANNUAL COST (2 + 4)		128,400

n. Sugar Hill. - (1) General. - The Sugar Hill Reservoir, on the Ammonoosuc River, New Hampshire, 14.7 miles above its junction with the Connecticut River, is outlined on Plate No. 50. The dam site is located 2.8 miles northeast of Lisbon, New Hampshire. The reservoir will extend 7 miles up the Ammonoosuc River to the Town of Littleton and will lie in the Towns of Lisbon and Littleton in Grafton County, New Hampshire. The drainage area of 246 square miles is hilly to mountainous and heavily wooded, with considerable farming activities. The area and capacity curves are shown on Plate No. 50. The flood control storage capacity will be equivalent to 7.0 inches of run-off from the drainage or 91,600 acre-feet at spillway crest. The reservoir area below the spillway crest elevation of 739.0 feet above mean sea level will be approximately 1750 acres, classified as follows:

(a)	Agricultural land	1000 acres
(b)	Pasture land	360 acres
(c)	Wooded land	270 acres
(d)	Swamp land	120 acres
(e)	Towns, etc.	48 sets of buildings; the village of Barrett; 1 cemetery of 400 graves.

(2) Highways and roads. - Seven and one-half miles of 18-foot concrete highway and 2.4 miles of 16-foot gravel road will be relocated as indicated on Plate No. 50.

(3) Railroads. - Nine miles of the White Mountain Division, single-track, Boston and Maine Railroad will be relocated as indicated on Plate No. 50.

(4) Other public works. - Eighteen and one-half miles of telephone, telegraph, and electric distribution lines will be relocated. Six and one-half miles of electric transmission lines will be relocated.

(5) Dam. - The general plan of the dam and the geologic features are indicated on Plates Nos. 51 and 52.

(a) Geology. - Bedrock is exposed on the right bank in the vicinity of both the upstream and downstream toes of the proposed embankment. In the right abutment, along the center line, the rock surface rises steeply beneath an overburden of sand and gravel to the spillway level, located approximately 140 feet above the stream. Outcrops also occur on the left bank below the site. Stream deposits of sand and gravel occur in the middle portion of the valley and obscure a relatively shallow-seated rock floor.

(b) Available materials. - Sand and gravel are available within one-half mile of the site for pervious embankment construction. Impervious materials are also available within one-half mile of the site.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main stream with a concrete gravity overflow spillway at the right end of the dam. The earth fill will be 1770 feet long with the top at elevation 759.0, which will be 163 feet above stream bed. This will allow a freeboard of 5 feet above the maximum water surface.

(d) Embankment. - The earth fill will have a 30-foot top width. The dam will be built with an impervious core from top to bottom. An impervious blanket will extend upstream from the core to 300 feet beyond the toe of the dam. The core and blanket in the dam will be backed by pervious sections both on the upstream and downstream faces, with outside slopes of 1 on 3 to within 20 feet of the top; the upper 20 feet will be 1 on 2-1/2. Structure excavations will be used in the embankment where suitable with the remainder of materials being obtained from borrow pits. Both faces of the dam will be riprapped.

(e) Spillway. - A concrete gravity overflow weir, 380 feet long, will be built on the ledge rock in the right abutment and will discharge into the spillway channel. With a crest at elevation 739.0, the discharge capacity under a 15-foot surcharge will be 86,000 cubic feet per second, or the equivalent of 350 cubic feet per second per square mile of drainage area controlled. The freeboard of 5 feet will be above the 15-foot surcharge.

(f) Outlet. - A 12-foot diameter concrete-lined tunnel, 1,250 feet long, constructed in rock in the right bank, will provide for diversion control during construction and for reservoir control later. The discharge capacity with the pool at spillway crest elevation will be 6,440 cubic feet per second. A concrete intake and gate-operating tower at the tunnel entrance, containing mechanically-operated gates, will provide the control of the discharge. A service bridge will provide access to the tower from the top of the dam. The tunnel will discharge into the spillway channel.

(g) Plan of construction. - It is proposed first to construct the outlet and gate house; the stream will then be diverted through the tunnel and the earth embankment will be constructed simultaneously with the spillway. The estimated time for construction is 30 months or 3 construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Sugar Hill Reservoir for flood control only are given in the following table:

COST ESTIMATE OF SUGAR HILL RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 62,000	
	Stream control			Lump sum	25,000	
	Earth excavation, common	640,000	cu.yd.	0.40	256,000	
	Earth excavation, borrow	2,460,000	cu.yd.	0.30	738,000	
	Rock excavation, open cut . .	216,000	cu.yd.	1.80	388,800	
	Rock excavation, tunnel or shaft	11,700	cu.yd.	11.00	128,700	
	Embankment, rolled	3,050,000	cu.yd.	0.08	244,000	
	Dumped rock	318,000	cu.yd.	0.30	95,400	
	Concrete, plain	17,400	cu.yd.	10.00	174,000	
	Concrete, reinforced	8,750	cu.yd.	16.00	140,000	
	Reinforcement steel	1,170,000	lb.	0.05	58,500	
	Gates and machinery			Lump sum	96,000	
	Gatehouse and miscellaneous			Lump sum	47,800	
	Bridges, service and road			Lump sum	82,000	
					2,536,200	
	Contingencies			20%	507,300	
					3,043,500	
	Engineering and overhead			15%	456,500	
	TOTAL					$3,500,000
2	Relocation of railroads and utilities					
	Main line - single track - B.&M. R.R.	9.0	mi.	Lump sum	1,350,000	
	Telephone, telegraph, & electric distribution lines	19.5	mi.	Lump sum	19,600	
	Steel-tower transmission line	6.5	mi.	Lump sum	32,000	
					1,401,600	
	Contingencies			10%	140,200	
					1,541,800	
	Engineering and overhead			10%	154,200	
	TOTAL					1,696,000
3	Rights-of-way and land					
	Land	1,930	acres	Lump sum	140,000	
	Buildings purchased	48	sets	Lump sum	295,000	
	Cemetery relocation	400	graves	Lump sum	40,000	
					475,000	
	Legal, overhead, and general expenses			20%	95,000	
	TOTAL					570,000
4	Highway relocation					
	U.S. Highway 302 - 18-ft. concrete	7.6	mi.	Lump sum	532,000	
	Local roads - 16-ft. gravel	2.4	mi.	Lump sum	59,400	
	Bridge			Lump sum	40,000	
					631,400	
	Contingencies			10%	63,100	
					694,500	
	Engineering and overhead			10%	69,500	
	TOTAL					764,000
5	Grand total capital cost					6,530,000

(1) Annual costs. - The estimated annual costs of the Sugar Hill Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF SUGAR HILL RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$6,530,000	
	Interest during construction ($6,530,000 x 0.045) . . .	294,000	
	TOTAL (Federal investment)	6,824,000	
2	Federal annual charges		
	Interest . . . . . ($6,824,000 x 0.035)	238,800	
	Amortization of obsolescence and depreciation		
	Earthwork and general. (1.38 x 1.045 x .0076 x $2,067,700)	22,700	
	Concrete . . . . . (1.38 x 1.045 x .0076 x 372,500)	4,100	
	Gates and machinery. . (1.38 x 1.045 x .0354 x 96,000)	4,900	
	Railroads and utilities(1.21 x 1.045 x .0076 x 1,401,600)	13,500	
	Rights-of-way and land (1.20 x 1.045 x .0076 x 475,000)	4,500	
	Highways . . . . . (1.21 x 1.045 x .0076 x 631,400)	6,100	
	Maintenance and operation		
	Embankment and general overhead	7,000	
	Operator and expendable supplies	2,000	
	Concrete . . . . . (1.38 x 0.01 x $372,500). . . .	5,100	
	Gates and machinery. . (1.38 x 0.03 x 96,000). . . .	4,000	
	TOTAL (Federal annual charges)		$312,700
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . ($435,000 x 0.035).	15,200	
	TOTAL (non-Federal annual charges)		15,200
	TOTAL ANNUAL COST (2 + 4)		327,900

o. Upper Fifteen Mile Falls. - (1) General. - The Upper Fifteen Mile Falls Reservoir, on the Connecticut River, 288 miles above its mouth, is outlined on Plate No. 53. The dam site is located one mile southwest of Waterford, Vermont, and one-half mile west of Pattenville, New Hampshire. The reservoir will extend upstream fifty miles to the Maine Central Railroad Bridge across the Connecticut River at Willard Mountain, Vermont. The reservoir will straddle the New Hampshire-Vermont State line and will lie in the following towns and counties:- Vermont: Waterford in Caledonia County; Concord, Lunenburg, Guildhall, Maidstone, and Brunswick in Essex County;= New Hampshire: Littleton in Grafton County; Dalton, Lancaster, Northumberland, and Stratford in Coos County. The drainage area of 1626 square miles is flat to hilly to mountainous and heavily wooded. The area and capacity curves are shown on Plate No. 53. The initial flood control storage capacity will be equivalent to 5.5 inches of run-off from the drainage area or 476,000 acre-feet at the spillway crest. The reservoir area at the spillway crest elevation of 851.0 feet above mean sea level will be approximately 12,800 acres, classified as follows:

(a)	Agricultural land	2450 acres
(b)	Pasture land	2250 acres
(c)	Wooded land	6850 acres
(d)	Swamp land	1250 acres
(e)	Towns, etc.	49 sets of buildings, 6 cemeteries with a total of 2800 graves.

All of the towns of Waterford, Vt., North Littleton and Pattenville, N. H., portions of the towns of Gilman, South Lunenburg, Guildhall Station, and Guildhall in Vermont and Cushman, Lancaster, Northumberland, and Groveton in New Hampshire.

(2) Highways and roads. - Eight miles of 20-foot bituminous macadam highway, 5.4 miles of 18-foot gravel road, and 2.1 miles of 16-foot gravel road will be relocated; 2 miles of 20-foot bituminous madadam highway will be raised or improved, all as indicated on Plate No. 53.

(3) Railroads. - Three miles of the Maine Central Railroad, single track line, will be relocated as indicated on Plate No. 53.

(4) Other public works. - Twenty-eight miles of telephone and electric distribution lines, 3.0 miles of trunk telephone lines, and 0.8 mile of electric transmission line (wooden pole) will be relocated.

(5) Dam. - A general plan of the dam is shown on Plate No. 54.

(a) Geology. - Numerous outcrops of schist occur on the left bank from river level to above the top of dam. Where rock does not outcrop on this side it is covered by a shallow overburden approximately 20 feet thick. The lower portion of the right abutment is a terrace deposit made up of pervious sand and gravel. The overburden on the main hillside above the terrace is more impervious, being composed of mixed materials of sand, silt, and gravel with numerous cobbles and boulders.

(b) Available materials. - Large supplies of sand and gravel are available upstream on the right bank for pervious embankment construction. Impervious mixtures of sand, silt, and gravel are also available on this side at higher elevations for construction of the impervious section. The distribution and type of materials available in the overburden lends itself to hydraulic construction as well as rolled fill, but for purposes of this report construction by the rolled-fill method is proposed. Rock for placement on the outer slopes will be obtained from spillway and tunnel excavations supplemented by boulders.

(c) Dam and appurtenant works. - A dam of earth and rock construction will extend across the main stream with an open spillway in the left abutment adjacent to the dam. With the top at Elevation 876.0, the dam will be 4,000 feet long and the top will be 241 feet above the stream bed. This will allow a freeboard of 5 feet above the maximum water surface. The outlet will consist of twin tunnels in rock in the left bank.

(d) Embankment. - The earth section will have a 30-foot top width. The dam will be built with an impervious core from top to bottom, keyed into the ground by a cut-off trench along the axis of the dam. The core will be backed by pervious material on both faces. The pervious material in turn will be backed with a graded heavy rock fill. The outside slopes of the dam will be 1 on 3 to within 25 feet of the top, the upper 25 feet being 1 on 2-1/2. Where suitable, all the structure excavations will be used in the embankment.

(e) Spillway. - A concrete-lined spillway with a broad-crested weir 755 feet long will be excavated in rock in the left abutment at the end of the dam. A retaining wall will separate the dam from the spillway. With a permanent crest at Elevation 851.0, the discharge capacity under a 20-foot surcharge will be 202,000 cubic feet per second or the equivalent of 124 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - Two 22-foot diameter tunnels, 1,560 feet long, located in rock in the left bank will provide for stream diversion during the construction of the embankment and for reservoir control later. An intake and gate-operating tower will be located at the upstream end of the tunnels. Access to the tower will be across a service bridge from the top of the dam. The discharge capacity of the outlet with the pool at spillway crest will be 59,000 cubic feet per second.

(g) Plan of construction. - It is proposed to construct the tunnels and outlet works first. The stream will then be diverted through the outlet and the embankment constructed. The spillway will be excavated and completed simultaneously with the aforementioned operations. The time estimated for construction is 48 months or four long construction seasons.

(h) Flood control storage - initial. - The entire reservoir capacity of 5.5 inches of run-off or 476,000 acre-feet will be initially utilized for flood control. The estimated costs of the initial project chargeable to flood control are as follows:

(1)	Construction.	$11,250,000
(2)	Relocation of railroad and utilities.	645,000
(3)	Rights-of-way and land. . .	1,226,000
(4)	Highway relocation.	1,229,000
(5)	Grand total capital cost. .	14,350,000
(6)	Total annual costs.	742,000

(i) Power storage - ultimate. - The development of power at this site at some time in the future may be economically justified. At such time, a portion of the initial flood control capacity will be utilized for power. Approximately 2.5 inches of run-off or 216,000 acre-feet of storage will be devoted to power. Over half of this will be used as active storage to increase dry-weather flow. The cost of adaptations to be made in the initial construction to enable future development of power is $485,000.

(j) Flood control storage - ultimate. - If power is developed at the site, there will remain flood control storage equivalent to 3.0 inches of run-off or 260,000 acre-feet. The estimated costs of this flood control portion of the storage are as follows:

(1)	Construction.	$ 9,200,000
(2)	Relocation of railroad and utilities.	16,000
(3)	Rights-of-way and land. . .	954,000
(4)	Highway relocation.	415,000
(5)	Grand total capital cost...	10,590,000
(6)	Total annual costs.	563,000

These estimates are based upon the cost of a dam having a top at Elevation 846.0, a spillway at Elevation 821.0, and storage capacity as above. The area of such a reservoir, at spillway crest elevation, would be 4,000 acres.

(k) Conservation storage. - No conservation storage is initially provided. If power is developed at the site, there will be a substantial volume of active power and conservation storage.

(l) Estimate of cost, initial construction. - The estimated costs of the Upper Fifteen Mile Falls Reservoir for initial construction, including adaptations for future power plant installation, are as follows:

COST ESTIMATE OF UPPER FIFTEEN MILE FALLS RESERVOIR
FOR INITIAL CONSTRUCTION

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$108,000	
	Stream control			Lump sum	100,000	
	Earth excavation, common	1,650,000	cu.yd.	0.40	660,000	
	Earth excavation, borrow	6,790,000	cu.yd.	0.30	2,037,000	
	Rock excavation, open cut	1,500,000	cu.yd.	1.60	2,400,000	
	Rock excavation, tunnel	60,000	cu.yd.	8.80	528,000	
	Embankment, rolled	8,325,000	cu.yd.	0.08	666,000	
	Dumped rock	2,175,000	cu.yd.	0.08	174,000	
	Concrete, plain	30,000	cu.yd.	10.00	300,000	
	Concrete, reinforced	48,000	cu.yd.	14.00	672,000	
	Reinforcement, steel	4,700,000	lb.	0.05	235,000	
	Gates and machinery			Lump sum	351,000	
	Gatehouse and miscellaneous			Lump sum	145,000	
	Bridges, service and road			Lump sum	127,000	
					8,503,000	
	Contingencies			20%	1,701,000	
					10,204,000	
	Engineering and overhead			15%	1,531,000	
	TOTAL					$11,735,000
2	Relocation of railroads and utilities					
	Maine Central R.R. - single track	3.2	mi.	Lump sum	480,000	
	Bridge			Lump sum	25,000	
	Telephone and electric distribution lines	21.0	mi.	Lump sum	20,500	
	Telephone trunk line	3.0	mi.	Lump sum	3,600	
	Wood pole transmission line	0.8	mi.	Lump sum	4,000	
					533,100	
	Contingencies			10%	53,300	
					586,400	
	Engineering and overhead			10%	58,600	
	TOTAL					645,000
3	Rights-of-way and land					
	Land	13,000	acres	Lump sum	133,700	
	Buildings purchased	49	sets	Lump sum	376,000	
	Cemetery relocation	2,800	graves	Lump sum	112,000	
	Water rights, developed			Lump sum	400,000	
					1,021,700	
	Legal, overhead, and general expenses			20%	204,300	
	TOTAL					1,226,000
4	Highway relocation					
	U.S. Highway 2 - 20-ft. bit.macadam	1.0	mi.	Lump sum	100,000	
	State Highway 18 - 20-ft.bit.macadam	5.6	mi.	Lump sum	280,000	
	Local road - 20-ft.bit.macadam.	3.4	mi.	Lump sum	170,000	
	Local roads - 18-ft.& 16-ft.gravel	7.5	mi.	Lump sum	152,700	
	Bridges	7		Lump sum	313,000	
					1,015,700	
	Contingencies			10%	101,600	
					1,117,300	
	Engineering and overhead			10%	111,700	
	TOTAL					11,229,000
5	Grand total capital cost					14,835,000

(m) Annual costs, initial construction. - The estimated annual costs for initial construction, including adaptations for future power plant installation, of the Upper Fifteen Mile Falls Reservoir are given in the following table:

ESTIMATED ANNUAL COSTS OF UPPER FIFTEEN MILE FALLS RESERVOIR FOR INITIAL CONSTRUCTION

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	14,835,000	
	Interest during construction ($14,835,000 x 0.06) . . .	890,000	
	TOTAL (Federal investment)	15,725,000	
2	Federal annual charges		
	Interest ($15,725,000 x 0.035)	550,400	
	Amortization of obsolescence and depreciation		
	Earthwork and general . (1.38 x 1.06 x .0076 x $6,945,000)	77,200	
	Concrete . . . . . (1.38 x 1.06 x .0076 x 1,207,000)	13,400	
	Gates and machinery . . (1.38 x 1.06 x .0354 x 351,000)	18,200	
	Railroads and utilities (1.21 x 1.06 x .0076 x 533,000)	5,200	
	Rights-of-way and land. (1.20 x 1.06 x .0076 x 1,021,700)	9,800	
	Highways. . . . . (1.21 x 1.06 x .0076 x 1,229,000)	9,900	
	Maintenance and operation		
	Embankment and general overhead	15,000	
	Operator and expendable supplies	2,000	
	Concrete . . . . . (1.38 x 0.01 x $1,207,000) . . .	16,600	
	Gates and machinery. . (1.38 x 0.03 x 351,000) . . .	14,500	
	TOTAL (Federal annual charges).		$732,200
3	Non-Federal investment.	None	
4	Non-Federal annual charges		
	Tax loss on land ($909,700 x 0.035)	31,800	
	TOTAL (non-Federal annual charges)		31,800
	TOTAL ANNUAL COST (2 + 4)		764,000

(n) Estimate of cost, future power development. - The estimated additional costs for the future development of power including all the power plant installations, but exclusive of the dam and reservoir, are as follows:

COST ESTIMATE OF UPPER FIFTEEN MILE FALLS RESERVOIR
FOR FUTURE POWER DEVELOPMENT

Item No.	Item	Quantity	Unit cost	Cost	Total cost
1	Construction				
	Power installation, complete		Lump sum	$6,870,000	
	Contingencies		20%	1,374,000	
				8,244,000	
	Engineering and overhead		15%	1,236,000	
			TOTAL		$9,480,000
2	Relocation of railroads and utilities			None	
3	Rights-of-way and land			None	
4	Highway relocation			None	
5	Grand total capital cost				9,480,000

(o) Annual costs, future power development. - The estimated annual costs for future power development at the Upper Fifteen Mile Falls Reservoir, exclusive of the dam and reservoir, are given in the following table:

ESTIMATED ANNUAL COSTS OF UPPER FIFTEEN MILE FALLS RESERVOIR FOR FUTURE POWER DEVELOPMENT

Item No.	Item	Cost	Total cost
1	Federal investment	None	
2	Federal annual charges	None	
3	Non-Federal investment		
	Grand total capital cost (Item 5)	$9,480,000	
	Interest during construction ($9,480,000 x 0.045)	427,000	
	TOTAL (non-Federal investment)	$9,902,000	
4	Non-Federal annual charges		
	Interest ($9,902,000 x 0.045)	445,600	
	Amortization of obsolescence and depreciation (1.38 x 1.045 x .0056 x $6,870,000)	54,400	
	Maintenance and operation		
	General overhead	3,000	
	Operating charges (2.00 x $125,000)	250,000	
	TOTAL (non-Federal annual charges)		$753,000
	TOTAL ANNUAL COST (2 + 4)		753,000

p. Williamsville. - (1) General. - The Williamsville Reservoir, on the West River, Vermont, 8.3 miles above the confluence with the Connecticut River, is outlined on Plate No. 55. The dam site is located 2 miles east of Williamsville close to Williamsville Station in the Town of Dummerston. The reservoir will extend upstream 12 miles and lie in the Towns of Dummerston, Newfane, Putney, Brookline and Townshend, all in Windham County, Vermont. The drainage area of 400 square miles is hilly to mountainous and very rugged along the main stream. The area and capacity curves are shown on Plate No. 55. The flood control storage capacity will be equivalent to 7.0 inches of runoff from the drainage area above or 150,000 acre-feet at the spillway crest. The reservoir area at the spillway crest Elevation 488.0 feet above mean sea level will be approximately 2800 acres, classified as follows:

(a)	Agricultural land ...	1350 acres
(b)	Pasture land	540 acres
(c)	Wooded land	620 acres
(d)	Swamp land	290 acres
(e)	Towns, etc.	56 sets of buildings. One cemetery of 350 graves. The village of Harmonyville.

(2) Highway and roads. - Five miles of 18-foot bituminous macadam highway, four miles of 18-foot gravel road, and 12.2 miles of secondary roads will be relocated as indicated on Plate No. 55.

(3) Railroads. - No railroads are involved.

(4) Other public works. - Fourteen miles of telephone and electric distribution lines will be relocated.

(5) Dam. - The general plan of the dam is shown on Plate No. 56.

(a) Geology. - Rock is exposed on the left bank adjacent to the river both upstream and downstream from the site. Erosion

by a tributary brook downstream on the right side indicates that bedrock is available for foundations at a depth of approximately 30 feet. The rock surface on the left side rises to a height of approximately 10 feet above the stream, above which point its slope is uncertain. The overburden on both banks is composed of relatively impervious sediments of sand, gravel, and silt.

(b) Available materials. - Impervious materials made up of mixed sand, gravel, and silt are available upstream on both banks within one-half mile. Sand and gravel are available nearby for pervious embankment construction. Rock for dumped rock embankment may be obtained from required rock excavations of the spillway and conduit located in the right abutment.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main channel, with a concrete side-channel spillway, cut through rock in the right bank (see sub-paragraph (k) following). The length of the earth fill will be 1800 feet; the top at Elevation 509.0 will be 182 feet above the stream bed, and will allow a freeboard of 5 feet above the maximum water surface. The outlet will consist of a tunnel in rock in the right bank.

(d) Embankment. - The rolled-fill earth dam will have a top width of 30 feet. The dam will be built with an impervious core, keyed into the foundation with a cut-off trench, except where ledge is at or near the surface, where a concrete key wall will be used. The core will be backed on both upstream and downstream sides by a pervious section with outside slopes of 1 on 2-1/2 for the downstream side and 1 on 3 for the upstream side. Such structure excavation as is suitable will be used in the embankment. Both faces of the embankment will be riprapped.

(e) Spillway. - A side-channel spillway, with a concrete weir 672 feet long, will be provided on the right bank. The

discharge will be carried around the dam in a concrete-lined rock cut and returned to the stream well below the toe of the dam. With crest at Elevation 488.0, under a surcharge of 16 feet, the spillway will discharge the design flood of 162,000 cubic feet per second, or 405 cubic feet per second per square mile of drainage area.

(f) Outlet. - The outlet will be a concrete-lined tunnel 20 feet in diameter excavated through ledge rock in the right bank and will provide for diversion control during construction of the embankment and for reservoir control later. Control will be accomplished by gates operated from a tower located at the intake end of the tunnel. A service bridge will provide access from the top of the dam to the tower. The discharge with the pool at spillway crest will be 21,750 cubic feet per second.

(g) Plan of construction. - It is proposed to construct the outlet and part of the embankment simultaneously with the spillway excavation, then to divert the river through the outlet and complete the embankment and spillway. The construction period will be 30 months or three construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for at this site. Reference is made to page 83 of the Report with respect to power investigations at the West Dummerston site.

(k) Estimate of cost. - The estimated costs of the Williamsville Reservoir for flood control only are given in the

following table. Investigations to date have not completely determined the type of dam and more detailed studies may establish that the dam should be a concrete gravity-type instead of earth embankment.

COST ESTIMATE OF WILLIAMSVILLE RESERVOIR

FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit Cost	Cost	Total Cost
1	Construction					
	Clearing			Lump sum	$142,000	
	Stream control			Lump sum	75,000	
	Earth excavation, common	211,000	cu. yd.	0.50	105,500	
	Rock excavation, open cut	1,100,000	cu. yd.	2.40	2,640,000	
	Rock excavation, tunnel	18,400	cu. yd.	10.00	184,000	
	Embankment, rolled	1,650,000	cu. yd.	0.60	990,000	
	Dumped rock	560,000	cu. yd.	0.25	140,000	
	Concrete, plain	25,000	cu. yd.	15.00	375,000	
	Concrete, reinforced	12,500	cu. yd.	18.00	225,000	
	Reinforcement steel	1,500,000	lb.	0.05	75,000	
	Gates and machinery			Lump sum	200,000	
	Gatehouse and miscellaneous			Lump sum	160,000	
	Bridges, service and road			Lump sum	50,000	
					$5,362,000	
	Contingencies			20%	1,211,900	
					6,573,900	
	Engineering and overhead			15%	986,100	
	TOTAL					$7,560,000
2	Relocation of railroads and utilities					
	Telephone and electric distribution lines	15.0	mi.	Lump sum	10,700	
					10,700	
	Contingencies			10%	1,100	
					11,800	
	Engineering and overhead			10%	1,200	
	TOTAL					13,00
3	Rights-of-way and land					
	Land	2,800	acres	Lump sum	120,000	
	Buildings purchased	56	sets	Lump sum	127,500	
	Cemetery relocation	350	graves	Lump sum	35,000	
					282,500	
	Legal, overhead, and general expenses			20%	56,500	
	TOTAL					339,00
4	Highway relocation					
	State Route 30	9.0	mi.	Lump sum	291,300	
	Local roads, 16-ft. gravel	12.2	mi.	Lump sum	112,000	
					403,300	
	Contingencies			10%	40,300	
					443,600	
	Engineering and overhead			10%	44,400	
	TOTAL					488,00
5	Grand total capital cost					$8,400,00

(1) Annual costs. - The estimated annual costs of the Williamsville Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF WILLIAMSVILLE RESERVOIR

FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total Cost
1	Federal investment		
	Grand total capital cost (Item 5).....	$8,400,000	
	Interest during construction($8,400,000 x 0.03)	252,000	
	TOTAL (Federal investment).....	8,652,000	
2	Federal annual charges		
	Interest.....($8,652,000 x 0.035).....	302,820	
	Amortization of absolescence and depreciation		
	Earthwork and general (1.38 x 1.03 x .0076 x $4,562,000).....	49,280	
	Concrete.(1.38 x 1.03 x .0076 x $600,000)....	6,480	
	Gates and machinery (1.38 x 1.03 x .0354 x $200,000).....	10,060	
	Railroads and utilities (1.21 x 1.03 x .0076 x $13,000).....	120	
	Rights-of-way and land (1.20 x 1.03 x .0076 x $339,000).....	3,180	
	Highways.(1.21 x 1.03 x .0076 x $488,000)....	4,620	
	Maintenance and operation		
	Embankment and general overhead.....	6,000	
	Operator and expendable supplies.....	3,000	
	Concrete.(1.38 x 0.01 x $600,000).....	8,280	
	Gates and machinery. (1.38 x 0.03 x 200,000).....	8,280	
	TOTAL (Federal annual charges).....		$402,120
3	Non-Federal investment.....	None	
4	Non-Federal annual charges		
	Tax loss on land.....($282,500 x 0.035)	9,880	
	TOTAL (non-Federal annual charges).....		9,880
	TOTAL ANNUAL COST (2 + 4).....		$412,000

q. Cambridgeport. - (1) General. - The Cambridgeport Reservoir, on the Saxtons River, Vermont, 7.8 miles above its junction with the Connecticut River, is outlined on Plate No. 57. The dam site is located 2 miles northwest of Saxtons River and 0.6 mile southeast of Cambridgeport, Vermont. The reservoir will extend 1.5 miles up the main stream in the Towns of Rockingham, Athens, and Grafton; 1.6 miles up Weaver Brook in the Towns of Rockingham and Grafton; 1.8 miles up Bull Creek in the Towns of Rockingham and Athens, all in Windham County, Vermont. The drainage area of 58 square miles is hilly to mountainous except in the river valley, which is fairly level. Considerable farming is done in the river valley. The area and capacity curves are shown on Plate No. 57. The flood control storage capacity will be equivalent to 7.0 inches of run-off from the drainage area or 21,600 acre feet at the spillway crest. The reservoir area below the spillway crest Elevation of 642.0 feet above mean sea level will be approximately 630 acres, classified as follows:

(a)	Agricultural	300 acres of fair value.
(b)	Pasture land	230 acres
(c)	Wooded land	60 acres
(d)	Swamp land	60 acres
(e)	Towns, etc.	35 sets of buildings, 2 churches, 2 schools, and one 400-grave cemetery. The Town of Cambridgeport and a portion of the Town of Athens.

(2) Highways and roads. - Three miles of 18-foot gravel road, 0.5 mile of 14-foot gravel road, and 1.6 miles of 18-foot bituminous macadam highway will be relocated as indicated on Plate No. 57.

(3) Railroads. - No railroads are involved.

(4) Other public works. - Five miles of telephone and electric distribution lines will be relocated.

(5) Dam. - The general plan of the dam and the geologic features are shown on Plates Nos. 58 and 59.

(a) Geology. - Bedrock occurs in the left abutment at shallow depth. The rock surface dips and passes beneath the river at a depth of approximately 50 feet. Throughout the middle portion of the valley, rock is buried beneath an overburden made up of irregular beds of fine sand, silt and sand, and gravel. Overburden in the right abutment is approximately 100 feet thick and composed of sand, silt, and gravel with boulders.

(b) Available materials. - Impervious and pervious materials are available upstream within one-half mile for embankment construction. Rock for rock fill on embankment slopes will be available from conduit and spillway excavations in rock.

(c) Dam and apourtenant works. - An earth dam of rolled-fill construction will extend across the main channel and up both banks. A concrete side-channel spillway in the left abutment will be entirely apart from the embankment. The length of the earth fill will be 1,130 feet; the top at Elevation 657.0 will be 101 feet above the stream bed, and will allow a freeboard of 5 feet above maximum water surface. The outlet will be a concrete-lined tunnel cut through rock in the left bank.

(d) Embankment. - The rolled-earth fill will have a 30-foot top width. The dam will be built with an impervious core from top to bottom, keyed into the ground by a cut-off trench the length of the dam, except on the left abutment where a low concrete wall will key it into rock ledge. The core will be backed by a section of pervious material on both upstream and downstream faces, the slopes being 1 on 3 from the bottom to within 15 feet of the top, and the upper 15 feet 1 on 2-1/2. A rock-filled trench at the downstream toe will provide for drainage.

The spillway and outlet excavation that is suitable will be used for embankment, but the greater portion of the embankment materials will be obtained from borrow pits. The upstream face will be riprapped and the downstream face will be finished with dumped rock.

(e) Spillway. - A side-channel spillway with a 350-foot concrete weir will be built on the rock ledge in the left abutment. The concrete-lined spillway channel cut through rock will carry the flood discharge around to the left of the dam about 900 feet downstream, where it will be allowed to fall freely into the main river channel. With a permanent crest at Elevation 642.0 the discharge capacity under a 10-foot surcharge, maximum flood level, will be 42,000 cubic feet per second or the equivalent of 725 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - A concrete-lined tunnel 8 feet in diameter and 530 feet long, cut through rock in the left bank, will provide for diversion control during the construction of the embankment and for reservoir control later. At the entrance of the tunnel a concrete intake and gate-operating tower will be provided, containing mechanically operated gates which will control the discharge. A service birdge will provide access to the gatehouse from the top of the dam. The outlet channel will return the discharge to the main stream 300 feet below the toe of the dam. The discharge capacity with the pool at spillway elevation will be 2,460 cubic feet per second.

(g) Plan of construction. - It is proposed to construct the outlet, excavate the spillway channel, and place part of the embankment on the right bank simultaneously. Then the stream will be diverted through the outlet, the embankment completed, and the spillway constructed. The time estimated for construction is 24 months or two construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Cambridgeport Reservoir for flood control only are given in the following table:

COST ESTIMATE OF CAMBRIDGEPORT RESERVOIR FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 6,200	
	Stream control			Lump sum	15,000	
	Earth excavation, common	148,000	cu.yd.	0.40	59,200	
	Earth excavation, borrow	464,000	cu.yd.	0.30	139,200	
	Rock excavation, open cut	131,000	cu.yd.	2.00	262,000	
	Rock excavation, tunnel	1,900	cu.yd.	14.00	26,600	
	Embankment, rolled	596,000	cu.yd.	0.15	89,400	
	Dumped rock	186,000	cu.yd.	0.30	55,800	
	Concrete, plain	9,825	cu.yd.	12.00	117,900	
	Concrete, reinforced	3,450	cu.yd.	18.00	62,100	
	Reinforcement steel	472,000	lb.	0.05	23,600	
	Gates and machinery			Lump sum	46,000	
	Gatehouse and miscellaneous			Lump sum	42,900	
	Bridges, service and road			Lump sum	36,000	
					981,900	
	Contingencies			20%	196,400	
					1,178,300	
	Engineering and overhead			15%	176,700	
	TOTAL					$1,355,000
2	Relocation of railroads and utilities					
	Telephone and electric distribution lines	5.1	mi.	Lump sum	4,100	
					4,100	
	Contingencies			10%	400	
					4,500	
	Engineering and overhead			10%	500	
	TOTAL					5,000
3	Rights-of-way and land					
	Land	680	acres	Lump sum	24,000	
	Buildings purchased	39	sets	Lump sum	98,000	
	Cemetery relocation	400	graves	Lump sum	24,000	
	Water rights, developed			Lump sum	4,000	
	Water rights, undeveloped				None	
					150,000	
	Legal, overhead, and general expenses			20%	30,000	
	TOTAL					180,000
4	Highway relocation					
	State Highway 121 - 18-foot bituminous macadam	1.6	mi.	Lump sum	96,000	
	Local roads - 14-foot and 18-foot gravel	3.5	mi.	Lump sum	119,500	
	Reservoir crossing			Lump sum	100,000	
	Bridges	2		Lump sum	44,000	
					359,500	
	Contingencies			10%	35,900	
					395,400	
	Engineering and overhead			10%	39,600	
	TOTAL					435,000
5	Grand total capital cost					1,975,000

(1) Annual costs. - The estimated annual costs of the Cambridgeport Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF CAMBRIDGEPORT RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item		Cost	Total cost
1	Federal investment			
	Grand total capital cost (Item 5).		$1,975,000	
	Interest during construction	($1,975,000 x 0.03)	59,000	
	TOTAL (Federal investment)		2,034,000	
2	Federal annual charges			
	Interest	($2,034,000 x 0.035)	71,200	
	Amortization of obsolescence and depreciation			
	Earthwork and general	(1.38 x 1.03 x .0076 x $732,300)	7,900	
	Concrete.	(1.38 x 1.03 x .0076 x 203,600)	2,200	
	Gates and machinery .	(1.38 x 1.03 x .0354 x 46,000)	2,300	
	Railroads and utilities	(1.21 x 1.03 x .0076 x 4,100)	0	
	Rights-of-way and land	(1.20 x 1.03 x .0076 x 150,000)	1,400	
	Highway	(1.21 x 1.03 x .0076 x 359,500)	3,400	
	Maintenance and operation			
	Embankment and general overhead.		4,500	
	Operator and expendable supplies		2,000	
	Concrete	(1.38 x 0.01 x $203,600)	2,800	
	Gates and machinery.	(1.38 x 0.03 x 46,000)	1,900	
	TOTAL (Federal annual charges)			$ 99,600
3	Non-Federal investment		None	
4	Non-Federal annual charges			
	Tax loss on land	($126,000 x 0.035). .	4,400	
	TOTAL (non-Federal annual charges)			4,400
	TOTAL ANNUAL COST (2 + 4).			104,000

r. Brockway. - (1) General. - The Brockway Reservoir, on the Williams River, Vermont, 5.5 miles above its junction with the Connecticut River, is outlined on Plate No. 60. The dam site is located 0.4 mile west of Brockway Mills; and the reservoir will extend upstream 5 miles and will lie in the Town of Rockingham, Windham County, and the Towns of Springfield and Chester in Windsor County, Vermont. The drainage area of 101 square miles is very mountainous. The area and capacity curves are shown on Plate No. 60. The flood control storage capacity will be equivalent to 6.0 inches of run-off from the drainage area or 32,300 acre-feet at spillway crest. The reservoir area below the spillway crest at Elevation 552.5 feet above mean sea level will be approximately 820 acres, classified as follows:

(a) Agricultural land ... 490 acres of fair value

(b) Pasture land ..... 240 acres

(c) Wooded land ....., 90 acres

(d) Towns, etc. ..... 30 sets of buildings, including a portion of the village of Bartonsville.

(2) Highways and roads. - Two and six-tenths miles of 18-foot bituminous macadam highway and 3.6 miles of gravel road will be relocated as indicated on Plate No. 60.

(3) Railroads. - Five and eight-tenths miles of the Rutland Railroad single-track line will be relocated as indicated on Plate No. 60.

(4) Other public works. - Fourteen and one-half miles of telephone, telegraph, and electric distribution lines will be relocated.

(5) Dam. - The general plan of the dam is indicated on Plate No. 61.

(a) Geology. - Schist occurs throughout the left abutment from an elevation approximately 25 feet above the river to above the top of dam. The right abutment is formed in a glacial overburden

comprised of sand, gravel, and silt. Numerous cobbles and boulders are present. Both spillway and tunnel will be cut in the schist rock forming the left abutment.

(b) Available materials. - The thick overburden on the right side will furnish materials for both impervious and pervious embankment construction. Rock for the thick dumped rock sections will be supplied from excavations of tunnel and spillway.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main channel and up both banks. The length of the earth-fill section will be 820 feet. The top at Elevation 567.5 will be 132 feet above the stream bed, allowing a freeboard of 5 feet above the maximum water surface. The spillway in the left abutment will be an overflow weir. The outlet will consist of a concrete-lined tunnel in rock in the left abutment.

(d) Embankment. - The rolled-earth fill will have a 30-foot top width. The dam will be built with an impervious core from top to bottom keyed into the ground with a cut-off trench, except on the left bank where the cut-off will consist of a low concrete wall keyed into the rock ledge. The core will be backed by a section of pervious material on both upstream and downstream faces, the outside slopes being 1 on 3 from bottom to within 15 feet of the top, the upper 15 feet being 1 on 2-1/2. Both upstream and downstream faces of the slope will be riprapped with dumped rock. A rock-filled trench at the downstream toe will provide for drainage. The spillway excavation that is suitable will be utilized, but the greater portion of the embankment materials will be obtained from borrow pits.

(e) Spillway. - The spillway weir will be a concrete overflow section 410 feet long built on rock ledge in the left abutment. The flood waters flowing over the weir into the spillway channel will

discharge into the main stream below the toe of the dam. The spillway weir will be separated from the earth dam by a concrete gravity retaining wall. With a permanent crest at Elevation 552.5 the discharge capacity under a 10-foot surcharge, maximum flood level, will be 50,000 cubic feet per second, or the equivalent of 495 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - A concrete-lined tunnel 12.5 feet in diameter, 565 feet long, cut through rock in the left bank, will provide for diversion control during construction of the embankment and for reservoir control later. A concrete tower will be provided, at the tunnel intake, and connected to the top of the dam by a service bridge. An outlet channel will return the discharge to the main stream below the dam. The discharge capacity with pool at spillway elevation will be 7,360 cubic feet per second.

(g) Plan of construction. - It is proposed first to construct the outlet for diversion control and prepare the ground for the embankment; then to divert the stream through the outlet, construct the spillway, and complete the embankment. The time estimated for construction is 18 months or two construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Brockway Reservoir for flood control only are given in the following table:

COST ESTIMATE OF BROCKWAY RESERVOIR

FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 8,500	
	Stream control			Lump sum	10,000	
	Earth excavation, common	90,000	cu. yd.	0.40	36,000	
	Earth excavation, borrow	434,000	cu. yd.	0.35	151,900	
	Rock excavation, open cut	130,000	cu. yd.	2.00	260,000	
	Rock excavation, tunnel	4,000	cu. yd.	10.00	40,000	
	Embankment, rolled	508,000	cu. yd.	0.15	76,200	
	Dumped rock	188,000	cu. yd.	0.30	56,400	
	Concrete, plain	7,300	cu. yd.	12.00	87,600	
	Concrete, reinforced	5,350	cu. yd.	16.00	85,600	
	Reinforcement steel	420,000	lb.	0.05	21,000	
	Gates and machinery			Lump sum	90,000	
	Gatehouse and miscellaneous			Lump sum	54,800	
	Bridges, service and road			Lump sum	22,000	
					1,000,000	
	Contingencies			20%	200,000	
					1,200,000	
	Engineering and overhead			15%	180,000	
	TOTAL					$1,380,000
2	Relocation of railroads and utilities					
	Single track - Rutland R.R.	6.0	mi.	Lump sum	870,000	
	Telephone, telegraph, and electric distribution lines	20.0	mi.	Lump sum	11,000	
					881,000	
	Contingencies			10%	88,100	
					969,100	
	Engineering and overhead			10%	96,900	
	TOTAL					1,066,000
3	Rights-of-way and land					
	Land	1,000	acres	Lump sum	57,000	
	Buildings purchased	32	sets	Lump sum	69,300	
	Water rights, undeveloped			Lump sum	7,000	
					133,300	
	Legal, overhead, and general expenses			20%	26,700	
	TOTAL					160,000
4	Highway relocation					
	State Highway 103 - 18-ft bit. macadam	3.0	mi	Lump sum	156,000	
	Local road - 16-ft. gravel	4.0	mi.	Lump sum	108,400	
	Bridge			Lump sum	15,000	
					279,400	
	Contingencies			10%	27,900	
					307,300	
	Engineering and overhead			10%	30,700	
	TOTAL					338,000
5	Grand total capital cost					2,944,000

(1) Annual costs. - The estimated annual costs of the Brockway Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF BROCKWAY RESERVOIR

FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$2,944,000	
	Interest during construction ($2,944,000 x 0.03)	88,000	
	TOTAL (Federal investment)	3,032,000	
2	Federal annual charges		
	Interest . . . . . ($3,032,000 x 0.035).	106,100	
	Amortization of obsolescence and depreciation		
	Earthwork and general. (1.38 x 1.03 x .0076 x $715,800)	7,700	
	Concrete . . . . . (1.38 x 1.03 x .0076 x 194,200)	2,100	
	Gates and machinery. . (1.38 x 1.03 x .0354 x 90,000)	4,500	
	Railroads and utilities (1.21 x 1.03 x .0076 x 881,000)	8,400	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 133,300)	1,300	
	Highways . . . . . (1.21 x 1.03 x .0076 x 279,400)	2,600	
	Maintenance and operation		
	Embankment and general overhead.	4,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . (1.38 x 0.01 x $194,200). . . .	2,700	
	Gates and machinery. . (1.38 x 0.03 x 90,000). . . .	3,700	
	TOTAL (Federal annual charges)		$145,600
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . ($133,300 x 0.035).	4,700	
	TOTAL (non-Federal annual charges.		4,700
	TOTAL ANNUAL COST (2 + 4)		150,300

s. North Springfield. - (1) General. - North Springfield Reservoir, on the Black River, Vermont, 8.2 miles above its junction with the Connecticut, is outlined on Plate No. 62. The dam site is located one-half mile northeast of North Springfield, Vermont; and the reservoir will extend up the main stream 4.5 miles and will lie in the Towns of Springfield and Weathersfield, Windsor County. The reservoir will also extend 2.5 miles up the North Branch of the Black River and will lie in the Town of Weathersfield. The net drainage area of 102 square miles is mostly rugged hill-land; the hilltops are wooded and some pasture farm lands are in the valleys. The area and capacity curves are shown on Plate No. 62. The flood control storage capacity will be equivalent to 6.2 inches of run-off from the net drainage area or 33,400 acre-feet at the spillway crest. The reservoir area below the spillway crest Elevation of 528.5 feet above mean sea level will be approximately 960 acres, classified as follows:

(a)	Agricultural land	300 acres of average value
(b)	Pasture land	150 acres
(c)	Wooded land	430 acres
(d)	Swamp land	80 acres
(e)	Towns, etc.	17 sets of buildings. One cemetery, consisting of 150 graves. A small section of the community of Perkinsville.

(2) Highways and roads. - A short stretch of 16-foot gravel road and 0.7 mile of 18-foot bituminous macadam road will be relocated as indicated on Plate No. 62.

(3) Railroads. - No railroads are involved.

(4) Other public works. - Seven-tenths of a mile of telephone and electric distribution lines will require relocation.

(5) Dam. - A general plan of the dam and the geologic features are indicated on Plates Nos. 63 and 64.

(a) Geology. - Granite and gneiss forms the lower part of the right abutment. The rock surface rises from river level to a point approximately 45 feet above the stream, where it dips towards the north. On the left side, it dips beneath the abutment and at bore hole BH2 lies approximately 30 feet below river level. Pervious sand and gravel lie above the rock in this abutment. These sediments grade upstream into more impervious fine-grained sediments.

(b) Available materials. - Materials for the impervious embankment section are available one-half mile upstream, under an overlay of sand and gravel. Pervious materials are also available in this area and may be supplemented by sand and gravel deposits which occur along and in the river. Any deficiency in rock for toe and shoulder construction may be supplemented by rock quarried from a hill located one-half mile east.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main channel and up the left bank. The top at Elevation 547.5 will be 106 feet above the stream bed, allowing a freeboard of 5 feet above the maximum water surface. The spillway in the right abutment will be a gravity section, overflow type. The outlet will be a reinforced-concrete open channel between the embankment and the spillway. Three dikes with tops at Elevation 547.5 and 28 feet maximum height will be constructed, two in saddles north of the dam, the other in a saddle southeast of the dam.

(d) Embankment. - The rolled-earth fill will have a 30-foot top width and will be 610 feet long. The dam will be built with an impervious core from top to bottom keyed into the ground with a cut-off trench and steel sheet piling reaching to rock, except under the river bed

and on the right bank, where the cut-off will consist of a low concrete wall keyed into the rock ledge. The core will be backed by a section of pervious material on both upstream and downstream faces, the outside slopes being 1 on 3 from the bottom to within 19 feet of the top, the upper 19 feet being 1 on 2-1/2. The upstream face will be riprapped, and a rock-filled trench at the downstream toe will provide for drainage. To protect against scour from spillway overflow, the downstream toe will be constructed of heavy rock fill. The spillway excavation that is suitable will be utilized, but the greater portion of the embankment materials will be obtained from borrow pits. The dikes, with a 20-foot top width, 380 and 470 feet long, and with 1 on 3 side slopes, will be of similar construction.

(e) Spillway. - A concrete gravity section overflow spillway with a crest length of 415 feet will be built on rock ledge in the right abutment. The spillway channel on rock surface will carry the flood discharge around to the right of the dam, returning it to the natural channel of the main stream below the dam. With a permanent crest at Elevation 528.5, the discharge capacity under a 14-foot surcharge, maximum flood level, will be 84,000 cubic feet per second, or the equivalent of 824 cubic feet per second per square mile of net drainage area controlled.

(f) Outlet. - The outlet will consist of an open-channel riprapped and concrete-lined approach; five 5-foot by 9-foot rectangular conduits 40 feet long, containing mechanically-operated gates, through the base of the concrete gate tower located on the axis of the dam; and a reinforced concrete stilling basin terminating in the spillway channel below the dam. Concrete gravity retaining walls will form the sides of the channel through the embankment and spillway. The discharge with the reservoir at spillway Elevation will be 13,100 cubic feet per

second.

(g) Plan of construction. - It is proposed to construct the outlet, excavate the spillway channel, and place a considerable portion of the embankment on the left bank simultaneously. Then the stream will be diverted through the outlet, the embankment completed, and the spillway constructed. The time estimated for construction is 24 months or two long construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the North Springfield Reservoir for flood control only are given in the following table:

COST ESTIMATE OF NORTH SPRINGFIELD RESERVOIR FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 21,600	
	Stream control			Lump sum	15,000	
	Earth excavation, common	400,000	cu.yd.	0.40	160,000	
	Earth excavation, borrow	295,000	cu.yd.	0.30	88,500	
	Rock excavation, open cut	42,000	cu.yd.	2.30	96,600	
	Embankment, rolled	446,000	cu.yd.	0.15	66,900	
	Dumped rock	55,000	cu.yd.	0.30	16,500	
	Riprap, hand-placed	4,000	cu.yd.	3.50	14,000	
	Concrete, plain	33,860	cu.yd.	10.00	338,600	
	Concrete, reinforced	10,350	cu.yd.	16.00	165,600	
	Reinforcement steel	856,000	lb.	0.05	42,800	
	Sheet-piling	24,000	sq.ft.	1.25	30,000	
	Gates and machinery			Lump sum	117,000	
	Gatehouse and miscellaneous			Lump sum	53,900	
					1,227,000	
	Contingencies			20%	245,400	
					1,472,400	
	Engineering and overhead			15%	220,600	
	TOTAL					$1,693,000
2	Relocation of railroads and utilities					
	Railroads				None	
	Telephone and electric distribution lines	0.7	mi.	Lump sum	800	
					800	
	Contingencies			10%	100	
					900	
	Engineering and overhead			10%	100	
	TOTAL					1,000
3	Rights-of-way and land					
	Land	1,320	acres	Lump sum	51,000	
	Buildings purchased	17	sets	Lump sum	61,300	
	Cemetery relocation	150	graves	Lump sum	11,500	
	Water rights, developed			Lump sum	22,000	
	Water rights, undeveloped				None	
					145,800	
	Legal, overhead, and general expenses			20%	29,200	
	TOTAL					175,000
4	Highway relocation					
	State Highway 106 - 18-foot bituminous macadam	0.7	mi.	Lump sum	34,200	
	Bridge			Lump sum	19,000	
	Reservoir crossing			Lump sum	70,000	
					123,200	
	Contingencies			10%	12,300	
					135,500	
	Engineering and overhead			10%	13,500	
	TOTAL					149,000
5	Grand total capital cost					2,018,000

(1) Annual costs. - The estimated annual costs of the North Springfield Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF NORTH SPRINGFIELD RESERVOIR FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5).	$2,018,000	
	Interest during construction . .($2,018,000 x 0.03)	61,000	
	TOTAL (Federal investment)	2,079,000	
2	Federal annual charges		
	Interest . . . . . ($2,079,000 x 0.035)	72,800	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.03 x .0076 x $563,000)	6,100	
	Concrete. . . . .(1.38 x 1.03 x .0076 x 547,000)	5,900	
	Gates and machinery (1.38 x 1.03 x .0354 x 117,000)	5,900	
	Railroads and utilities (1.21 x 1.03 x .0076 x 800)	0	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 145,800)	1,400	
	Highways. . . . .(1.21 x 1.03 x .0076 x 123,200)	1,200	
	Maintenance and operation		
	Embankment and general overhead	4,500	
	Operator and expendable supplies.	2,000	
	Concrete . . . . . (1.38 x 0.01 x $547,000)	7,600	
	Gates and machinery. . . (1.38 x 0.03 x 117,000)	4,800	
	TOTAL (Federal annual charges).		$112,200
3	Non-Federal investment.	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . . ($134,300 x 0.035)	4,700	
	TOTAL (non-Federal annual charges).		4,700
	TOTAL ANNUAL COST (2 + 4)		116,900

t. Ludlow. - (1) General. - The Ludlow Reservoir, located on the upper reach of the Black River, Vermont, 27.7 miles above its junction with the Connecticut River, is outlined on Plate No. 65. The dam site is located three-quarters of a mile northwest of Ludlow, Vermont. The reservoir will extend up the Black River seven miles to the head of Lake Amherst, and will be in the Towns of Ludlow and Plymouth in Windsor and Rutland Counties, respectively, and will also extend one mile up Branch Brook, lying in the Town of Ludlow. The drainage area of 56 square miles is hilly to mountainous; the hilltops are wooded and some of the hillsides are farmed. The area and capacity curves are shown on Plate No. 65. The flood control and conservation storage capacity will be equivalent to 18.0 inches of run-off from the drainage area or 54,000 acre-feet at the spillway crest. The reservoir area below the spillway crest at Elevation 1090.0 feet above mean sea level will be approximately 1,600 acres, classified as follows:

(a)	Agricultural land	- 290 acres of considerable value
(b)	Pasture land	- 130 acres
(c)	Wooded land	- 130 acres
(d)	Swamp land	- 50 acres
(e)	Ponds, lakes, etc.	-1,000 acres
(f)	Towns, etc.	- 76 sets of buildings, including the Town of Grahamville and houses around the shores of Reservoir Pond, Rescue Lake, Echo Lake, and Lake Amherst

(2) Highways and roads. - Two and six-tenths miles of 18-foot bituminous macadam and 1.3 miles of 18-foot concrete highway will require relocation; 0.6 mile of 18-foot bituminous macadam and 6.4 miles of 16-foot gravel road will be improved as indicated on Plate No. 65.

(3) Railroads. - No railroads are involved in this area.

(4) Other public works. - Three and one-half miles of electric transmission line and 5.7 miles of telephone and electric distribution lines will be relocated.

(5) Dam. - The general design of the dam, the area and capacity curves, and the geologic features are indicated on Plates Nos. 66 and 67.

(a) Geology. - The right abutment, which rises steeply from river level, is formed entirely in schist. The rock surface dips eastward to an undetermined depth beneath the river and the left abutment. Gravel and interstratified sand are deposited beneath the flood plain. These materials also comprise the overburden forming the left abutment.

(b) Available materials. - The spillway and outlet conduit will be constructed in rock in the right abutment. These excavations will supply a large quantity of rock, which will be used in constructing heavy rock shoulders. The remaining portion of the dam will be comprised of rolled impervious and pervious sections. Large quantities of sand and gravel suitable for pervious embankment are available upstream along the lower left or east side of the valley. Impervious materials of sand and silt are available in the valley bottom upstream within one-half mile.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main river channel, with a spillway, apart from the embankment, cut through rock in the right bank. The length of the earth fill will be about 650 feet; the top at Elevation 1,111.0 will be 118 feet above the stream bed, allowing a freeboard of 5 feet above the maximum water surface. The outlet will consist of a reinforced concrete conduit in the right bank.

(d) Embankment. - The earth fill will have a 30-foot top width. The dam will be built with an impervious core from top to bottom.

A concrete key wall will be provided at the rock surface on the right bank to the edge of the river, on the left bank a trench filled with impervious material will be provided. The impervious core will be backed on both upstream and downstream faces with a pervious section, with outside slopes of 1 on 3 from bottom to within 21 feet of the top, the upper 21 feet being 1 on 2-1/2. To prevent seepage through the left abutment, an impervious blanket will be provided under the upstream pervious section and beyond the upstream toe. At the downstream slope a rock-filled trench will provide drainage. Both upstream and downstream faces will be riprapped. The fill materials will be obtained mostly from borrow pits; spoil from the spillway excavation will be utilized where suitable. A concrete gravity retaining wall will separate the embankment from the spillway channel.

(e) Spillway. - A side-channel spillway with a 175-foot weir, constructed in the ledge on the right hillside, will discharge flood water into an open rock cut, lined with concrete, which will carry the discharge through the hillside, where it will be allowed a free fall returning it to the river approximately 300 feet below the toe of the dam. With a permanent crest at Elevation 1090.0, the capacity under a surcharge of 16 feet will be 42,000 cubic feet per second, equivalent to 750 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - A reinforced-concrete conduit, 8.0 feet in diameter, 670 feet long, constructed in a rock cut along the right bank, will provide for diversion control during the construction of the earth fill, and for reservoir control later. With the water surface at the elevation of the spillway crest, the discharge capacity will be 2,660 cubic feet per second. At the conduit intake a concrete gate-operating tower will be provided. A service bridge will provide access to the tower from the top of the dam. At the discharge end, a reinforced-con-

crete stilling basin will return the water to the river below the toe of the dam.

(g) Plan of construction. - It is proposed first to construct the outlet and gatehouse, including service bridge piers. The stream will then be diverted through the outlet and the rolled-fill embankment constructed simultaneously with the spillway excavation. Finally, the spillway weir will be constructed, the spillway channel lined, and the service bridge constructed. It is estimated that the time of construction will be 30 months, or three construction seasons.

(h) Flood control storage. - The estimated costs of the reservoir as designed for flood control only were as follows:

(1)	Construction.....	$ 925,000
(2)	Relocation of railroad and utilities	28,000
(3)	Rights-of-way and land.....	314,000
(4)	Highway relocation.....	474,000
(5)	Grand total capital cost	1,741,000
(6)	Total annual costs	97,100

The dam was designed with a top at Elevation 1089.5 and the spillway at Elevation 1068.5. At those elevations the reservoir would provide for 8 inches of run-off or 23,900 acre-feet of flood control storage. The area flooded at spillway crest would be 1100 acres.

(i) Conservation storage. - Conservation for downstream power benefits has been found economically feasible for immediate development. The conservation pool will be maintained by means of a siphon at Elevation 1074.0, flooding an area of 1200 acres. This will provide for 10.0 inches of run-off or 30,100 acre-feet of conservation storage. The additional cost over and above the cost for flood control will be $459,000, with an annual cost of $26,900.

(j) Power storage. - No power storage is provided for or

considered feasible.

(k) Estimate of cost. - The estimated costs for the construction of the Ludlow Reservoir, including both flood control and conservation storage, are given in the following table.

COST ESTIMATE OF LUDLOW RESERVOIR
INCLUDING FLOOD CONTROL AND CONSERVATION STORAGE

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 2,000	
	Stream control			Lump sum	10,000	
	Earth excavation, common	40,000	cu.yd.	0.40	16,000	
	Earth excavation, borrow	500,000	cu.yd.	0.30	150,000	
	Rock excavation, open cut	70,000	cu.yd.	2.30	161,000	
	Embankment, rolled	530,000	cu.yd.	0.15	79,500	
	Dumped rock	100,000	cu.yd.	0.30	30,000	
	Concrete, plain	6,100	cu.yd.	14.00	85,400	
	Concrete, reinforced	4,000	cu.yd.	18.00	72,000	
	Reinforcement steel	500,000	lb.	0.05	25,000	
	Gates and machinery			Lump sum	55,000	
	Gatehouse and miscellaneous			Lump sum	60,000	
	Bridges, service and road			Lump sum	30,000	
					775,900	
	Contingencies			20%	155,200	
					931,100	
	Engineering and overhead			15%	139,900	
	TOTAL					$1,071,000
2	Relocation of railroads and utilities					
	Telephone and electric distribution lines	10.0	mi.	Lump sum	17,300	
	Wood pole transmission line	3.5	mi.	Lump sum	10,000	
					27,300	
	Contingencies			10%	2,700	
					30,000	
	Engineering and overhead			10%	3,000	
	TOTAL					33,000
3	Rights-of-way and land					
	Land	1,650	acres	Lump sum	38,800	
	Buildings purchased	120	sets	Lump sum	320,000	
	Water rights, developed			Lump sum	2,000	
					360,800	
	Legal, overhead, and general expenses			20%	72,200	
	TOTAL					433,000
4	Highway relocation					
	State Highway 103 - 18 ft. concrete	1.3	mi.	Lump sum	104,000	
	State Highway 103 - 18 ft. bit.macadam	0.8	mi.	Lump sum	48,000	
	State Highway 100 - 18 ft. bit.macadam and gravel	6.4	mi.	Lump sum	308,900	
	Local road	2.6	mi.	Lump sum	57,000	
	Bridges	3		Lump sum	30,000	
					547,900	
	Contingencies			10%	54,800	
					602,700	
	Engineering and overhead			10%	60,300	
	TOTAL					663,000
5	Grand total capital cost					2,200,000

(1) Annual costs. -

The estimated annual costs for flood control and conservation storage in the Ludlow Reservoir are given in the following table:

ESTIMATED ANNUAL COSTS OF LUDLOW RESERVOIR
INCLUDING FLOOD CONTROL AND CONSERVATION STORAGE

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$2,200,000	
	Interest during constructing ($2,200,000 x 0.045)	99,000	
	TOTAL (Federal investment).	2,299,000	
2	Federal annual charges		
	Interest ($2,299,000 x 0.035).	80,400	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.045 x .0076 x $538,500)	5,900	
	Concrete . . . . . .(1.38 x 1.045 x .0076 x 182,400)	2,000	
	Gates and machinery. .(1.38 x 1.045 x .0354 x 55,000)	2,800	
	Railroads and utilities(1.21 x 1.045 x .0076 x 27,300)	300	
	Rights-of-way and land(1.20 x 1.045 x .0076 x 360,800)	3,500	
	Highways . . . . . .(1.21 x 1.045 x .0076 x 547,900)	5,200	
	Maintenance and operation		
	Embankment and general overhead	4,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . .(1.38 x 0.01 x $182,400).	2,500	
	Gates and machinery. .(1.38 x 0.03 x 55,000).	2,300	
	TOTAL (Federal annual charges).		$111,400
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . .($360,800 x 0.035).	12,600	
	TOTAL (non-Federal annual charges).		12,600
	TOTAL ANNUAL COST (2 + 4).		124,000

u. North Hartland. - (1) General. - North Hartland Reservoir on the Ottauquechee River, Vermont, 1.5 miles above its junction with the Connecticut River, is outlined on Plate No. 68. The dam site is located one mile northwest from North Hartland, Vermont, and the reservoir will extend upstream 5.5 miles, to the lower limits of the Village of Quechee. The reservoir lies in the Towns of Hartland and Hartford, in Windsor County, Vermont. The drainage area of 222 square miles is rugged and heavily wooded. Some of the hillsides are farmed. The area and capacity curves are shown on Plate No. 68. The flood control storage capacity will be equivalent to 6.0 inches of run-off from the drainage area, or 71,100 acre-feet at spillway crest. The reservoir area below the spillway crest elevation of 546.5 feet above mean sea level will be approximately 1,120 acres, classified as follows:

(a) Agricultural land..... 210 acres

(b) Pasture land..... 95 acres

(c) Wooded land..... 815 acres

(d) Towns, etc. ..... 18 sets of buildings, one dam and factory at Dewey Mills.

(2) Highways and roads. - One mile of 18-foot gravel road will be relocated as indicated on Plate No. 68.

(3) Railroads. - No railroads are involved.

(4) Other public works. - One mile of telephone and electric distribution lines will be relocated.

(5) Dam. - The general plan of the dam and the geologic features are indicated on Plates Nos. 69 and 70.

(a) Geology. - Bedrock occurs at shallow depths in the left abutment, in the river, and at depths of 45 to 60 feet in the right abutment. The overburden is fine sand and silt, which in the right abutment is compact and impervious.

(b) Available materials. - There is a dearth of coarse materials at the site, but sand and gravel are available within one mile downstream for pervious embankment construction. Impervious materials of sand and silt are available on the right side for construction of the impervious section. Spillway and tunnel excavations will furnish a large supply of rock for the heavy rock sections.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main channel, with a concrete side-channel spillway cut in rock on the left bank. The total length will be 1,730 feet; the top will be at Elevation 563.5 feet, or about 176 feet above the stream bed. This will allow a freeboard of 5 feet above the maximum water surface. In addition, an earth dike 1,970 feet long, with a maximum height of 44 feet, top elevation 563.5, is necessary on a saddle in a ridge south of the main dam.

(d) Embankment. - The rolled-earth and rock-fill embankment for the dam will have a 30-foot top width. The dam will be built with an impervious core from top to bottom, keyed into the rock by a concrete core wall along the axis of the dam, except in the right abutment where the cut-off will consist of a trench. The core is to be backed by a pervious section on both upstream and downstream sides, the outside slope of each being 1 on 3 from the bottom to within 17 feet of the top, the upper 17 feet being 1 on 2-1/2. The outer layers of the upstream and downstream section will be built of rock, with a rock-filled trench along the downstream toe to provide for drainage. Suitable materials from the spillway and tunnel excavation will be used together with borrow as needed. The dike, with a 20-foot top width and outside slopes of 1 on 3, will be constructed similarly.

(e) Spillway. - A side-channel spillway, with a concrete

weir 650 feet long, will be provided on the left bank. The discharge will be carried around the end of the dam in a concrete-lined rock cut and returned to the river below the dam. With the permanent crest at Elevation 546.5, the discharge capacity under a 12-foot surcharge, maximum flood level, will be 102,000 cubic feet per second, or the equivalent of 460 cubic feet per second per square mile of drainage area controlled. The freeboard of 5 feet will be above this 12-foot surcharge. A concrete gravity retaining wall will separate the spillway and embankment.

(f) Outlet. - A concrete-lined tunnel, 14 feet diameter and 900 feet long, cut through rock and located in the left bank, will provide for diversion control during construction of the embankment and for reservoir control later. At the entrance of the tunnel a concrete intake and gate-operating tower will be provided with mechanically operated gates operated from the house above. A service bridge will provide access to the gatehouse from the top of the dam. An outlet channel will return the discharge to the main stream below the dam without scour. The discharge capacity with the water surface at spillway crest will be 10,600 cubic feet per second.

(g) Plan of construction. - It is proposed first to construct the outlet works for diversion control and to prepare the ground for the embankment; then to excavate the spillway, using the excavation in the embankment; finally, to complete the embankment and the spillway-channel lining. The time estimated for construction is 18 months, or two construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the North Hartland Reservoir for flood control only are given in the following table:

COST ESTIMATE OF NORTH HARTLAND RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item		Unit cost	Cost	Total cost
1	Construction				
	Clearing		Lump sum	$ 52,000	
	Stream control		Lump sum	20,000	
	Earth excavation, common	425,000 cu.yd.	0.40	170,000	
	Earth excavation, borrow	1,480,000 cu.yd.	0.35	518,000	
	Rock excavation, open cut	375,000 cu.yd.	1.80	675,000	
	Rock excavation, tunnel	10,000 cu.yd.	10.00	100,000	
	Embankment, rolled	1,860,000 cu.yd.	0.08	148,800	
	Dumped rock	540,000 cu.yd.	0.10	54,000	
	Riprap, hand-placed	1,000 cu.yd.	3.50	3,500	
	Concrete, plain	20,500 cu.yd.	10.00	205,000	
	Concrete, reinforced	9,400 cu.yd.	16.00	150,400	
	Reinforcement steel	1,250,000 lb.	0.05	62,500	
	Gates and machinery		Lump sum	109,000	
	Gatehouse and miscellaneous		Lump sum	58,100	
	Bridges, service and road		Lump sum	65,000	
				2,391,300	
	Contingencies		20%	478,300	
				2,869,600	
	Engineering and overhead		15%	430,400	
	TOTAL				$3,300,000
2	Relocation of railroads and utilities				
	Telephone and electric distribution lines	1.0 mi.	Lump sum	800	
				800	
	Contingencies		10%	100	
				900	
	Engineering and overhead		10%	100	
	TOTAL				1,000
3	Rights-of-way and land				
	Land	1,300 acres	Lump sum	20,000	
	Buildings purchased	18 sets	Lump sum	180,000	
	Water rights, developed		Lump sum	30,000	
	Water rights, undeveloped		Lump sum	20,000	
				250,000	
	Legal, overhead, and general expenses		20%	50,000	
	TOTAL				300,000
4	Highway relocation				
	Local road - 18-ft. gravel	1.0 mi.	Lump sum	24,000	
				24,000	
	Contingencies		10%	2,400	
				26,400	
	Engineering and overhead		10%	2,600	
	TOTAL				29,000
5	Grand total capital cost				3,630,000

(1) Annual costs. -

The estimated annual costs of the North Hartland Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF NORTH HARTLAND RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5).	$3,630,000	
	Interest during construction ($3,630,000 x 0.03) . . .	109,000	
	TOTAL (Federal investment)	3,739,000	
2	Federal annual charges		
	Interest . . . . . .($3,739,000 x 0.035) . .	130,900	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.03 x .0076 x $1,864,400)	20,100	
	Concrete . . . . . (1.38 x 1.03 x .0076 x 417,900)	4,500	
	Gates and machinery (1.38 x 1.03 x .0354 x 109,000)	5,500	
	Railroads and utilities(1.21 x 1.03 x.0076 x 800)	0	
	Rights-of-way and land(1.20 x 1.03 x .0076 x 250,000)	2,300	
	Highways . . . . . (1.21 x 1.03 x .0076 x 24,000)	200	
	Maintenance and operation		
	Embankment and general overhead.	6,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . .(1.38 x 0.01 x $417,900)	5,800	
	Gates and machinery. . . . .(1.38 x 0.03 x 109,000)	4,500	
	TOTAL (Federal annual charges)		$182,300
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land ($250,000 x 0.035).	8,800	
	TOTAL (non-Federal annual charges)		8,800
	TOTAL ANNUAL COST (2 + 4).		191,100

v. South Tunbridge. - (1) General. - South Tunbridge Reservoir, on the First Branch of the White River, Vermont, 1.0 miles above its junction with the White River, is outlined on Plate No. 71. The dam site is located 1.5 miles north of South Royalton, Vermont, and the reservoir will extend upstream 4.5 miles to the village of Tunbridge. The reservoir lies in the Town of Royalton, Windsor County, and in the Town of Tunbridge, Orange County, Vermont. The drainage area of 102 square miles is rugged terrain, with farm lands on the hillsides and the valleys, and wooded hilltops. The area and capacity curves are shown on Plate No. 71. The flood control storage capacity will be equivalent to 6.0 inches of run-off from the drainage area or about 32,600 acre-feet at the spillway crest. The reservoir area below the spillway crest elevation of 564.0 feet above mean sea level will be approximately 800 acres, classified as follows:

(a)	Agricultural land	200 acres
(b)	Pasture land	260 acres
(c)	Wooded land	300 acres
(d)	Towns, etc.	40 sets of buildings. The village of South Tunbridge, the Tunbridge Fair Grounds, and one cemetery of 165 graves.

(2) Highways and roads. - Four miles of 18-foot bituminous macadam highway and 2.6 miles of 14-foot gravel road will be relocated as indicated on Plate No. 71.

(3) Railroads. - No railroads are involved.

(4) Other public works. - Six and one-half miles of telephone and electric distribution lines will be relocated.

(5) Dam. - The general plan of the dam and the geologic features are indicated on Plates Nos. 72 and 73.

(a) Geology. - The upper portion of the right abutment is

formed in overburden which overlies a low rock hill, the summit of which lies approximately 25 feet above river level. Schist is exposed at the surface on this side at a height of 15 feet above the river. The rock surface dips beneath the flood plain of sand and silt to a depth of approximately 40 feet, but reaches the surface again on the left bank approximately 20 feet above the river, above which level, beneath a thin overburden, it forms the left abutment.

(b) Available materials. - Sand and silt are available on the right bank about one-half mile upstream for impervious embankment construction. Sand and gravel are available a short distance downstream for the pervious sections. Rock for rock fill will be obtained from excavation of the spillway located in the left abutment.

(c) Dam and appurtenant parts. - A dam of rolled-fill construction is proposed, with a side-channel spillway cut into the rock of the left abutment. The dam will be 1,140 feet long. The top at Elevation 585.0 will be 105 feet above the stream bed. This will allow a freeboard of 5 feet above the maximum water surface. The outlet will consist of a reinforced concrete conduit in the right bank.

(d) Embankment. - The earth fill will have a 30-foot top width. The dam will be built with an impervious core keyed into the ground with a cut-off trench, except where ledge is at or near the surface, where a concrete cut-off wall will be used. Both the upstream and downstream faces of the impervious core will be backed with pervious material, the outside of which will be heavy rock fill. The outside slopes will be 1 on 3 from bottom to within 21 feet of the top, the upper 21 feet 1 on 2-1/2. Most of the rolled-earth fill material will be obtained from borrow pits within one-quarter mile distance, the rock fill being obtained from the spillway excavation.

(e) Spillway. - A side channel spillway having a concrete

weir with a crest length of 300 feet, built into the ledge of the left abutment, will discharge into a concrete-lined channel cut in rock in the left bank. This channel will carry the flood water around the left end of the embankment, returning it to the river 150 feet below the downstream toe of the dam without scour. With a permanent crest at Elevation 564.0 the discharge capacity under a 16-foot surcharge, maximum flood level, will be 73,000 cubic feet per second, or the equivalent of 716 cubic feet per second per square mile of drainage area controlled. The freeboard of 5 feet will be above this 16-foot surcharge. The spillway channel will be separated from the earth dam by a concrete gravity retaining wall.

(f) Outlet. - The reservoir outlet will consist of a reinforced-concrete tunnel, 12 feet in diameter and 530 feet long, constructed in the rock floor of the left bank. It will provide diversion control during the construction of the embankment, and reservoir control later. Control will be accomplished by gates operated from a tower located at the intake end of the tunnel. The discharge capacity with the reservoir at spillway elevation will be 5,660 cubic feet per second. The gate house will be accessible by means of a service bridge from the top of the dam. A reinforced-concrete stilling basin will be provided at the discharge end of the outlet.

(g) Plan of construction. - It is proposed to construct the outlet and gate house, including piers for the service bridge, simultaneously with spillway excavation and part of the embankment. The stream will then be diverted through the outlet and the embankment and the spillway will be completed. The time estimated for construction will be 16 months or two construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the South Tunbridge Reservoir for flood control only are given in the following table:

COST ESTIMATE OF SOUTH TUNBRIDGE RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 10,000	
	Stream control			Lump sum	10,000	
	Earth excavation, common	95,000	cu.yd.	0.40	38,000	
	Earth excavation, borrow	402,000	cu.yd.	0.30	120,600	
	Rock excavation, open cut	146,000	cu.yd.	2.00	292,000	
	Embankment, rolled	484,000	cu.yd.	0.15	72,600	
	Dumped rock	204,000	cu.yd.	0.20	40,800	
	Concrete, plain	9,100	cu.yd.	12.00	109,200	
	Concrete, reinforced	4,850	cu.yd.	16.00	77,600	
	Reinforcement steel	560,000	lb.	0.05	28,000	
	Gates and machinery			Lump sum	78,000	
	Gatehouse and miscellaneous			Lump sum	32,900	
	Bridges, service and road			Lump sum	36,000	
					945,700	
	Contingencies			20%	189,100	
					1,134,800	
	Engineering and overhead			15%	170,200	
	TOTAL					$1,305,000
2	Relocation of railroads and utilities					
	Telephone and electric distribution lines	6.5	mi.	Lump sum	5,800	
					5,800	
	Contingencies			10%	600	
					6,400	
	Engineering and overhead			10%	600	
	TOTAL					7,000
3	Rights-of-way and land					
	Land	920	acres	Lump sum	121,800	
	Buildings purchased	40	sets	Lump sum	220,000	
	Cemetery relocation	165	graves	Lump sum	16,500	
	Water rights, developed			Lump sum	10,000	
	Tunbridge Fair Grounds				15,000	
					383,300	
	Legal, overhead, and general expenses			20%	76,700	
	TOTAL					460,000
4	Highway relocation					
	State Highway 110 - 18-ft.bit.macadam	3.9	mi.	Lump sum	234,000	
	Local roads - 14-ft. gravel	2.6	mi.	Lump sum	90,000	
	Small bridges			Lump sum	31,700	
	Reservoir crossing			Lump sum	60,000	
					415,700	
	Contingencies			10%	41,600	
					457,300	
	Engineering and overhead			10%	45,700	
	TOTAL					503,000
5	Grand total capital cost					2,275,000

(1) Annual costs. -

The estimated annual costs of the South Tunbridge Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF SOUTH TUNBRIDGE RESERVOIR FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$2,275,000	
	Interest during construction ($2,275,000 x 0.03)	68,000	
	TOTAL (Federal investment)	2,343,000	
2	Federal annual charges		
	Interest . . . . . ($2,343,000 x 0.035). . . .	82,000	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.03 x .0076 x $652,900)	7,000	
	Concrete . . . . . (1.38 x 1.03 x .0076 x 214,800)	2,300	
	Gates and machinery. . (1.38 x 1.03 x .0354 x 78,000)	3,900	
	Railroads and utilities(1.21 x 1.03 x .0076 x 5,800)	100	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 383,300)	3,600	
	Highways . . . . . (1.21 x 1.03 x .0076 x 415,700)	3,900	
	Maintenance and operation		
	Embankment and general overhead.	4,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . (1.38 x 0.01 x $214,800). . . .	3,000	
	Gates and machinery. . (1.38 x 0.03 x 78,000). . . .	3,200	
	TOTAL (Federal annual charges)		$115,500
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . ($366,800 x 0.035).	12,800	
	TOTAL (non-Federal annual charges)		12,800
	TOTAL ANNUAL COST (2 + 4).		128,300

w. South Randolph. (1) General. - The South Randolph Reservoir, located on the Second Branch of the White River, Vermont, 5 miles above its confluence with the White River, is outlined on Plate No. 74. The dam site is located one-half mile northeast of East Bethel. The reservoir will extend 6.3 miles upstream and will lie wholly in the Town of Randolph, Orange County, Vermont. The drainage area of 63 square miles is mountainous, partly wooded, and with some cultivation in the flatter portions of the valley. The area and capacity curves are shown on Plate No. 74. The flood control storage capacity will be equivalent to 7.0 inches of run-off from the drainage area or 23,500 acre-feet at the spillway crest. The reservoir area below the spillway crest elevation of 596.5 feet above mean sea level will be approximately 630 acres, classified as follows:

(a) Agricultural land . . . . . 320 acres

(b) Pasture land . . . . . 170 acres

(c) Wooded land . . . . . 135 acres

(d) Swamp land . . . . . 5 acres

(e) Towns, etc. . . . . 21 sets of buildings including the village of South Randolph and a portion of East Randolph.

(2) Highways and roads. - Four and six tenths miles of 18-foot bituminous macadam highway will be relocated and 1.3 miles of the same will be improved as indicated on Plate No. 74.

(3) Railroads. - No railroads are involved.

(4) Other public works. - Four and six tenths miles of telephone and electric distribution lines will be relocated.

(5) Dam. - The general plan of the dam and the geologic features are shown on Plates Nos. 75 and 76.

(a) Geology. - The terrace forming the left abutment is underlaid by a schist formation. Scattered outcrops and borings in this

area indicate an irregular rock surface beneath a maximum thickness of overburden of approximately 30 feet. Westerly of this area the rock surface dips steeply toward the river and passes beneath the stream at a depth of approximately 35 feet. The depth to rock in the right abutment area is greater than 160 feet. Interbedded silt and clay sediments form the major portion of the overburden on the right side.

(b) Available Materials. - Fine sand and silt are available within one-half mile for impervious rolled fill construction. Sand and gravel are available downstream on the left bank within one mile for pervious embankment construction. Excavation of the tunnel and spillway will provide rock for toes and embankment slopes.

(c) Dam and appurtenant works. - A dam of earth and rock-fill construction will extend across the main channel and terrace on the right bank with a broad-crested weir spillway east of the dam. The length of the earth fill will be 995 feet; the top at Elevation 616.5 will be 94 feet above the stream bed, and will allow a freeboard of 5 feet above the maximum water surface. The outlet will consist of a concrete-lined tunnel in rock in the left bank.

(d) Embankment. - The rolled-fill earth dam will have a top width of 25 feet. The dam will be built with an impervious core extending from top to bottom, keyed into the foundation by a cut-off trench along the axis of the dam. The core will be backed on both upstream and downstream sides by a pervious section with outside slopes of 1 on 2-1/2 for the upper 15 feet and 1 on 5 for the remainder to the base. Both faces of the dam will be dumped rock with a dumped-rock trench at the downstream toe to provide for drainage. Structure excavation that is suitable will be used for the embankment.

(e) Spillway. - The spillway will consist of a broad-crested concrete weir, 270 feet long, built on rock 700 feet northeast of the

dam. The discharge will be carried around the dam in a rock-cut channel and returned to the stream 150 feet below the downstream toe of the dam. With crest at Elevation 596.5, under a 15-foot surcharge the spillway will discharge the design flood of 47,000 cubic feet per second or 746 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - The outlet will consist of an approach channel and a concrete-lined tunnel, 8 feet in diameter and 320 feet long, cut through rock in the left bank, and will provide for diversion control during construction of the embankment and for reservoir control later. Control will be accomplished by gates operated from a tower located at the intake end of the tunnel. A short service bridge will provide access to the tower. The tunnel will terminate in a concrete stilling basin discharging into the spillway channel. The discharge capacity with the water surface at spillway crest will be 2,220 cubic feet per second.

(g) Plan of construction. - It is proposed to construct the outlet, excavate the spillway, and construct much of the embankment simultaneously. The river will then be diverted through the outlet and the embankment and spillway completed. The time estimated for construction is 20 months or two construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the South Randolph Reservoir for flood control only are given in the following table:

COST ESTIMATE OF SOUTH RANDOLPH RESERVOIR

FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit Cost	Cost	Total Cost
1	Construction					
	Clearing			Lump sum	$ 19,600	
	Stream control			Lump sum	15,000	
	Earth excavation, common	250,000	cu.yd.	0.40	100,000	
	Earth excavation, borrow	264,000	cu.yd.	0.30	79,200	
	Rock excavation, open cut	111,600	cu.yd.	2.00	223,200	
	Rock excavation, tunnel	1,150	cu.yd.	14.00	16,100	
	Embankment, rolled	444,000	cu.yd.	0.15	66,600	
	Dumped rock	156,000	cu.yd.	0.25	39,000	
	Concrete, plain	800	cu.yd.	14.00	11,200	
	Concrete, reinforced	2,750	cu.yd.	18.00	49,500	
	Reinforcement steel	218,000	lb.	0.05	10,900	
	Gates and machinery			Lump sum	44,500	
	Gatehouse and miscellaneous			Lump sum	52,900	
	Bridges, service and road			Lump sum	4,200	
					731,900	
	Contingencies			20%	146,400	
					878,300	
	Engineering and overhead			15%	131,700	
	TOTAL					$1,010,000
2	Relocation of railroads and utilities					
	Telephone and electric distribution lines	4.6	mi.	Lump sum	2,500	
	Contingencies			10%	200	
					2,700	
	Engineering and overhead			10%	300	
	TOTAL					3,000
3	Rights-of-way and land					
	Land	720	acres	Lump sum	22,300	
	Buildings purchased	21	sets	Lump sum	74,000	
	Water rights, developed			Lump sum	10,000	
	Severance			Lump sum	2,000	
					108,300	
	Legal, overhead, and general expenses			20%	21,700	
	TOTAL					130,000
4	Highway relocation					
	State Highway 14 - 18-ft. bit. macadam	5.9	mi.	Lump sum	350,000	
	Bridge			Lump sum	25,000	
	Small structures			Lump sum	20,000	
	Reservoir crossing			Lump sum	40,500	
					435,500	
	Contingencies			10%	43,600	
					479,100	
	Engineering and overhead			10%	47,900	
	TOTAL					527,000
5	Grand total capital cost					1,670,000

(1) Annual costs. - The estimated annual costs of the South Randolph Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF SOUTH RANDOLPH RESERVOIR

FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$1,670,000	
	Interest during construction ($1,670,000 x 0.03)	50,000	
	TOTAL (Federal investment)	1,720,000	
2	Federal annual charges		
	Interest . . . . . ($1,720,000 x 0.035).	60,200	
	Amortization of obsolescence and depreciation		
	Earthwork and general. (1.38 x 1.03 x .0076 x $615,800)	6,700	
	Concrete . . . . . (1.38 x 1.03 x .0076 x 71,600)	800	
	Gates and machinery. . (1.38 x 1.03 x .0354 x 44,500)	2,200	
	Railroads and utilities(1.21 x 1.03 x .0076 x 2,500)	0	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 108,300)	1,000	
	Highways . . . . . (1.21 x 1.03 x .0076 x 435,500)	4,100	
	Maintenance and operation		
	Embankment and general overhead.	4,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . (1.38 x 0.01 x $71,600)	1,000	
	Gates and machinery. . . . . (1.38 x 0.03 x 44,500)	1,800	
	TOTAL (Federal annual charges)		$ 84,300
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . . .($108,300 x 0.035) . .	3,800	
	TOTAL (non-Federal annual charges)		3,800
	TOTAL ANNUAL COST (2 + 4)		$88,100

x. Ayers Brook. - (1) General. - Ayers Brook Reservoir, on Ayers Brook, 1.2 miles above its junction with the Third Branch of the White River, is outlined on Plate No. 77. The dam site is located one mile north of Randolph, Vermont, and the reservoir will extend upstream four miles, all in the Town of Randolph in Orange County. The drainage area of 30 square miles is mostly hilly farm land, embracing several small village centers. The area and capacity curves are shown on Plate No. 77. The flood control storage capacity will be equivalent to 7.0 inches of run-off from the drainage area above, or 11,200 acre-feet at spillway crest. The reservoir area below the spillway crest elevation of 697.5 feet above mean sea level will be approximately 610 acres, classified as follows:

(a) Agricultural land ..... 300 acres

(b) Pasture land ..... 175 acres of considerable value.

(c) Wooded land ..... 80 acres.

(d) Swamp land ..... 25 acres.

(e) Towns, etc. ..... No community centers in the area. 7 sets of buildings.

(2) Highways and roads. - Three miles of 18-foot bituminous macadam and 0.5 mile of 16-foot gravel highway will require relocation as indicated on Plate No. 77.

(3) Railroads. - No railroads are involved.

(4) Other public utilities. - Three and one-half miles of telephone and electric distribution lines will require relocation.

(5) Dam. - A general plan of the dam and the geologic features are indicated on Plates Nos. 78 and 79.

(a) Geology. - The right abutment, which rises steeply from the river is composed of schist. The rock surface dips steeply beneath the river. The left abutment is a flat terrace, 2,200 feet wide and 50 feet

high; this abutment terminates in a hill where rock is exposed above the top of the dam. This terrace is composed of a layer of fine and medium sand above a thick formation of medium and coarse silt.

(b) Available materials. - Fine sand and silt is available nearby for impervious rolled-fill embankment construction. Coarse sand and gravel for pervious embankment construction are available within one-half mile downstream. Rock fill for toe and outer shell construction will be obtained from spillway and outlet conduit excavations.

(c) Dam and appurtenant works. - An earth dam of rolled-filled construction will extend across the main channel and far up on the left bank. A concrete side-channel spillway in the right abutment will be entirely separated from the embankment. The length of the earth fill will be 2,640 feet; the top at Elevation 712.5 will be 75.5 feet above the stream bed, and will allow a freeboard of 5 feet above the maximum water surface. The outlet will be a reinforced-concrete conduit in the right bank.

(d) Embankment. - The rolled-earth fill will have a 25-foot top width. The dam will be built with an impervious core from top to bottom, keyed to the ground by a cut-off trench extending the length of the dam, except on the right end where the cut-off will consist of a low concrete wall keyed into the rock ledge. The core will be backed by a section of pervious material on both upstream and downstream faces, the outside slopes being 1 on 3 from bottom to within 15 feet of the top, and the upper 15 feet 1 on 2-1/2. A rock-filled trench at the downstream toe will provide for drainage. The spillway excavation that is suitable will be utilized, but the greater portion of the embankment materials will be obtained from borrow pits. Both upstream and downstream faces on the slopes will be riprapped.

(e) Spillway. - A concrete side-channel spillway with a 135-foot weir will be built on the rock ledge in the right abutment. The spillway channel will carry the flood discharge from around to the right of the dam, returning it into a rock ravine off the natural channel of the main stream, where it will be allowed a free fall back to the main channel of the stream 150 feet below the toe of the dam. With a permanent crest at Elevation 697.5, the discharge capacity under a 10-foot surcharge, maximum flood level, will be 16,000 cubic feet per second or the equivalent of 533 cubic feet per second per square mile of drainage area controlled.

(f) Outlet. - A reinforced-concrete conduit, 8 feet diameter and 340 feet long, and located in a rock cut on the right bank, will provide for diversion control during the construction of the embankment and for reservoir control later. At the entrance of the conduit a concrete intake and gate-operating tower will be provided, containing gates mechanically-operated from the gatehouse immediately above. A service bridge will provide access to the gatehouse from the top of the dam. A reinforced-concrete stilling pool will return the discharge to the main stream below the dam without scour. The discharge with the water surface at spillway crest elevation will be 2,120 cubic feet per second.

(g) Plan of construction. - It is proposed to construct the outlet, excavate the spillway channel, and place a considerable part of the long embankment on the left terrace simultaneously. Then the stream will be diverted through the outlet, the embankment completed, and the spillway constructed. The upstream slope of the fill will be riprapped as the fill progresses. The time estimated for construction is 12 months, or one construction season.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Ayers Brook Reservoir for flood control only are given in the following table:

COST ESTIMATE OF AYERS BROOK RESERVOIR

FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 8,100	
	Stream control			Lump sum	5,000	
	Earth excavation, common	78,000	cu.yd.	0.40	31,200	
	Earth excavation, borrow	146,000	cu.yd.	0.30	43,800	
	Rock excavation, open cut	43,000	cu.yd.	2.30	98,900	
	Rock excavation, tunnel or shaft	1,150	cu.yd.	14.00	16,100	
	Embankment, rolled	200,000	cu.yd.	0.25	50,000	
	Dumped rock	66,000	cu.yd.	0.25	16,500	
	Concrete, plain	2,350	cu.yd.	14.00	32,900	
	Concrete, reinforced	2,580	cu.yd.	18.00	46,400	
	Reinforcement steel	260,000	lb.	0.05	13,000	
	Gates and machinery			Lump sum	43,000	
	Gatehouse and miscellaneous			Lump sum	42,000	
	Bridges, service and road			Lump sum	20,500	
					467,400	
	Contingencies			20%	93,500	
					560,900	
	Engineering and overhead			15%	84,100	
	TOTAL					$ 645,000
2	Relocation of railroads and utilities					
	Telephone and electric distribution lines	3.5	mi.	Lump sum	2,450	
	Railroad				none	
					2,450	
	Contingencies			10%	250	
					2,700	
	Engineering and overhead			10%	300	
	TOTAL					3,000
3	Rights-of-way and land					
	Land	700	acre	Lump sum	34,000	
	Buildings purchased	7	sets	Lump sum	27,200	
	Cemetery relocation				none	
	Water rights, developed				none	
	Water rights, undeveloped				none	
	Severance				8,000	
					69,200	
	Legal, overhead, and general expenses			20%	13,800	
	TOTAL					83,000
4	Highway relocation					
	State Highway 12 - 18-ft. bit. macadam	3.0	mi.	Lump sum	129,000	
	Local road - 16 ft. gravel	0.5	mi.	Lump sum	8,900	
	Small bridges	2		Lump sum	10,000	
					147,900	
	Contingencies			10%	14,800	
					162,700	
	Engineering and overhead			10%	16,300	
	TOTAL					179,000
5	Grand total capital cost					910,000

(1) Annual costs. -

The estimated annual costs of the Ayers Brook Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF AYERS BROOK RESERVOIR

FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal Investment		
	Grand total capital cost (Item 5)	$910,000	
	Interest during construction	0	
	TOTAL (Federal investment)	910,000	
2	Federal annual charges		
	Interest . . . . . (910,000 x 0.035)	31,900	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x .0076 x 332,100)	3,500	
	Concrete . . . . . .(1.38 x .0076 x 92,300)	1,000	
	Gates and machinery . .(1.38 x .0354 x 43,000)	2,100	
	Railroads and utilities(1.21 x .0076 x 2,450)	0	
	Rights-of-way and land (1.20 x .0076 x 69,200)	600	
	Highways . . . . . .(1.21 x .0076 x 147,900)	1,400	
	Maintenance and operation		
	Embankment and general overhead	3,500	
	Operator and expendable supplies.	2,000	
	Concrete . . . . . .(1.38 x 0.01 x 92,300).	1,300	
	Gates and machinery . .(1.38 x 0.03 x 43,000).	1,800	
	TOTAL (Federal annual charges)		$ 49,100
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . .(69,200 x 0.035)	2,400	
	TOTAL (non-Federal annual charges).		2,400
	TOTAL ANNUAL COST (2 + 4)		51,500

y. Gaysville. - (1) General - Gaysville Reservoir, on the main stream of the White River, 31.6 miles above its junction with the Connecticut, is outlined on Plate No. 80. The dam site is located one-half mile southwest of Gaysville, Vermont, and the reservoir will extend up the main stream for ten miles, to the Village of Talcville, and up the Tweed River to within one mile of Pittsfield. For the most part, it lies in the Towns of Stockbridge and Rochester in Windsor County, and a small portion lies along the Windsor-Rutland county line in the Town of Pittsfield in Rutland County. The drainage area of 226 square miles is mostly rough mountainous terrain embracing a number of sizable mill villages scattered along the lower reaches of the main streams. The area and capacity curves are shown on Plate No. 80. As designed, the flood control storage capacity will be equivalent to 7.0 inches of run-off from the drainage area or 84,300 acre-feet at the spillway crest. The reservoir area below spillway crest elevation of 798.0 feet above mean sea level will be approximately 1,860 acres classified as follows:

(a)	Agricultural land	680 acres of fair quality
(b)	Pasture land.	810 acres
(c)	Wooded land	370 acres
(d)	Towns, etc.	Parts of the villages of Stockbridge, Tupper, and Emerson, including 80 sets of building.

(2) Highways and roads. - State Highway No. 107, an 18-foot bituminous macadam road, will require 7 miles of relocation and a reservoir crossing over Stony Brook. State Highway No. 100, an 18-foot gravel road, will require 5.0 miles of relocation and a reservoir crossing over the White River. A local 16-foot gravel highway will require 0.6 mile of relocation. These relocations are indicated on Plate

No. 80.

(3) Railroads. - No railroads are involved.

(4) Other public works. - Thirteen and seven-tenths miles of telephone and electric distribution lines will require relocation.

(5) Dam. - A general plan of the dam and the geologic features are indicated on Plates Nos. 81 and 82.

(a) Geology. - At the dam site the river flows in a rock gorge. Both right and left abutments are composed of metamorphic rock or schist, which also occurs at a shallow depth beneath the river. A thin veneer of sand and gravel, lying on bedrock, occurs high on the right abutment. A more ancient channel of the White River lies approximately one-quarter of a mile to the northwest, in a saddle beyond the rock hill. Here at the dike site, bedrock descends beneath fine and medium sand and gravel to a depth of more than 80 feet below the valley floor. The spillway channel will be excavated in rock in the right abutment.

(b) Available materials. - Sand and gravel deposits are available in and along the river for processing into concrete aggregates. Aggregates are also available at commercial sources at a distance of approximately 25 miles. Embankment materials for the earth dike may be obtained nearby on the left side.

(c) Dam and appurtenant works. - A variable-radius concrete single arch dam will extend across the main channel, with a concrete gravity overflow spillway at the right end. An earth dike 650 feet long of rolled-fill construction, will be built across the saddle 600 feet north of the dam. The main dam will be 840 feet long, 290 feet being the gravity spillway section. The 550-foot arch section, with provisions for a surcharge of 6 feet of water over the top at Elevation 808.0 will be 178 feet above the stream bed. This arch section

will be keyed into sound rock at the base.

(d) Embankment. - The rolled-fill earth dike will have an average height of 50 feet and a top width of 20 feet. The top will be at elevation 819.0 which allows a freeboard of 5 feet above the maximum water surface. The dike will be built with an impervious core keyed into the ground with a cut-off trench along the axis of the dike. The core will be backed with pervious material on both faces, the outside slopes of which will be 1 on 2-1/2. Both faces of the slopes will be rip-rapped. A rock-filled trench at the downstream toe will facilitate drainage. As much of the structure excavations as is suitable will be used in the embankment; the remainder needed for the embankment will be obtained from borrow pits.

(e) Spillway. - The concrete gravity overflow section, 290 feet long, with a crest at Elevation 798.0 will discharge under a surcharge of 16.0 feet. The remainder of the discharge will pass over the arch section at a depth of 6.0 feet. The total discharge capacity will be 96,000 cubic feet per second or the equivalent of 425 cubic feet per second per square mile of the drainage area controlled.

(f) Outlet. - The outlet will consist of 4 circular conduits through the base of the arch dam. Each will be 5 feet in diameter, and the total discharge capacity for the four conduits, under the maximum operating head at spillway crest elevation, will be 6,200 cubic feet per second. The outlet discharge will be controlled by gates operated from a control house immediately above the gates on the downstream side of the dam. Energy from the discharge will be dissipated by a stilling basin.

(g) Plan of construction. - It is proposed to divert the river flow around the site of the outlet until the outlet can be built

and that section of the dam can be raised above ordinary flood heights. Then the dam will be completed in convenient sections including the spillway section. Finally, the dike in the saddle will be completed. It is estimated that the construction period will be 16 months or two construction seasons.

(h) Flood control storage. - The estimated costs of the reservoir as designed for flood control only were as follows:

(1)	Construction	$2,130,000
(2)	Relocation of railroads and utilities	16,000
(3)	Rights-of-way and land	420,000
(4)	Highway relocation	1,514,000
(5)	Grand total capital cost	4,080,000
(6)	Total annual cost.	224,900

The dam had a top at Elevation 819.0 with the spillway crest at Elevation 798.0.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - The development of power at this site at some time in the future may be economically justifiable. The design of the dam was made such that it is suitable for being raised and the spillway modified to permit future raising of the crest 19.0 feet. If and when the dam is raised 19 feet, it will provide for the storage of an additional 3.3 inches of run-off from the contributing drainage area, or 40,000 acre-feet, for power development.

(k) Estimate of cost, initial construction. - The estimated costs of the Gaysville Reservoir for initial construction which includes the flood control dam with adaptations for future raising are as follows:

COST ESTIMATE OF GAYSVILLE RESERVOIR

INITIAL CONSTRUCTION WITH ADAPTATIONS FOR FUTURE RAISING

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 16,000	
	Stream control			Lump sum	15,000	
	Earth excavation, common	90,000	cu.yd.	0.40	36,000	
	Earth excavation, borrow	86,000	cu.yd.	0.30	25,800	
	Rock excavation, open cut	38,000	cu.yd.	2.30	87,400	
	Embankment, rolled	150,000	cu.yd.	0.20	30,000	
	Dumped rock	50,000	cu.yd.	0.25	12,500	
	Concrete, plain	160,000	cu.yd.	9.00	1,440,000	
	Concrete, reinforced	2,400	cu. yd.	18.00	43,200	
	Reinforcement steel	232,000	lb.	0.05	11,600	
	Gates and machinery			Lump sum	163,000	
	Gatehouse and miscellaneous			Lump sum	41,700	
	Bridges, service and road			Lump sum	9,000	
					1,931,200	
	Contingencies			20%	386,200	
					2,317,400	
	Engineering and overhead			15%	347,600	
	TOTAL					$2,665,000
2	Relocation of railroads and utilities					
	Telephone and electric distribution lines	15.0	mi.	Lump sum	14,900	
	Contingencies			10%	1,500	
					16,400	
	Engineering and overhead			10%	1,600	
	TOTAL					18,000
3	Rights-of-way and land					
	Land	2,400	acres	Lump sum	130,000	
	Buildings purchased	80	sets	Lump sum	200,000	
	Water rights, developed			Lump sum	20,000	
					350,000	
	Legal, overhead, and general expenses			20%	70,000	
	TOTAL					420,000
4	Highway relocation					
	State Highway 107 - 18-ft. bit. macadam	7.2	mi.	Lump sum	470,000	
	State Highway 100 - 18-ft. gravel	7.0	mi.	Lump sum	350,000	
	Local road - 16-ft. gravel	0.6	mi.	Lump sum	20,000	
	Viaducts	2		Lump sum	425,000	
	Bridges and small structures			Lump sum	125,000	
					1,390,000	
	Contingencies			10%	139,000	
					1,529,000	
	Engineering and overhead			10%	153,000	
	TOTAL					1,682,000
5	Grand total capital cost					4,785,000

(1) Annual costs, initial construction. - The estimated annual costs for the initial construction of the Gaysville Reservoir, with adaptations for future raising, are given in the following table:

ESTIMATED ANNUAL COSTS OF GAYSVILLE RESERVOIR

INITIAL CONSTRUCTION WITH ADAPTATIONS FOR FUTURE RAISING

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$4,785,000	
	Interest during construction ($4,785,000 x 0.03) . . .	144,000	
	TOTAL (Federal investment)	4,929,000	
2	Federal annual charges		
	Interest . . . . . ($4,929,000 x 0.035). . . .	172,500	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.03 x .0076 x $273,400)	3,000	
	Concrete . . . . . .(1.38 x 1.03 x .0076 x 1,494,800)	16,100	
	Gates and machinery. .(1.38 x 1.03 x .0354 x 163,000)	8,200	
	Railroads and utilities(1.21 x 1.03 x .0076 x 14,900)	100	
	Rights-of-way and land(1.20 x 1.03 x .0076 x 350,000)	3,300	
	Highways . . . . . .(1.21 x 1.03 x .0076 x 1,390,000)	13,200	
	Maintenance and operation		
	Embankment and general overhead	3,500	
	Operator and expendable supplies.	2,000	
	Concrete . . . . . .(1.38 x 0.01 x $1,494,800). .	20,600	
	Gates and machinery. .(1.38 x 0.03 x 163,000). .	6,800	
	TOTAL (Federal annual charges)		$249,300
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . . ($350,000 x 0.035)	12,300	
	TOTAL (non-Federal annual charges).		12,300
	TOTAL ANNUAL COST (2 + 4)		261,600

(n) Estimate of cost for future power development. - The estimated additional costs of the Gaysville Reservoir for the future raising for the development of power, including all the power plant installation, are as follows:

ESTIMATE OF ADDITIONAL COST OF RAISING GAYSVILLE RESERVOIR

TO INCLUDE POWER DEVELOPMENT

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 2,000	
	Stream control			Lump sum	5,000	
	Earth excavation, common	10,000	cu.yd.	0.40	4,000	
	Earth excavation, borrow	210,000	cu.yd.	0.30	63,000	
	Rock excavation, open cut	1,000	cu.yd.	2.30	2,300	
	Embankment, rolled . . .	220,000	cu.yd.	0.20	44,000	
	Dumped rock.	25,000	cu.yd.	1.80	45,000	
	Concrete, plain.	10,000	cu.yd.	12.00	120,000	
	Reinforcement steel. . .	94,000	lb.	0.05	4,700	
	Power installation, complete			Lump sum	942,000	
					1,232,000	
	Contingencies.			20%	246,000	
					1,478,000	
	Engineering and overhead			15%	222,000	
	TOTAL. . . .					$1,700,000
2	Relocation of railroads and utilities.				None	
3	Rights-of-way and land					
	Land.	650	acres	Lump sum	35,000	
	Buildings purchased	25	sets	Lump sum	65,000	
					100,000	
	Legal, overhead, and general expenses. . .			20%	20,000	
	TOTAL. . . .					120,000
4	Highway relocation.				None	
5	Grand total capital cost.					1,820,000

(n) Annual costs for future power development. - The estimated additional annual costs for the future raising of the Gaysville Reservoir for the development of power, including power installations, are given in the following table:

ESTIMATED ANNUAL COSTS OF RAISING GAYSVILLE RESERVOIR

TO INCLUDE POWER DEVELOPMENT

Item No.	Item	Cost	Total cost
1	Federal investment	None	
2	Federal annual charges	None	
3	Non-Federal investment		
	Grand total capital cost (Item 5).	$1,820,000	
	Interest during construction ($1,820,000 x 0.045). . . .	82,000	
	TOTAL (non-Federal investment)	1,902,000	
4	Non-Federal annual charges		
	Interest . . . . . ($1,902,000 x 0.045). . . .	85,600	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.045 x .0056 x $165,300)	1,400	
	Concrete . . . . . .(1.38 x 1.045 x .0056 x 124,700)	1,000	
	Power installation . .(1.38 x 1.045 x .0056 x 942,000)	7,600	
	Rights-of-way and land . . . . . .(1.20 x 1.045 x .0056 x 100,000)	700	
	Maintenance and operation		
	Embankment and general overhead.	3,500	
	Operating charges. . .($8,000 x 2.00).	16,000	
	Concrete . . . . . .(1.38 x 0.01 x 124,700).	1,700	
	Tax loss on land . . . .(100,000 x 0.035).	3,500	
	TOTAL (non-Federal annual charges).		$121,000
	TOTAL ANNUAL COST (2 + 4).		121,000

z. Union Village. - (1) General. - Union Village Reservoir, on the Ompompanoosuc River, 4.1 miles above its junction with the Connecticut, is outlined on Plate No. 83. The dam site is located 1/4 mile north of Union Village, Vermont, and the reservoir will extend upstream 3-1/2 miles, all in the Town of Thetford in Orange County. The drainage area of 126 square miles is generally rugged. The hilltops are wooded, but the valleys are farmed. The area and capacity curves are shown on Plate No. 83. The flood control storage capacity will be equivalent to 4.5 inches of run-off from the drainage area, or 30,200 acre-feet at spillway crest. The reservoir area below spillway crest elevation of 564.0 feet above mean sea level will be approximately 720 acres, classified as follows:

(a) Agricultural land ..... 280 acres

(b) Pasture land ..... 250 acres

(c) Wooded land ..... 110 acres

(d) Swamp land ..... 80 acres

(e) Towns, etc. ..... 17 sets of buildings

(2) Highways and roads. - One and two-tenths miles of 16-foot gravel highway will be relocated and 1.8 miles will be improved as indicated on Plate No. 83.

(3) Railroads. - No railroads are involved.

(4) Other public works. - None are involved.

(5) Dam. - A general plan of the low and high dams and the geologic features are indicated on Plates Nos. 84-L and 84-H and 85.

(a) Geology. - Mica schist forms the left abutment of the dam, the rock surface rising steeply from the river's edge to heights of 250 feet or more. In the right abutment, the rock surface rises from a depth of 20 feet below the river at the bank almost to spillway elevation, approximately 1,500 feet west of the river. Above bedrock adjacent to the river, the right abutment consists of pervious deposits of sand

and gravel which grade laterally into relatively impervious and compact mixtures of sand, rock flour, and some gravel in the adjacent higher ground.

(b) Available materials. - Impervious and pervious materials will be available from spillway channel excavations. Supplementary pervious materials may be obtained within one-half mile of the site both upstream and downstream. Rock excavations for tunnel and spillway channel will supply material for riprap and toes.

(c) Dam and appurtenant works. - A rolled-fill earth dam will extend across the main stream with a saddle spillway in the right abutment. The dam with a top at Elevation 584.0, 1,100 feet long, will be 170 feet above the stream bed and will allow an ultimate freeboard at 5 feet above the maximum water surface. The outlet will consist of a tunnel in rock in the left bank.

(d) Embankment. - The rolled-fill earth dam will have a 20-foot top width. The dam will be built with an impervious core from top to bottom and keyed into the ground to solid rock by an impervious cut-off trench along the axis of the dam. The core will be backed by pervious materials which in turn will be covered with riprap on both upstream and downstream faces. The outside slopes of the dam will be 1 on 4 to Elevation 480, 1 on 3 to Elevation 564, and 1 on 2-1/2 to the top of the dam at Elevation 584. All suitable materials from excavations will be used in the embankment.

(e) Spillway. - The spillway, excavated in the saddle adjacent to the right end of the dam, will have an ogee weir, 388 feet long, built on rock. The crest will be at Elevation 564.0. The discharge under a 15-foot surcharge will be 84,900 cubic feet per second, or the equivalent of 674 cubic feet per second per square mile of drainage area controlled. The flood waters passing over the spillway will be discharged into Avery Brook and thence into the main stream.

(f) Outlet. - The outlet will consist of a 13-foot

diameter tunnel, 1,200 feet long, excavated through rock in the left bank and will provide for diversion control during construction and for reservoir control later. Control will be accomplished by gates mechanically operated from a house over a shaft near the middle of the tunnel. The discharge capacity with the pool at spillway crest Elevation 564.0 will be 7,860 cubic feet per second.

(g) Plan of construction. - It is proposed first to build the outlet works, then to divert the stream and construct the embankment. The construction of the dam and spillway must go on at the same time as most of the material from the spillway excavation will be used in the embankment as rolled fill. The various other items of construction will then be completed. The estimated time for construction is 30 months or three construction seasons.

(h) Flood control storage. - The dam for flood control only was designed with a top elevation of 574.0 feet above mean sea level and the spillway at Elevation 554.0. At these elevations the reservoir would provide for 4.5 inches of run-off or 30,200 acre-feet of flood control storage. The estimated cost of the reservoir as designed for flood control only was as follows:

COST ESTIMATE OF UNION VILLAGE RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 11,000	
	Stream control			Lump sum	8,500	
	Earth excavation, common	84,000	cu.yd.	0.40	33,600	
	Rock excavation, open cut	56,000	cu.yd.	2.30	128,800	
	Rock excavation, tunnel and shaft	32,000	cu.yd.	6.00	192,000	
	Embankment, rolled	1,008,000	cu.yd.	0.45	453,600	
	Dumped rock	27,600	cu.yd.	1.50	41,400	
	Concrete, plain	9,800	cu.yd.	10.00	98,000	
	Concrete, reinforced	9,200	cu.yd.	14.00	128,800	
	Reinforcement steel	900,000	lb.	0.05	45,000	
	Gates and machinery			Lump sum	86,000	
	Gatehouse and miscellaneous			Lump sum	24,000	
					1,250,700	
	Contingencies			20%	250,200	
					1,500,900	
	Engineering and overhead			15%	225,100	
	TOTAL					$1,726,000
2	Relocation of railroads and utilities					
	Railroads				None	
	Telephone lines	3.0	mi.	Lump sum	1,600	
					1,600	
	Contingencies			10%	200	
					1,800	
	Engineering and overhead			10%	200	
	TOTAL					2,000
3	Rights-of-way and land					
	Land	700	acres	Lump sum	30,000	
	Buildings purchased	17	sets	Lump sum	35,000	
	Cemetery relocation				None	
	Water rights			Lump sum	5,000	
					70,000	
	Legal, overhead, and general expenses			20%	14,000	
	TOTAL					84,000
4	Highway relocation					
	Local roads - 16-ft. gravel	3.0	mi.	Lump sum	84,100	
	Bridge			Lump sum	25,000	
					109,100	
	Contingencies			10%	10,900	
					120,000	
	Engineering and overhead			10%	12,000	
	TOTAL					132,000
5	Grand total capital cost					1,944,000

(i) Annual costs. - The estimated annual costs of the Union Village Reservoir for flood control only are gien in the following table:

ESTIMATED ANNUAL COSTS OF UNION VILLAGE RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$1,944,000	
	Interest during construction ($1,944,000 x 0.03). . .	58,000	
	TOTAL (Federal investment).	2,002,000	
2	Federal annual charges		
	Interest. . . . . .($2,002,000 x 0.035)	70,100	
	Amortization of obsolescence and depreciation		
	Earthwork and general .(1.38 x 1.03 x .0076 x $892,900)	9,700	
	Concrete. . . . . .(1.38 x 1.03 x .0076 x 271,800)	2,900	
	Gates and machinery . .(1.38 x 1.03 x .0354 x 86,000)	4,300	
	Railroads and utilities(1.21 x 1.03 x .0076 x 1,600)	None	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 70,000)	700	
	Highways. . . . . .(1.21 x 1.03 x .0076 x 109,100)	1,000	
	Maintenance and operation		
	Embankment and general overhead	5,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . .(1.38 x 0.01 x $271,800) . .	3,800	
	Gates and machinery . .(1.38 x 0.03 x 86,000) . .	3,600	
	TOTAL (Federal annual charges).		$103,600
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land. . . . .($70,000 x 0.035).	2,500	
	TOTAL (non-Federal annual charges).		2,500
	TOTAL ANNUAL COST (2 + 4)		106,100

(j) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(k) Recreational storage. - At the request of the local authorities, a recreational pool will be maintained during certain seasons, by means of a siphon, at Elevation 460.0, occupying an area of 80 acres.

(l) Power storage. - In order to comply with the request of the Federal Power Commission to install a portion of a penstock for adapting the dam to future power storage, the dam and spillway were designed to be raised 10 feet in the initial construction, and the outlet works were modified to provide the beginnings of a power penstock. The 10-foot increase in height of the spillway will provide for an additional 1.1 inches of run-off or 7,800 acre-feet of power storage. The reservoir area with the spillway crest at Elevation 564.0 will be 720 acres.

(m) Estimate of cost, initial construction. - The estimated costs for the initial construction of the Union Village Reservoir, including the adaptations for future power development at the site, are given in the following table:

COST ESTIMATE OF UNION VILLAGE RESERVOIR
INITIAL CONSTRUCTION INCLUDING ADAPTATIONS FOR FUTURE POWER DEVELOPMENT

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 12,000	
	Stream control			Lump sum	8,500	
	Earth excavation, common	384,000	cu.yd.	0.25	96,000	
	Rock excavation, open cut	58,200	cu.yd.	2.30	133,900	
	Rock excavation, tunnel and shaft	33,400	cu.yd.	6.00	200,400	
	Embankment, rolled	1,288,000	cu.yd.	0.45	579,600	
	Dumped rock	39,600	cu.yd.	1.50	59,400	
	Riprap, hand-placed	1,000	cu.yd.	3.00	3,000	
	Concrete, plain	11,800	cu.yd.	10.00	118,000	
	Concrete, reinforced	9,700	cu.yd.	14.50	140,600	
	Reinforcement steel	940,000	lb.	0.05	47,000	
	Gates and machinery			Lump sum	86,000	
	Gatehouse and miscellaneous			Lump sum	43,100	
					1,527,500	
	Contingencies			20%	305,500	
					1,833,000	
	Engineeringg and overhead			15%	275,000	
	TOTAL					$2,108,000
2	Relocation of railroads and utilities					
	Railroads				None	
	Telephone lines	3.0	mi.	Lump sum	1,600	
					1,600	
	Contingencies			10%	200	
					1,800	
	Engineering and overhead			10%	200	
	TOTAL					2,000
3	Rights-of-way and land					
	Land	740	acres	Lump sum	36,700	
	Buildings purchased	21	sets	Lump sum	45,000	
	Water rights			Lump sum	5,000	
					86,700	
	Legal, overhead, and general expenses			20%	17,300	
	TOTAL					104,000
4	Highway relocation					
	Local roads, 16-foot gravel	3.7	mi.	Lump sum	103,900	
	Bridge			Lump sum	30,000	
					133,900	
	Contingencies			10%	13,400	
					147,300	
	Engineering and overhead			10%	14,700	
	TOTAL					162,000
5	Grand total capital cost					2,376,000

(n) Annual costs, initial construction. - The estimated annual costs for the initial construction of the Union Village Reservoir with adaptations for future power development at the site are given in the following table:

ESTIMATED ANNUAL COSTS OF UNION VILLAGE RESERVOIR
INITIAL CONSTRUCTION INCLUDING ADAPTATIONS FOR FUTURE POWER DEVELOPMENT

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$2,376,000	
	Interest during construction ($2,376,000 x 0.03). . .	71,000	
	TOTAL (Federal investment).	2,447,000	
2	Federal annual charges		
	Interest. . . . . .($2,447,000 x 0.035) . .	85,600	
	Amortization of obsolescence and depreciation		
	Earthwork and general .(1.38 x 1.03 x .0076 x $1,135,900)	12,300	
	Concrete. . . . . .(1.38 x 1.03 x .0076 x 305,600)	3,300	
	Gates and machinery . .(1.38 x 1.03 x .0354 x 86,000)	4,300	
	Railroads and utilities(1.21 x 1.03 x .0076 x 1,600)	0	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 86,700)	800	
	Highways. . . . . .(1.21 x 1.03 x .0076 x 133,900)	1,300	
	Maintenance and operation		
	Embankment and general overhead	5,500	
	Operator and expendable supplies.	2,000	
	Concrete. . . . . .(1.38 x 0.01 x $305,600)	4,200	
	Gates and machinery . .(1.38 x 0.03 x 86,000)	3,600	
	TOTAL (Federal annual charges		$122,900
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land. . . . .($86,700 x 0.035).	3,000	
	TOTAL (non-Federal annual charges).		3,000
	TOTAL ANNUAL COST (2 + 4)		125,900

aa. South Branch. - (1) General. - The South Branch Reservoir, located on the South Branch of Waits River, Vermont, 1-1/2 miles above its junction with the Waits River, is outlined on Plate No. 86. The dam site is located 0.2 mile upstream from a bridge on the Bradford-South Corinth Road. The reservoir will extend upstream 3.0 miles, and will lie in the Towns of Bradford and Corinth, in Orange County, Vermont. The drainage area of 45 square miles is mountainous and heavily wooded. The area and capacity curves are shown on Plate No. 86. The flood control storage capacity will be equivalent to 7.0 inches of run-off from the drainage area or 16,800 acre-feet at spillway crest. The reservoir area at spillway crest elevation of 815.0 feet above mean sea level will be approximately 570 acres, classified as follows:

(a) Agricultural land . . . . . 200 acres

(b) Pasture land. . . . . 130 acres

(c) Wooded land . . . . . 190 acres

(d) Swamp land. . . . . 50 acres

(e) Towns, etc. . . . . 8 sets of buildings

(2) Highways and roads. - Three miles of 18-foot gravel road and 2 miles of 16-foot gravel road will be relocated as indicated on Plate No. 86.

(3) Railroads. - No railroads are involved.

(4) Other public works. - None are involved.

(5) Dam. - The general plan of the dam and the geologic features are indicated on Plates Nos. 87 and 88.

(a) Geology. - Rock is exposed in the river near the proposed center line of the dam. Borings indicate a broad but rather irregularly eroded and disintegrated rock flour. Near the end of the dam, on the right bank, relatively sound rock occurs approximately 30

feet above river level beneath 25 to 30 feet of disintegrated rock. On both sides of the stream the overburden is comprised of a mixture of sand, rock flour, and boulders. On the right bank two borings disclosed 30 to 40 feet of very soft, badly weathered mica schist overlying sound rock.

(b) Available materials. - Suitable material for both impervious and pervious rolled-fill construction is available upstream and downstream within one-half mile. Rock for riprap and toe construction may be obtained from the more sound rock portions of spillway and conduit excavations supplemented by boulder accumulations.

(c) Dam and appurtenant works. - A dam of rolled-fill construction, having a length of 975 feet, the top at Elevation 833.0, and a maximum height of 108 feet, is proposed. This will allow a freeboard of five feet above the maximum water surface. The spillway will be a concrete "Morning Glory" type, situated on the right bank, and the outlet will be a concrete conduit.

(d) Embankment. - The main dam will have a 30-foot top width. The dam will be built with an impervious core keyed to impervious foundation by a cut-off trench along the axis of the embankment. Where hard rock is at or near the surface, a concrete key wall will be used. The core will be backed by pervious material with outside slopes of 1 on 3 from the bottom up to within 15 feet of the top, the upper 15 feet being 1 on 2-1/2. The upstream slope will be riprapped. A rock-filled trench will be constructed along the downstream toe to provide for drainage. Earth and rock excavated on the job will be used in the dam. Across a saddle located on the left bank, about 200 feet north of the dam, an earth dike, with a 10-foot top width, 250 feet long, and with a 21-foot maximum height, will be similarly constructed. The top of this dike will be at elevation 831.0, two feet below the top of the main dam,

thus providing additional safety to the main dam in the event of exceptionally high water.

(e) Spillway. - The spillway will consist of a reinforced concrete "Morning Glory", 54 feet in diameter, with an effective crest length of 140 feet, discharging into a 23-foot diameter reinforced concrete conduit, 410 feet long, embedded in rock. The crest will be at Elevation 815.0. With a surcharge of 13 feet at maximum water surface, the spillway will have a discharge capacity of 25,000 cubic feet per second, equivalent to 555 cubic feet per second per square mile of drainage area controlled. The spillway intake will be located on the right bank in the upstream side of the embankment. A reinforced concrete stilling basin will be provided at the discharge end of the conduit and the discharge will return to the river 150 feet below the dam.

(f) Outlet. - An outlet, consisting of a reinforced concrete conduit 7.0 feet in diameter, 130 feet long, and founded on rock, will discharge into the spillway conduit. Control will be accomplished by gates operated from a tower located at the intake end of the conduit. A service bridge will provide access to the gatehouse from the top of the dam. The outlet capacity with the water surface at spillway crest will be 2,280 cubic feet per second.

(g) Plan of construction. - It is proposed to construct first the outlet and spillway with the conduit back into the bank far enough so that cofferdams will be necessary only at the intake and stilling basin. When the stream is diverted through the conduit, the placing of the embankment will start. It is estimated that the construction will require 20 months, or two construction seasons.

(h) Flood control storage - The estimated costs of the reservoir as designed for flood control only were as follows:

(1)	Construction	$1,040,000
(2)	Relocation of railroad and utilities	none
(3)	Rights-of-way and land	55,000
(4)	Highway relocation	175,000
(5)	Grand total capital cost	1,270,000
(6)	Total annual cost.	70,600

The dam was designed with top at elevation 833.0 and with the spillway crest at elevation 815.0.

(i) Conservation storage. - Conservation for downstream power benefits will probably become economically feasible for future development if and when additional downstream installations, which may reasonably be expected to develop, are constructed. When this storage was provided, the conservation pool level would be maintained, by means of a siphon, at elevation 826.0, flooding an area of 700 acres and providing conservation storage of 24,200 acre-feet, or 10.0 inches of run-off from the contributing drainage area. To provide the flood control storage of 16,800 acre-feet, the spillway crest would be raised 29.0 feet to elevation 844.0. The reservoir at spillway crest would then flood an area of 950 acres, 380 acres in excess of the area flooded by the reservoir for flood control only. No change would be necessary in the general design of the dam or other appurtenant structures. The additional cost over and above the cost for flood control would be $832,000, with an annual cost of $38,700.

(j) Power storage. - No storage for power development at the site is provided for or considered economically feasible.

(k) Estimate of cost, initial construction. - The estimated costs for the initial construction of the South Branch Reservoir, which includes the flood control dam with adaptations for future raising, are given in the following table:

COST ESTIMATE OF SOUTH BRANCH RESERVOIR

INITIAL CONSTRUCTION WITH ADAPTATIONS FOR FUTURE RAISING

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 32,000	
	Stream control			Lump sum	5,000	
	Earth excavation, common	120,000	cu.yd.	0.40	48,000	
	Earth excavation, borrow	310,000	cu.yd.	0.30	93,000	
	Rock excavation, open cut	5,000	cu.yd.	2.30	11,500	
	Embankment, rolled	414,000	cu.yd.	0.15	62,100	
	Dumped rock	46,000	cu.yd.	1.60	73,600	
	Concrete, reinforced	16,000	cu.yd.	16.00	256,000	
	Reinforcement steel	1,280,000	lb.	0.05	64,000	
	Gates and machinery			Lump sum	48,000	
	Gatehouse and machinery			Lump sum	54,800	
	Bridges, service and road			Lump sum	60,000	
					808,000	
	Contingencies			20%	161,600	
					969,600	
	Engineering and overhead			15%	145,400	
			TOTAL			$1,115,000
2	Relocation of railroads and utilities				None	
3	Rights-of-way and land					
	Land	710	acres	Lump sum	21,000	
	Buildings purchased	8	sets	Lump sum	24,000	
	Water rights, developed			Lump sum	5,000	
					50,000	
	Legal, overhead, and general expenses			20%	10,000	
			TOTAL			60,000
4	Highway relocation					
	Local road - 18-ft. gravel	3.9	mi.	Lump sum	118,400	
	Local road - 16-ft. gravel	1.2	mi.	Lump sum	36,000	
	Bridge			Lump sum	5,000	
	Small structures			Lump sum	20,000	
					179,400	
	Contingencies			10%	17,900	
					197,300	
	Engineering and overhead			10%	19,700	
			TOTAL			217,000
5	Grand total capital cost					1,392,000

(1) Annual costs, initial construction. - The estimated annual costs for the initial construction of the South Branch Reservoir with adaptations for future raising are given in the following table:

ESTIMATED ANNUAL COSTS OF SOUTH BRANCH RESERVOIR

INITIAL CONSTRUCTION WITH ADAPTATIONS FOR FUTURE RAISING

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$1,392,000	
	Interest during construction ($1,392,000 x 0.03)	42,000	
	TOTAL (Federal investment)	1,434,000	
2	Federal annual charges		
	Interest ($1,434,000 x 0.035)	50,200	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.03 x .0076 x $440,000)	4,700	
	Concrete (1.38 x 1.03 x .0076 x 320,000)	3,500	
	Gates and machinery (1.38 x 1.03 x .0354 x 4 ,000)	2,400	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 50,000)	500	
	Maintenance and operation		
	Embankment and general overhead	4,000	
	Operator and expendable supplies	2,000	
	Concrete (1.38 x 0.01 x $320,000)	4,400	
	Gates and machinery (1.38 x 0.03 x 48,000)	2,000	
	TOTAL (Federal annual charges)		$ 73,700
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land (0.30,000 x 0.035)	1,800	
	TOTAL (non-Federal annual charges)		1,800
	TOTAL ANNUAL COST (2 + 4)		75,500

(m) Estimate of cost, future raising. - The estimated additional costs for the future raising of the South Branch Reservoir for conservation are given in the following table:

ESTIMATE OF ADDITIONAL COST OF RAISING

SOUTH BRANCH RESERVOIR FOR CONSERVATION

Item No.	Unit	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum	$ 3,000	
	Stream control			Lump sum	2,000	
	Earth excavation, common	8,000	cu. yd.	0.40	3,200	
	Earth excavation, borrow	577,000	cu. yd.	0.30	173,100	
	Rock excavation, open cut				None	
	Embankment, rolled	577,000	cu. yd.	0.15	86,500	
	Dumped rock	89,000	cu. yd.	1.80	160,200	
	Concrete, reinforced	1,000	cu. yd.	18.00	18,000	
	Reinforcement steel	80,000	lb.	0.05	4,000	
	Gates and machinery			Lump sum	5,000	
	Gatehouse and miscellaneous			Lump sum	33,600	
	Bridges, service and road			Lump sum	15,000	
					503,600	
	Contingencies			20%	100,700	
					604,300	
	Engineering and overhead			15%	90,700	
			TOTAL			$695,000
2	Relocation of railroads and utilities				None	
3	Rights-of-way and land					
	Land	90	acres	Lump sum	2,500	
	Buildings purchased	5	sets	Lump sum	10,000	
					12,500	
	Legal, overhead, and general expenses			20%	2,500	
			TOTAL			15,000
4	Highway relocation				None	
5	Grand total capital cost					710,000

(n) Annual costs, future raising. - The estimated additional annual costs for the future raising of the South Branch Reservoir for conservation are given in the following table:

ESTIMATED ADDITIONAL ANNUAL COSTS FOR RAISING

SOUTH BRANCH RESERVOIR FOR CONSERVATION

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$710,000	
	Interest during construction ($710,000 x 0.03).	21,000	
	TOTAL (Federal investment).	731,000	
2	Federal annual charges		
	Interest. . . . . ($731,000 x 0.035).	25,600	
	Amortization of obsolescence and depreciation		
	Earthwork and general (1.38 x 1.03 x .0076 x $476,600).	5,100	
	Concrete. . . . . (1.38 x 1.03 x .0076 x 22,000).	200	
	Gates and machinery . (1.38 x 1.03 x .0354 x 5,000).	300	
	Railroads and utilities.	None	
	Rights-of-way and land(1.20 x 1.03 x .0076 x 15,000).	100	
	Highways.	None	
	Maintenance and operation		
	Embankment and general overhead	1,500	
	Operator and expendable supplies.	None	
	Concrete. . . . . (1.38 x 0.01 x $22,000)	300	
	Gates and machinery . . (1.38 x 0.03 x 5,000)	200	
	TOTAL (Federal annual charges).		$33,300
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land. . . . . ($15,000 x 0.035)	500	
	TOTAL (non-Federal annual charges).		500
	TOTAL ANNUAL COST (2 + 4)		33,800

bb. Victory. - (1) General. - The Victory Reservoir, on the Moose River, 17.2 miles above its junction with the Passumpsic River, Vermont, is outlined on Plate No. 89. The dam site is located 4 miles north of North Concord and 1/2 mile upstream from the South Victory school. The reservoir will extend upstream 5 miles and will lie wholly in the Town of Victory, Essex County, Vermont. The drainage area of 66 square miles is hilly to mountainous and heavily wooded. Water rights for power development have been acquired by the New England Power Association, but no steps toward construction have been taken. The area and capacity curves are shown on Plate No. 89. The flood control and conservation storage capacity will be equivalent to 23.0 inches of run-off from the drainage area, or 81,000 acre-feet at spillway crest. The reservoir area below the spillway crest elevation of 1175.0 feet above mean sea level will be approximately 2830 acres, classified as follows:

(a) Agricultural land..... 150 acres, mostly of poor quality and abandoned.

(b) Wooded land (upland).. 830 acres, mostly cut over.

(c) Wooded land (swampy).. 1850 acres, mostly cut over.

(d) Towns, etc. ....., 3 sets of buildings.

(2) Highways and roads. - Four and six-tenths miles of 18-foot gravel highway will be relocated as indicated on Plate No. 89.

(3) Railroads. - No railroads are involved.

(4) Other public works. - None are involved.

(5) Dam. - A general plan of the dam and the geologic features are indicated on Plates No.90 and No. 91.

(a) Geology. - At the site, the Moose River flows over a thick formation of glacial sediments which extend to a depth of at least 74 feet below the stream. This overburden is composed of a mixture of sand, gravel, and boulders, together with much rock flour or glacial silt.

Nests of granite boulders occur throughout the area, being scattered over the surface and in the overburden. Rock is not available for foundations of either conduit or spillway. The overburden, however, is well consolidated.

(b) Available materials. - The overburden materials are of suitable quality for use in rolled-fill embankment construction. The quantity available within one-half mile of the site greatly exceeds the demands of the project. Considerable flexibility in selecting the most suitable material is therefore possible. Materials for both pervious and impervious sections of the dam occur in the same formation within close proximity. Rock for riprap and toes may be obtained at the site from the large quantity of boulders scattered over the surface of the ground.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main channel, with a concrete gravity spillway on the right bank. The length of the earth fill is 710 feet; the top, at Elevation 1192.0, will be 75 feet above the stream bed, and will allow a freeboard of 5 feet above the maximum water surface. The outlet will consist of a conduit in the right bank.

(d) Embankment. - The rolled-fill embankment will have a 25-foot top width. The dam will be built with an impervious core from top to bottom keyed into the ground with a cut-off trench. The core will be backed by a pervious section on both upstream and downstream faces, the outside slopes of which will be 1 on 2-1/2 for the upper 17 feet and 1 on 3 for the remainder to the base. The upstream slope will be paved with riprap, and the outer layer of the downstream section will be built of heavy cobble or field stone, with a rock-filled trench along the toe to provide for drainage. Such spillway excavation as is suitable will be used for the embankment. A concrete gravity section retaining wall will protect the embankment at the spillway.

(e) Spillway. - An open concrete overflow-weir spillway, 160 feet long, will be provided on the right bank. The discharge will be carried around the end of the dam in a reinforced-concrete-lined channel, and returned to the river below. With the permanent spillway crest at Elevation 1175.0, the discharge capacity under a 12-foot surcharge will be 24,000 cubic feet per second, or the equivalent of 364 cubic feet per second per square mile of drainage area controlled. There will be a freeboard of 5 feet above this 12-foot surcharge. The spillway will discharge well below the toe of the dam, and a stilling basin will be provided to obviate danger of scour. An access bridge will be constructed across the spillway.

(f) Outlet. - The reservoir outlet will consist of a concrete conduit 9 feet in diameter and 440 feet long, located in the right bank, and will provide for diversion control during the construction of the embankment and for reservoir control later. Control will be accomplished by gates operated from a tower located at the intake end of the tunnel, and a service bridge will provide access from the top of the dam to the tower. The discharge capacity with the pool at spillway elevation will be 2770 cubic feet per second. A reinforced concrete stilling basin will be provided at the discharge end to prevent scour.

(g) Plan of construction. - It is proposed to construct first the outlet and stilling basin for diversion control and to prepare the ground for the embankment; then the spillway will be excavated and lined, the spoil being used in the embankment. The upstream side of the embankment will be riprapped as the fill progresses. The time estimated for construction is 30 months, or three construction seasons.

(h) Flood control storage. - The estimated costs of the reservoir as designed for flood control only were as follows:

(1)	Construction	$ 729,000
(2)	Relocation of railroad and utilities. .	None
(3)	Rights-of-way and land.	81,000
(4)	Highway relocation.	213,000
(5)	Grand total capital costs	1,023,000
(6)	Total annual costs.	60,100

The dam was designed with the top at elevation 1169.5 and the spillway at elevation 1152.5. At these elevations the reservoir would provide for 8.0 inches of run-off or 28,200 acre-feet of flood control storage. The area flooded at spillway crest would be 1900 acres.

(i) Conservation storage. - Conservation for downstream power benefits has been found economically feasible for immediate development. The conservation pool will be maintained by means of a siphon at elevation 1164.0, flooding an area of 2300 acres. This will provide for 15.0 inches of run-off or 52,800 acre-feet of conservation storage. The additional cost over and above the cost for flood control will be $392,000, with an annual cost of $20,100.

(j) Power storage. - No power storage for power development at the site is provided or considered economically feasible.

(k) Estimate of cost. - The estimated costs for the construction of the Victory Reservoir, including both flood control and conservation storage, are given in the following table:

COST ESTIMATE OF VICTORY RESERVOIR

FOR FLOOD CONTORL AND CONSERVATION STORAGE

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
	Construction					
	Clearing			Lump sum	$ 69,000	
	Stream control			Lump sum	20,000	
	Earth excavation, common	240,000	cu.yd.	0.40	96,000	
	Earth excavation, borrow	75,000	cu.yd.	0.35	26,300	
	Embankment, rolled	225,000	cu.yd.	0.20	45,000	
	Dumped rock	25,000	cu.yd.	1.80	45,000	
	Concrete, plain	23,500	cu.yd.	10.00	235,000	
	Concrete, reinforced	3,500	cu.yd.	18.00	63,000	
	Reinforcement steel	980,000	lb.	0.05	49,000	
	Sheet-piling	10,000	sq.ft.	1.25	12,500	
	Gates and machinery			Lump sum	60,000	
	Gatehouse and miscellaneous			Lump sum	50,300	
	Bridges, service and road			Lump sum	26,000	
					797,100	
	Contingencies			20%	159,400	
					956,500	
	Engineering and overhead			15%	143,500	
	TOTAL					$1,100,000
2	Relocation of railroads and utilities				None	
3	Rights-of-way and land					
	Land	3,000	acre	Lump sum	72,000	
	Buildings purchased	4	sets	Lump sum	10,500	
	Cemetery relocation				None	
	Water rights, developed				None	
	Water rights, undeveloped			Lump sum	2,500	
					85,000	
	Legal, overhead, and general expenses			20%	17,000	
	TOTAL					102,000
4	Highway relocation					
	Local Road - 18-ft. gravel	4.6	mi.	Lump sum	161,000	
	Small structures			Lump sum	15,000	
					176,000	
	Contingencies			10%	17,600	
					193,600	
	Engineering and overhead			10%	19,400	
	TOTAL					213,000
5	Grand total capital cost					1,415,000

(1) Annual costs. - The estimated annual costs for flood control and conservation storage at the Victory Reservoir are given in the following table:

ESTIMATED ANNUAL COSTS OF VICTORY RESERVOIR

FOR FLOOD CONTROL AND CONSERVATION STORAGE

Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$1,415,000	
	Interest during construction ($1,415,000 x 0.03)	42,000	
	TOTAL (Federal investment)	1,457,000	
2	Federal annual charges		
	Interest . . . . . ($1,457,000 x 0.035). . .	51,000	
	Amortization of obsolescence and depreciation		
	Earthwork and general. (1.38 x 1.03 x .0076 x $390,100)	4,200	
	Concrete . . . . . (1.38 x 1.03 x .0076 x 347,000)	3,700	
	Gates and machinery. . (1.38 x 1.03 x .0354 x 60,000)	3,000	
	Railroads and utilities(- - - -)	None	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 85,000)	800	
	Highways . . . . . (1.21 x 1.03 x .0076 x 176,000)	1,700	
	Maintenance and operation		
	Embankment and general overhead	3,500	
	Operator and expendable supplies	2,000	
	Concrete . . . . . (1.38 x 0.01 x $347,000). . . .	4,800	
	Gates and machinery. . (1.38 x 0.03 x 60,000). . . .	2,500	
	TOTAL (Federal annual charges)		$ 77,200
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . . ($85,000 x 0.035)	3,000	
	TOTAL (non-Federal annual charges)		3,000
	TOTAL ANNUAL COST (2 + 4).		80,200

cc. Lyndonville. - (1) General. - The Lyndonville Reservoir, located on the Passumpsic River, 24.0 miles above its confluence with the Connecticut River, is outlined on Plate No. 92. The dam site is located 2 miles northeast of the Town of Lyndonville, Vermont. The reservoir will extend up the main stream 5 miles and will lie in the Town of Burke in Caledonia County, Vermont. The drainage area of 70 square miles is hilly farm and forest land. The area and capacity curves are shown on Plate No. 92. The flood control capacity will be equivalent to 7.0 inches of run-off from the drainage area or 26,100 acre-feet at the spillway crest. The reservoir area of 600 acres below the spillway crest elevation of 844.0 feet above mean sea level is classified as follows:

(a)	Agricultural land	220 acres
(b)	Pasture land	120 acres
(c)	Wooded land	260 acres
(d)	Towns, etc.	40 sets of buildings - a portion of the village of East Burke.

(2) Highways and roads. - One-half mile of 18-foot gravel road will be relocated and 3 miles of existing roads improved as indicated on Plate No. 92.

(3) Railroads. - No railroads are involved.

(4) Other public works. - Three and one-half miles of telephone and electric distribution lines will be relocated.

(5) Dam. - The general plan of the dam and the geologic features are indicated on Plates Nos. 93 and 94.

(a) Geology. - Bedrock rises in the right abutment from an exposure near river level to 75 feet above river level at bore hole No. 4. Rock is also exposed in a hill situated beyond the right end of the dam. The spillway and conduit will be constructed in schist on

this side. The left abutment is formed in stratified pervious sediments composed of sand and gravel.

(b) Available materials. - A large supply of pervious material is available near the site. Impervious materials are available within one mile upstream, and random impervious materials are available in the high ground above the left abutment.

(c) Dam and appurtenant works. - An earth dam of rolled-fill construction will extend across the main stream with an open spillway in the right bank. The total length of the earth dam will be 1600 feet; the top at Elevation 859.0, will be 130 feet above the stream bed. This will allow a freeboard of 5 feet above the maximum water surface. A reinforced concrete conduit on the right bank will be the outlet.

(d) Embankment. - The rolled-fill embankment will have a 30-foot top width. The dam will be built with an impervious core from top to bottom keyed into the ground by a cut-off trench on the left bank and by a key wall on the right bank. The core will be backed by pervious material which in turn will be riprapped on the upstream face and finished with dumped rock on the downstream face. The outside slopes of the embankment will be 1 on 3 from the bottom to within 15 feet of the top, the upper 15 feet being 1 on 2-1/2. Structure excavation will be utilized where suitable and the remainder of embankment material obtained from borrow pits.

(e) Spillway. - The side-channel spillway will be cut in rock in the right bank. A concrete overflow weir 390 feet long, with the crest at Elevation 844.0 under a 10-foot surcharge, will discharge 44,000 cubic feet per second or the equivalent of 630 cubic feet per second per square mile of drainage area controlled. There will be a freeboard of 5 feet above the 10-foot surcharge.

(f) Outlet. - A 10-foot diameter reinforced-concrete conduit, 750 feet long, located on rock in the right bank will provide for diversion control during construction and for reservoir control later. The discharge capacity with the pool at spillway crest elevation will be 4350 cubic feet per second. A concrete intake and gate-operating tower will be provided at the upstream end of the conduit, containing mechanically operated gates which will control the discharge. A service bridge will provide access to the tower from the top of the dam. A concrete stilling basin will be built at the outlet of the conduit.

(g) Plan of construction. - It is proposed first to construct the outlet works and prepare the embankment foundation, then to divert the stream and construct the embankment. The spillway will be excavated simultaneously with the construction of the dam. The time estimated for construction is 24 months or two long construction seasons.

(h) Flood control storage. - Provisions for flood control storage are described in the preceding paragraphs.

(i) Conservation storage. - No conservation storage is provided for or considered economically feasible.

(j) Power storage. - No power storage is provided for or considered economically feasible.

(k) Estimate of cost. - The estimated costs of the Lyndonville Reservoir for flood control only are given in the following table:

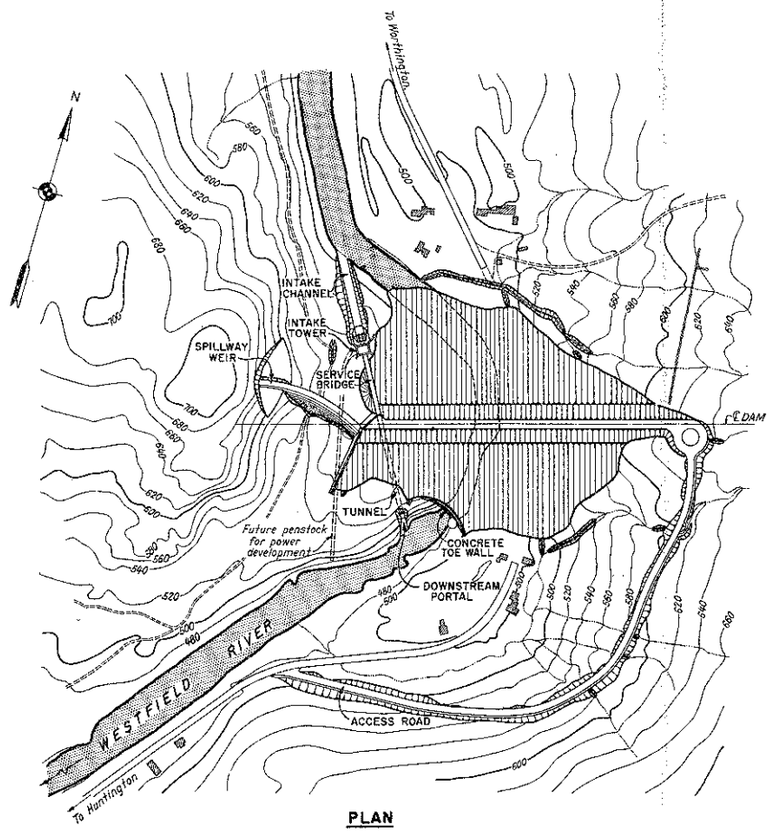
COST ESTIMATE OF LYNDONVILLE RESERVOIR
FOR FLOOD CONTROL ONLY

Item No.	Item	Quantity	Unit	Unit cost	Cost	Total cost
1	Construction					
	Clearing			Lump sum $	10,000	
	Stream control			Lump sum	10,000	
	Earth excavation, common	290,000	cu.yd.	0.40	116,000	
	Earth excavation, borrow	1,050,000	cu.yd.	0.35	367,500	
	Rock excavation, open cut	50,000	cu.yd.	2.30	115,000	
	Rock excavation, tunnel or shaft	4,000	cu.yd.	12.00	48,000	
	Embankment, rolled	1,305,000	cu.yd.	0.10	130,500	
	Dumped rock	145,000	cu.yd.	1.00	145,000	
	Concrete, plain	9,850	cu.yd.	12.00	118,200	
	Concrete, reinforced	4,800	cu.yd.	16.00	76,800	
	Reinforcement steel	640,000	lb.	0.05	32,000	
	Gates and machinery			Lump sum	66,000	
	Gatehouse and miscellaneous			Lump sum	53,200	
	Bridges, service and road			Lump sum	52,000	
					1,340,600	
	Contingencies			20%	268,100	
					1,608,700	
	Engineering and overhead			15%	241,300	
	TOTAL					$1,850,000
2	Relocation of railroads and utilities					
	Railroads				None	
	Telephone and electric distribution lines	3.5	mi.	Lump sum	4,100	
					4,100	
	Contingencies			10%	400	
					4,500	
	Engineering and overhead			10%	500	
	TOTAL					5,000
3	Rights-of-way and land					
	Land	640	acres	Lump sum	20,000	
	Buildings purchased	40	sets	Lump sum	138,300	
	Cemetery relocation				None	
	Water rights, developed				None	
	Water rights, undeveloped				None	
					158,300	
	Legal, overhead, and general expenses			20%	31,700	
	TOTAL					190,000
4	Highway relocation					
	State Highway 114, 18 ft. gravel	0.5	mi.	Lump sum	20,000	
	Local road - 18 ft. gravel	3.0	mi.	Lump sum	117,900	
	Bridge			Lump sum	15,000	
					152,900	
	Contingencies			10%	15,300	
					168,200	
	Engineering and overhead			10%	16,800	
	TOTAL					185,000
5	Grand total capital cost					2,230,000

(1) Annual costs. - The estimated annual costs of the Lyndonville Reservoir for flood control only are given in the following table:

ESTIMATED ANNUAL COSTS OF LYNDONVILLE RESERVOIR
FOR FLOOD CONTROL ONLY

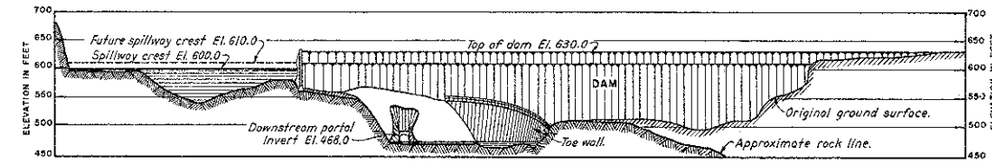
Item No.	Item	Cost	Total cost
1	Federal investment		
	Grand total capital cost (Item 5)	$2,230,000	
	Interest during construction. . ($2,230,000 x 0.03) . . .	67,000	
	TOTAL (Federal investment).	2,297,000	
2	Federal annual charges		
	Interest . . . . . ($2,297,000 x 0.035). . .	84,400	
	Amortization of obsolescence and depreciation		
	Earthwork and general .(1.38 x 1.03 x .0076 x $1,047,600)	11,300	
	Concrete. . . . . .(1.38 x 1.03 x .0076 x 227,000)	2,500	
	Gates and machinery . .(1.38 x 1.03 x .0354 x 66,000)	3,300	
	Railroads and utilities(1.21 x 1.03 x .0076 x 4,100)	0	
	Rights-of-way and land (1.20 x 1.03 x .0076 x 158,300)	1,500	
	Highways. . . . . .(1.21 x 1.03 x .0076 x 152,900)	1,500	
	Maintenance and operation		
	Embankment and general overhead	5,500	
	Operator and expendable supplies	2,000	
	Concrete. . . . . .(1.38 x 0.01 x $227,000)	3,100	
	Gates and machinery . .(1.38 x 0.03 x 66,000)	2,700	
	TOTAL (Federal annual charges).		$113,800
3	Non-Federal investment	None	
4	Non-Federal annual charges		
	Tax loss on land . . . .($158,300 x 0.035)	5,500	
	TOTAL (non-Federal annual charges).		5,500
	TOTAL ANNUAL COST (2 + 4)		119,300



PLAN

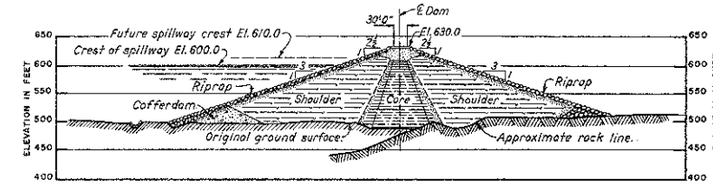
SCALE: 1" = 200'

200' 0 200' 400'



DOWNSTREAM ELEVATION OF DAM – DEVELOPED

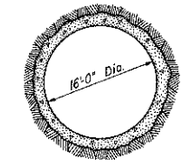
NOT TO SCALE



SECTION THRU DAM

SCALE: 1" = 100'

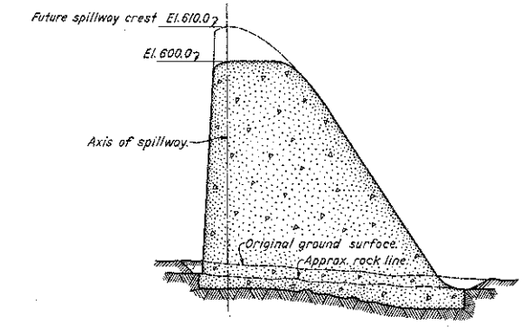
100' 0 100' 200'



TYPICAL TUNNEL SECTION

SCALE: $\frac{1}{8}$" = 1'-0"

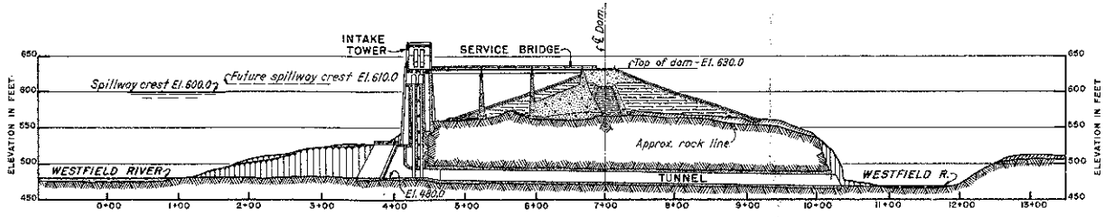
5' 0 5' 10' 15' 20'



TYPICAL SPILLWAY SECTION

SCALE: $\frac{1}{16}$" = 1'-0"

10' 0 10' 20' 30' 40'



SECTION ON ℄ TUNNEL

SCALE: 1" = 80'

80' 0 80' 160'

NOTES

Elevations refer to Mean Sea Level Datum.
Spillway has been constructed to elevation 610.0.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AR. BY

CONNECTICUT RIVER FLOOD CONTROL

KNIGHTVILLE DAM

GENERAL PLAN

WESTFIELD RIVER MASSACHUSETTS

IN 3 SHEETS SCALE: 1 IN. = 200 FT. 200' 0 200' 400' SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

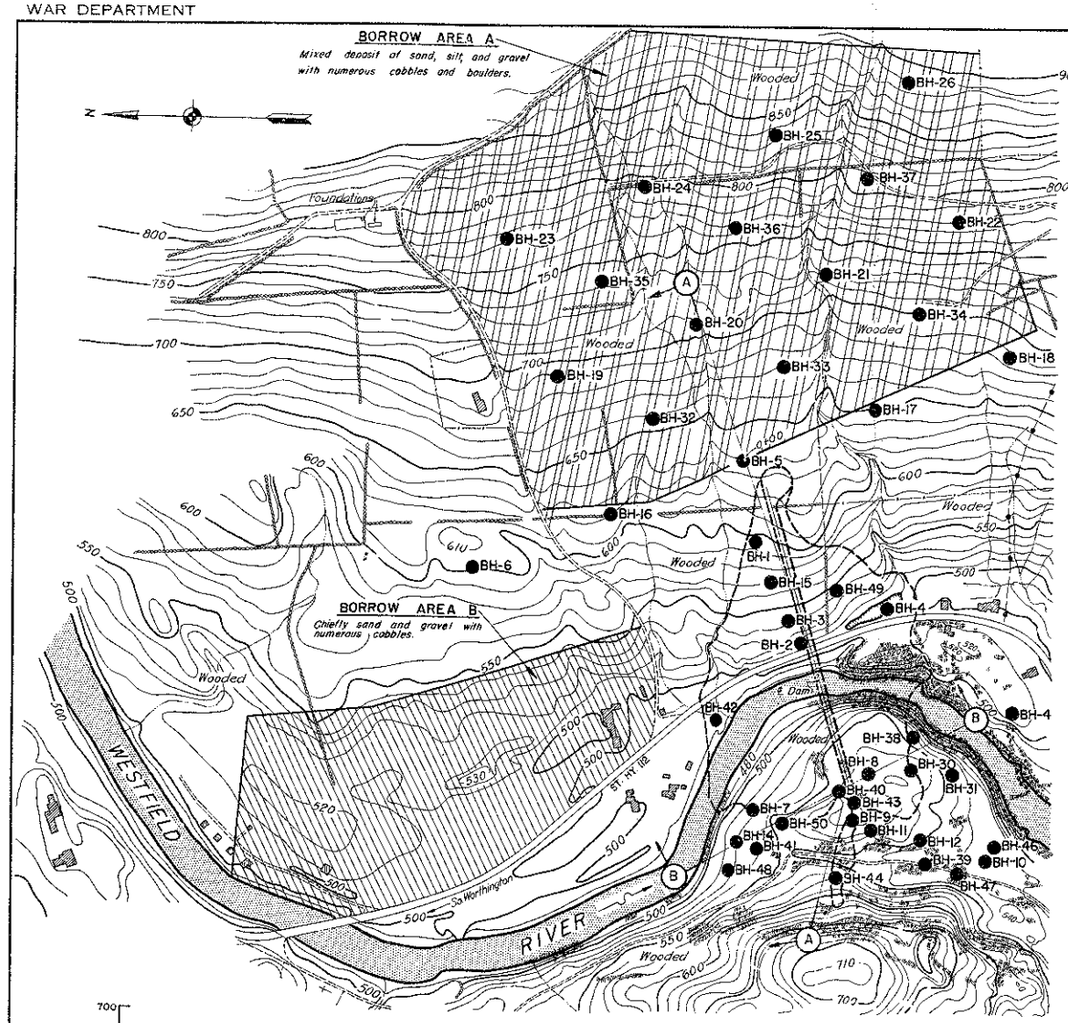
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

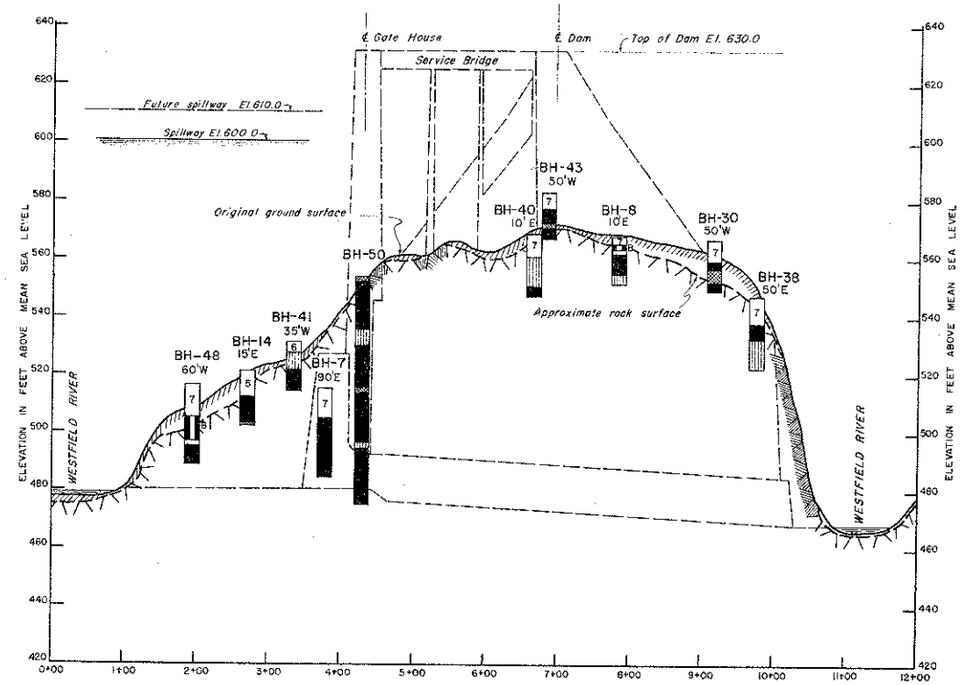
DRAWN: C.K.M. TRACED: T.C.M. CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-144



PLAN
SCALE: 1" = 200'



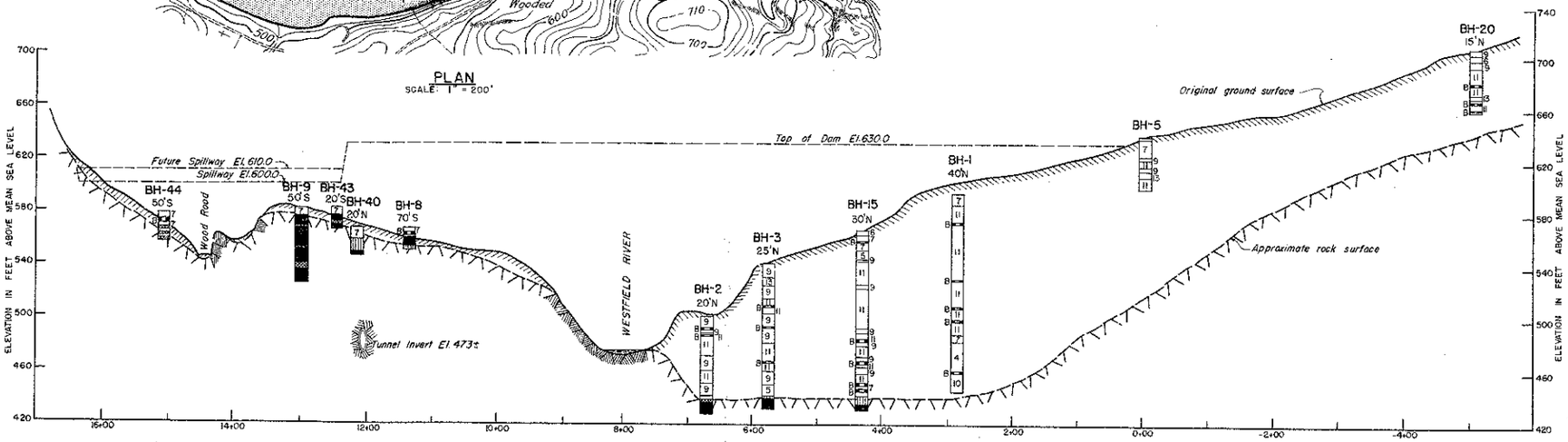
PROFILE ON LINE B-B, ℄ TUNNEL
SCALES: HOR. 1" = 80'
VERT. 1" = 20'

LEGEND

- Permissible impervious and hydraulic borrow area.
- Permissible pervious and hydraulic borrow area.
- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%.
- Weathered and fractured bedrock, core recovery between 50% and 75%.
- Less weathered and fractured bedrock, core recovery more than 75%.
- BH Drive sample bore hole.
- N. North of line A-A
- S. South of line A-A
- E. East of line B-B
- W. West of line B-B
- Ledge outcrop

NOTES

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14 A.
Spillway has been constructed to elevation 610.0.



PROFILE ON LINE A-A, LOOKING UPSTREAM
SCALES: HOR. 1" = 80'
VERT. 1" = 40'

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

KNIGHTVILLE DAM

GEOLOGY

WESTFIELD RIVER — MASSACHUSETTS

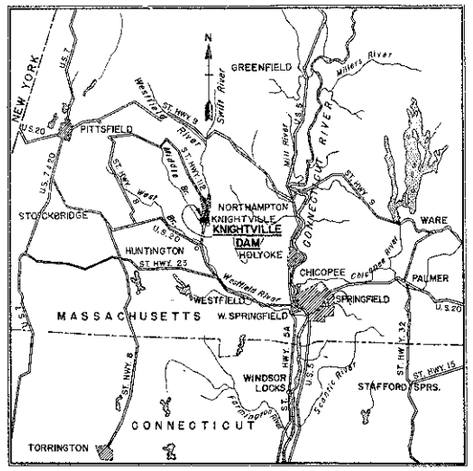
IN 3 SHEETS — SCALE: 1 IN. = 200 FT. — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: Senior Geologist, Head, Geology Section
APPROVAL RECOMMENDED: Principal Engineer, Chief, P. C. Engineering Div.
APPROVED: Col. Corps of Engineers, District Engineer

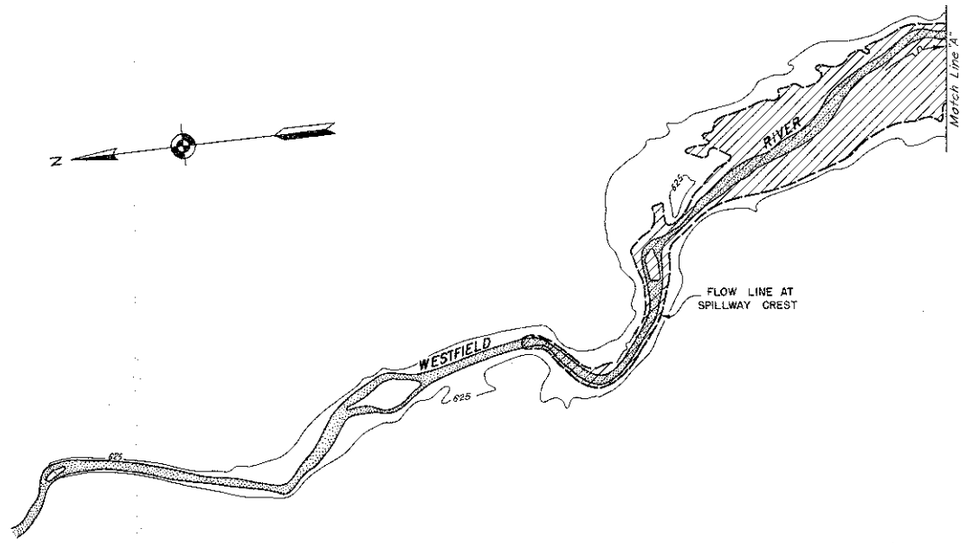
COMPILED: Asst. Engineer
DRAWN: J.M.C.L. TRACED: J.S. & A.L.K. CHECKED:

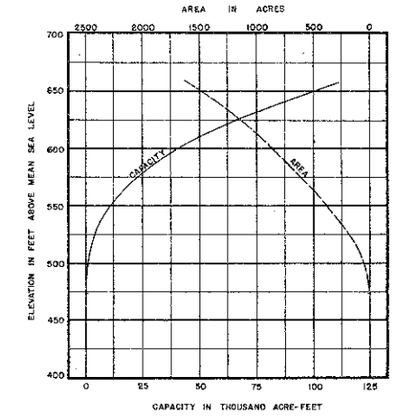
TO ACCOMPANY REPORT DATED: FEB. 26, 1940
FILE NO. CT-2-1242



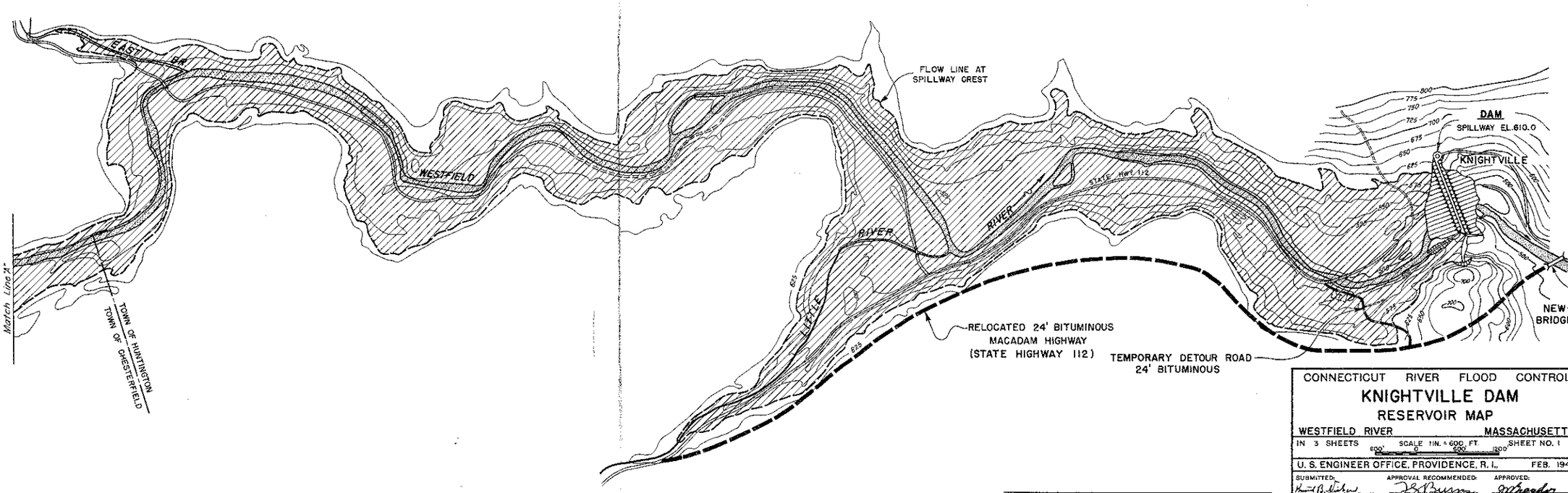
VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES



CONNECTICUT RIVER FLOOD CONTROL

KNIGHTVILLE DAM

RESERVOIR MAP

WESTFIELD RIVER MASSACHUSETTS

IN 3 SHEETS SCALE 1 IN. = 600 FT. SHEET NO. 1

600' 0 600' 1200'

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

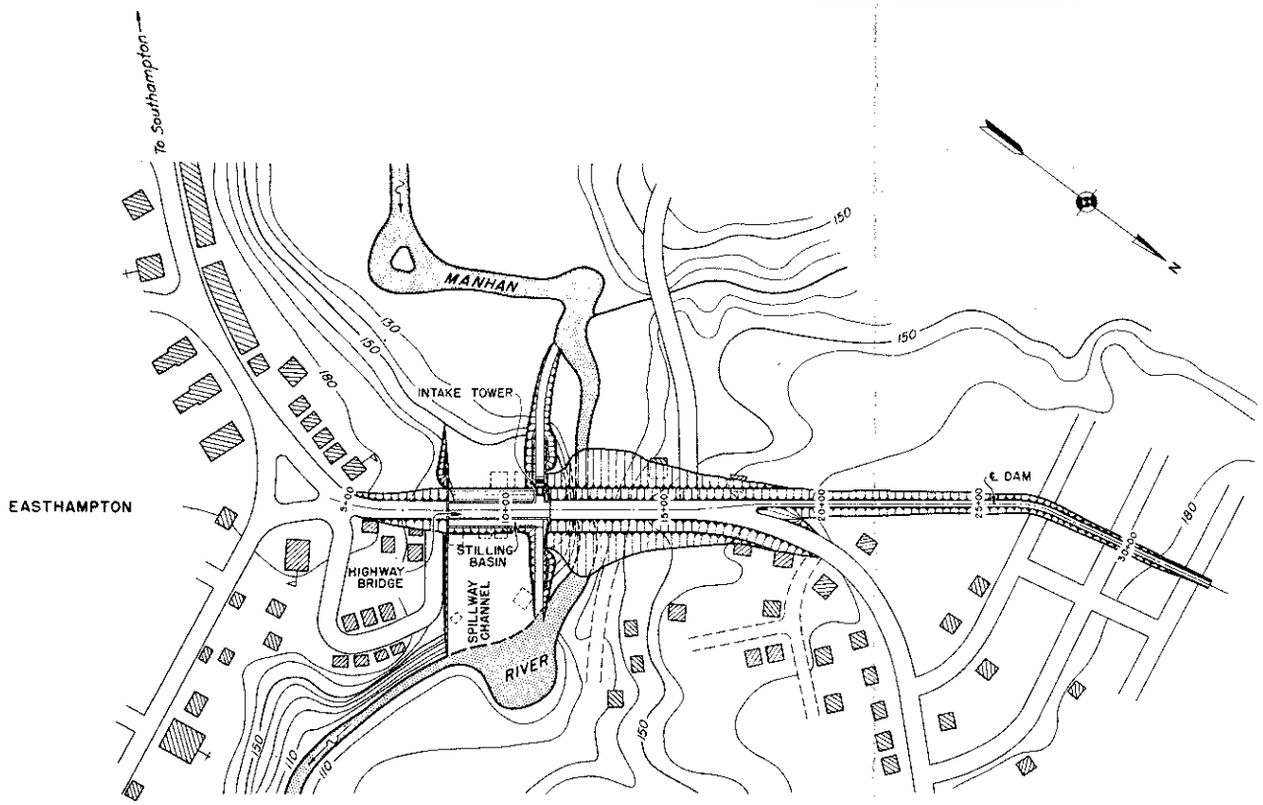
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. D. Wagner, ASSOC. ENGINEER

DRAWN: M.B.R. TRACED: M.B.R. CHECKED: M.D.K.

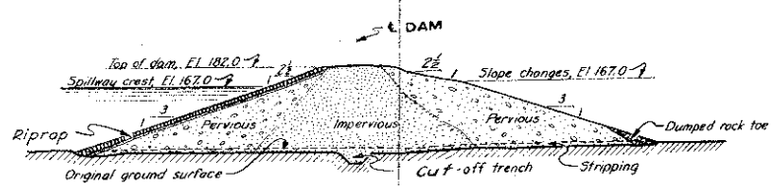
TO ACCOMPANY REPORT DATED FEB. 26 1940 FILE NO. CT-1-1437

KEY	DATE	REVISION (Indicated by Δ)	REV.BY	CK.BY	APBY



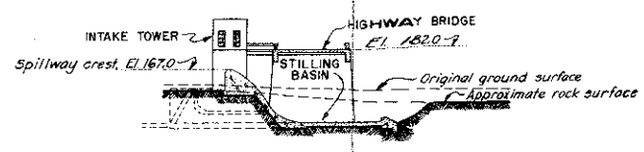
PLAN

SCALE 1" = 200'



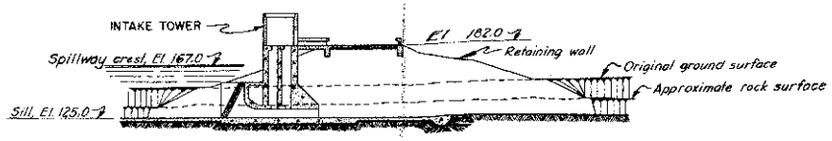
TYPICAL SECTION THRU DAM

SCALE 1" = 50'



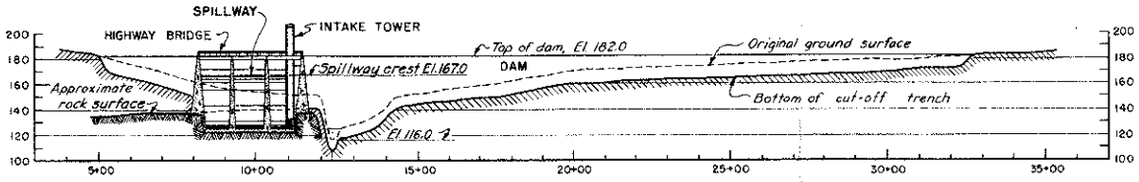
SECTION ON ℄ SPILLWAY CHANNEL

SCALE 1" = 50'



SECTION THRU OUTLET WORKS

SCALE 1" = 50'



PROFILE ON ℄ DAM

SCALE: HOR. 1" = 200'
VERT. 1" = 50'

NOTE

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by Δ)	REV BY	CK BY	APB Y

CONNECTICUT RIVER FLOOD CONTROL

EASTHAMPTON DAM

GENERAL PLAN

MANHAN RIVER — MASSACHUSETTS

IN 2 SHEETS — SCALE: 1 IN. = 200 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

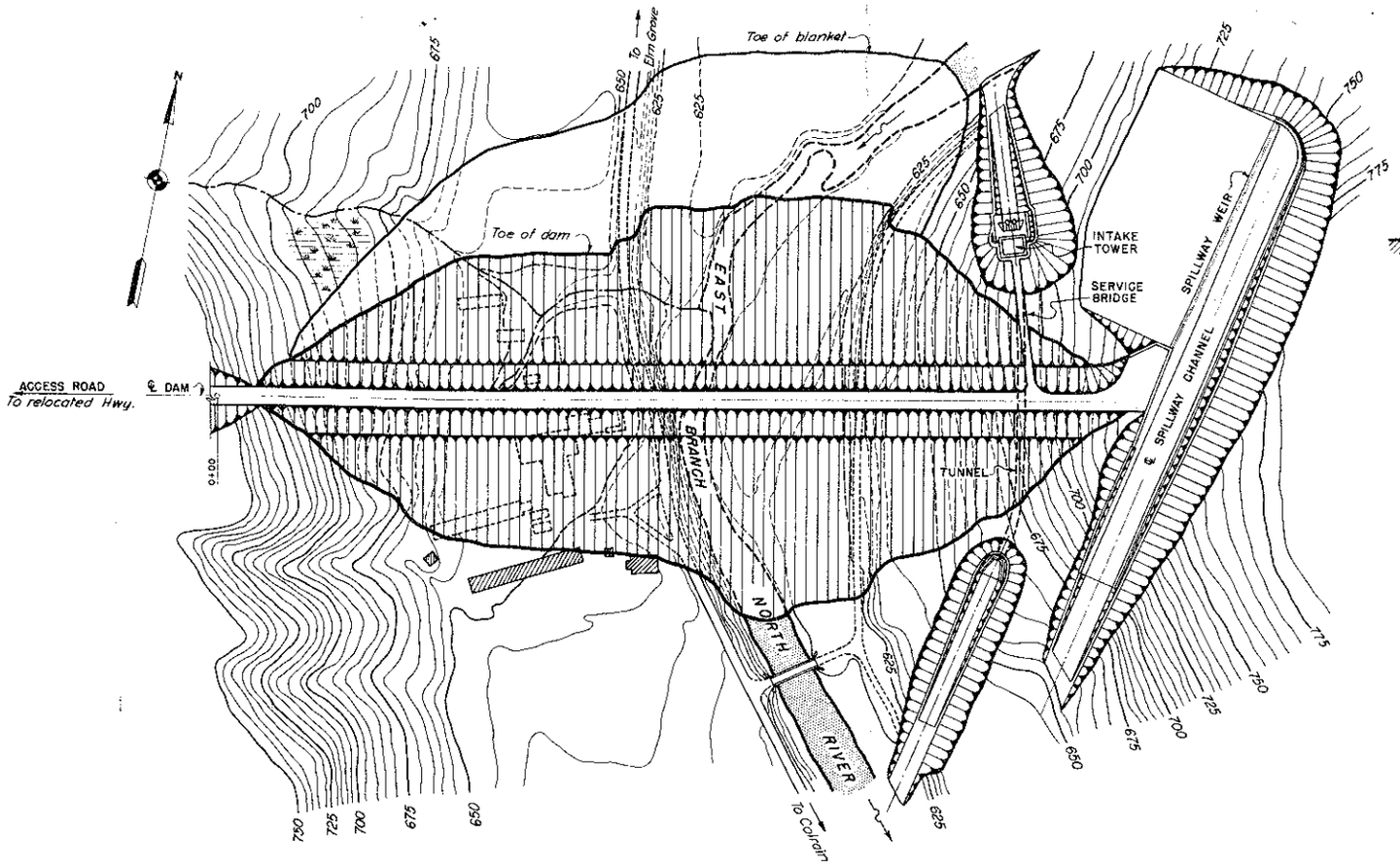
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. D. Wagner, ASSOC. ENGINEER

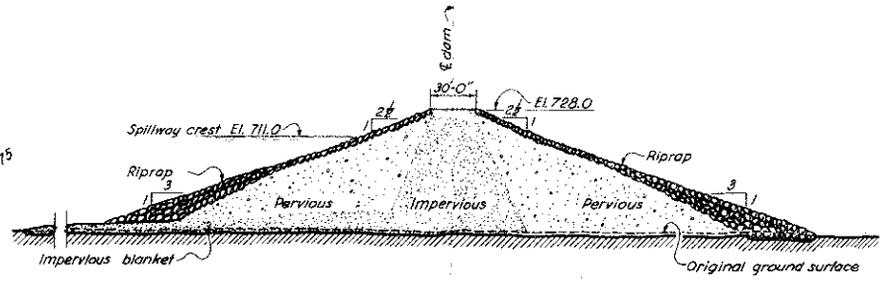
DRAWN: D. C.
TRACED: K. H. W.
CHECKED: J. W. H.

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-1-1468



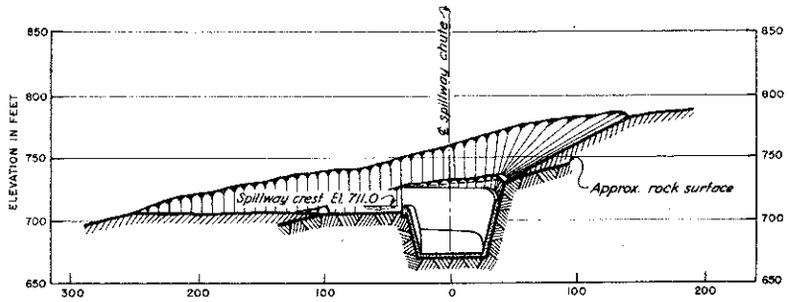
PLAN

SCALE: 1" = 100'



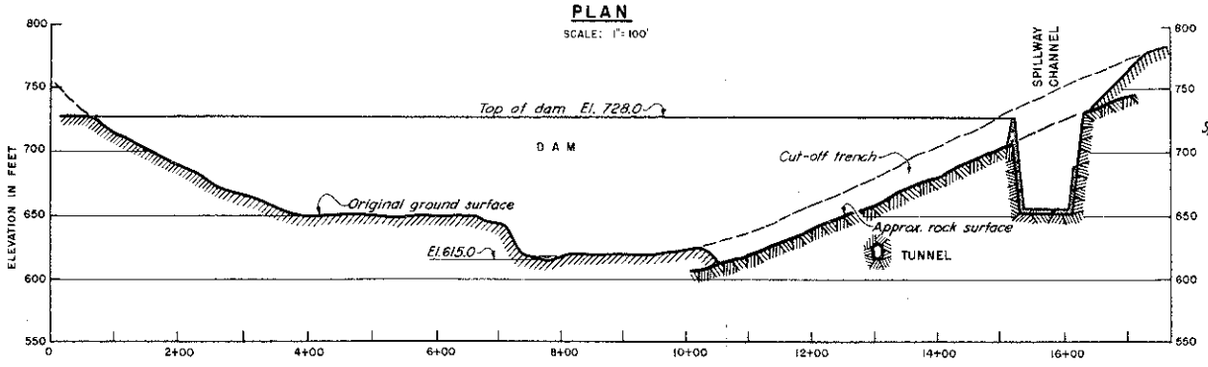
TYPICAL SECTION THRU DAM

SCALE: 1" = 40'



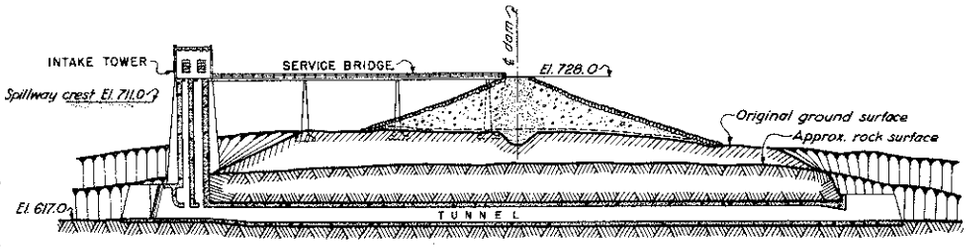
SECTION THRU SPILLWAY

SCALE: 1" = 50'



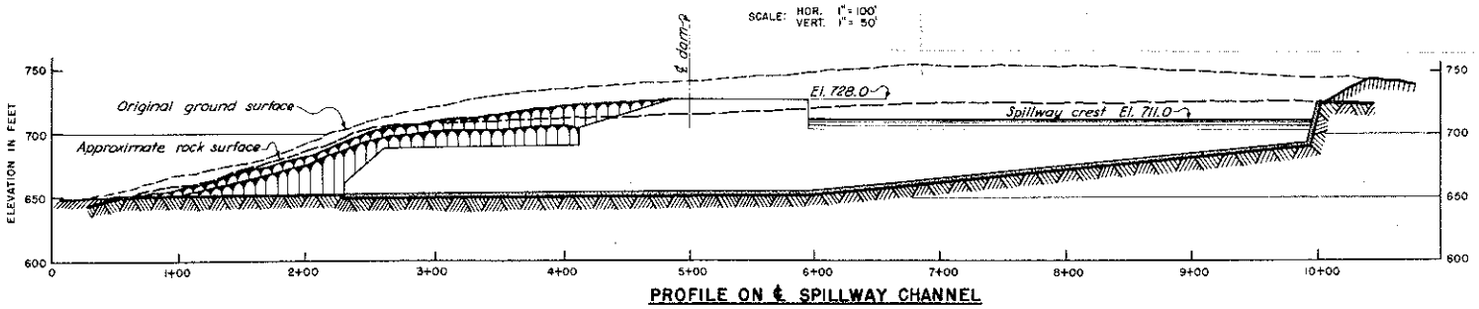
PROFILE ON ℄ DAM

SCALE: HOR. 1" = 100'
VERT. 1" = 50'



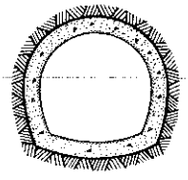
SECTION THRU OUTLET WORKS

SCALE: 1" = 50'



PROFILE ON ℄ SPILLWAY CHANNEL

SCALE: 1" = 50'



SECTION THRU TUNNEL

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

NOTE

Elevations refer to Mean Sea Level Datum

KEY	DATE	REVISION (indicated by Δ)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

FORT MORRISON DAM

GENERAL PLAN

NORTH RIVER, DEERFIELD WATERSHED MASSACHUSETTS

IN 3 SHEETS — SCALE: 1 IN = 100 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

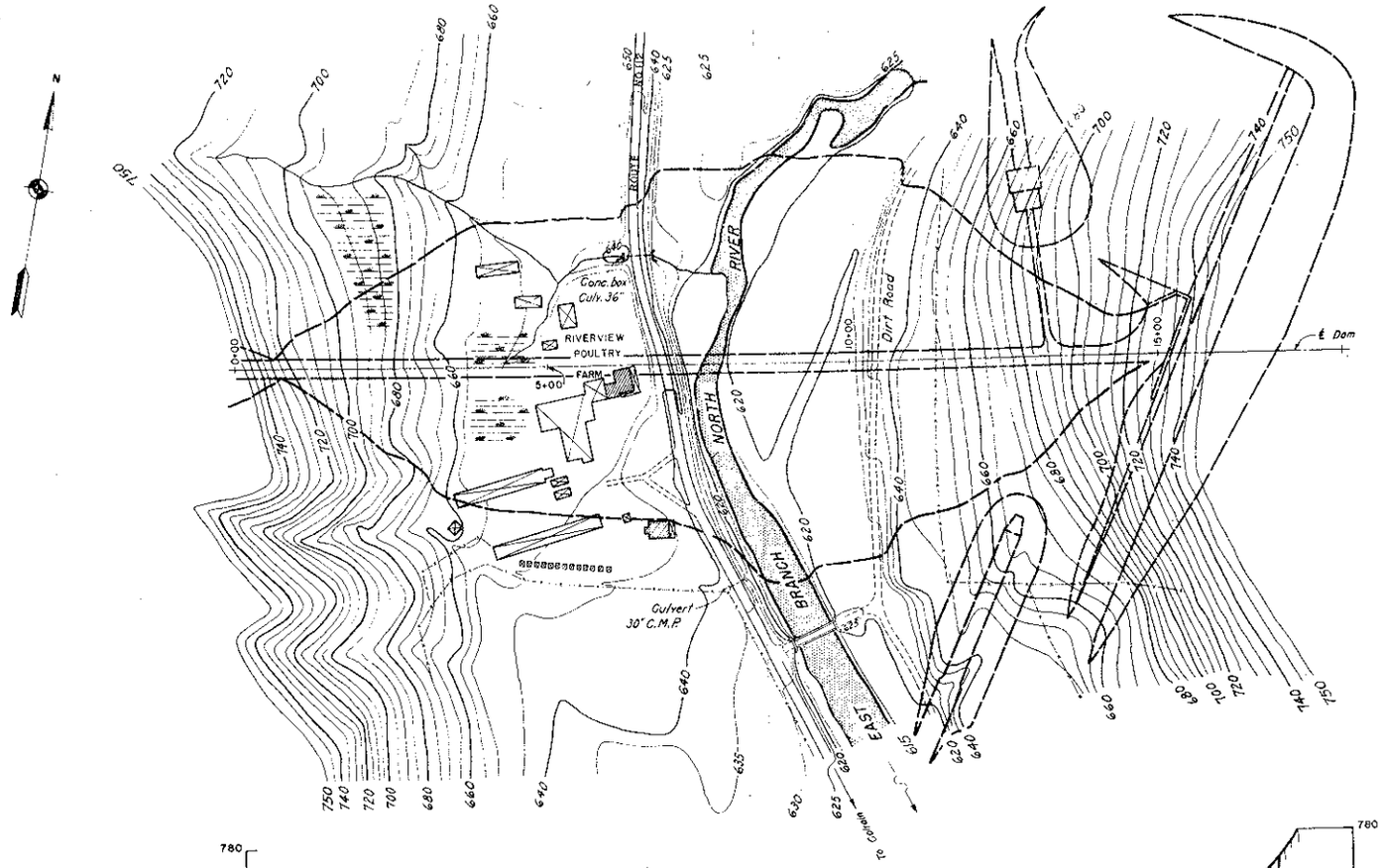
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. J. Murgier, ASSOC. ENGINEER

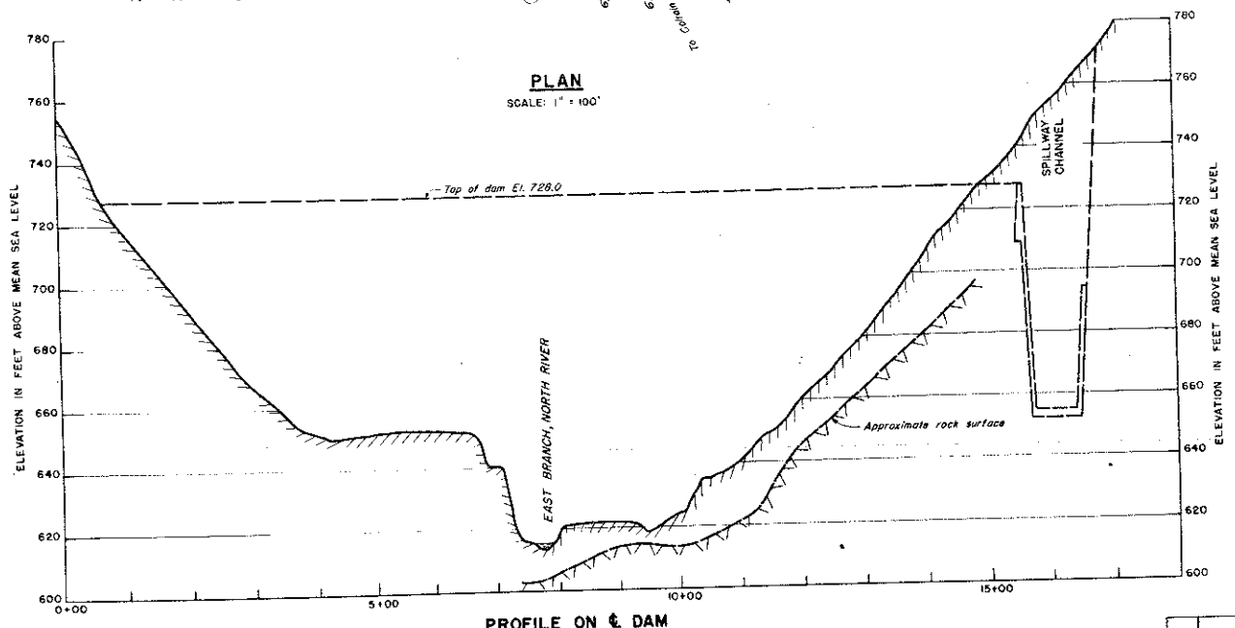
DRAWN: D. P.
TRACED: D. L. B. & E. E.
CHECKED: J. W. H.

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-1-1469



PLAN

SCALE: 1" = 100'



PROFILE ON ℄ DAM

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

SOURCES OF BORROW

Pervious material available within 0.5 miles upstream on right bank.
Impervious material available within 0.5 miles upstream on right bank.

NOTE

Rock surface determined by seismic investigations.

KEY	DATE	REVISION (Indicated by △)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

FORT MORRISON DAM

GEOLOGY

NORTH RIVER, DEERFIELD WATERSHED MASSACHUSETTS

IN 3 SHEETS SCALE: 1 IN. = 100 FT. SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR GEOLOGIST HEAD, GEOLOGY SECTION

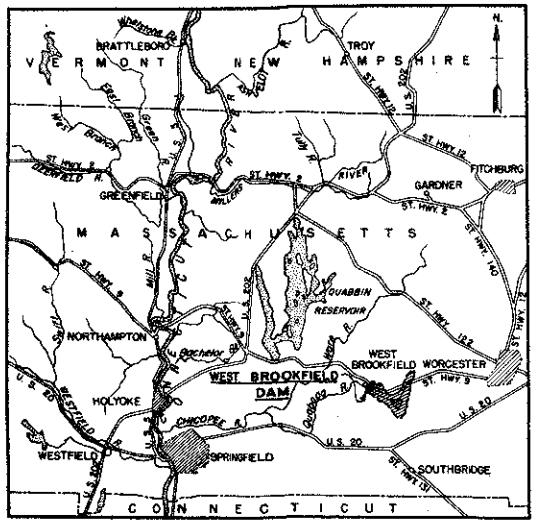
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER CHIEF, F. C. ENGINEERING DIV.

APPROVED: COL. CORPS OF ENGINEERS DISTRICT ENGINEER

COMPILED: ASST. ENGINEER

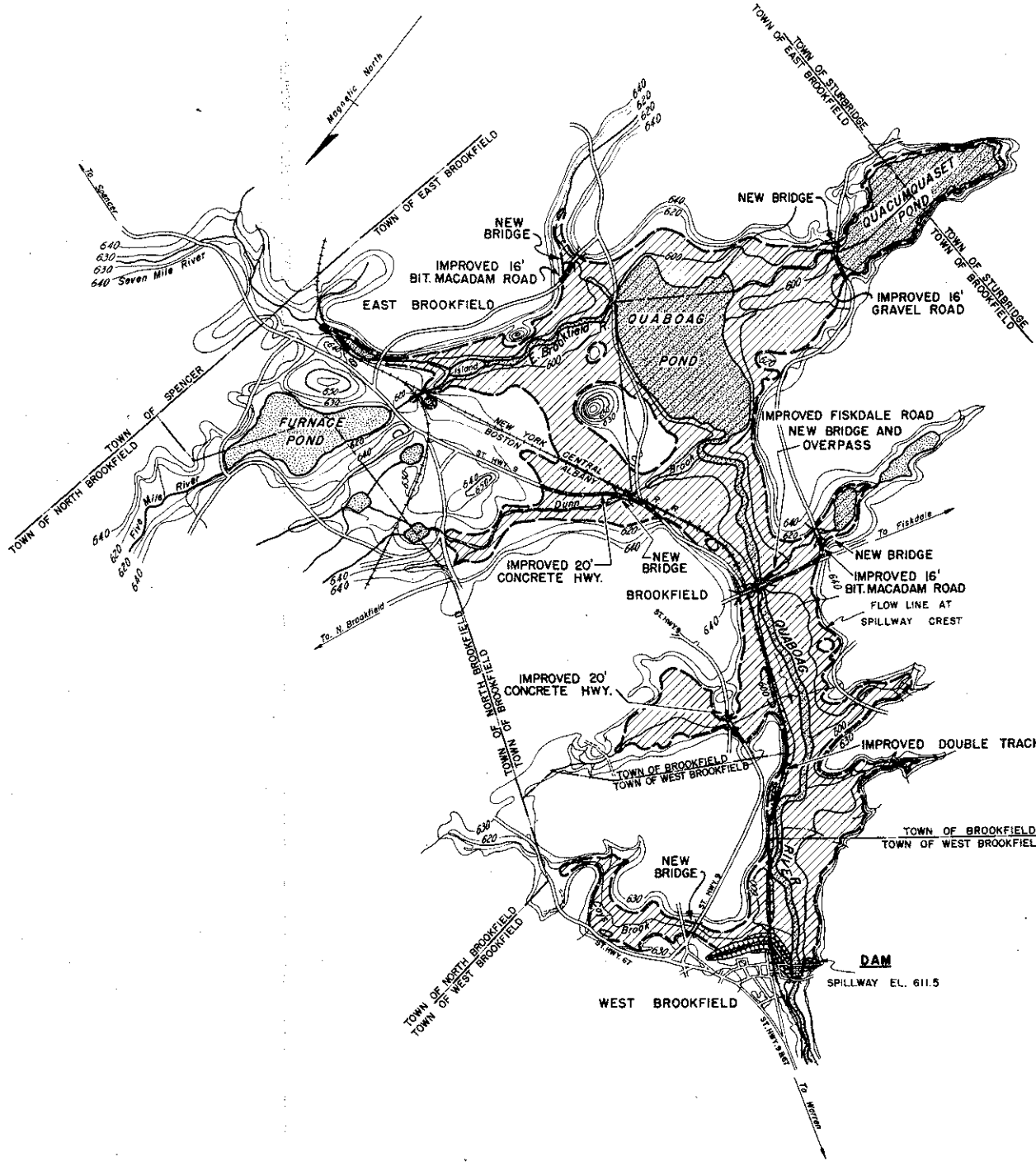
DRAWN: R.K.L. TRACED: L.B. CHECKED:

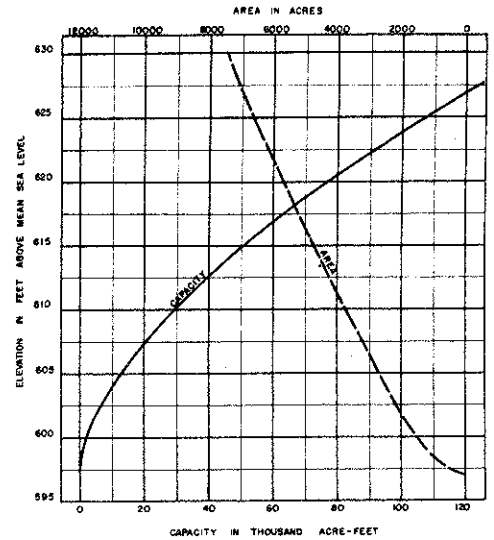
TO ACCOMPANY REPORT DATED: FEB. 28, 1940 FILE NO. CT-2-1227



VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (indicated by Δ)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

WEST BROOKFIELD DAM

RESERVOIR MAP

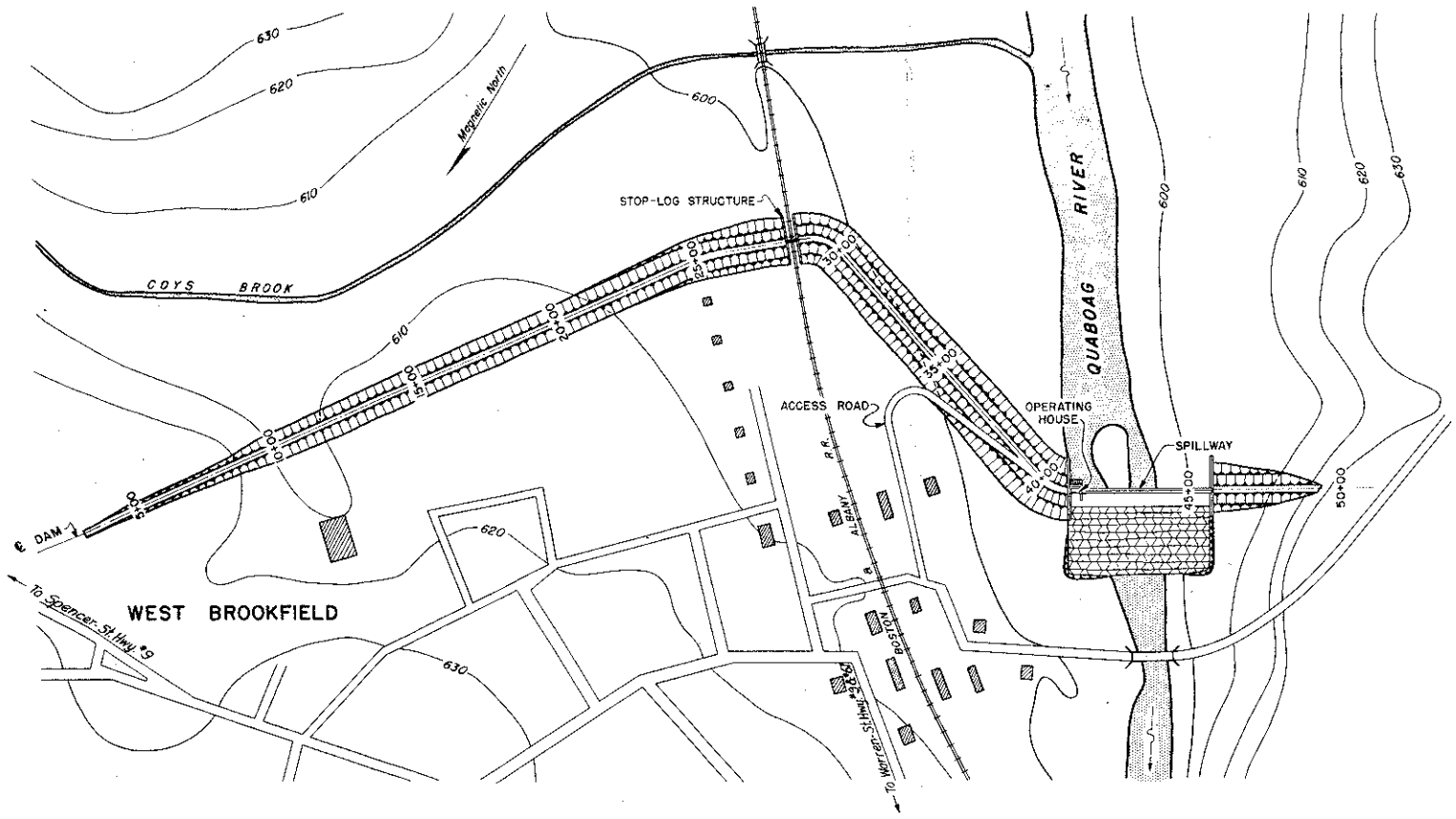
QUABOAG RIVER, CHICOPEE WATERSHED, MASSACHUSETTS

IN 3 SHEETS — SCALE: 1 IN. = 2000 FT. — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB., 1940

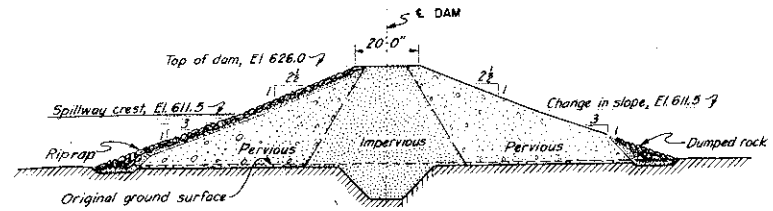
SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER — DRAWN: L.V.P. TRACED: L.V.P. CHECKED: — TO ACCOMPANY REPORT DATED: FEB. 28, 1940 FILE NO. CT-1-1436



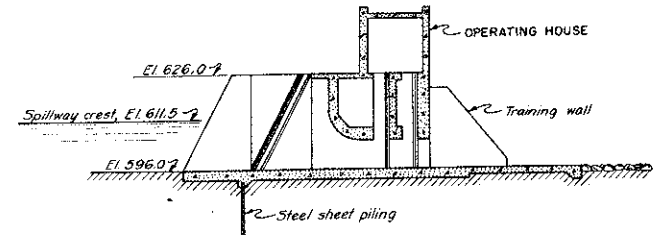
PLAN

SCALE 1" = 200'



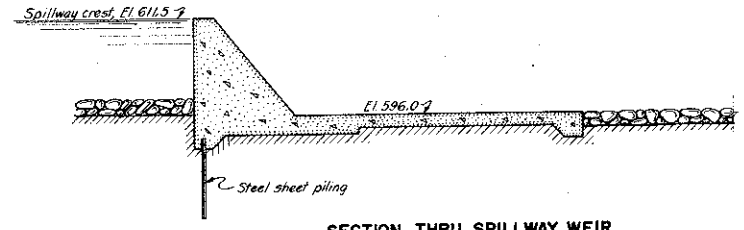
TYPICAL SECTION THRU DAM

SCALE 1" = 20'



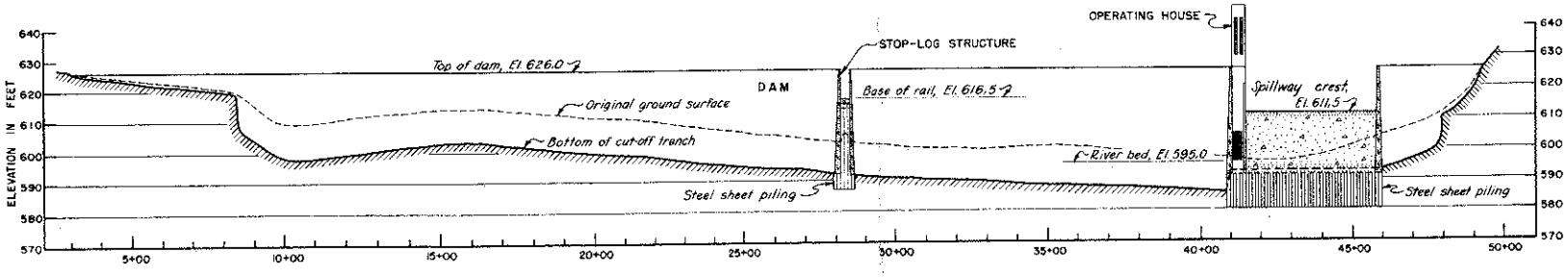
SECTION THRU OUTLET WORKS

SCALE 1" = 20'



SECTION THRU SPILLWAY WEIR

SCALE 1" = 10'



PROFILE ON ℄ DAM AND SPILLWAY

SCALE: HOR. 1" = 200'
VERT. 1" = 20'

NOTE

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by Δ)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

WEST BROOKFIELD DAM

GENERAL PLAN

QUABOAG RIVER, CHICOPEE WATERSHED, MASSACHUSETTS

1 IN 3 SHEETS — SCALE 1 IN. = 200 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

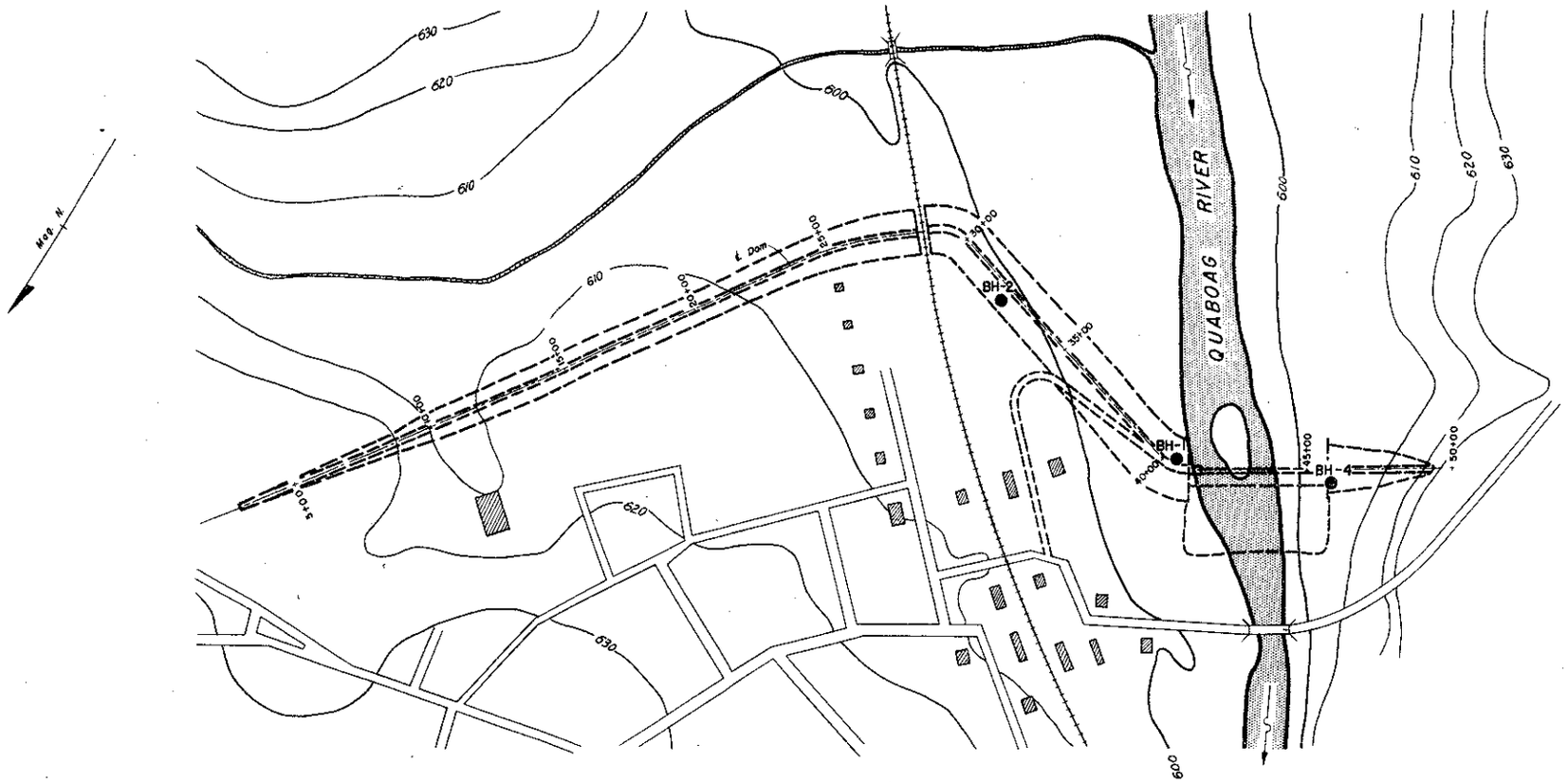
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

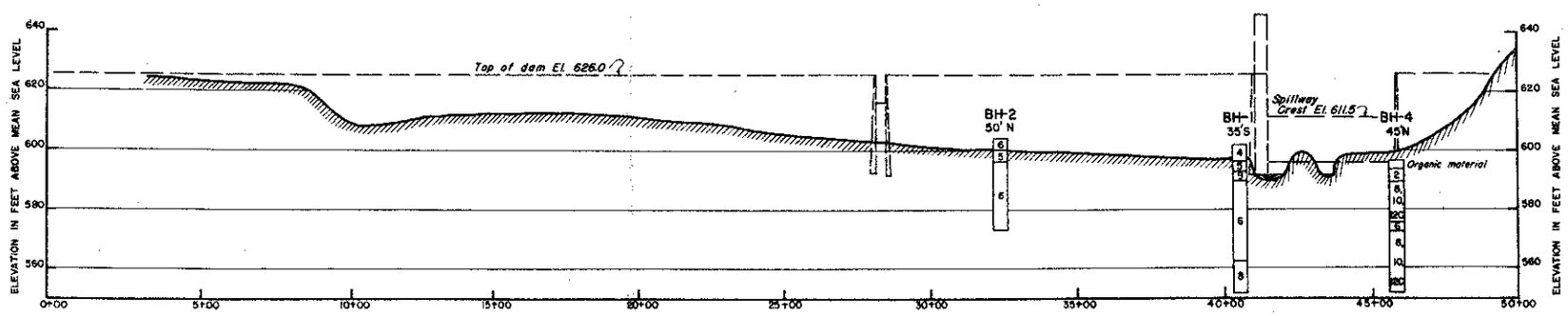
DRAWN: D. G.
TRACED: K. H. W.
CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-1-1465



PLAN

SCALE: 1" = 200'



PROFILE ON ℄ DAM AND SPILLWAY

SCALES: HOR. 1" = 200'
VERT. 1" = 20'

SOURCES OF BORROW

Pervious and impervious materials available adjacent to the site on the left bank.

LEGEND

- Boulder
- Badly weathered and fractured bedrock core recovery less than 50%.
- Weathered and fractured bedrock, core recovery between 50% and 75%
- Less weathered and fractured bedrock, core recovery more than 75%.
- ● BH Drive sample bore hole.
- N. North of ℄ dam
- S. South of ℄ dam
- Ledge outcrop

NOTES

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14 A.

Classes 8, 10, & 12C indicated in bore hole BH-4 generally occur in alternating bands, having thin layers of fine clay interbedded with thicker layers of silt and fine sand.

KEY	DATE	REVISION (Indicated by △)	REV BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

WEST BROOKFIELD DAM

GEOLOGY

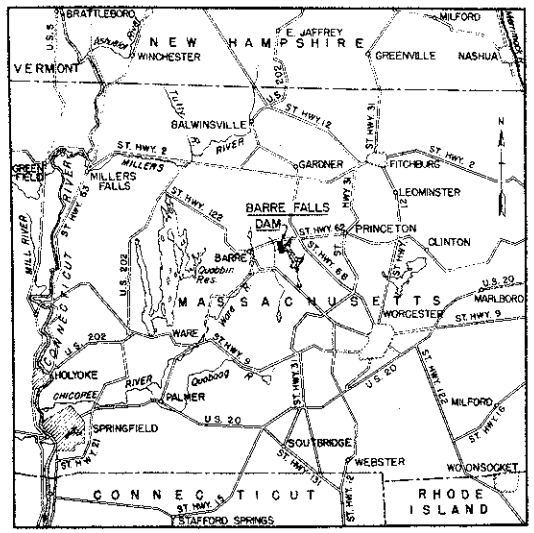
QUABOAG RIVER, CHICOPEE WATERSHED, MASSACHUSETTS

IN 3 SHEETS — SCALE: 1 IN. = 200 FT. (200' 0 200' 400') — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

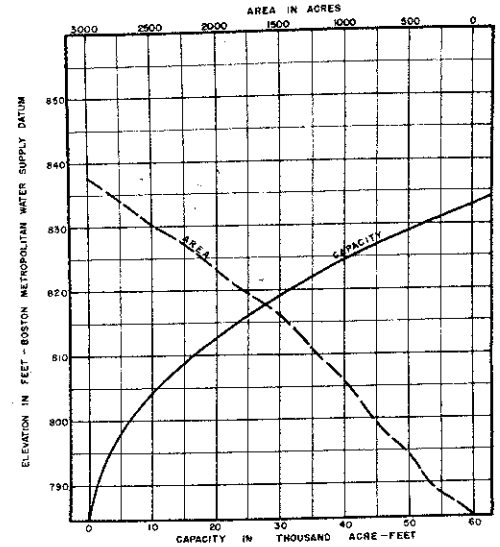
SUBMITTED: Senior Geologist, Head, Geology Section — APPROVAL RECOMMENDED: Principal Engineer, Chief, F. C. Engineering Div. — APPROVED: Col. Corps of Engineers, District Engineer

COMPILED: Asst. Engineer — DRAWN: J. M'L. TRACED: A. L. K. CHECKED: — TO ACCOMPANY REPORT DATED: FEB. 28, 1940 — FILE NO. CT-2-1235

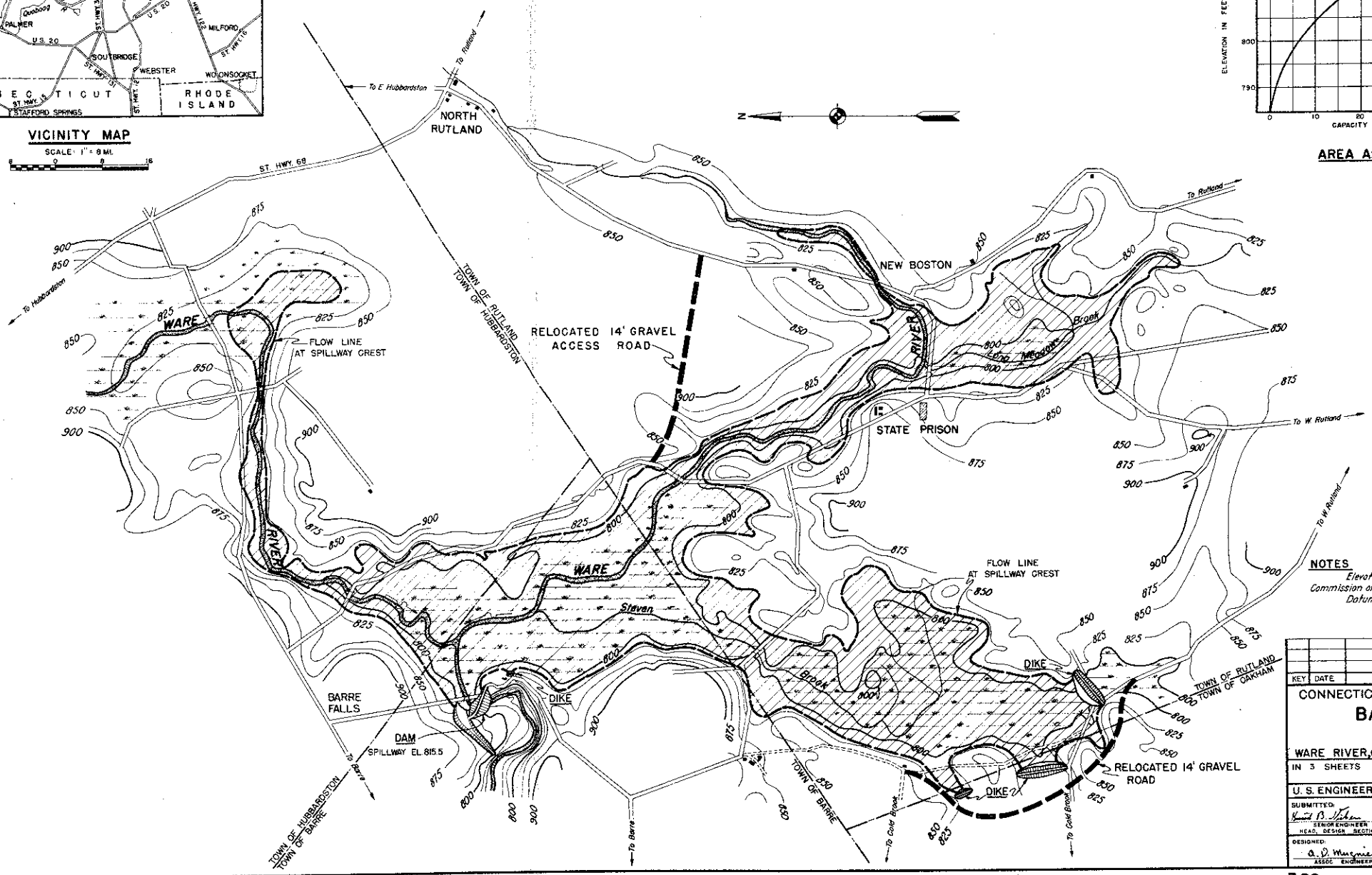


VICINITY MAP

SCALE: 1" = 8 MI.



AREA AND CAPACITY CURVES



NOTES

Elevations refer to Metropolitan District Water Supply Commission of the Commonwealth of Massachusetts Datum. Datum is 6.05 feet below Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

BARRE FALLS DAM

RESERVOIR MAP

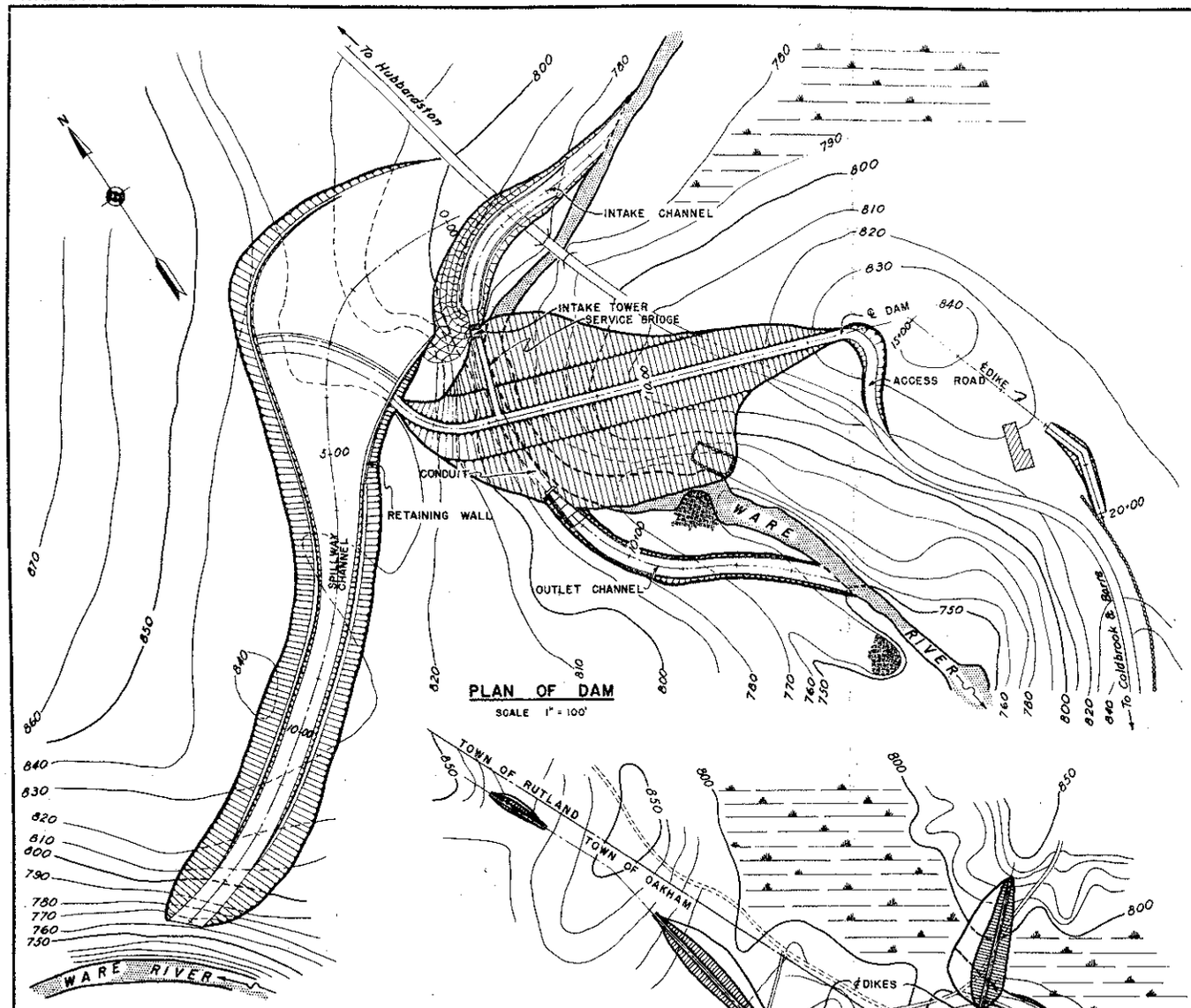
WARE RIVER, CHICOPEE WATERSHED, MASSACHUSETTS

IN 3 SHEETS — SCALE: 1 IN. = 1000 FT. — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER — DRAWN: J.E.O. TRACED: J.E.O. CHECKED: — TO ACCOMPANY REPORT DATED: FEB. 28 1940 FILE NO. CT-1-1435



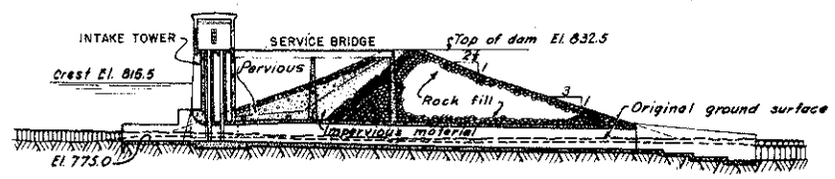
PLAN OF DAM

SCALE 1" = 100'

PLAN OF DIKES

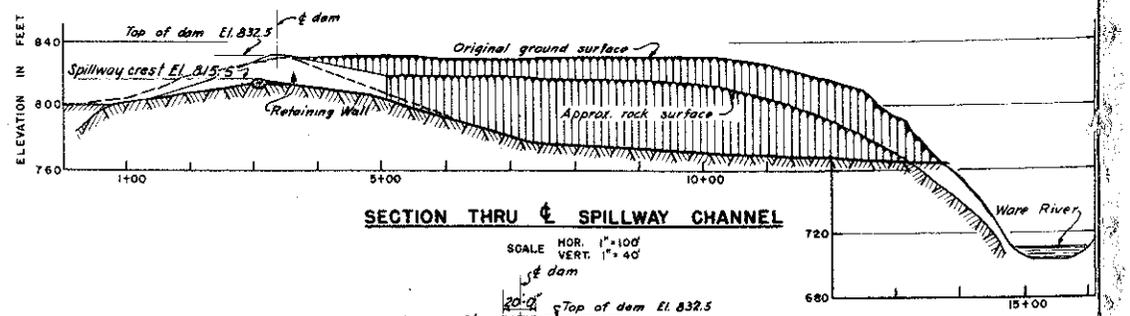
SCALE 1" 400'

See Reservoir Map, Plate No. 2.5 for relative position of dikes and dam.



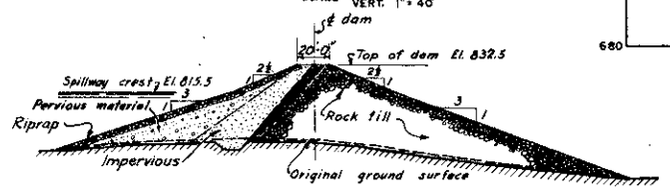
SECTION THRU ℄ CONDUIT

SCALE 1" = 40'



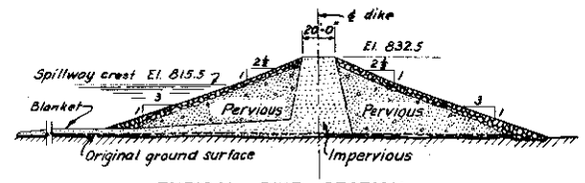
SECTION THRU ℄ SPILLWAY CHANNEL

SCALE HOR. 1" = 100' VERT. 1" = 40'



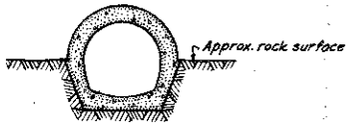
TYPICAL SECTION THRU DAM

SCALE 1" = 40'



TYPICAL DIKE SECTION

SCALE 1" = 40'

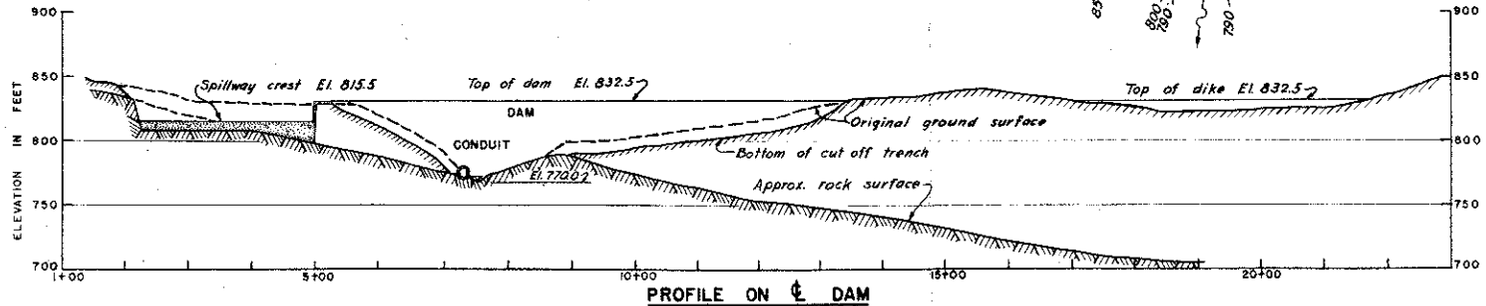


SECTION THRU CONDUIT

SCALE 1" = 5'

NOTES

Elevations refer to Metropolitan District Water Supply Commission of the Commonwealth of Massachusetts Datum. Datum is 6.05 feet below Mean Sea Level Datum.



PROFILE ON ℄ DAM

SCALE HOR. 1" = 100' VERT. 1" = 50'

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

BARRE FALLS DAM

GENERAL PLAN

WARE RIVER, CHICOPEE WATERSHED, MASSACHUSETTS

IN 3 SHEETS — SCALE: 1 IN. = 100 FT. — SHEET NO. 2

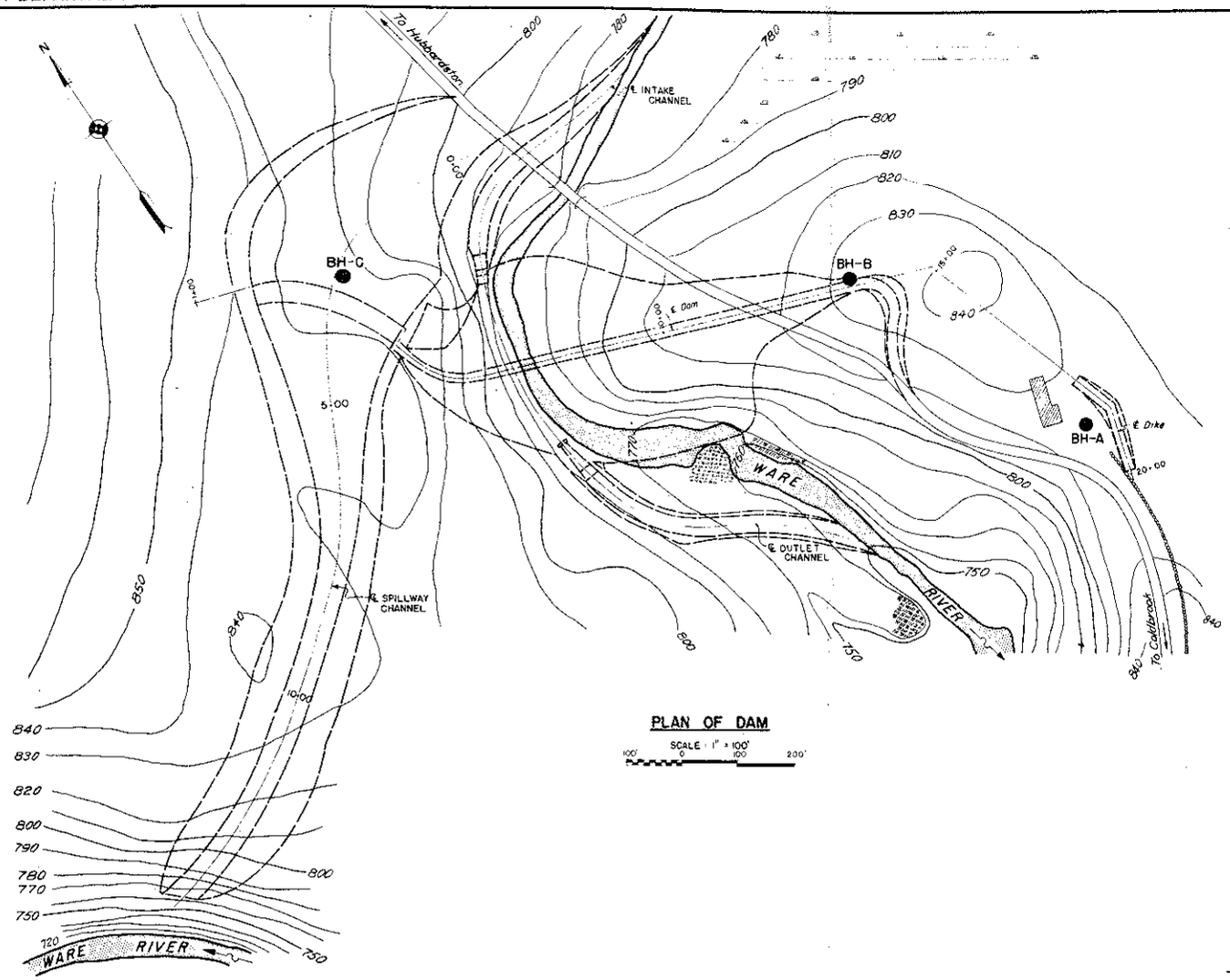
U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER — DRAWN: J. S. TRACED: S. Z. CHECKED:

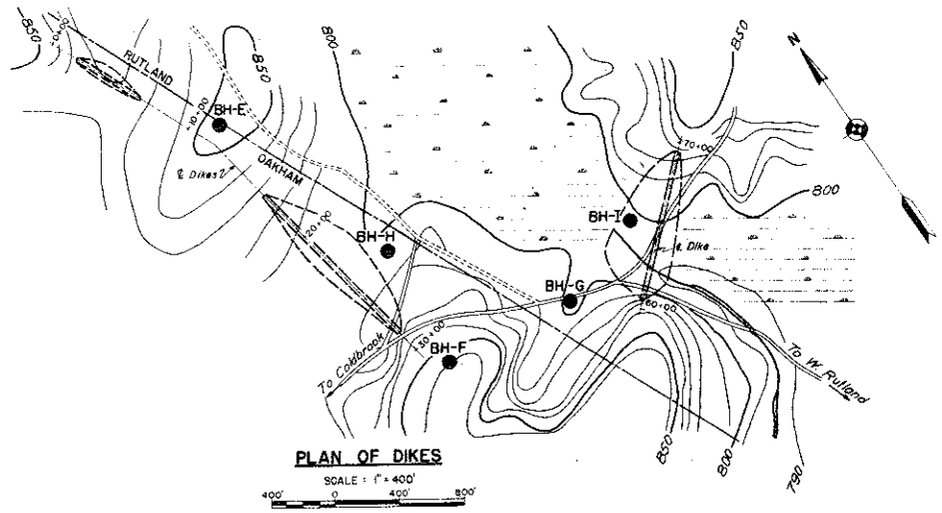
TO ACCOMPANY REPORT DATED: FEB. 26, 1940

FILE NO. CT-I-1467



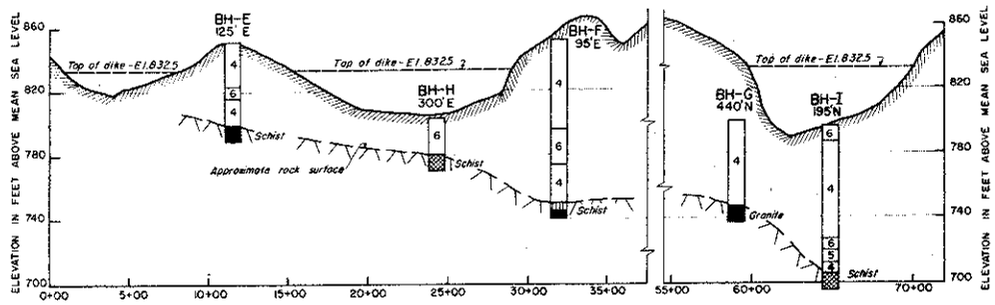
PLAN OF DAM

SCALE: 1" = 100'



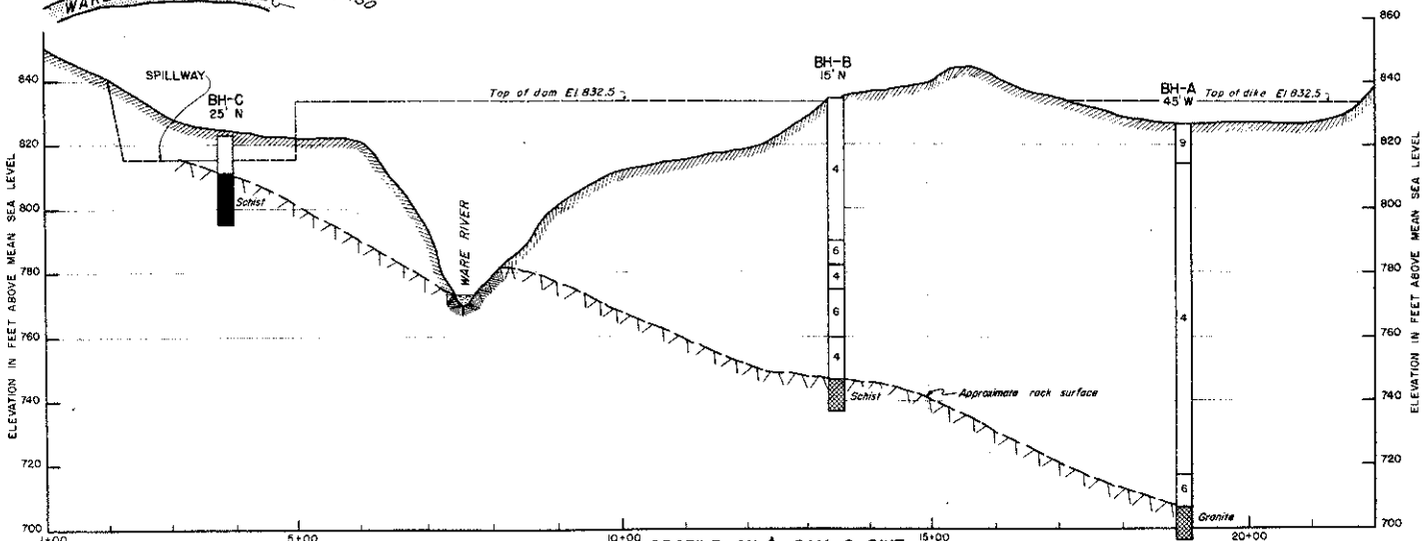
PLAN OF DIKES

SCALE: 1" = 400'



PROFILE ON ℄ DIKES

SCALES: HOR. 1" = 400' VERT. 1" = 40'



PROFILE ON ℄ DAM & DIKE

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

SOURCES OF BORROW

Pervious material available within 0.5 miles upstream.
Impervious material available within 1.0 miles upstream.

LEGEND

- B — Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%.
- Weathered and fractured bedrock, core recovery between 50% and 75%.
- Less weathered and fractured bedrock, core recovery more than 75%.
- BH — Drive sample bore hole
- N — North of ℄ dam or dike
- E — East of ℄ dike
- W — West of ℄ dike
- Ledge outcrop

NOTES

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A.
Borings made by Metropolitan District Water Supply Commission of the Commonwealth of Massachusetts.
Overburden and rock classified visually by Providence District.

KEY	DATE	REVISION (Indicated by △)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

BARRE FALLS DAM

GEOLOGY

WARE RIVER, CHICOPEE WATERSHED MASSACHUSETTS

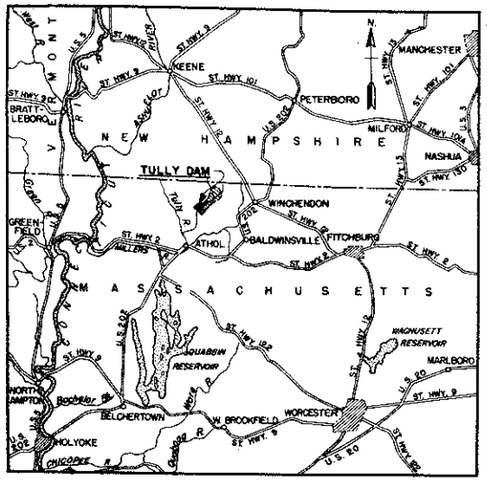
IN 3 SHEETS — SCALES AS SHOWN — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: Frank Fallquist, SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION
APPROVAL RECOMMENDED: F. B. Burns, PRINCIPAL ENGINEER, CHIEF, F. O. ENGINEERING DIV.
APPROVED: J. Bragdon, LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

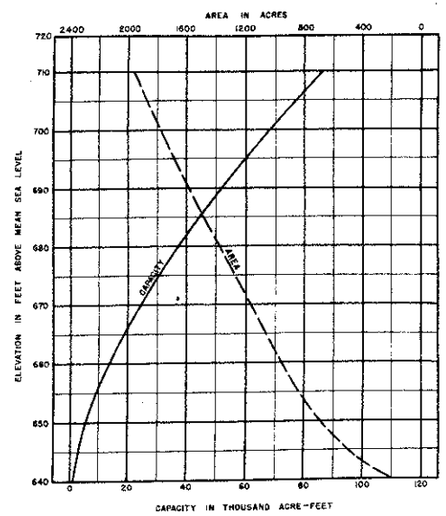
COMPILED: Wm. A. Slagle Jr., ASST. ENGINEER
DRAWN: R. R. L.
TRACED: F. O. W.
CHECKED: W. A. S. Jr.

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-2-1232

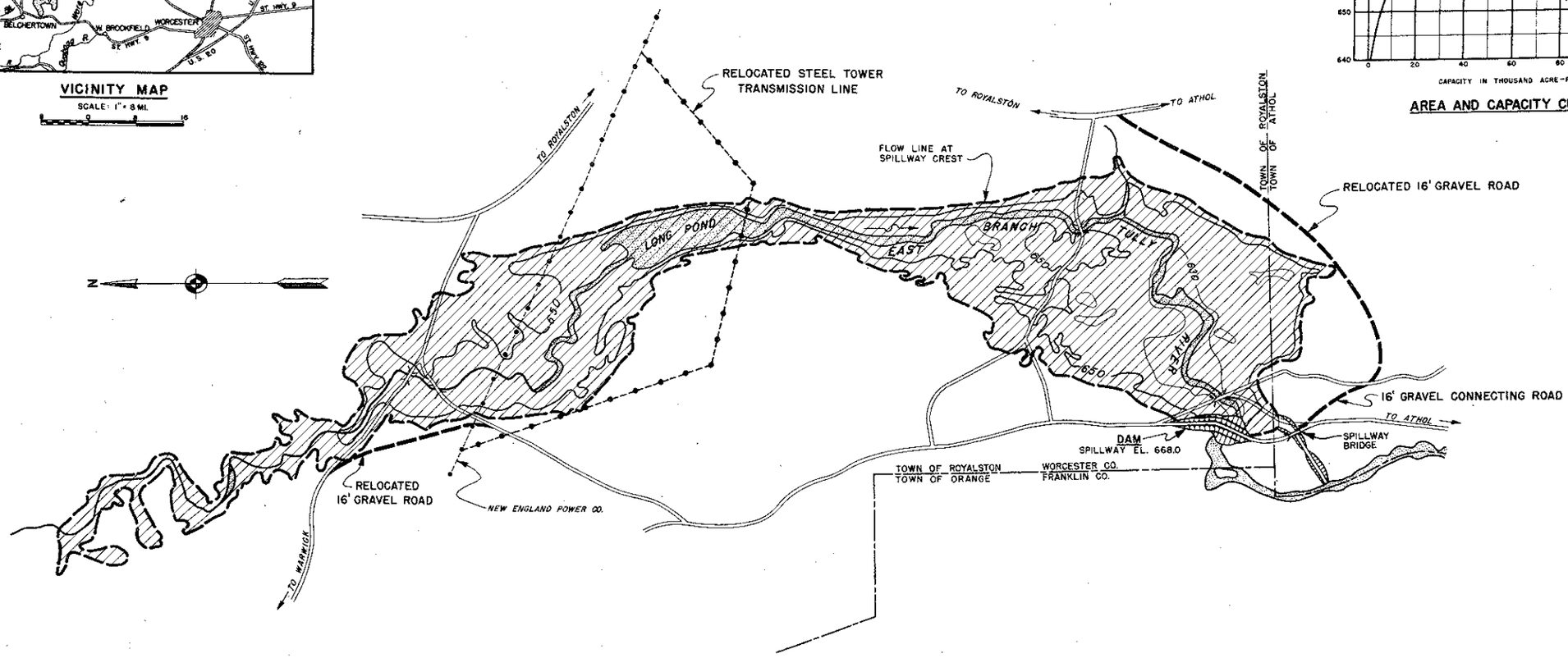


VICINITY MAP

SCALE: 1" = 8 MI.



AREA AND CAPACITY CURVES



KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

TULLY DAM

RESERVOIR MAP

TULLY RIVER, MILLERS WATERSHED MASSACHUSETTS

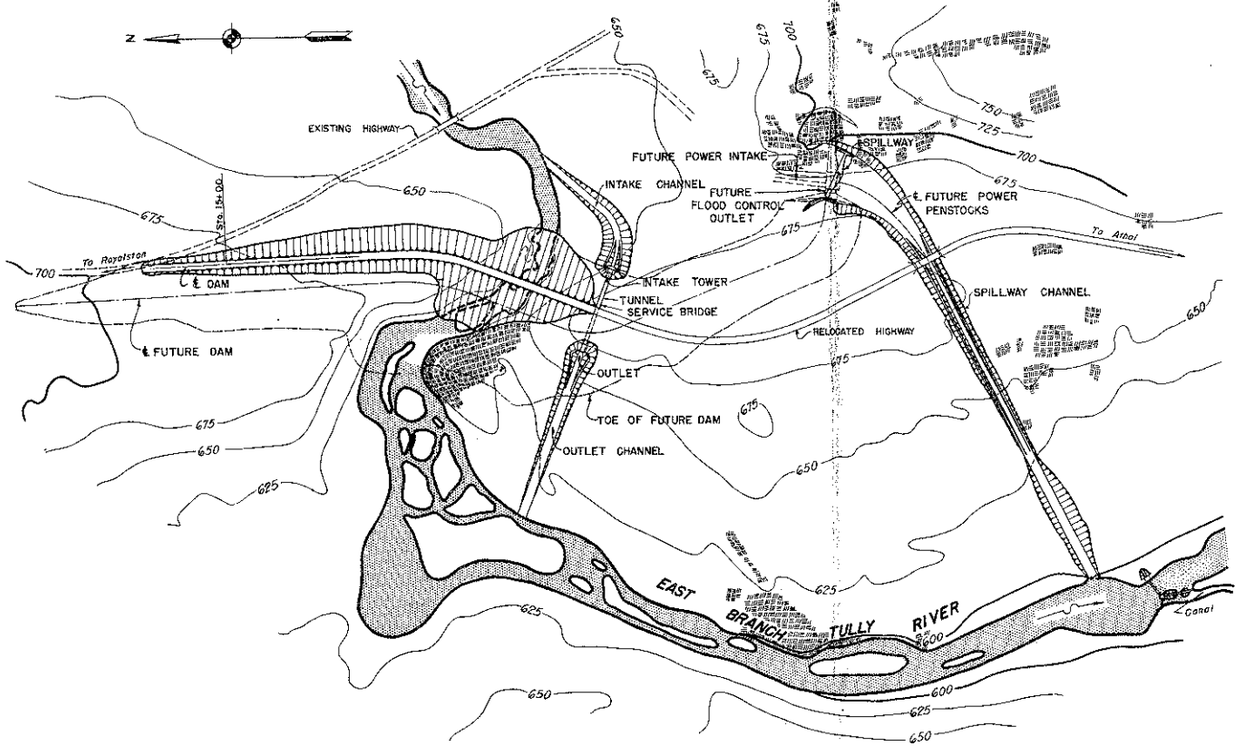
1 IN 3 SHEETS SCALE: 1 IN. = 1000 FT. SHEET NO. 1

1000' 0 1000' 2000'

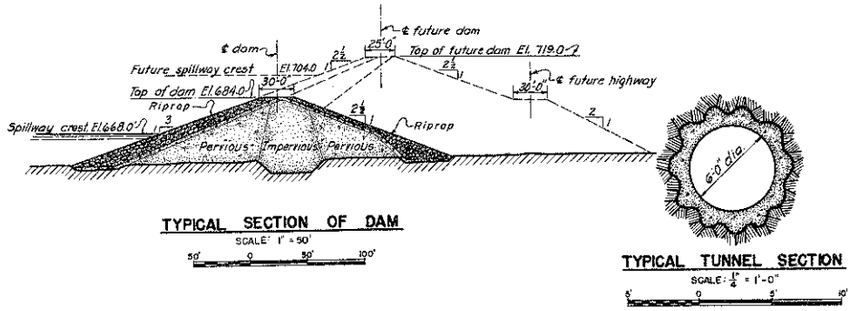
U. S. ENGINEER OFFICE, PROVIDENCE, R. I. FEB., 1940

SUBMITTED:	APPROVAL RECOMMENDED:	APPROVED:
SENIOR ENGINEER, HEAD, DESIGN SECTION	PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.	COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED:	DRAWN: H.A.V.	TO ACCOMPANY REPORT
ASSOC. ENGINEER	TRACED: H.A.V.	DATED: FEB. 28, 1940
	CHECKED:	FILE NO. CT-1-1432

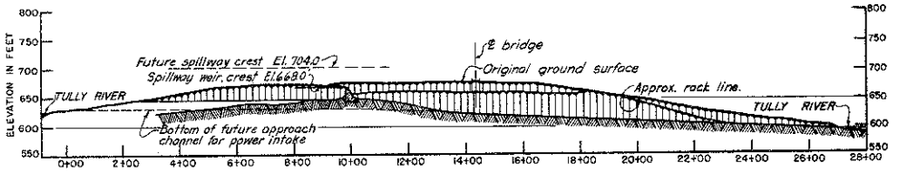


PLAN
SCALE: 1" = 200'

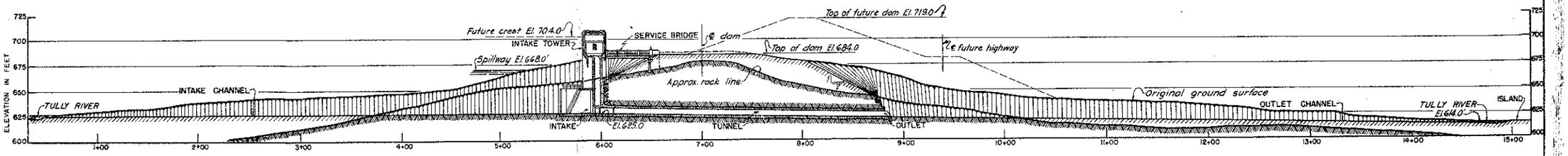


TYPICAL SECTION OF DAM
SCALE: 1" = 50'

TYPICAL TUNNEL SECTION
SCALE: 1/4" = 1'-0"

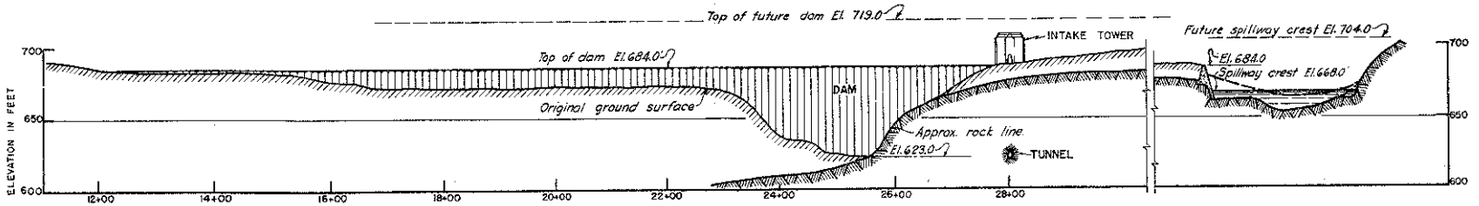


PROFILE OF SPILLWAY
SCALES: HOR. 1" = 200' VERT. 1" = 100'



PROFILE ON ℄ OUTLET WORKS
SCALE: 1" = 40'

NOTES
Elevations refer to Mean Sea Level Datum.
Top of dam at El. 684.0 (revised).



DOWNSTREAM ELEVATION OF DAM AND SPILLWAY
SCALES: HOR. 1" = 100' VERT. 1" = 40'

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

TULLY DAM
GENERAL PLAN

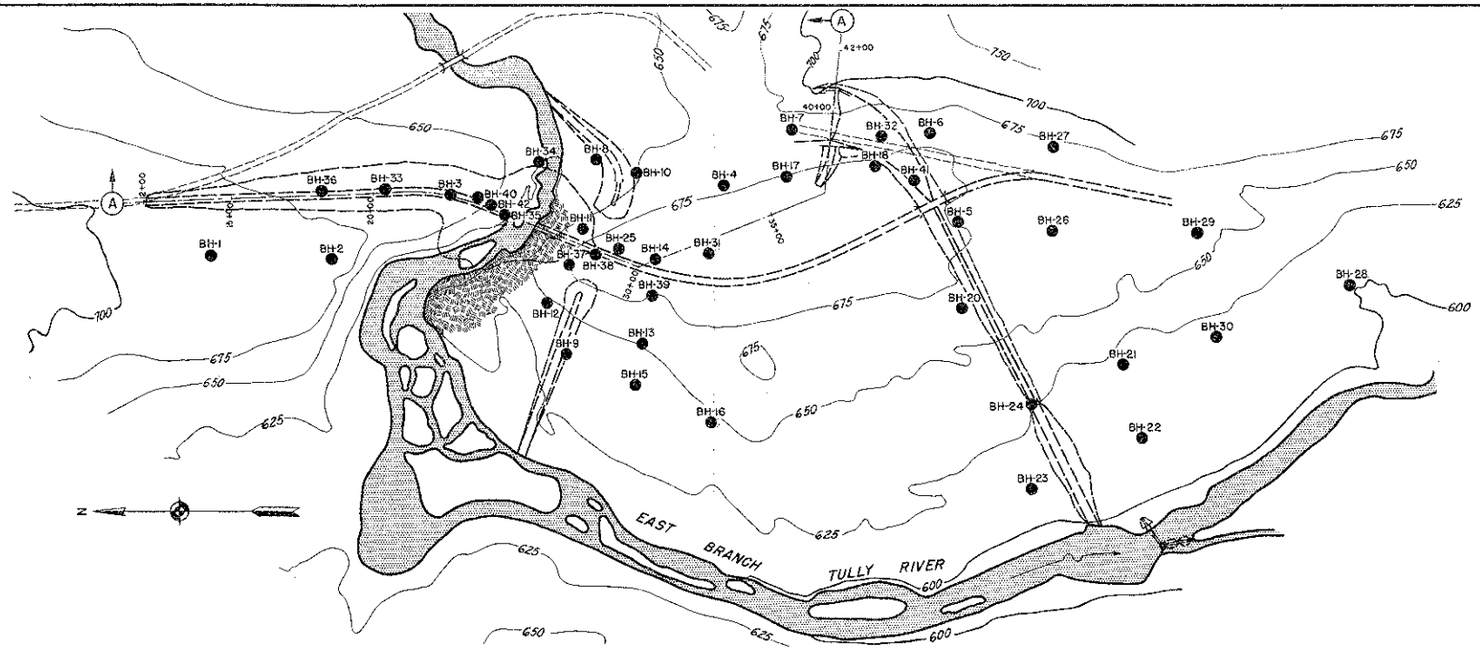
TULLY RIVER, MILLERS WATERSHED MASSACHUSETTS

IN 3 SHEETS SCALE: 1 IN. = 200' SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: Senior Engineer, Head, Design Section
APPROVAL RECOMMENDED: Principal Engineer, Chief, F. C. Engineering Div.
APPROVED: Lt. Colonel, Corps of Engineers, District Engineer

DESIGNED: A. D. Wurzner, Assoc. Engineer
DRAWN: A.R.A. TRACED: A.S. CHECKED:
TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-1-1440



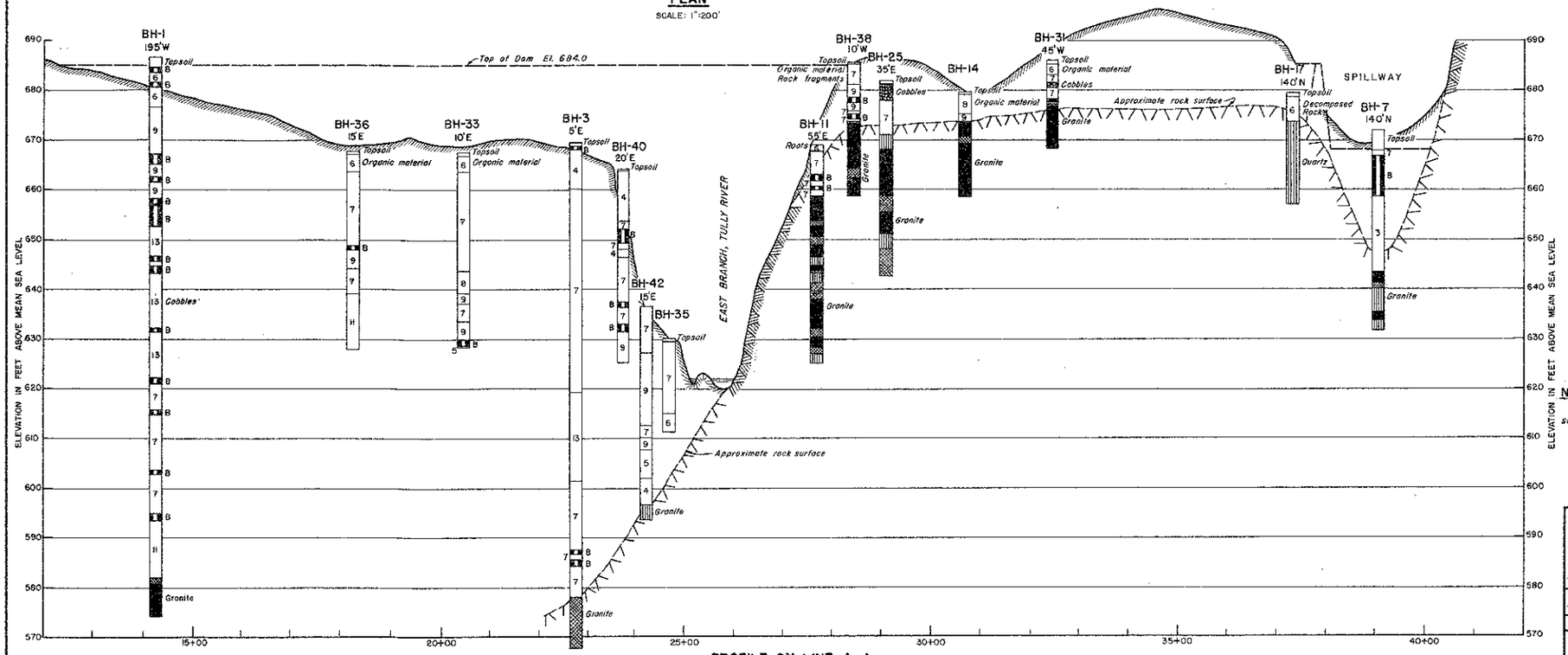
PLAN

SCALE: 1"=200'

SOURCES OF BORROW

Pervious material available within 0.5 miles downstream.

Impervious material available within 0.25 miles on both banks



PROFILE ON LINE A-A

SCALES: HOR. 1"=100' VERT. 1"=10'

LEGEND

- Ledge outcrop
- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%
- Weathered and fractured bedrock, core recovery between 50% and 75%
- Less weathered and fractured bedrock, core recovery more than 75%
- BH Drive sample bore hole
- W West of section
- N North of section
- E East of section

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14 A.

KEY	DATE	REVISION (Indicated by △)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

TULLY DAM

GEOLOGY

TULLY RIVER, MILLERS WATERSHED MASSACHUSETTS

IN 3 SHEETS SCALE: 1IN=200 FT. 200' 0 200' 400' SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. FEB. 1940

SUBMITTED: SENIOR GEOLOGIST, HEAD GEOLOGY SECTION

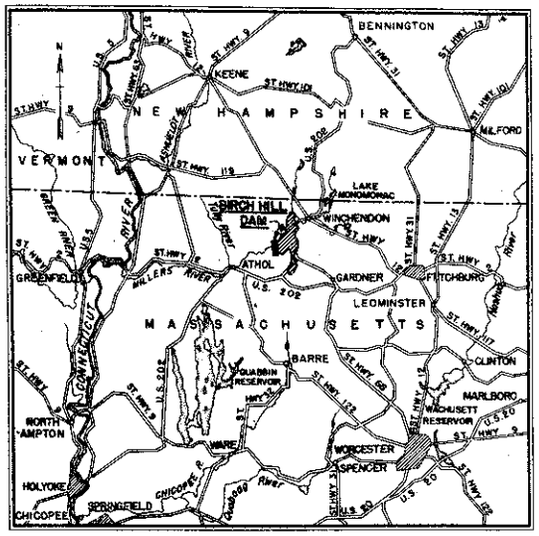
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASST. ENGINEER

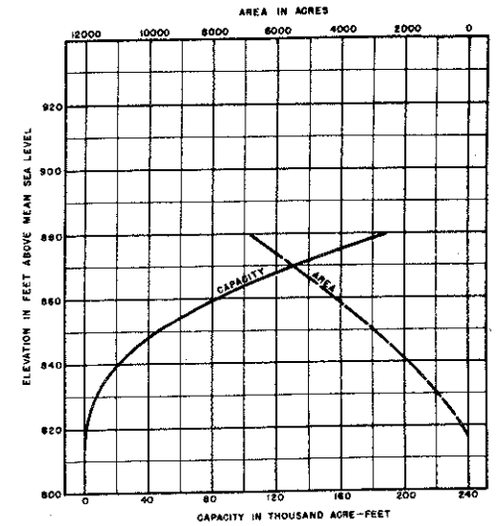
DRAWN: A.R.L. TRACED: H.R. CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 28, 1940 FILE NO. CT-2-1249

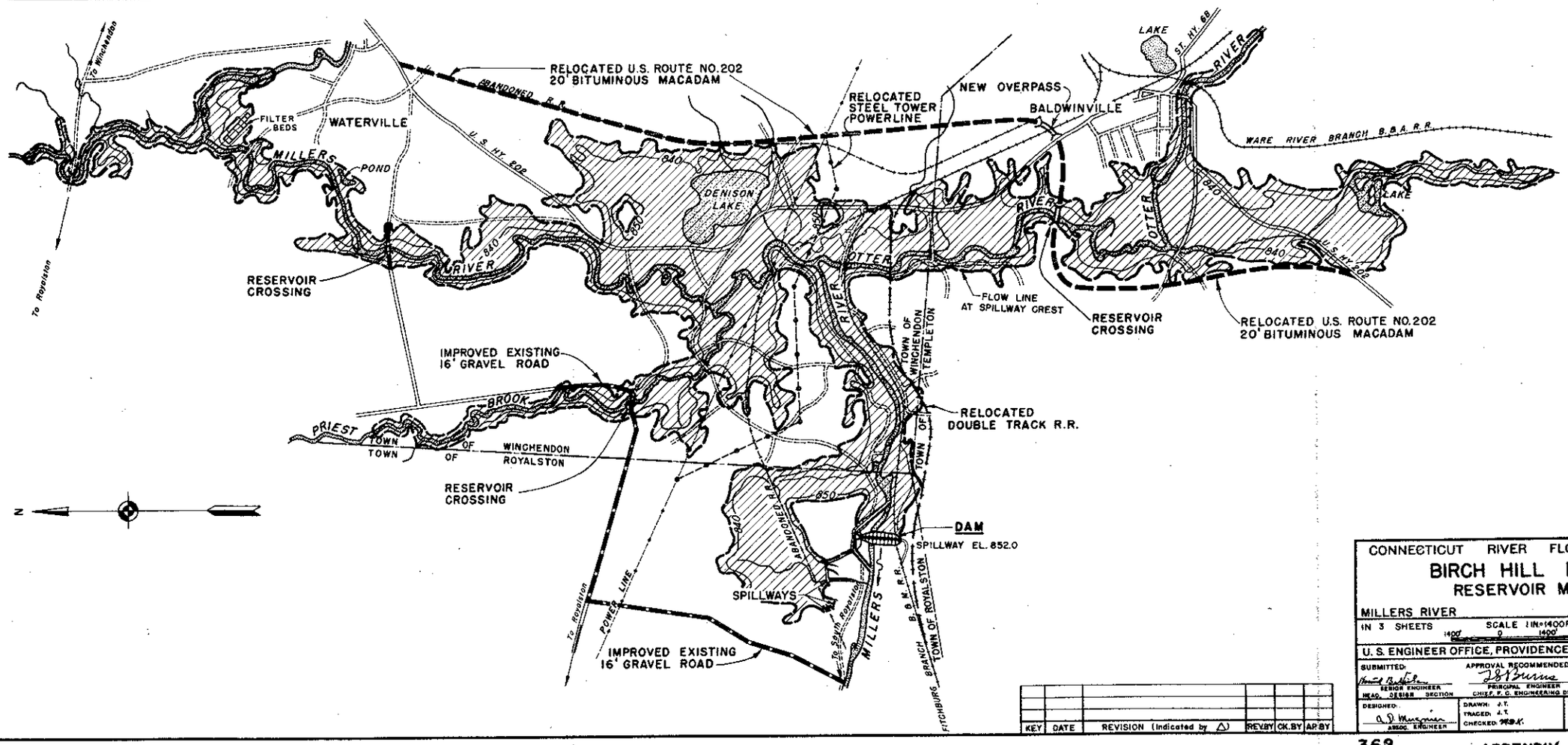


VICINITY MAP

SCALE 1" = 8 MI.



AREA AND CAPACITY CURVES



KEY	DATE	REVISION (Indicated by △)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

BIRCH HILL DAM

RESERVOIR MAP

MILLERS RIVER — MASSACHUSETTS

IN 3 SHEETS — SCALE 1 IN = 1400 FT. (1400' 0 1400' 2800') — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB., 1940

SUBMITTED: Harold Bartholomew, SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: J. S. Burns, PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

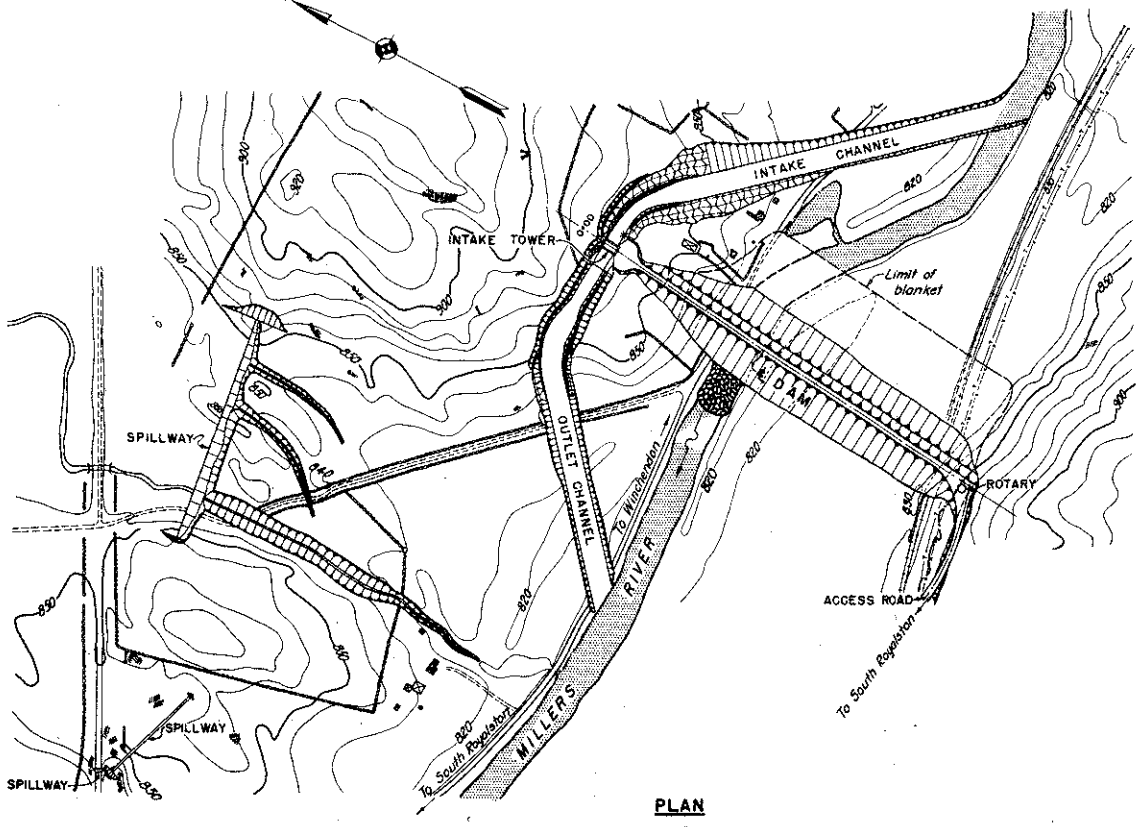
APPROVED: S. Meagher, LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. D. Mugnier, ASSOC. ENGINEER

DRAWN: J. T. TRACED: J. T. CHECKED: H.B.K.

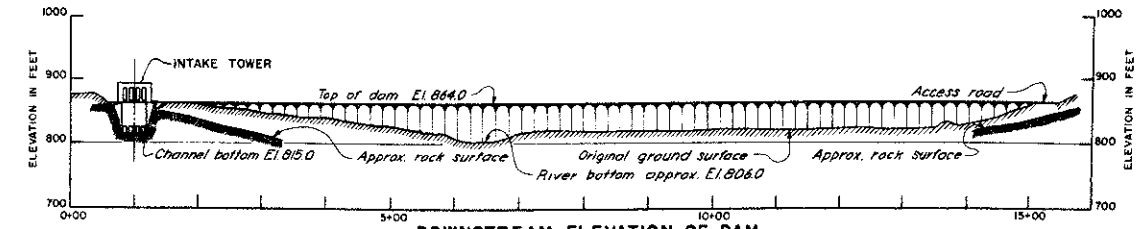
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-1434



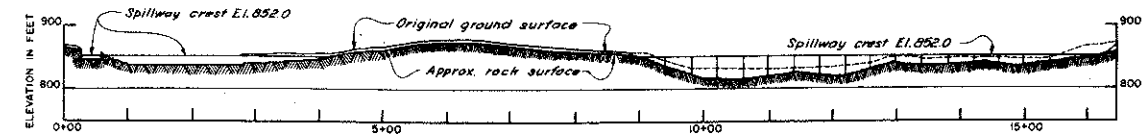
PLAN

SCALE: 1" = 200'



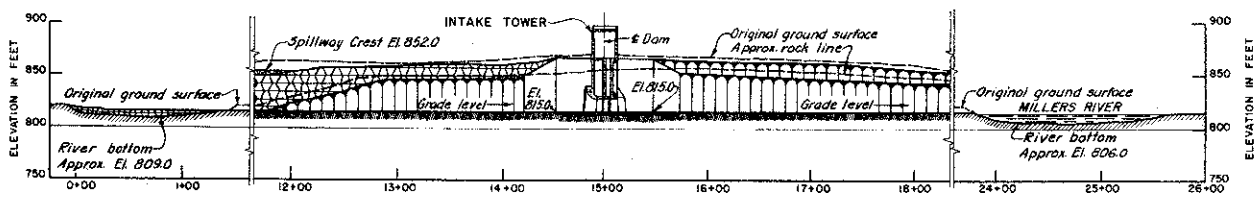
DOWNSTREAM ELEVATION OF DAM

SCALE: 1" = 100'



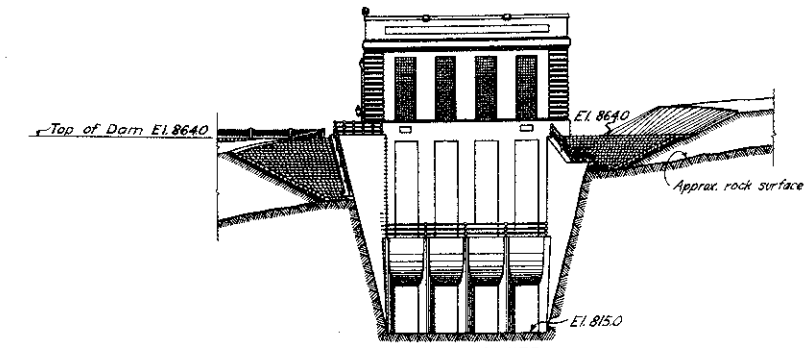
DOWNSTREAM ELEVATION OF SPILLWAYS

SCALE: 1" = 100'



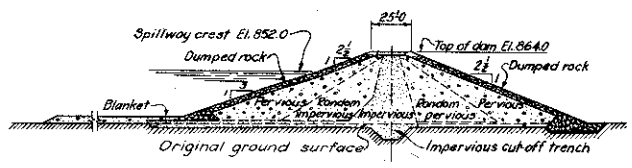
SECTION ON ℄ CHANNEL

SCALE: 1" = 60'



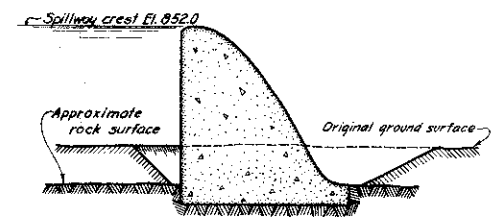
INTAKE TOWER
UPSTREAM ELEVATION

SCALE: 1/16" = 1'-0"



TYPICAL CROSS SECTION OF DAM

SCALE: 1" = 40'



TYPICAL SECTION OF MAIN SPILLWAY

SCALE: 1" = 10'

NOTE

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

BIRCH HILL DAM

GENERAL PLAN

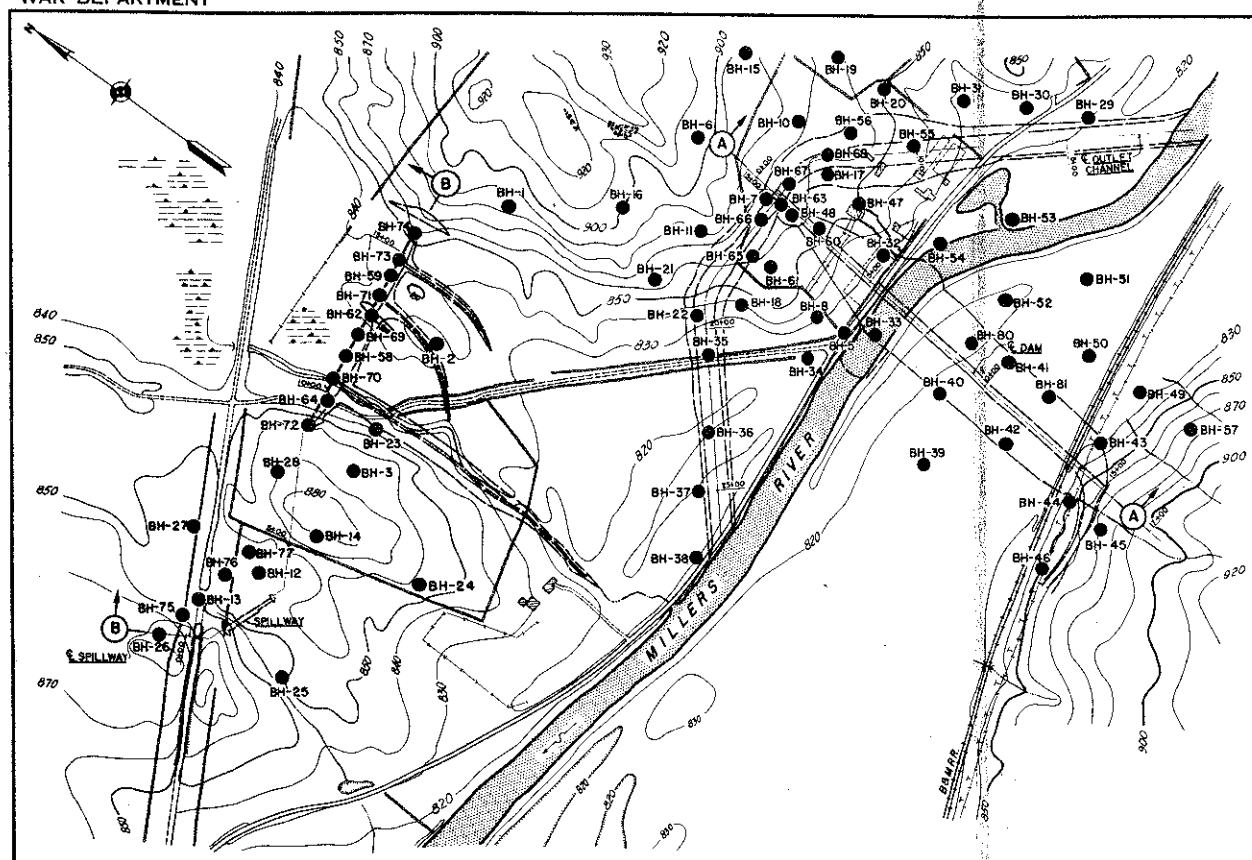
MILLERS RIVER — MASSACHUSETTS

IN 3 SHEETS — SCALE: 1 IN = 200 FT. — SHEET NO. 2

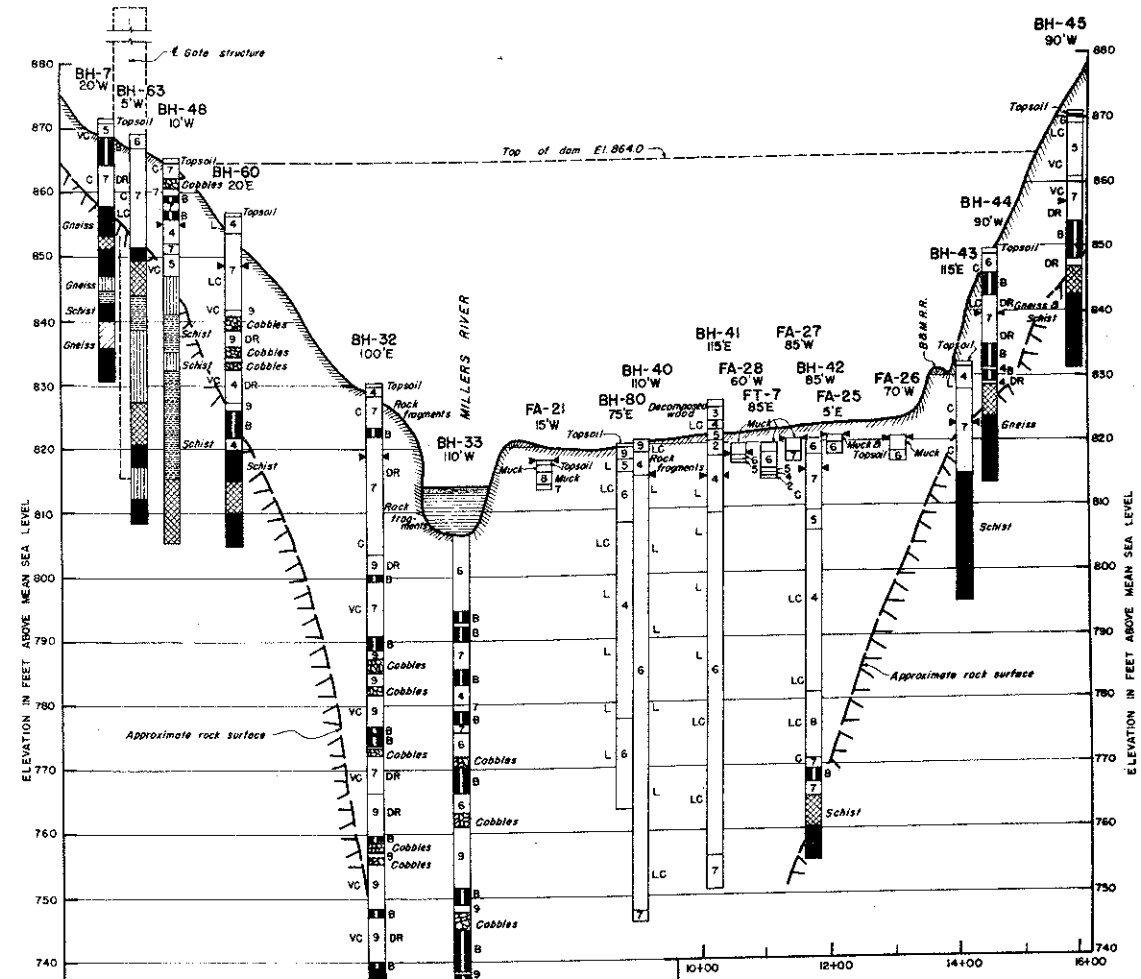
U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

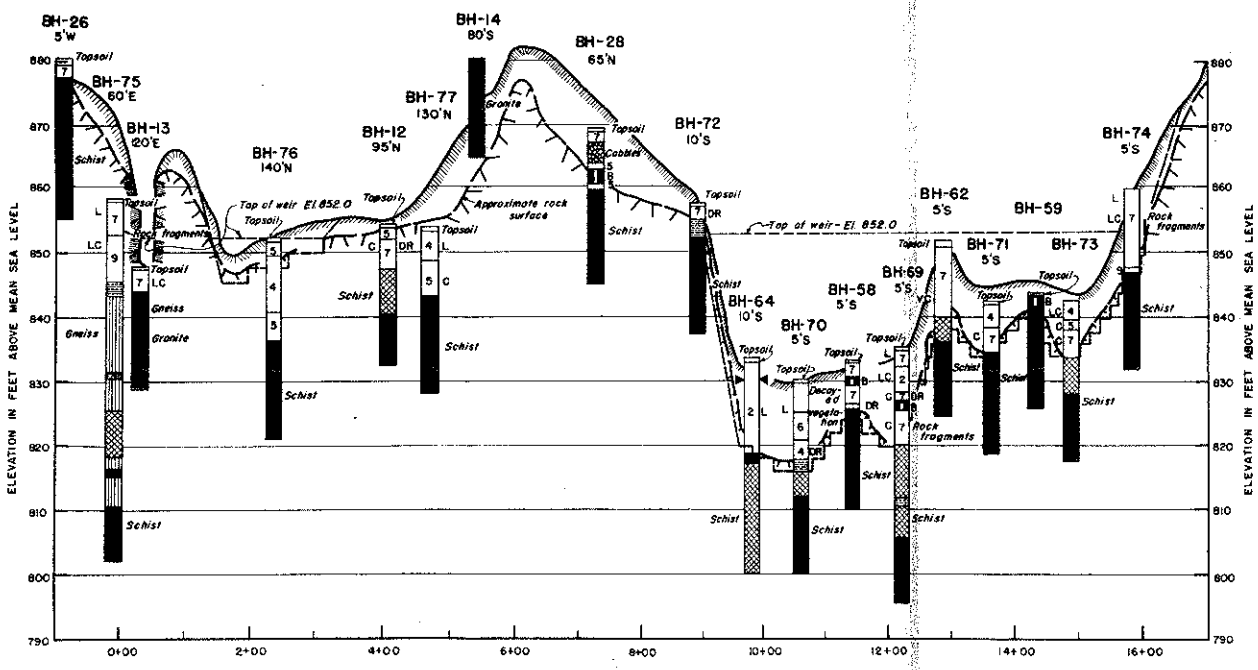
DESIGNED: ASSOC. ENGINEER — DRAWN: H. J. K. TRACED: H. R. & C. H. B. CHECKED: M. D. K. — TO ACCOMPANY REPORT DATED: FEB. 28, 1940 FILE NO. CT-1-1444



PLAN
SCALE: 1" = 200'



PROFILE ON LINE A-A, ℄ DAM
SCALES: HOR. 1" = 100' VERT. 1" = 10'



PROFILE ON LINE B-B, ℄ SPILLWAY
SCALES: HOR. 1" = 100' VERT. 1" = 10'

LEGEND

- Ledge outcrop
- BH - Drive sample bore hole
- FA - Foundation auger boring
- FT - Foundation test pit
- DR - Sample contains decayed and disintegrated rock
- VC - Very compact
- C - Compact
- LC - Less compact
- L - Loose
- Water table at time of exploration
- B - Boulder
- Badly weathed or decayed rock.
- Weathered and fractured bedrock, core recovery between 15% and 50%.
- Slightly weathered and fractured bedrock, core recovery between 50% and 75%.
- Relatively fresh or unweathered bedrock, core recovery greater than 75%.

NOTES

For description and limits of soil classes, see Table XXXVI and Plate No. 14A.

Compactness was determined by the number of blows required to drive 2" O.D. sample spoon one foot with 300-pound hammer dropped 18"

SOURCES OF BORROW

Pervious material available within 0.5 miles upstream on right bank.

Impervious material available within 0.5 miles upstream on right bank and from structure excavations.

KEY	DATE	REVISION (Indicated by Δ)	REV.BY	CK.BY	APBY

CONNECTICUT RIVER FLOOD CONTROL

BIRCH HILL DAM
GEOLOGY

MILLERS RIVER — MASSACHUSETTS

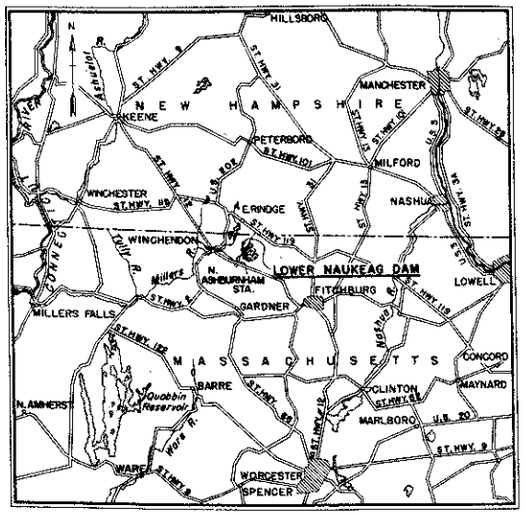
IN 3 SHEETS — SCALE: 1 IN. = 200 FT. — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

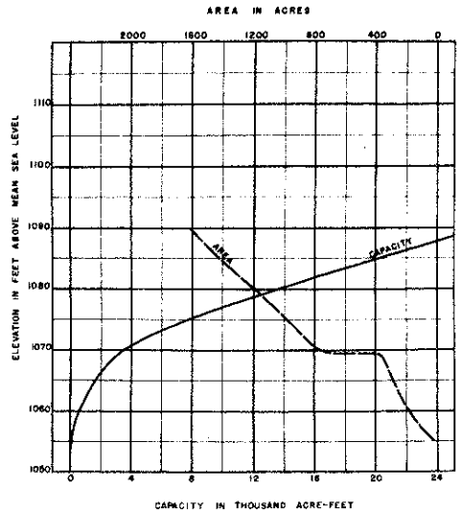
COMPILED: ASST. ENGINEER — DRAWN: J. MCL. TRACED: A.J.H. CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-2-1241

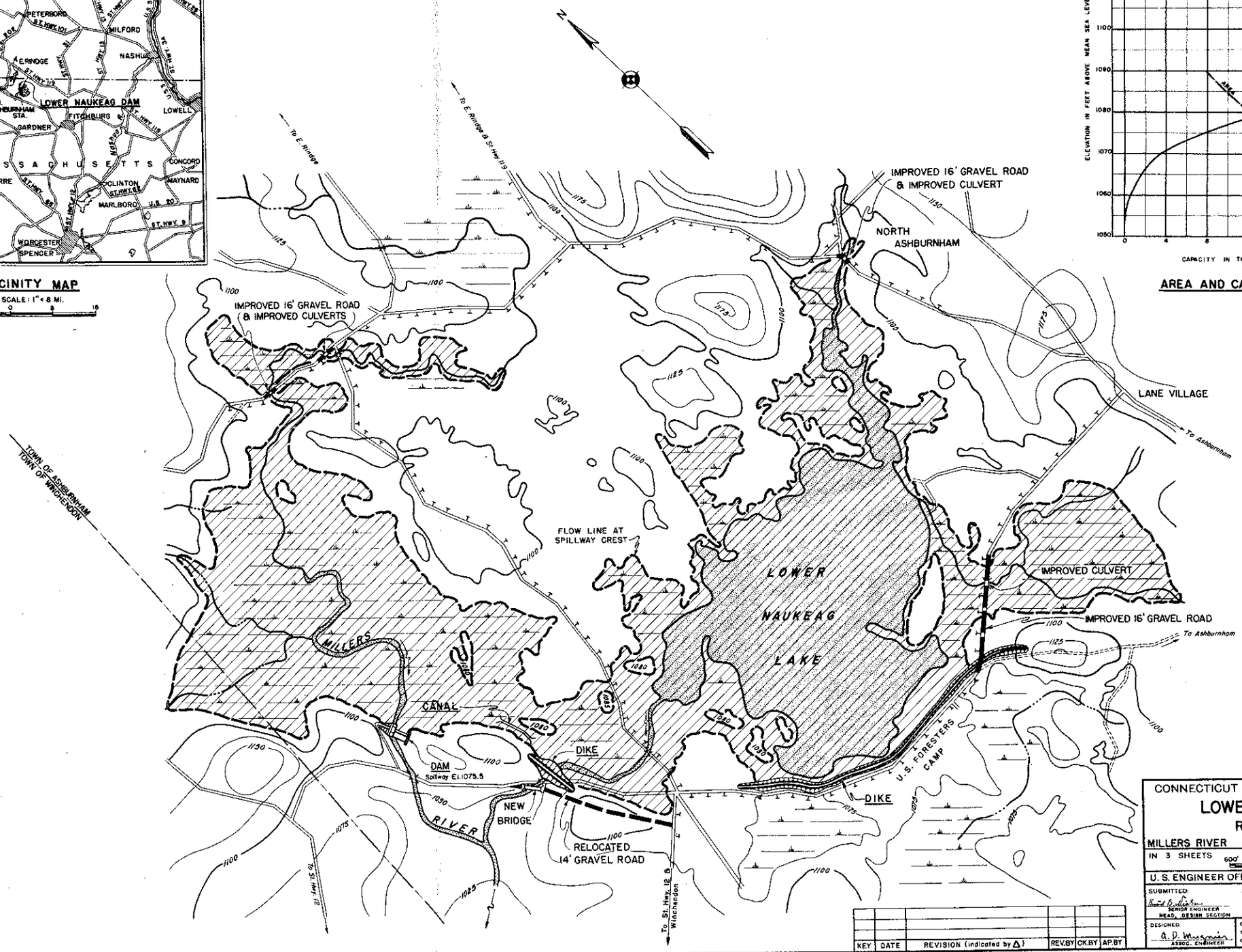


VICINITY MAP

SCALE: 1" = 8 Mi.



AREA AND CAPACITY CURVES



KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

LOWER NAUKEAG DAM
RESERVOIR MAP

MILLERS RIVER — MASSACHUSETTS

IN 3 SHEETS — SCALE: 1 IN. = 600 FT. (600' 0 600' 1200') — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940.

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

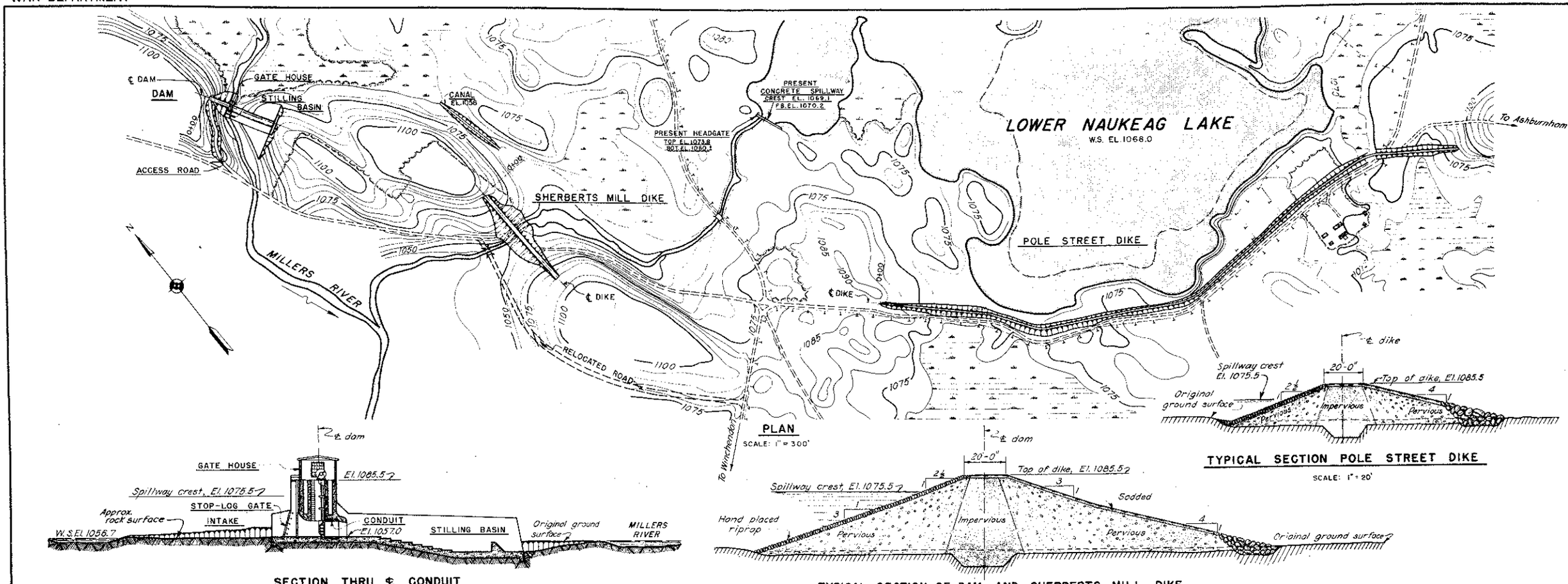
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

DRAWN: P.V.S.
TRACED: P.V.S.
CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-1-1433

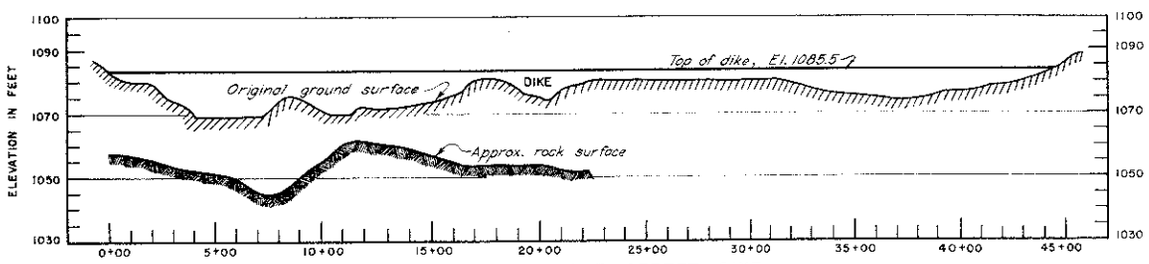


PLAN
SCALE: 1" = 300'

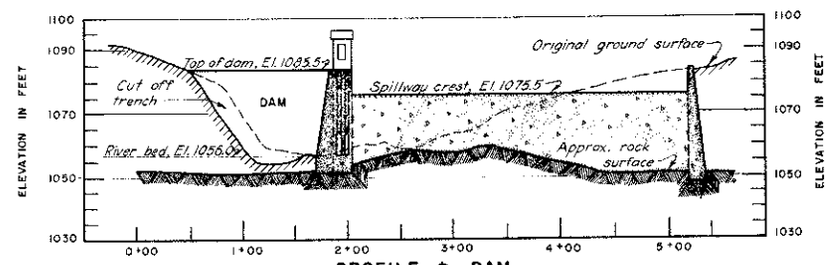
SECTION THRU ℄ CONDUIT
SCALE: 1" = 20'

TYPICAL SECTION OF DAM AND SHERBERTS MILL DIKE
SCALE: 1" = 20'

TYPICAL SECTION POLE STREET DIKE
SCALE: 1" = 20'

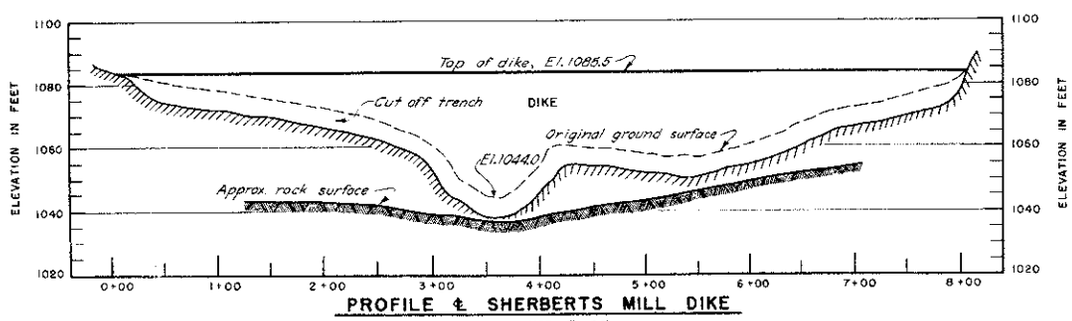


PROFILE ℄ POLE STREET DIKE
SCALE: HOR. 1" = 300' VERT. 1" = 20'

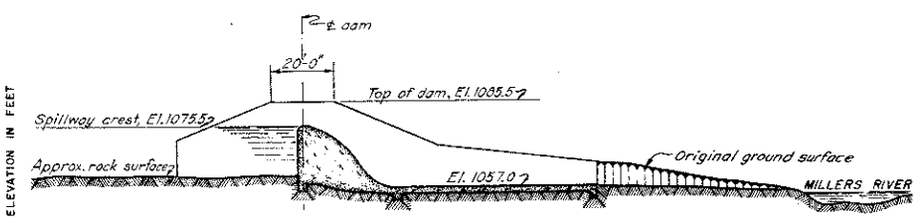


PROFILE ℄ DAM
SCALE: HOR. 1" = 60' VERT. 1" = 20'

NOTE
Elevations refer to Mean Sea Level Datum.



PROFILE ℄ SHERBERTS MILL DIKE
SCALE: HOR. 1" = 60' VERT. 1" = 20'



SECTION THRU ℄ SPILLWAY
SCALE: 1" = 20'

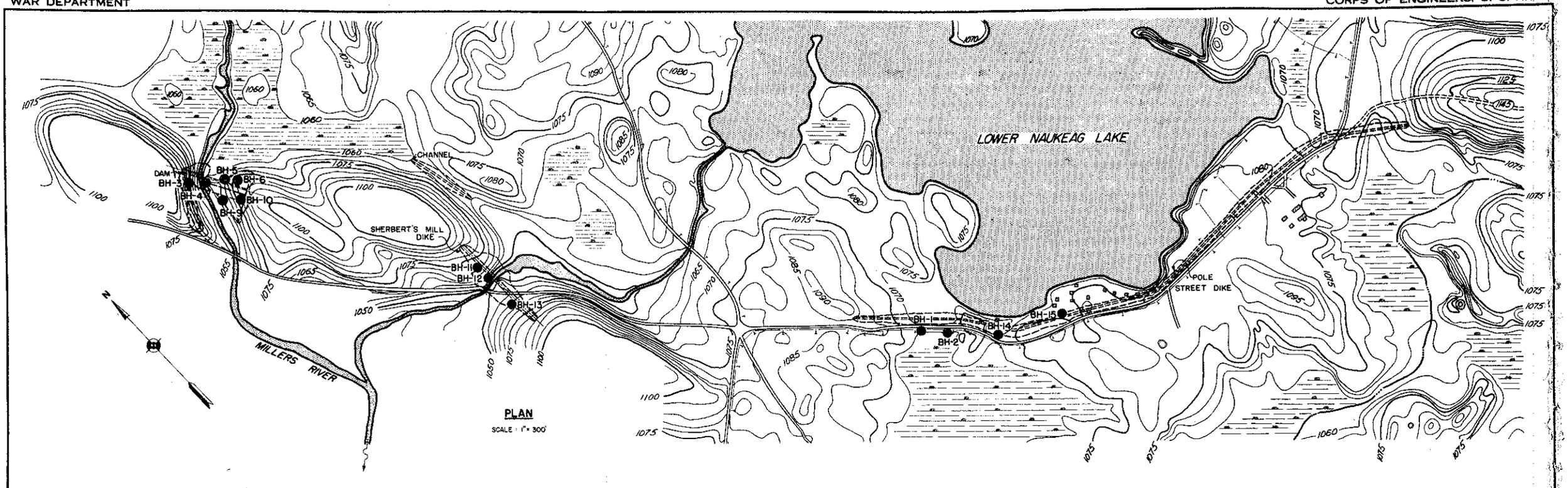
KEY	DATE	REVISION (Indicated by Δ)	REV BY	CK BY	APP BY

CONNECTICUT RIVER FLOOD CONTROL
LOWER NAUKEAG DAM
GENERAL PLAN
MILLERS RIVER MASSACHUSETTS
IN 3 SHEETS SCALE: 1 IN. = 300 FT. SHEET NO. 2
U. S. ENGINEER OFFICE, PROVIDENCE, R. I. FEB. 1940

SUBMITTED: SENIOR ENGINEER HEAD DESIGN SECTION
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER CHIEF, F. C. ENGINEERING DIV.
APPROVED: LT. COL., CORPS OF ENGINEERS DISTRICT ENGINEER
DESIGNED: ASSOC. ENGINEER
DRAWN P A B TRACED P J G CHECKED
TO ACCOMPANY REPORT DATED: FEB. 28, 1940 FILE NO. CT-1-1457

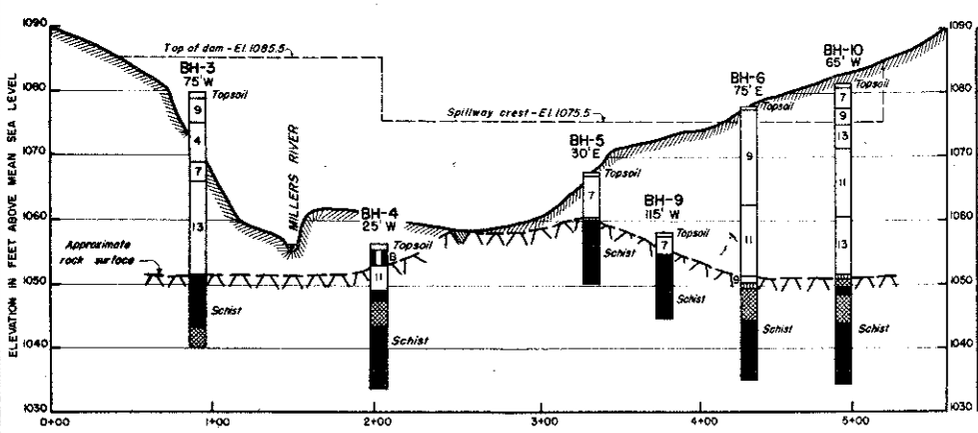
WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



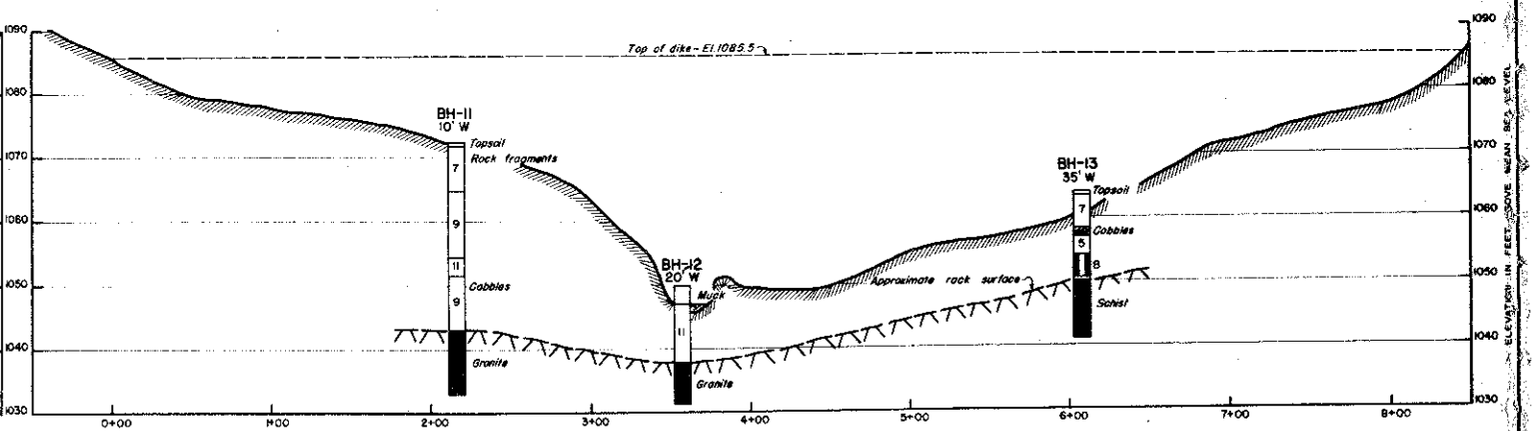
PLAN

SCALE: 1" = 300'



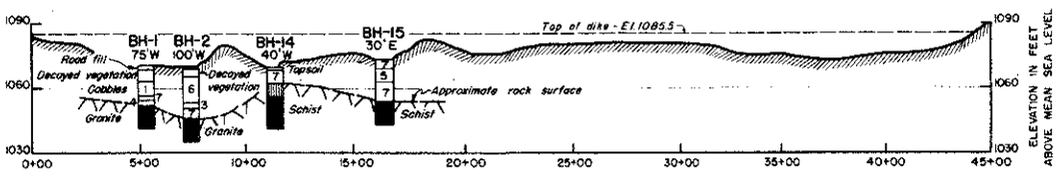
PROFILE ON ℄ DAM

SCALES: HOR. 1" = 40' VERT. 1" = 10'



PROFILE ON ℄ SHERBERT'S MILL DIKE

SCALES: HOR. 1" = 40' VERT. 1" = 10'



PROFILE ON ℄ POLE STREET DIKE

SCALES: HOR. 1" = 300' VERT. 1" = 30'

LEGEND

- B — Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%.
- Weathered and fractured bedrock, core recovery between 50% and 75%.
- Less weathered and fractured bedrock, core recovery more than 75%.
- BH — Drive sample bore hole.
- E — East of ℄ dam or dike.
- W — West of ℄ dam or dike.
- Ledge outcrop.

SOURCES OF BORROW

Pervious material available 0.5 miles downstream for Millers River dam and Sherbert's Mill dike.

Impervious material available within 0.25 miles upstream for Millers River dam and Sherbert's Mill dike.

Pervious and impervious material available within 0.5 miles for Pole Street dike.

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A.

KEY	DATE	REVISION (Indicated by △)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

LOWER NAUKEAG DAM

GEOLOGY

MILLERS RIVER — MASSACHUSETTS

IN 3 SHEETS — SCALE: 1 IN = 300 FT. — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION

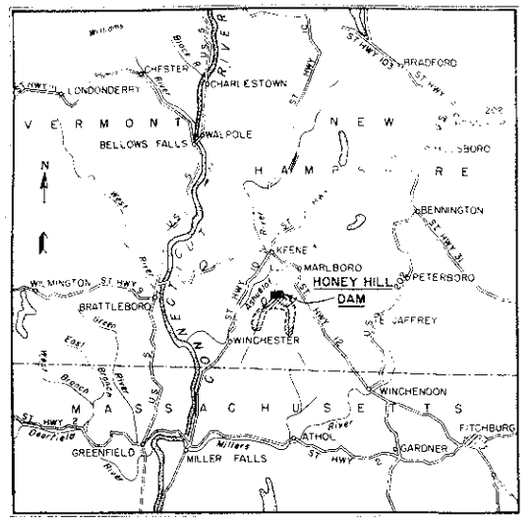
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASST. ENGINEER

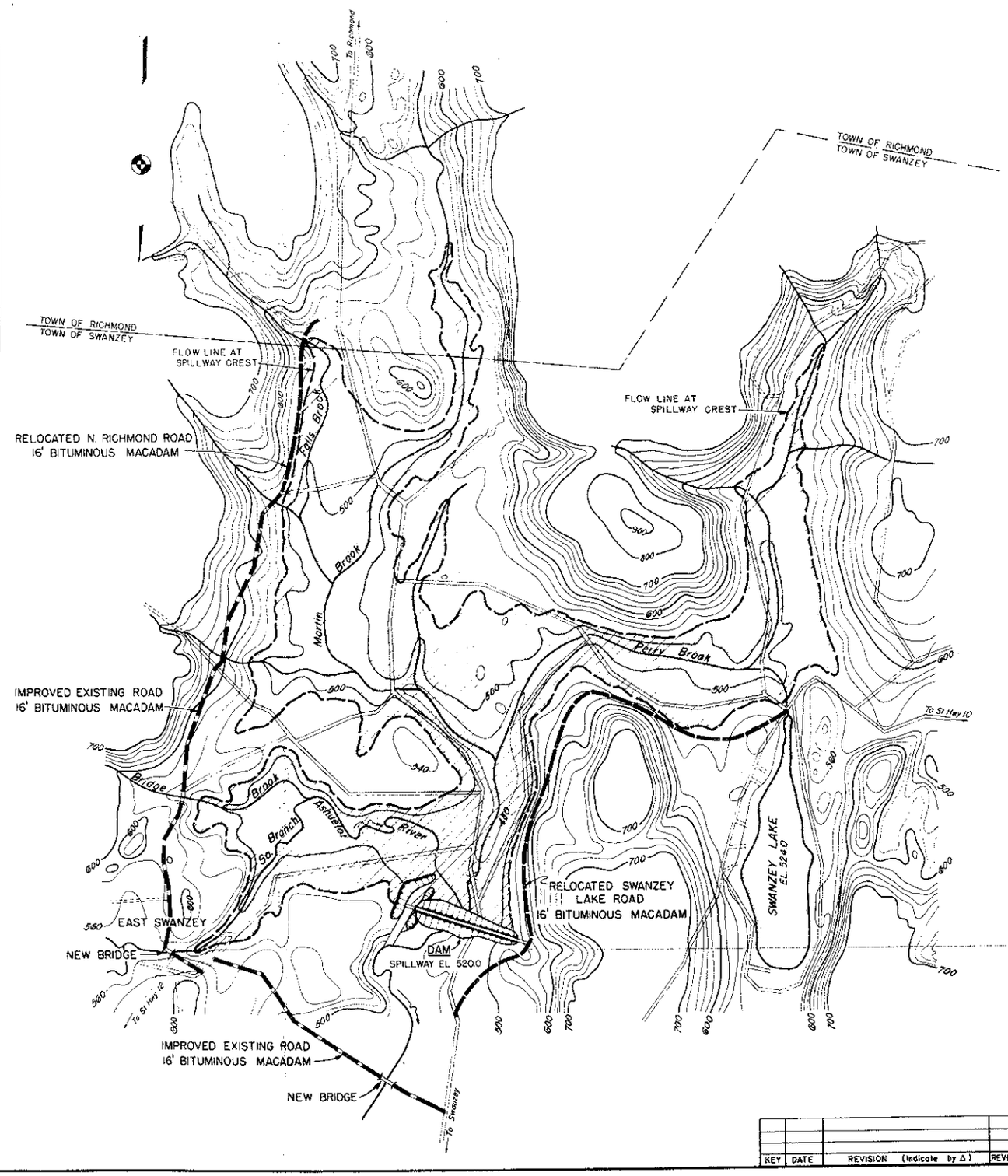
DRAWN: R. R. L.
TRACED: F. O. W.
CHECKED:

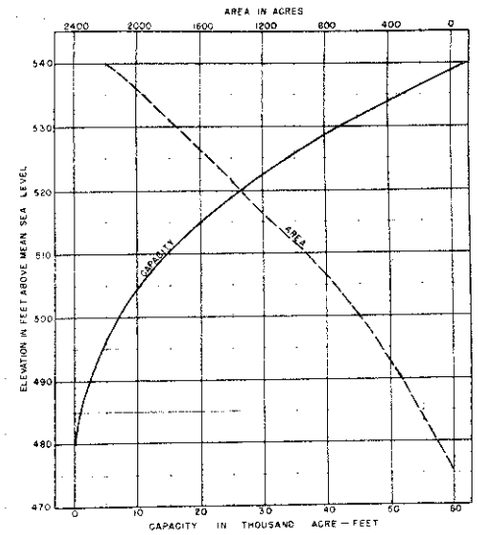
TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-2-1246



VICINITY MAP

SCALE: 1" = 8 MI





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (Indicate by Δ)	REV.BY	CH.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

HONEY HILL DAM

RESERVOIR MAP

SOUTH BRANCH, ASHUELOT WATERSHED, NEW HAMPSHIRE

IN 2 SHEETS — SCALE: 1 IN. = 1000 FT. (1000' 0 1000' 2000') — SHEET NO. 1

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

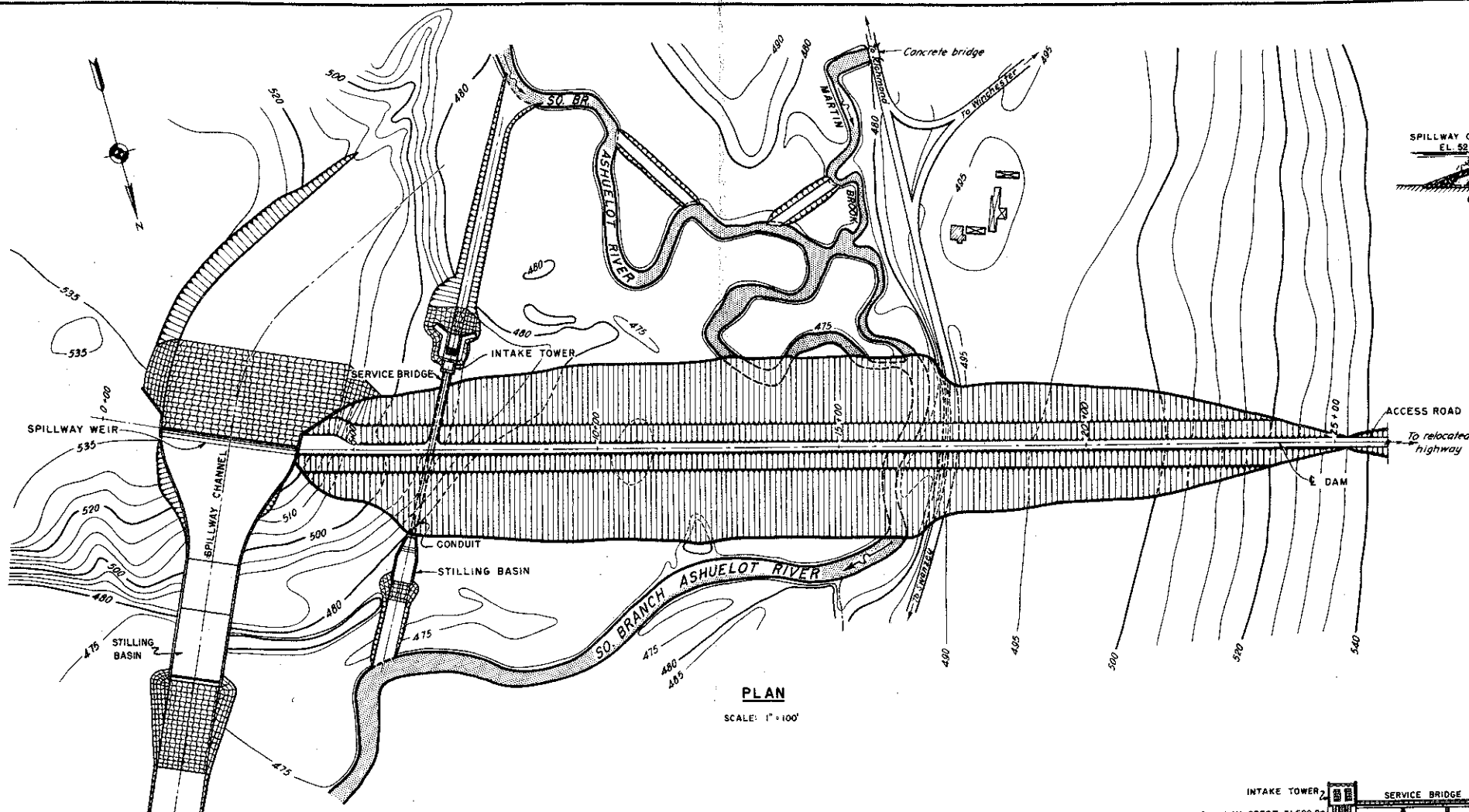
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV.

APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

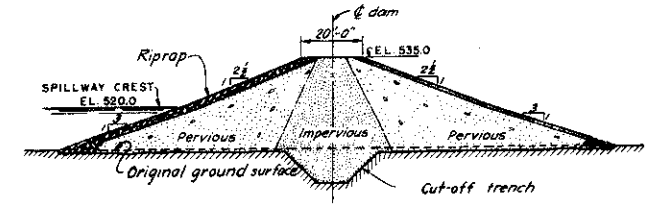
DRAWN: B.A.J.
TRACED: P.V.S. & J.R.G.
CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-1-1430



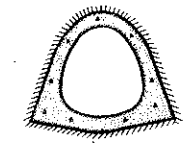
PLAN

SCALE: 1" = 100'



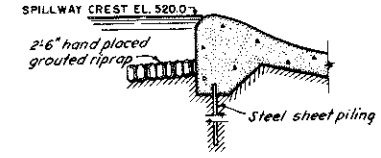
TYPICAL SECTION THRU DAM

SCALE: 1" = 20'



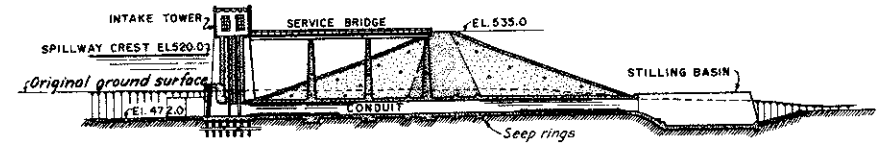
TYPICAL CONDUIT SECTION

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



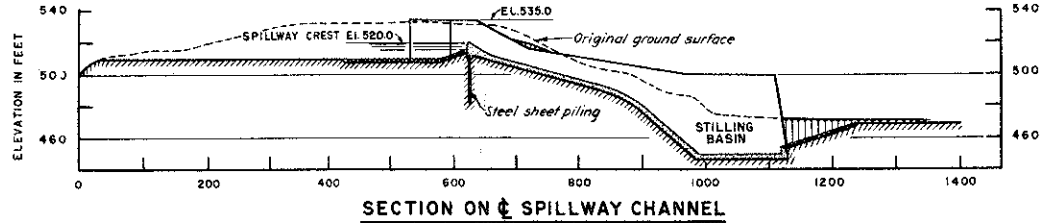
SECTION THRU SPILLWAY WEIR

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



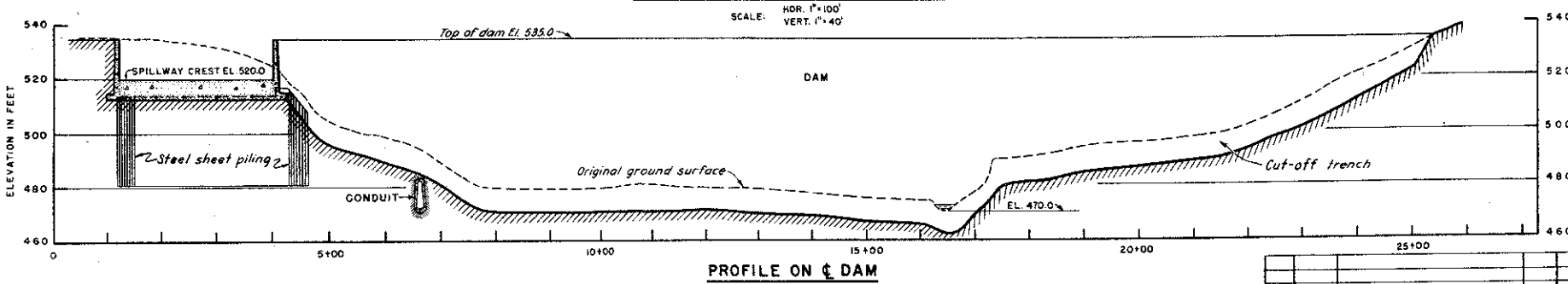
SECTION THRU OUTLET WORKS

SCALE: 1" = 50'



SECTION ON ℄ SPILLWAY CHANNEL

SCALE: HOR. 1" = 100' VERT. 1" = 40'



PROFILE ON ℄ DAM

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

NOTE

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

HONEY HILL DAM

GENERAL PLAN

SOUTH BRANCH, ASHUELOT WATERSHED, NEW HAMPSHIRE

IN 2 SHEETS — SCALE: 1 IN. = 100 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

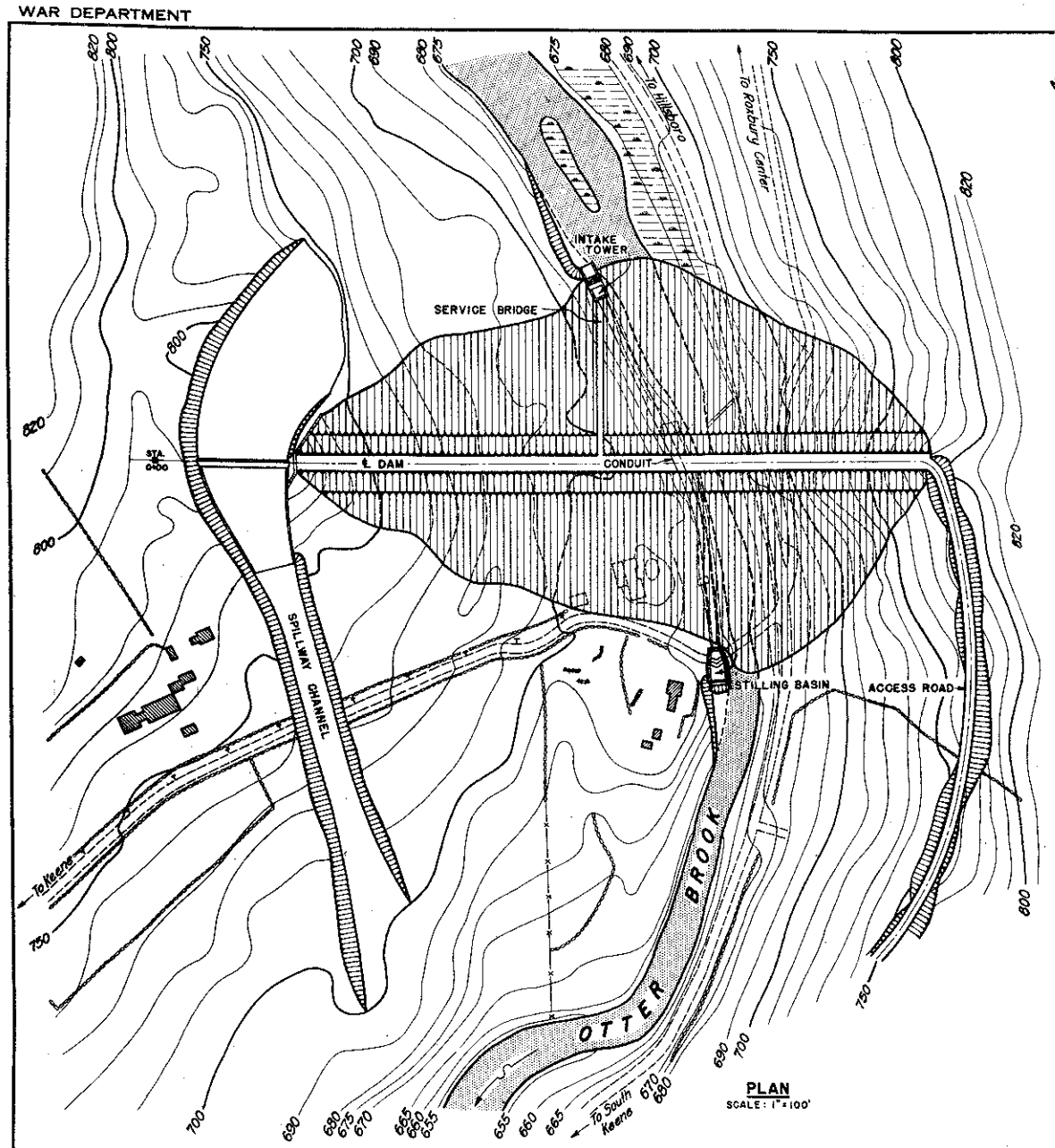
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

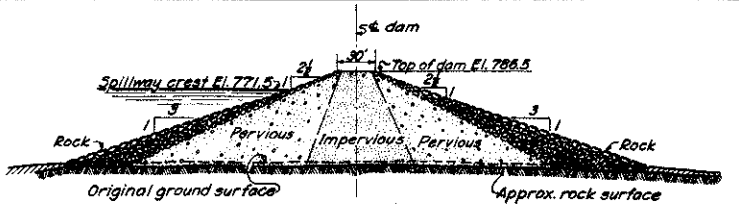
DRAWN: D. P. TRACED: C. J. M. CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 28, 1940

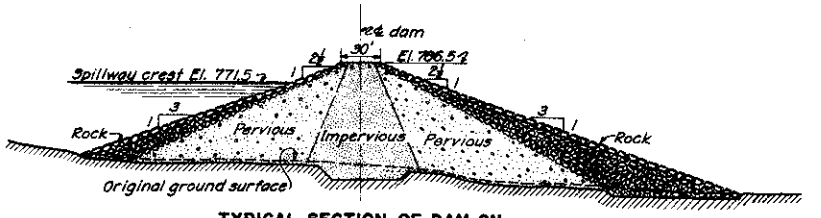
FILE NO. CT-1-1463



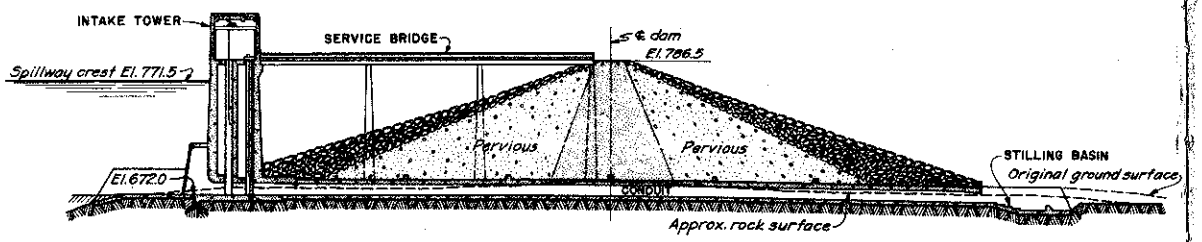
PLAN
SCALE: 1" = 100'



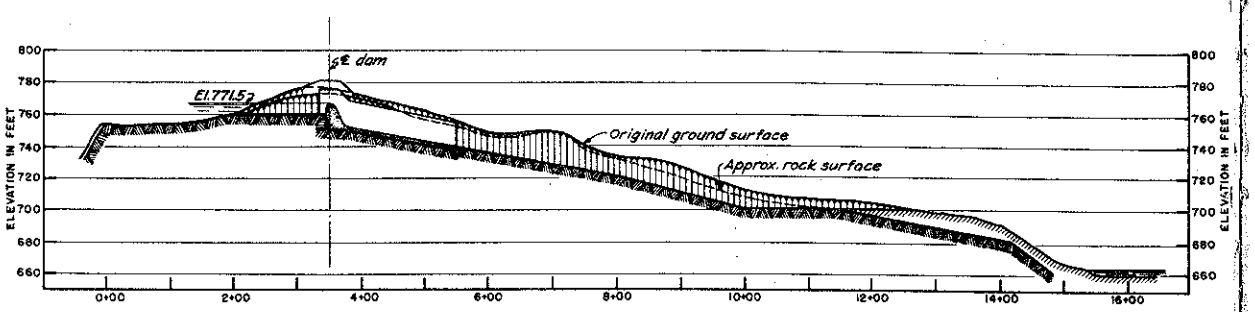
TYPICAL SECTION OF DAM ON WEST ABUTMENT
SCALE: 1" = 50'



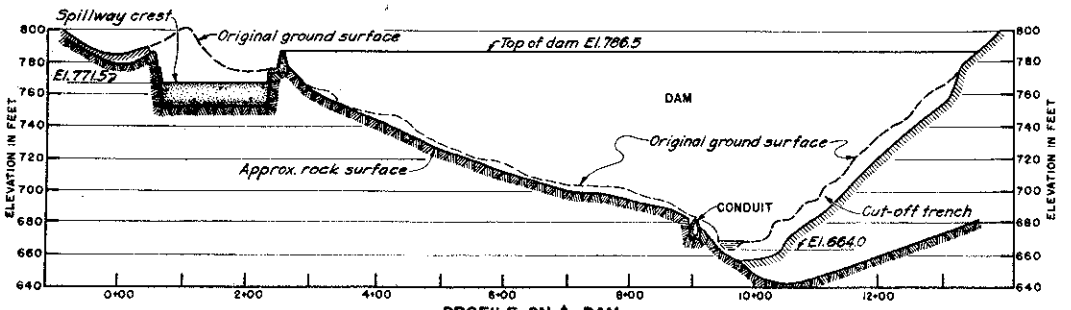
TYPICAL SECTION OF DAM ON EAST ABUTMENT
SCALE: 1" = 50'



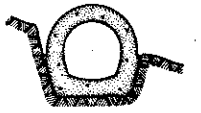
SECTION ON ℄ CONDUIT
SCALE: 1" = 50'



PROFILE ON ℄ SPILLWAY CHANNEL
SCALE: HOR: 1" = 100' VERT: 1" = 40'



PROFILE ON ℄ DAM
SCALE: HOR: 1" = 100' VERT: 1" = 40'



SECTION THRU CONDUIT
SCALE: 1" = 10'

NOTE
Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

OTTER BROOK DAM

GENERAL PLAN

OTTER BROOK, ASHUELOT WATERSHED, NEW HAMPSHIRE

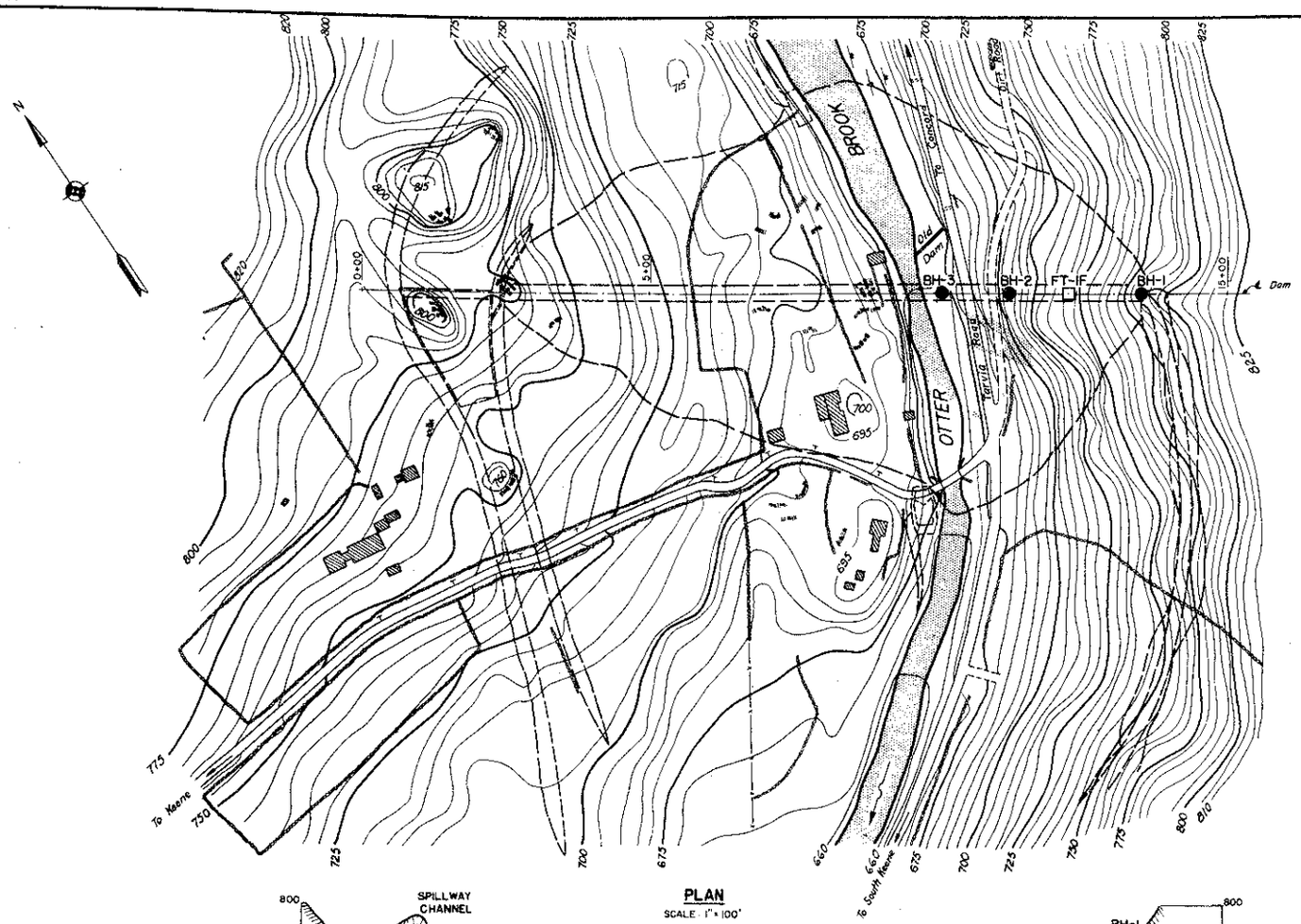
IN 3 SHEETS — SCALE 1 IN. = 100 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

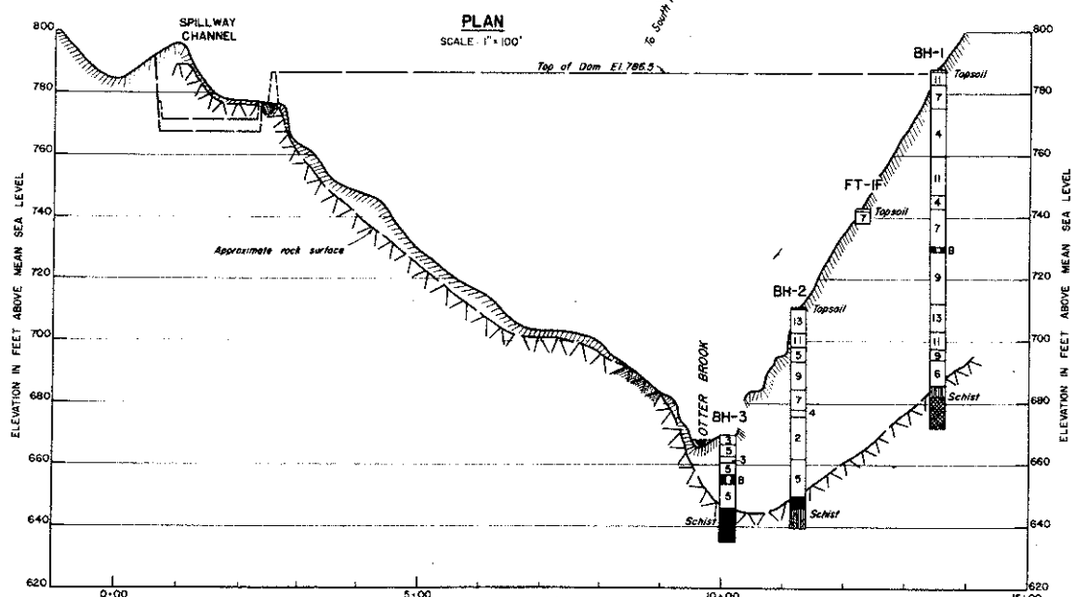
DESIGNED: ASSOC. ENGINEER
DRAWN: W. A. C.
TRACED: F. R. H.
CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 20, 1940
FILE NO. CT-1-1460



PLAN

SCALE: 1" = 100'



PROFILE ON ℄ DAM

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

SOURCES OF BORROW

Pervious material available within 0.5 miles upstream on left bank.

Impervious material available within 0.5 miles downstream and upstream on left bank.

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%.
- Weathered and fractured bedrock, core recovery between 50% and 75%.
- Less weathered and fractured bedrock, core recovery more than 75%
- BH Drive sample bore hole.
- FT Foundation test pit.
- Ledge outcrop.

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

OTTER BROOK DAM

GEOLOGY

OTTER BROOK, ASHUELOT WATERSHED-NEW HAMPSHIRE

IN 3 SHEETS — SCALE: 1 IN. = 100 FT. — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION

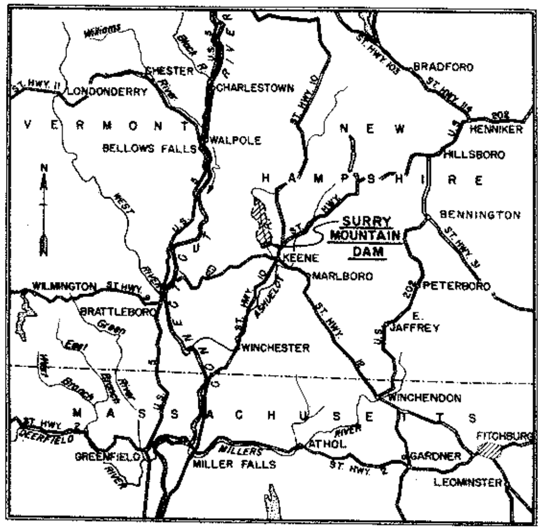
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASS'T. ENGINEER

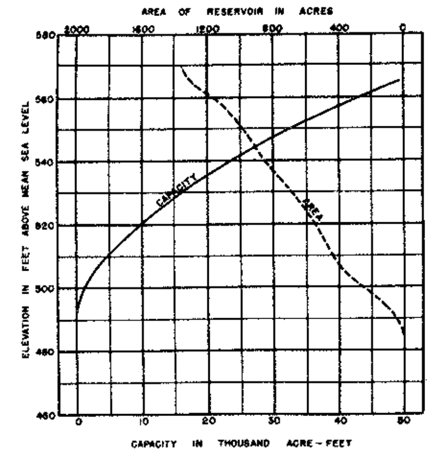
DRAWN: R. R. L.
TRACED: J. J. M.
CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-2-1239

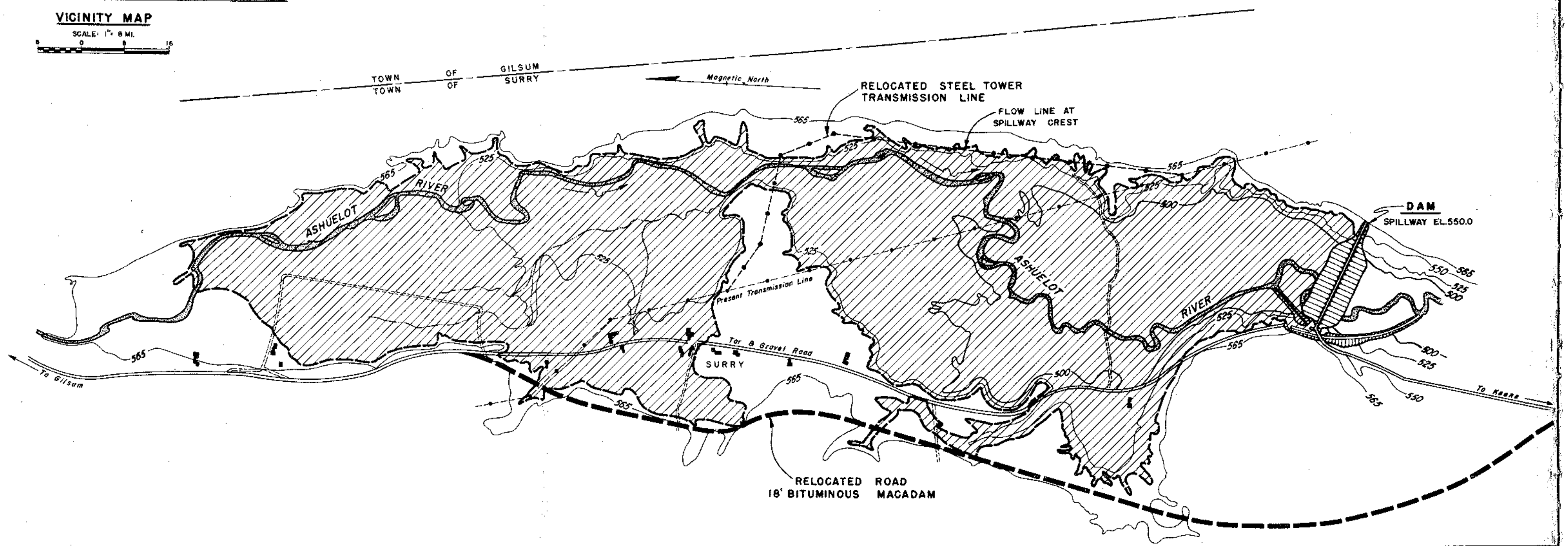


VICINITY MAP

SCALE: 1" = 8 MI.



AREA AND CAPACITY CURVES



KEY	DATE	REVISION (Indicated by Δ)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

SURRY MOUNTAIN DAM

RESERVOIR MAP

ASHUELOT RIVER — NEW HAMPSHIRE

IN 3 SHEETS — SCALE: 1 IN. = 600 FT. — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: [signature] SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: [signature] PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

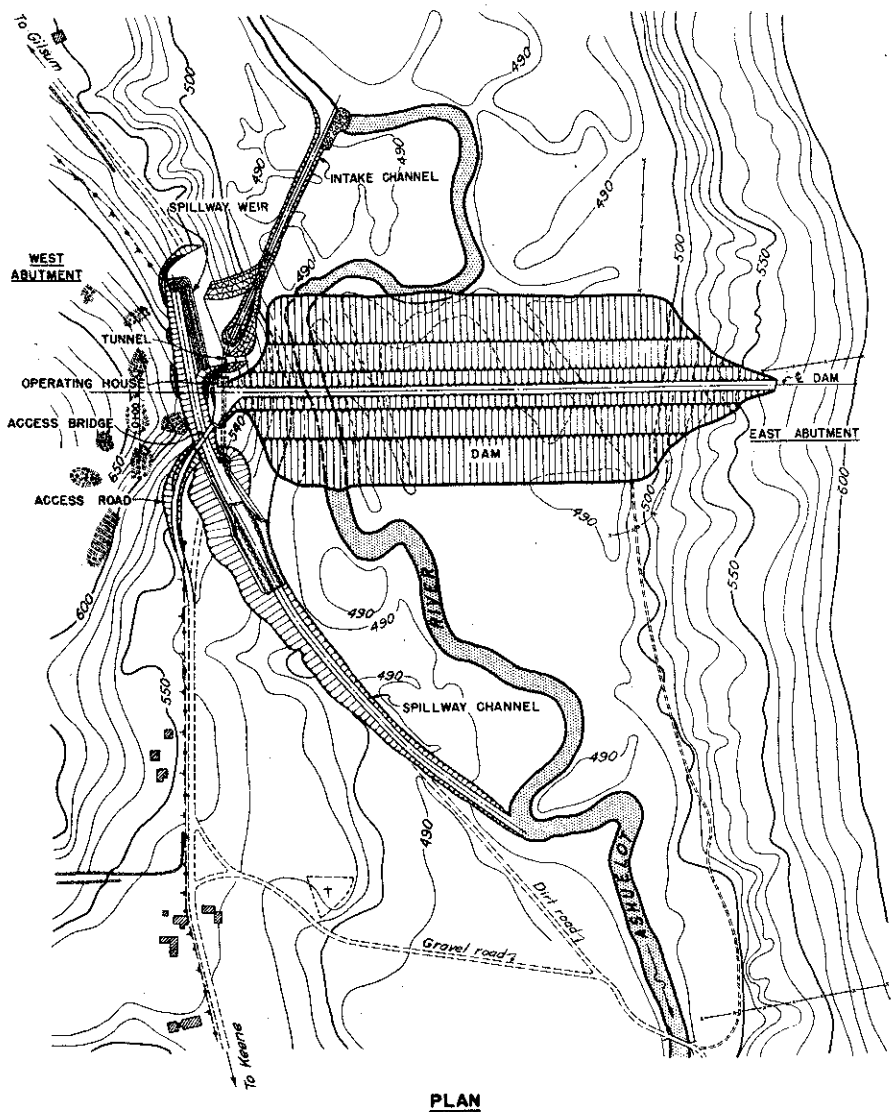
APPROVED: [signature] LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: [signature] ASSOC. ENGINEER

DRAWN: G.F.B. TRACED: G.F.B. CHECKED: M.D.K.

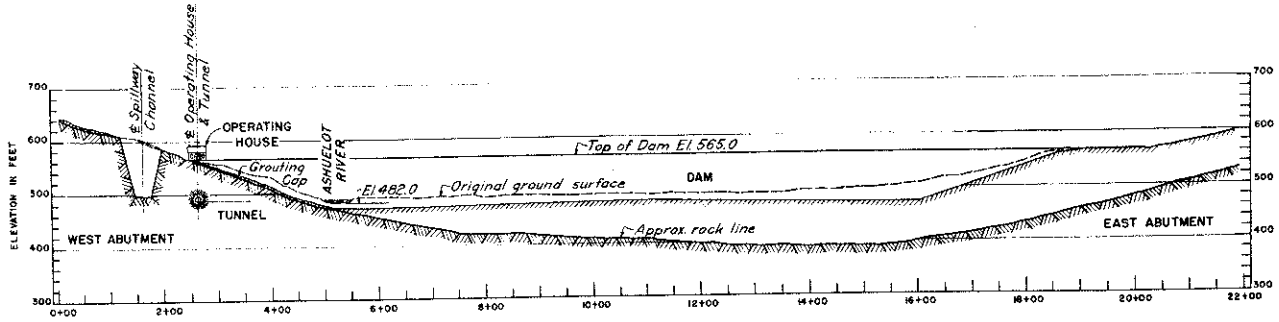
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-1427



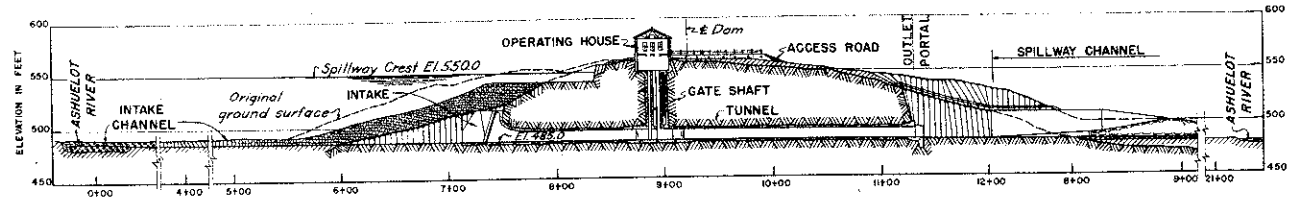
PLAN

SCALE: 1" = 200'



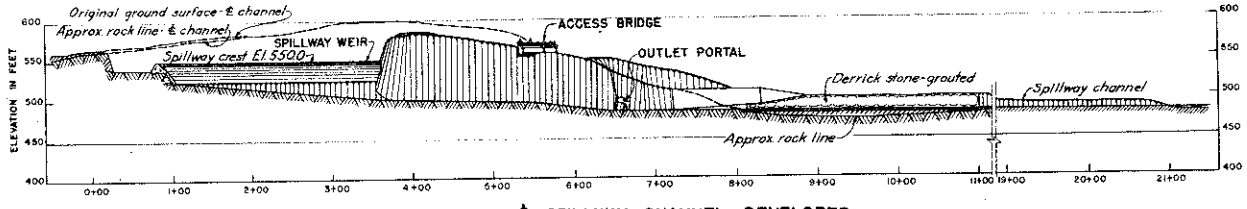
PROFILE ON ℄ DAM LOOKING UPSTREAM

SCALE: 1 IN. = 120 FT.



SECTION ON ℄ TUNNEL

SCALE: 1 IN. = 60 FT.

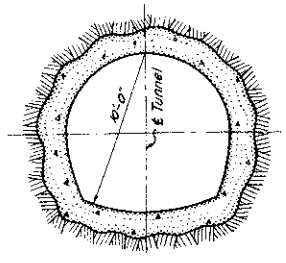


PROFILE ON ℄ SPILLWAY CHANNEL - DEVELOPED

SCALE: 1 IN. = 80 FT.

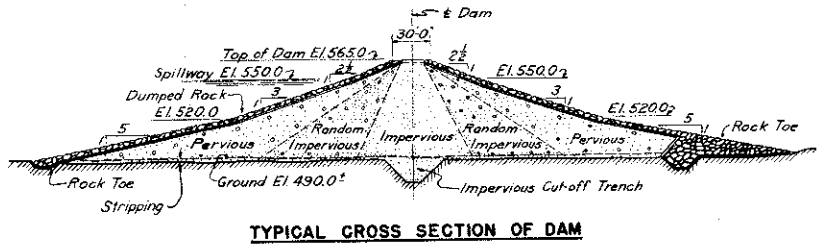
NOTE

Elevations refer to Mean Sea Level Datum.



TYPICAL TUNNEL SECTION

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



TYPICAL CROSS SECTION OF DAM

SCALE: 1 IN. = 50 FT.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

SURRY MOUNTAIN DAM

GENERAL PLAN

ASHUELOT RIVER — NEW HAMPSHIRE

IN 3 SHEETS — SCALE: 1 IN. = 200 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

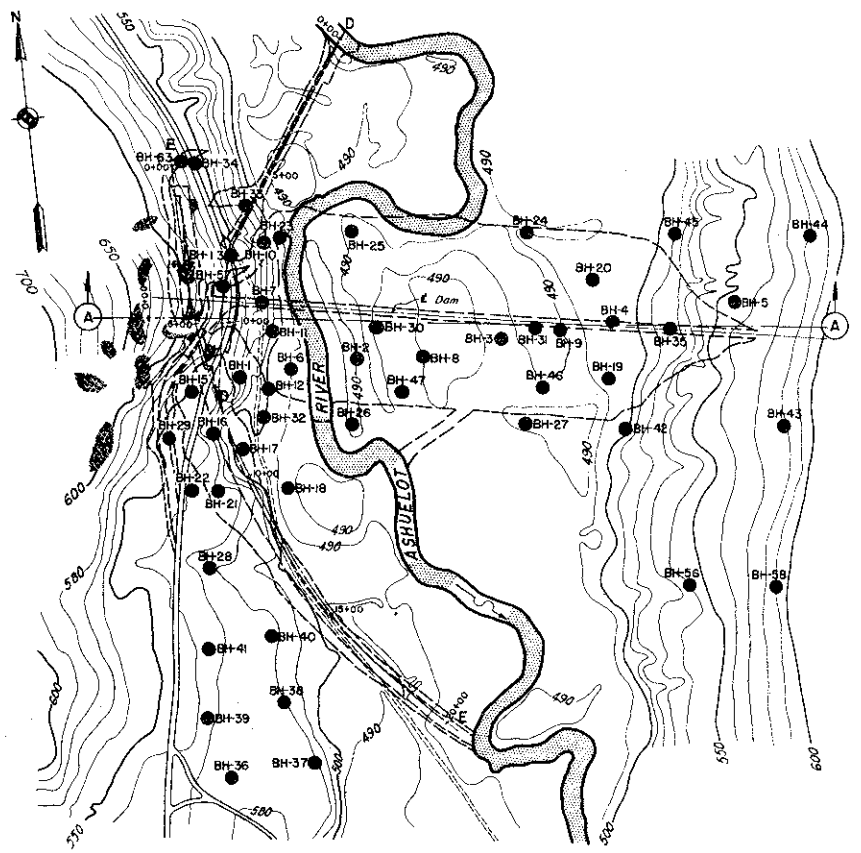
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

DRAWN: M. B. M. TRACED: C.J.P. CHECKED: M.D.K.

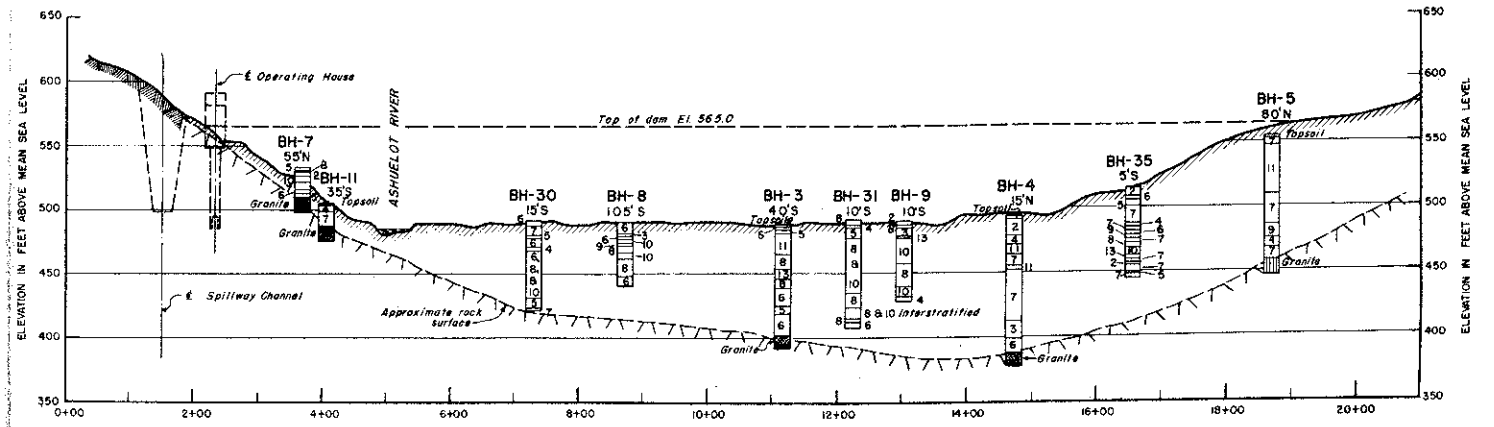
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-1442



PLAN

SCALE: 1" = 200'

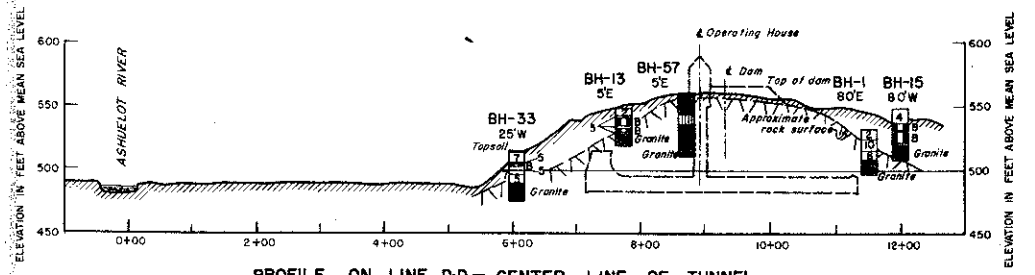


PROFILE ON LINE A-A- LOOKING UPSTREAM

SCALES: HOR. 1" = 100'
VERT. 1" = 50'

SOURCES OF BORROW

Pervious material available within 1.5 miles upstream on right bank.
Impervious material available within 0.3 miles downstream on left bank.



PROFILE ON LINE D-D- CENTER LINE OF TUNNEL

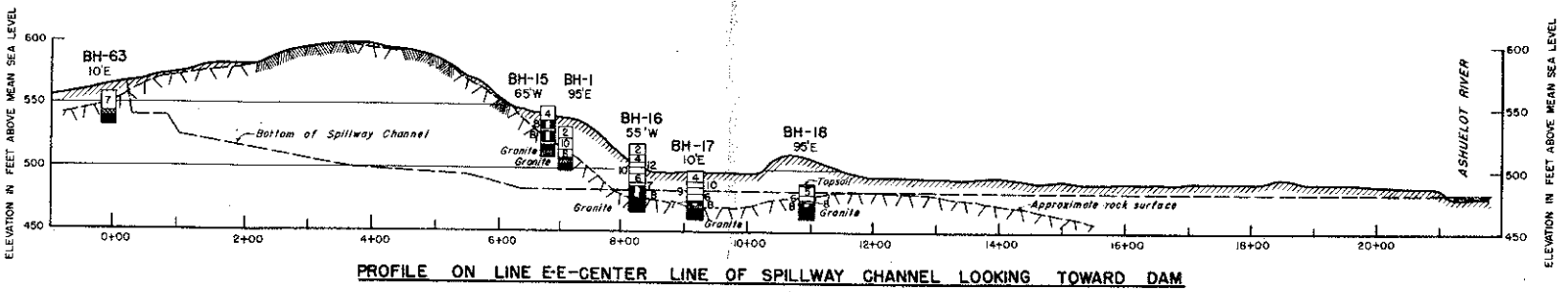
SCALES: HOR. 1" = 100'
VERT. 1" = 50'

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%
- Weathered and fractured bedrock, core recovery between 50% and 75%
- Less weathered and fractured bedrock, core recovery more than 75%
- BH Drive sample bore hole.
- N. North of ℄ dam
- S. South of ℄ dam
- E. East of ℄ tunnel or spillway channel
- W. West of ℄ tunnel or spillway channel
- Ledge outcrop

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A



PROFILE ON LINE E-E-CENTER LINE OF SPILLWAY CHANNEL LOOKING TOWARD DAM

SCALES: HOR. 1" = 100'
VERT. 1" = 50'

KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	APBY

CONNECTICUT RIVER FLOOD CONTROL

SURRY MOUNTAIN DAM

GEOLOGY

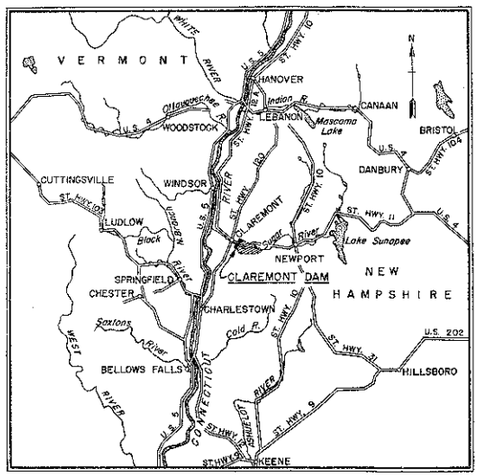
ASHUELOT RIVER — NEW HAMPSHIRE

IN 3 SHEETS — SCALE: 1 IN = 200 FT. (200' 0 200' 400') — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

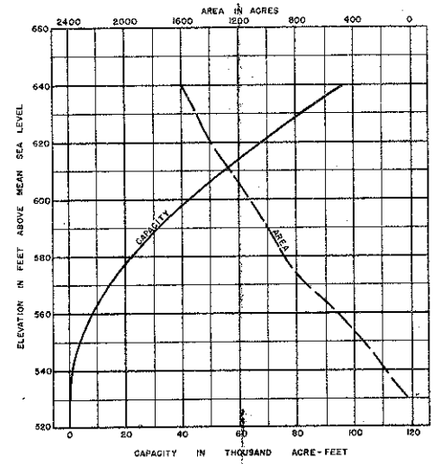
SUBMITTED: Senior Geologist, Head Geology Section — APPROVAL RECOMMENDED: Principal Engineer, Chief, F. C. Engineering Div. — APPROVED: Lt. Col. Corps of Engineers, District Engineer

COMPILED: Asst. Engineer — DRAWN: N. J. K. — TRACED: N. S. — CHECKED: — TO ACCOMPANY REPORT DATED: FEB. 28, 1940 — FILE NO. CT-2-1234

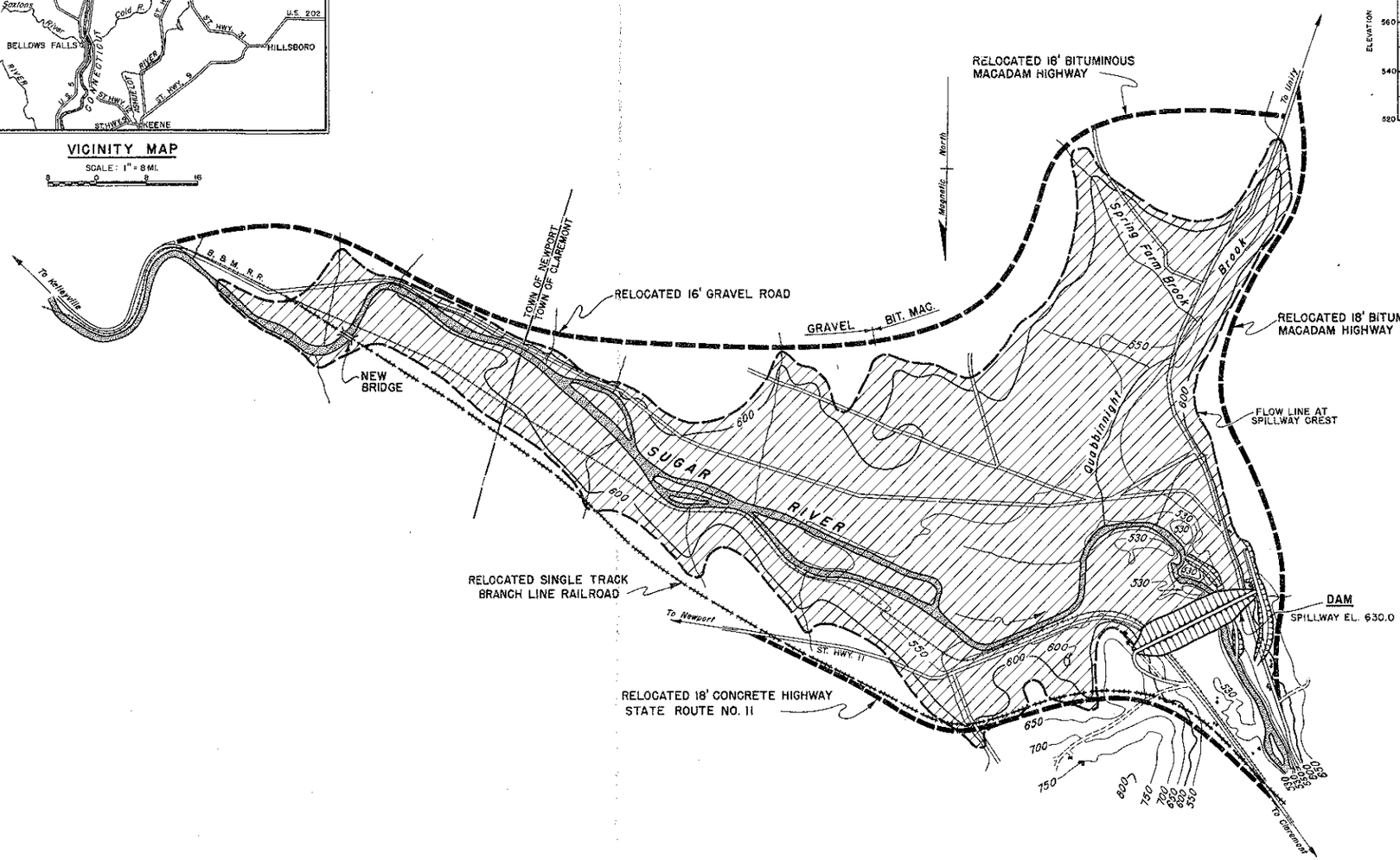


VICINITY MAP

SCALE: 1" = 8 MI.



AREA AND CAPACITY CURVES



NOTE

Spillway revised to gravity type on right bank, with crest at El. 630.0. Top of dam El. 650.0.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AR BY

CONNECTICUT RIVER FLOOD CONTROL

CLAREMONT DAM

RESERVOIR MAP

SUGAR RIVER — NEW HAMPSHIRE

IN 3 SHEETS — SCALE: 1 IN. = 800 FT. (600' 0 800' 1600') — SHEET NO. 1

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

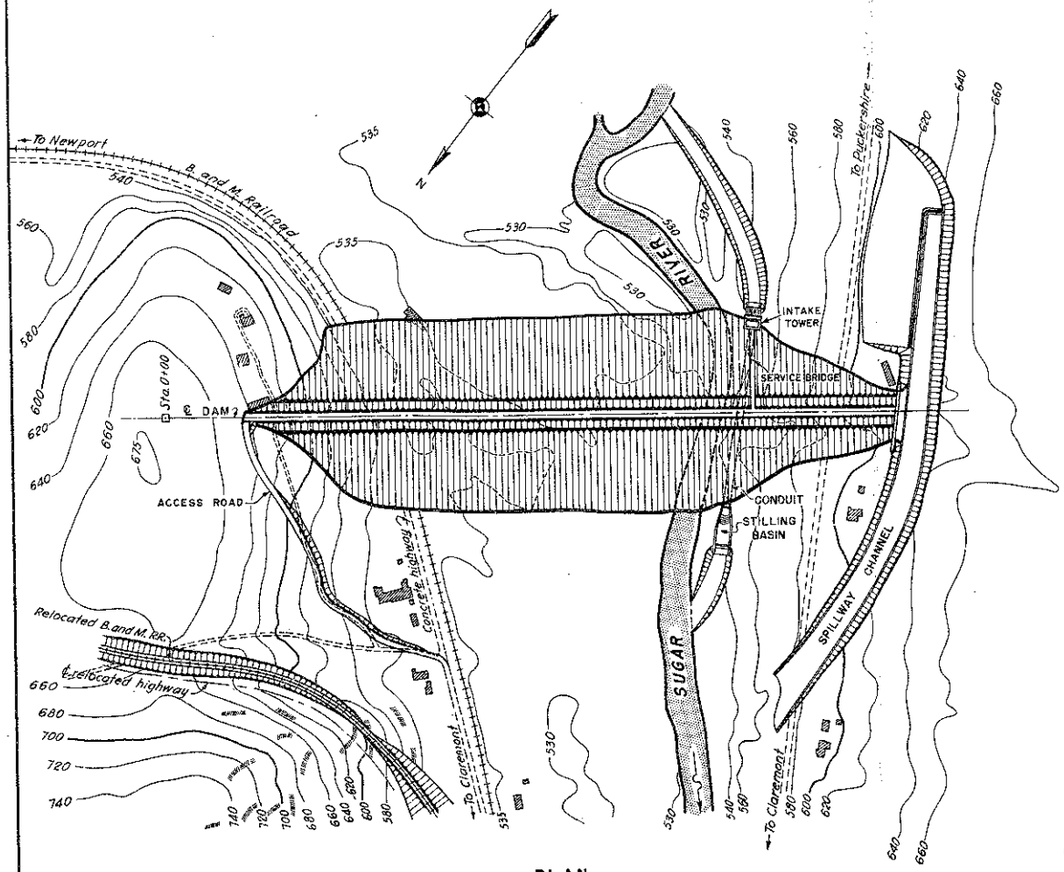
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV.

APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. J. Murphy, ASSOC. ENGINEER

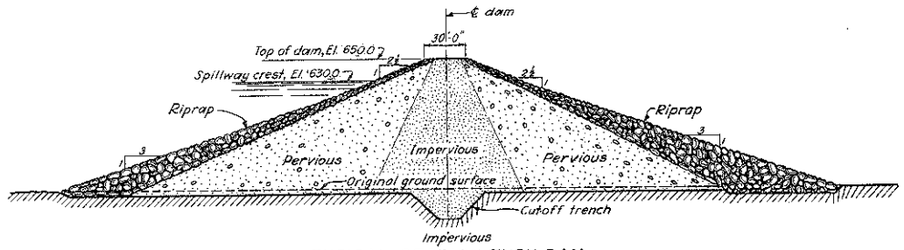
DRAWN: N.M.V. TRACED: N.M.V. CHECKED:

TO ACCOMPANY REPORT DATED: FEB., 28, 1940 FILE NO. CT-1-1424



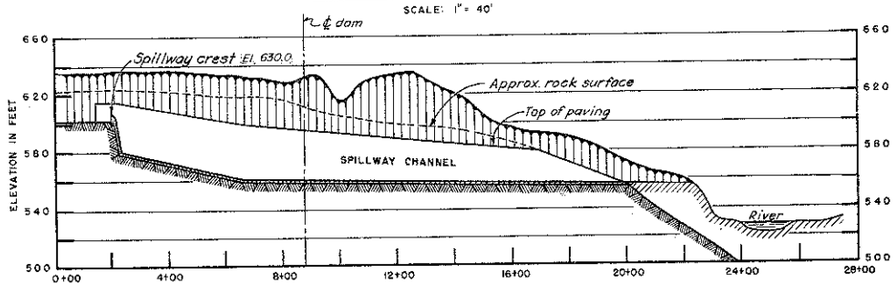
PLAN

SCALE: 1" = 200'



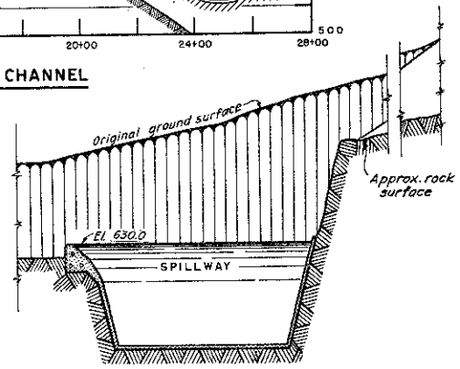
TYPICAL SECTION THRU DAM

SCALE: 1" = 40'



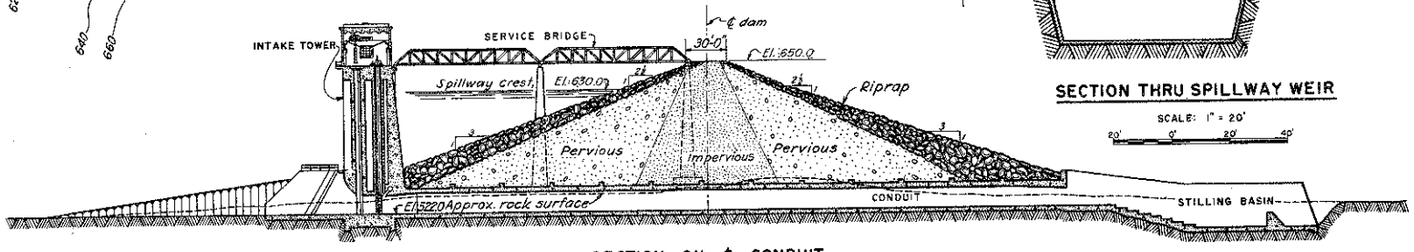
PROFILE ON ℄ SPILLWAY CHANNEL

SCALE: HOR. 1" = 200'
VERT. 1" = 40'



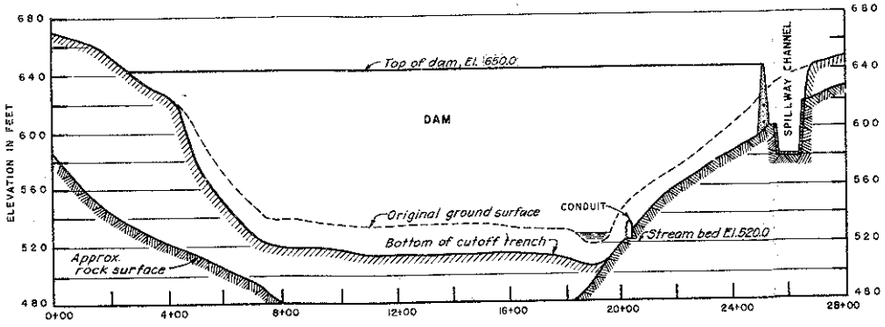
SECTION THRU SPILLWAY WEIR

SCALE: 1" = 20'



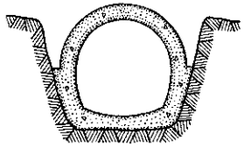
SECTION ON ℄ CONDUIT

SCALE: 1" = 40'



SECTION ON ℄ DAM

SCALE: HOR. 1" = 200'
VERT. 1" = 40'



SECTION THRU CONDUIT

SCALE: 1" = 10'

NOTES

Elevations refer to Mean Sea Level Datum.
Spillway revised to gravity type on right bank, with crest at El. 630.0. Top of dam El. 650.0.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

CLAREMONT DAM

GENERAL PLAN

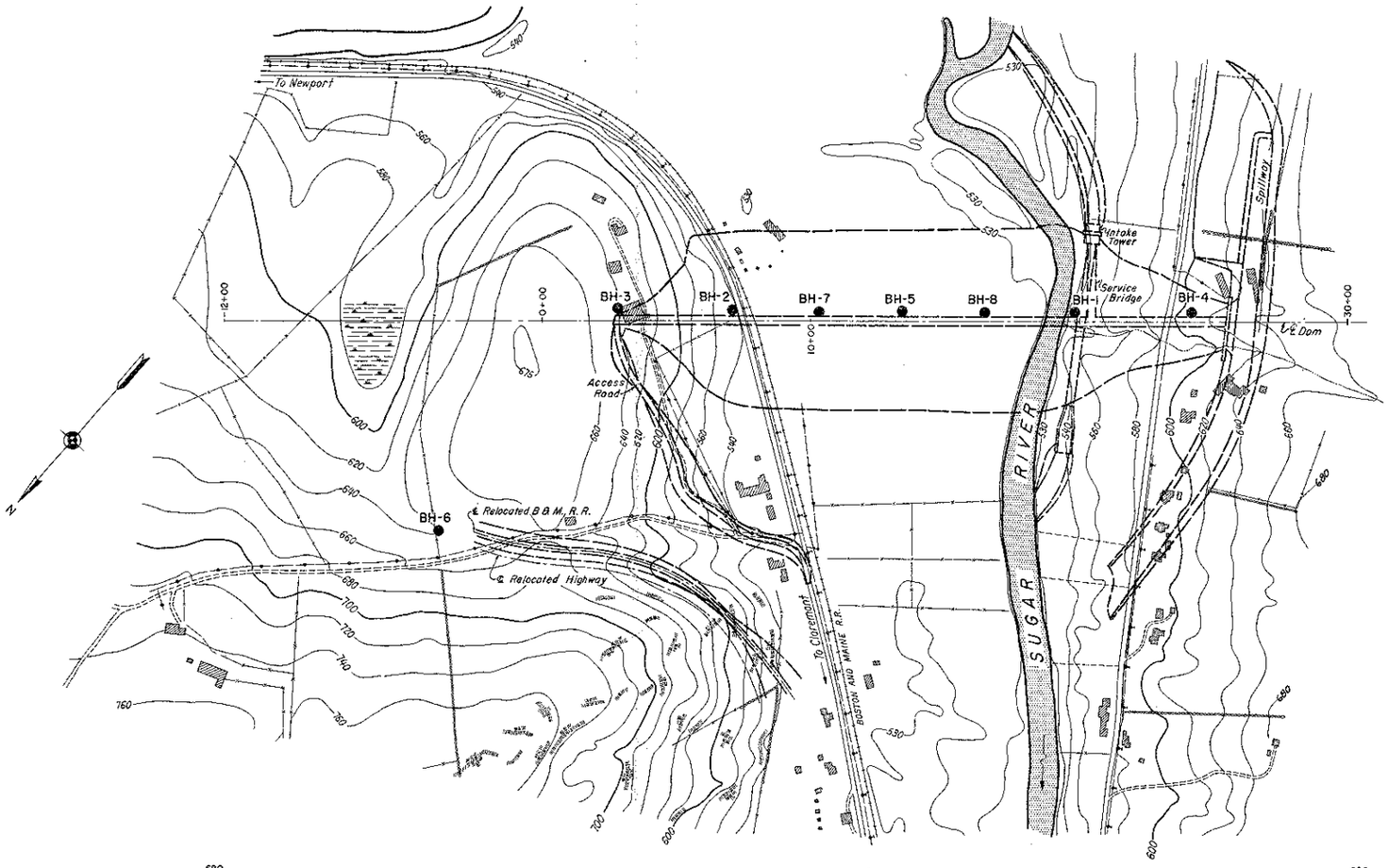
SUGAR RIVER, NEW HAMPSHIRE

IN 3 SHEETS — SCALE: 1" = 200 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

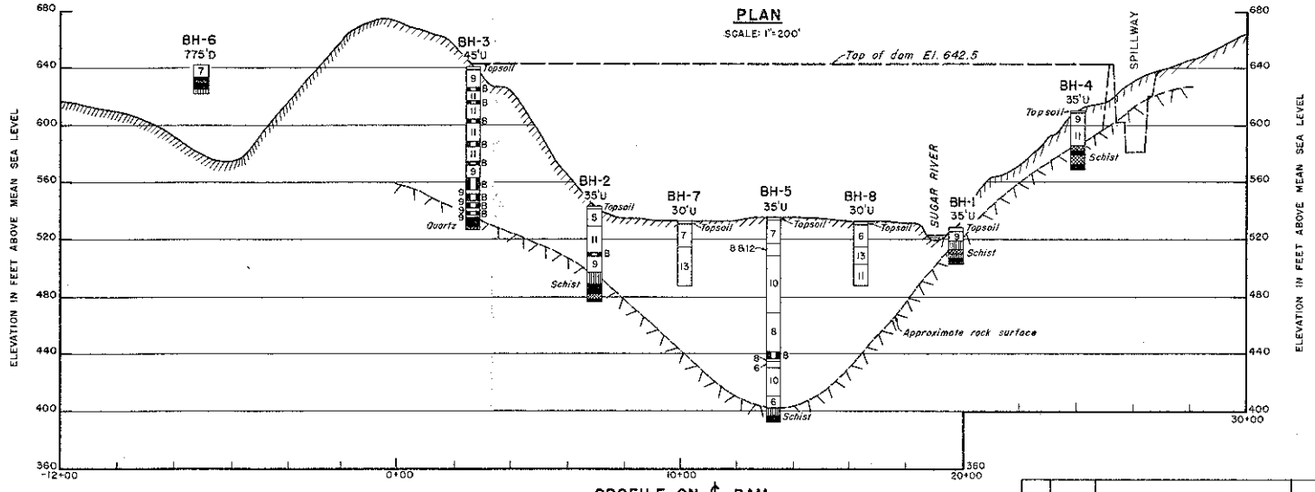
SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. D. Mugnier, ASST. ENGINEER — DRAWN: N.B. TRACED: C.J.M. CHECKED: [illegible] — TO ACCOMPANY REPORT DATED: FEB. 28 1940 FILE NO. CT-1-1450



PLAN

SCALE: 1" = 200'



PROFILE ON ℄ DAM

SCALES: HOR. 1" = 200'
VERT. 1" = 40'

SOURCES OF BORROW

Pervious material available within 0.5 miles upstream and downstream in valley bottom.
Impervious material available within 0.3 miles on left bank.

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50 %.
- Weathered and fractured bedrock, core recovery between 50 % and 75 %.
- Less weathered and fractured bedrock, core recovery more than 75 %.
- BH Drive sample bore hole.
- U Upstream from ℄ dam.
- D Downstream from ℄ dam.
- Ledge outcrop.

NOTES

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A
Spillway revised to gravity type on right bank, with crest at El. 630.0. Top of dam El. 650.0.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

CLAREMONT DAM

GEOLOGY

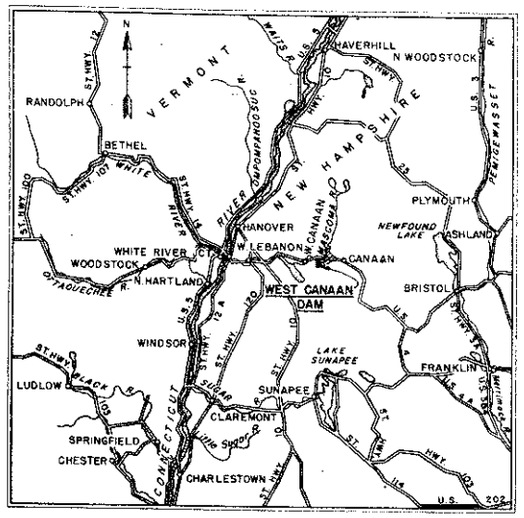
SUGAR RIVER — NEW HAMPSHIRE

IN 3 SHEETS — SCALE: 1 IN. = 200 FT. (200' 0 200' 400') — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

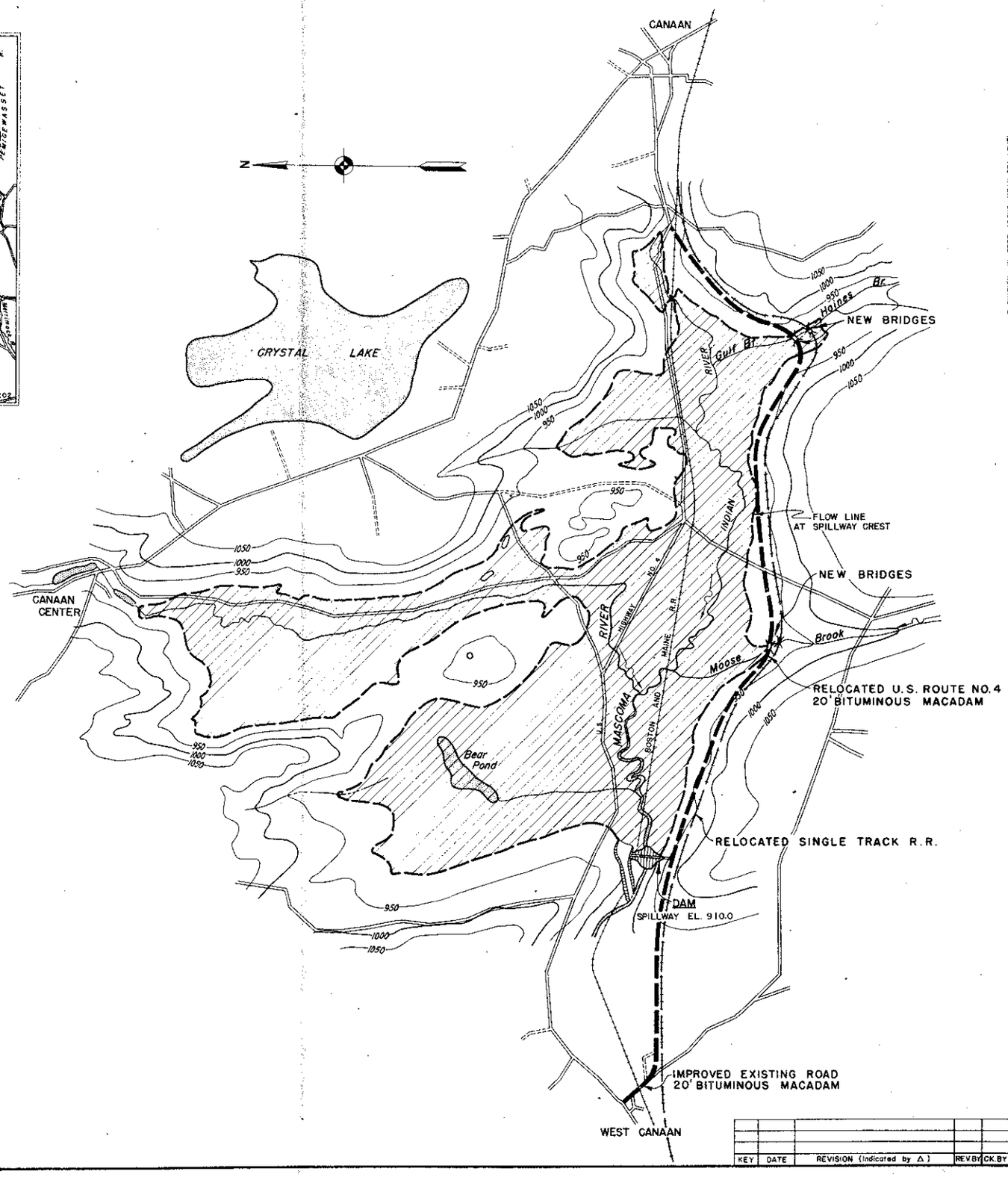
SUBMITTED: Senior Geologist, Head Geology Section — APPROVAL RECOMMENDED: Principal Engineer, Chief, F. C. Engineering Div. — APPROVED: Lt. Colonel, Corps of Engineers, District Engineer

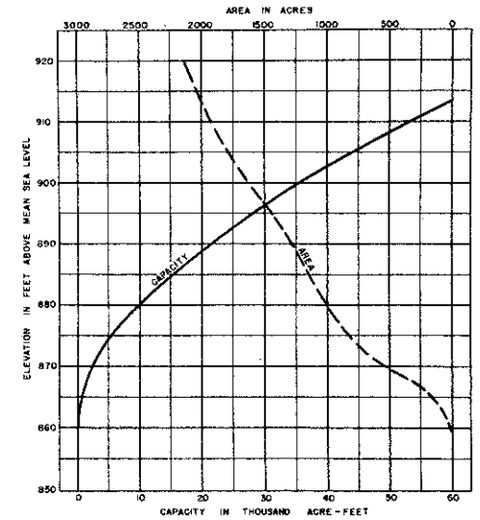
COMPILED: Asst. Engineer — DRAWN: R.R.L. — TRACED: T.C.M. — CHECKED: — TO ACCOMPANY REPORT DATED: FEB. 28, 1940 — FILE NO. CT-2-1236



VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

WEST CANAAN DAM

RESERVOIR MAP

MASCOMA RIVER — NEW HAMPSHIRE

IN 2 SHEETS — SCALE: 1 IN. = 1000 FT. — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

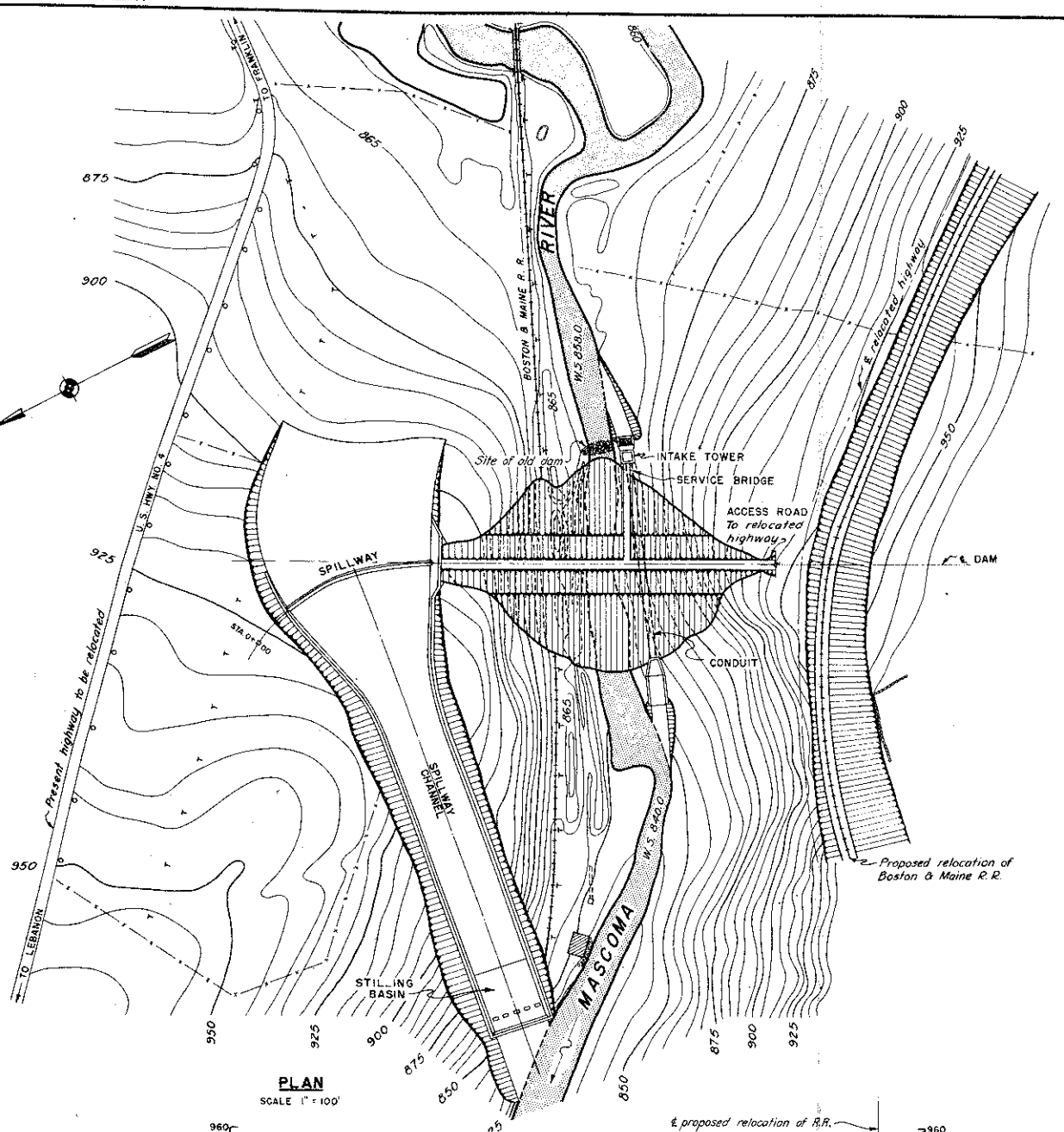
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, E. D. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

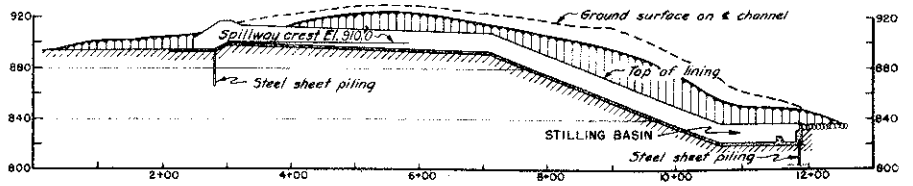
DRAWN: M.M. TRACED: M.M. CHECKED: T.J.K.

TO ACCOMPANY REPORT DATED: FEB., 28, 1940 FILE NO. CT-1-1420



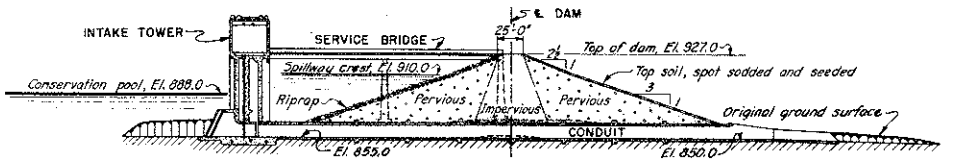
PLAN

SCALE 1" = 100'



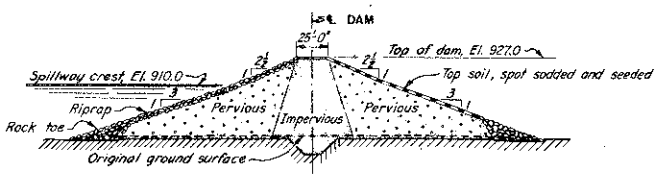
PROFILE ON ℄ SPILLWAY CHANNEL

SCALE: HOR. 1" = 100'
VERT. 1" = 50'



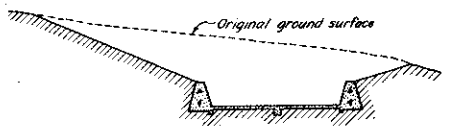
SECTION ON ℄ CONDUIT

SCALE 1" = 50'



TYPICAL SECTION THRU DAM

SCALE 1" = 40'

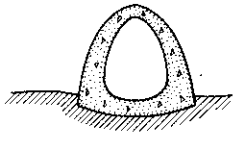


TYPICAL SECTION THRU SPILLWAY CHANNEL

SCALE 1" = 50'

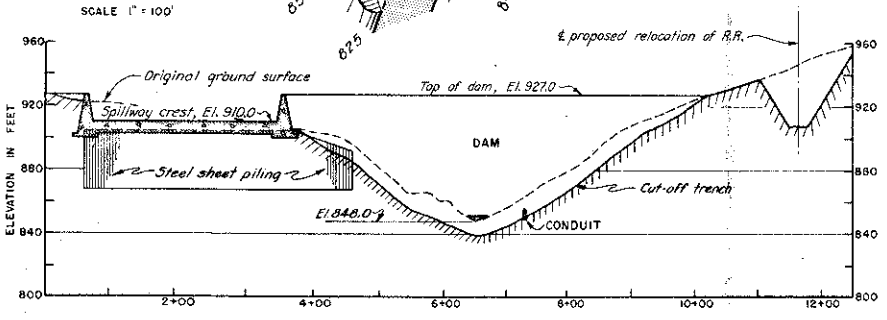
NOTE

Elevations refer to Mean Sea Level Datum



SECTION THRU CONDUIT

SCALE 1" = 10'



PROFILE ALONG ℄ DAM

SCALE: HOR. 1" = 100'
VERT. 1" = 40'

KEY	DATE	REVISION (Indicated by Δ)	REV BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

WEST CANAAN DAM

GENERAL PLAN

MASCOMA RIVER — NEW HAMPSHIRE

IN 2 SHEETS — SCALE: 1 IN = 100 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

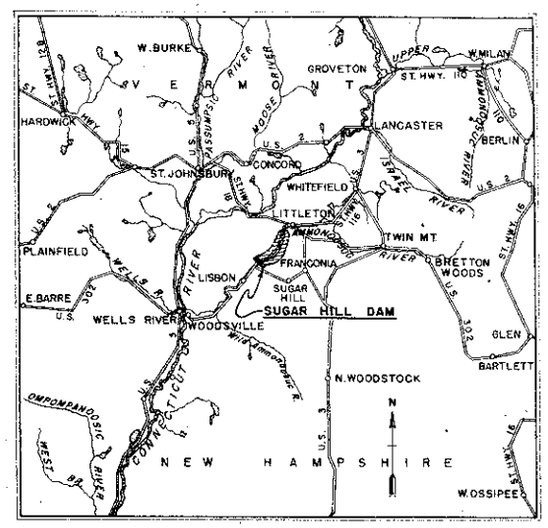
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

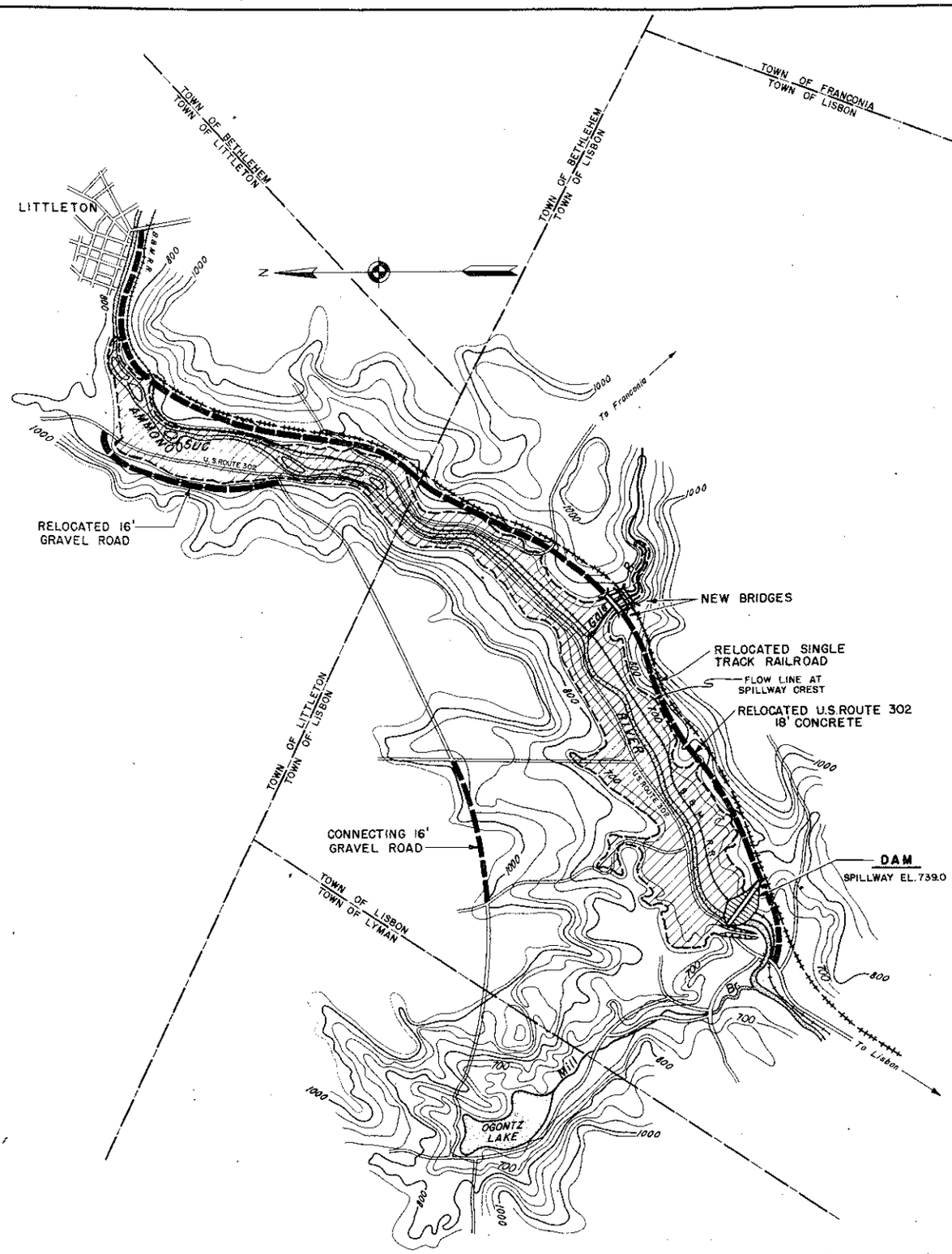
DRAWN: N.B.
TRACED: K.H.W.
CHECKED: N.D.K.

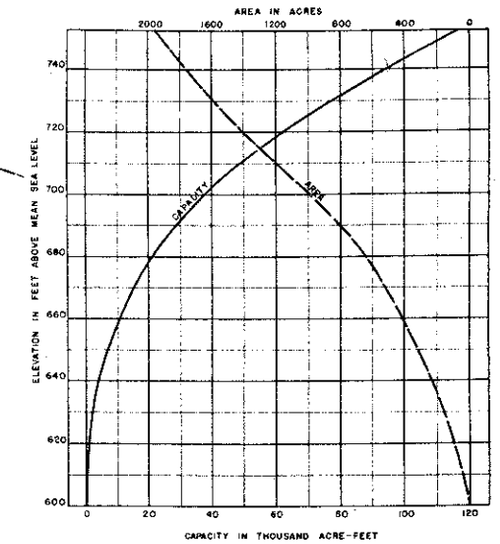
TO ACCOMPANY REPORT DATED: FEB 28, 1940
FILE NO. CT-1-1455



VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (indicated by Δ)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

SUGAR HILL DAM

RESERVOIR MAP

AMMONOOSUC RIVER — NEW HAMPSHIRE

IN 3 SHEETS — SCALE: 1 IN. = 2000 FT. (2000' 0 2000' 4000') — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

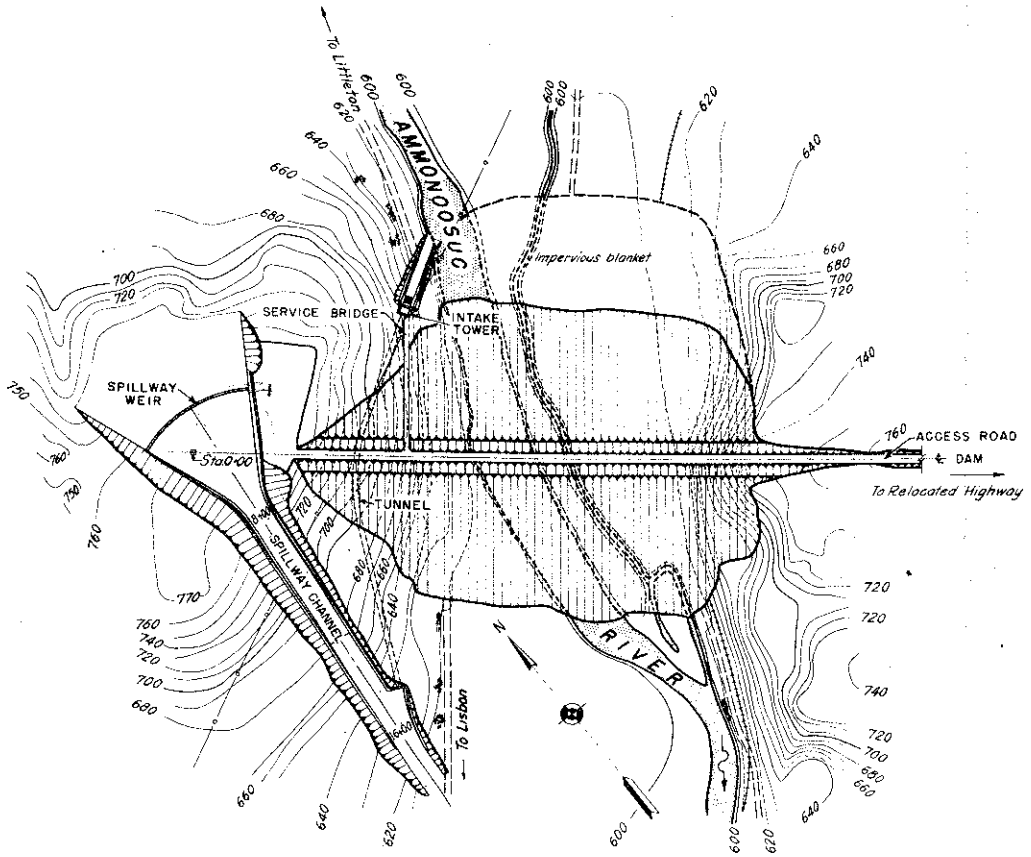
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. D. Mugnier, ASSOC. ENGINEER

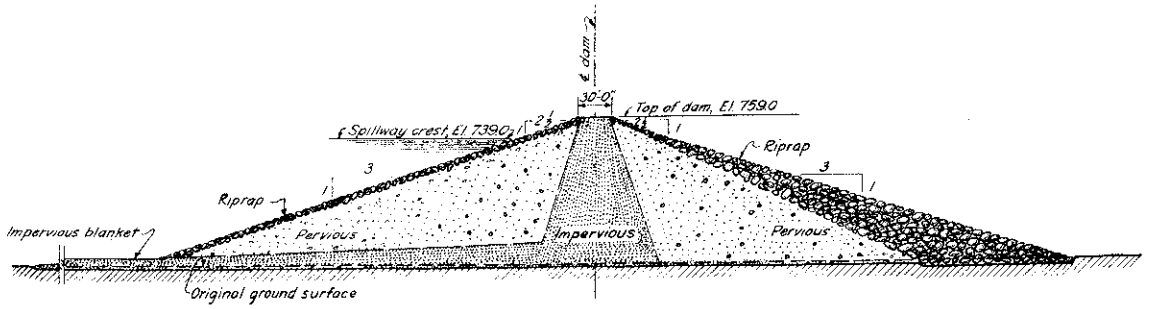
DRAWN: P.V.S. TRACED: P.V.S. CHECKED: M.D.K.

TO ACCOMPANY REPORT DATED: FEB. 28, 1940 FILE NO. CT-1-1413



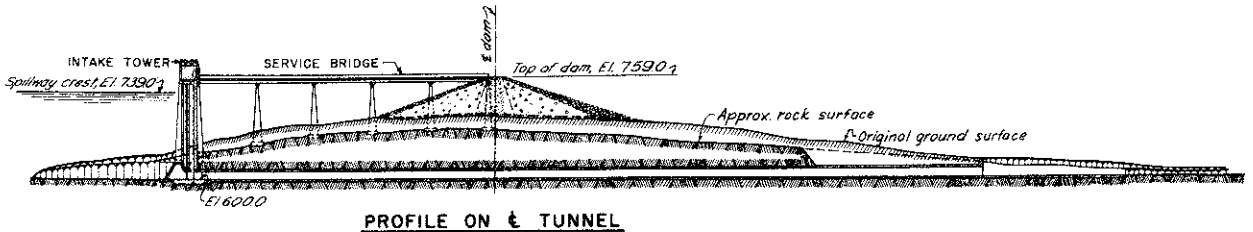
PLAN OF DAM

SCALE 1" = 200'



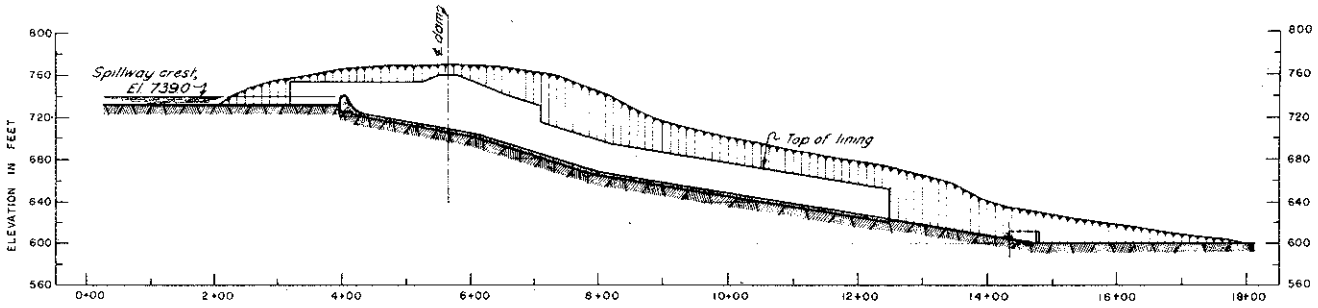
TYPICAL SECTION OF DAM

SCALE 1" = 60'



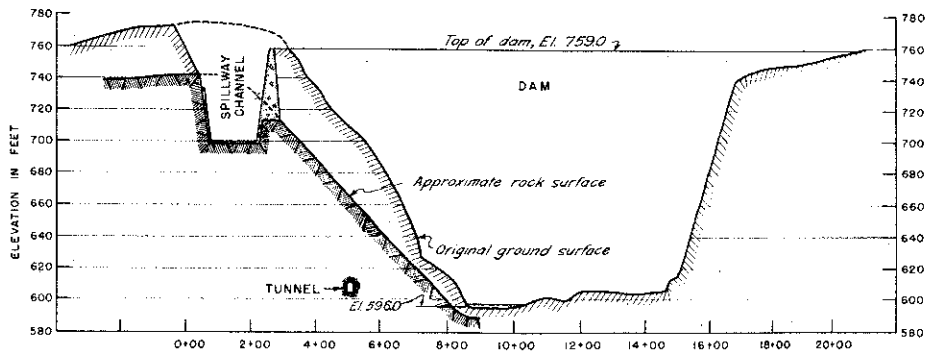
PROFILE ON ℄ TUNNEL

SCALE 1" = 100'



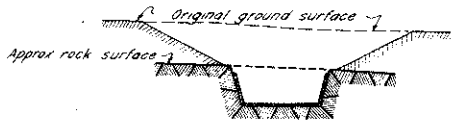
PROFILE ON ℄ SPILLWAY CHANNEL

SCALE HOR. 1" = 100' VERT. 1" = 60'



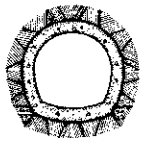
PROFILE ON ℄ DAM

SCALE HOR. 1" = 200' VERT. 1" = 40'



SECTION THRU SPILLWAY CHANNEL

SCALE 1" = 60'



SECTION THRU TUNNEL

SCALE 1" = 10'

NOTE

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

SUGAR HILL DAM

GENERAL PLAN

AMMONOOSUC RIVER — NEW HAMPSHIRE

IN 3 SHEETS — SCALE: 1 IN. = 200 FT — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

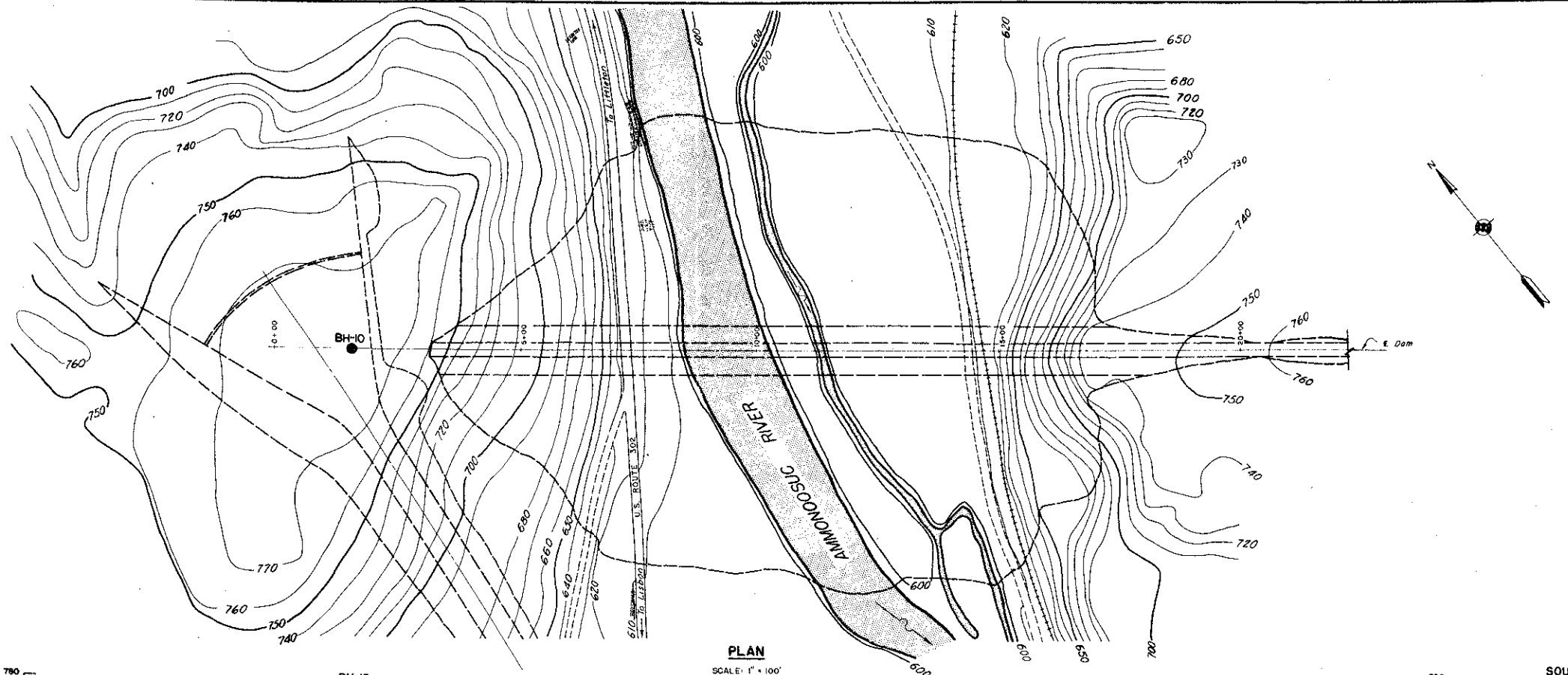
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

DRAWN: A. G. — TRACED: F. G. K. — CHECKED: M. D. K.

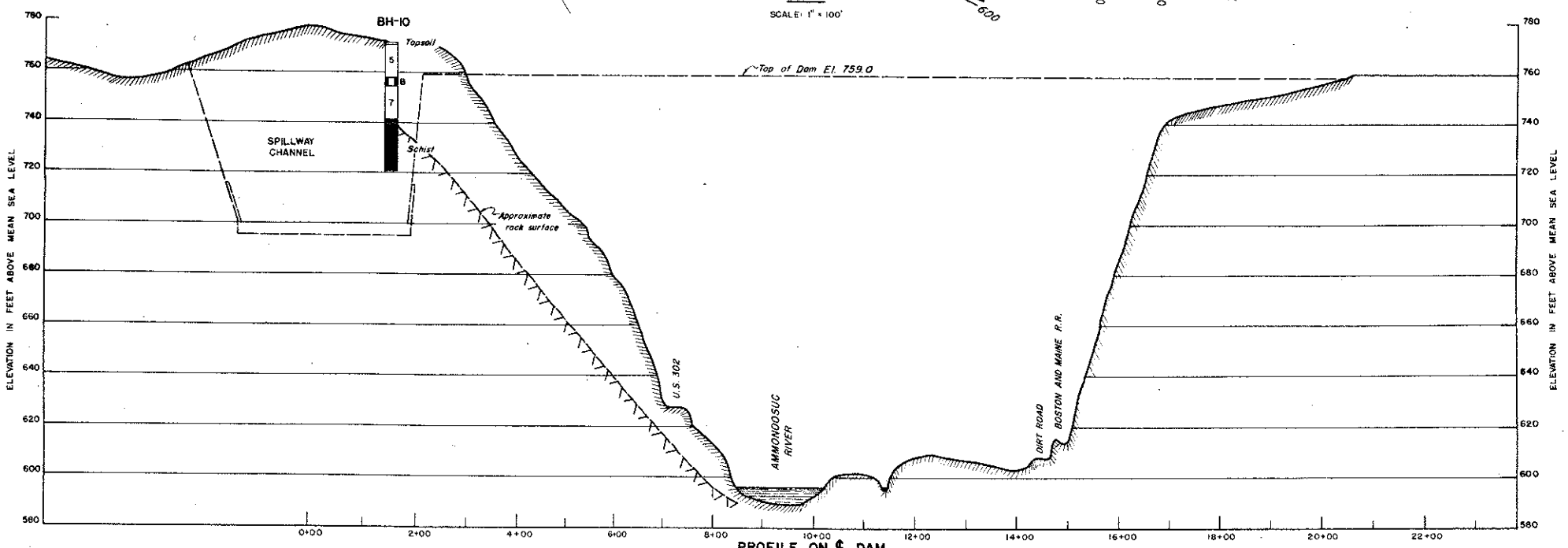
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-1466



PLAN

SCALE: 1" = 100'



PROFILE ON ℄ DAM

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

SOURCES OF BORROW

Pervious material available within 0.5 miles upstream on right bank.

Impervious material available within 0.5 miles upstream on right bank.

LEGEND

- B Boulder
- Bedrock, core recovery more than 75 %
- BH Drive sample bore hole
- Ledge outcrop

NOTE

For description and limits of numerical soil classes, see Table XXXVI and Plate No. IAA.

KEY	DATE	REVISION (Indicated by △)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

SUGAR HILL DAM

GEOLOGY

AMMONOOSUC RIVER — NEW HAMPSHIRE

IN 3 SHEETS — SCALE: 1 IN. = 100 FT. — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: Senior Geologist, Head, Geology Section

APPROVAL RECOMMENDED: Principal Engineer, Chief, F. C. Engineering Div.

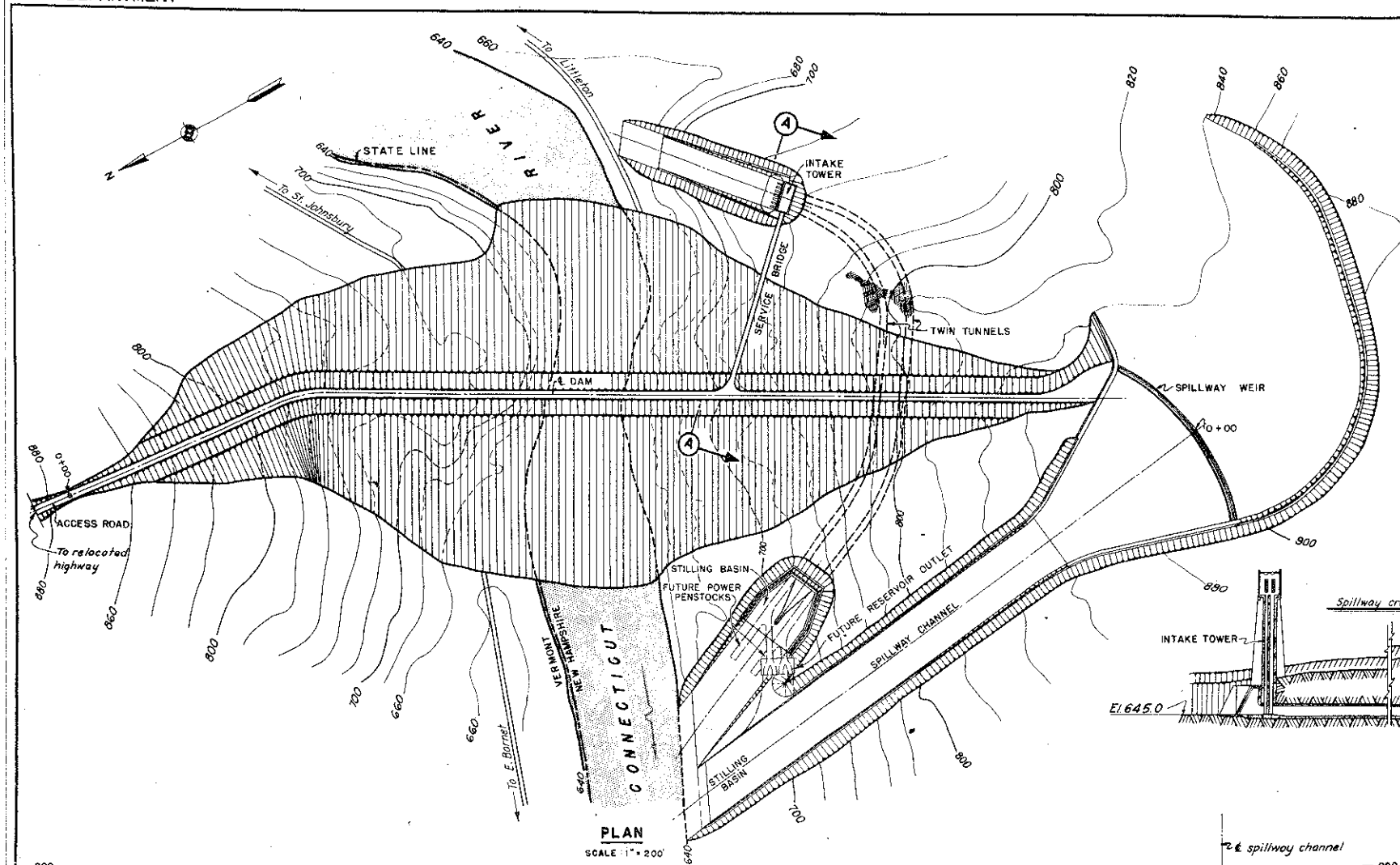
APPROVED: Lt. Col. Corps of Engineers, District Engineer

COMPILED: Asst. Engineer

DRAWN: R. R. L. TRACED: A. J. J. CHECKED

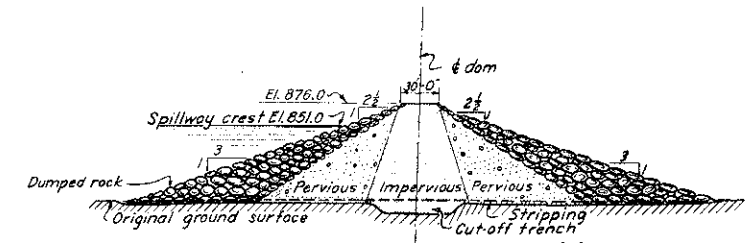
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-2-1244



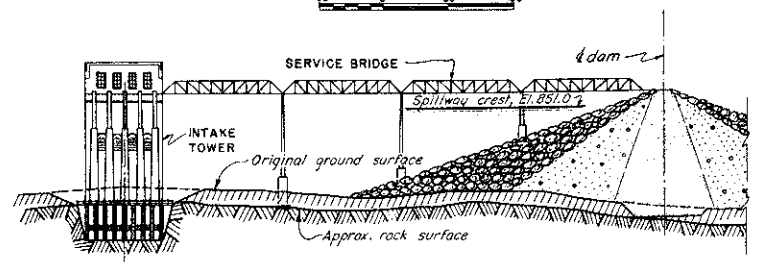
PLAN

SCALE: 1" = 200'



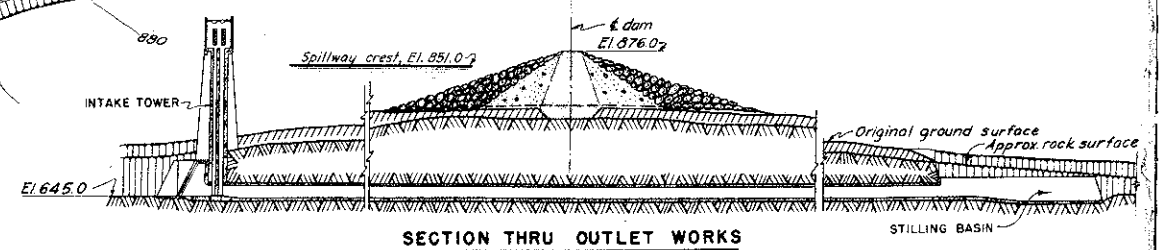
TYPICAL SECTION THRU DAM

SCALE: 1" = 50'



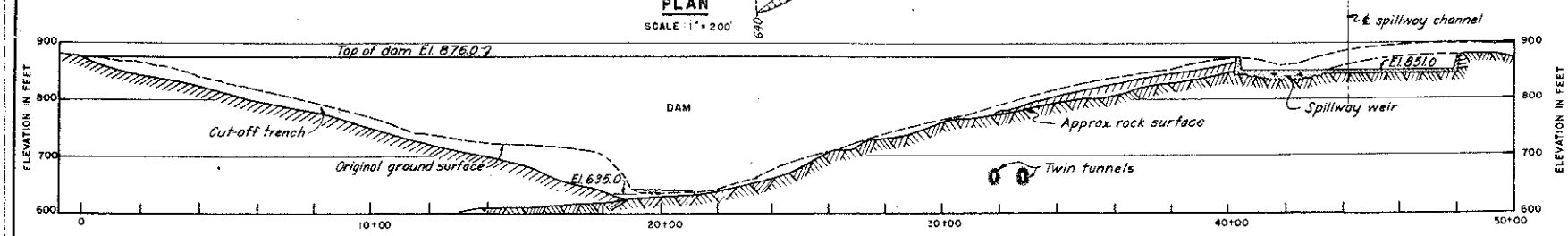
SECTION A - A

SCALE: 1" = 100'



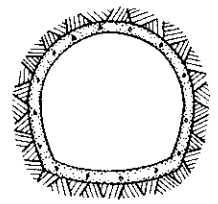
SECTION THRU OUTLET WORKS

SCALE: 1" = 100'



PROFILE ON ℄ DAM

SCALE HOR: 1" = 200' VERT: 1" = 100'

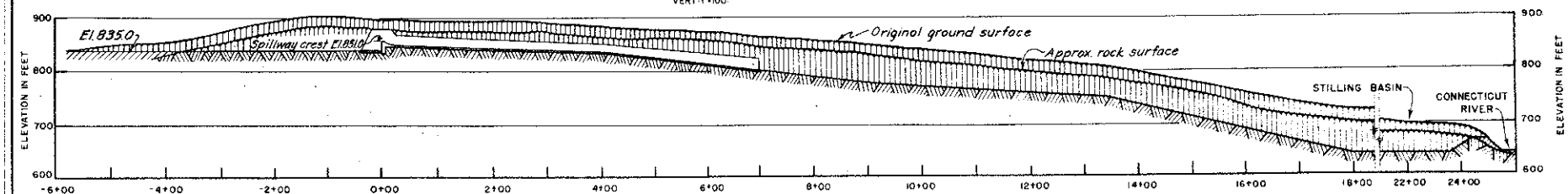


SECTION THRU TUNNEL

SCALE: 1" = 10'

NOTE

Elevations refer to Mean Sea Level Datum.



PROFILE ON ℄ SPILLWAY CHANNEL

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

KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

UPPER FIFTEEN MILE FALLS

GENERAL PLAN

CONNECTICUT RIVER NEW HAMPSHIRE & VERMONT

IN 2 SHEETS SCALE: 1 IN. = 200 FT. SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. FEB. 1940

SUBMITTED: SENIOR ENGINEER HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER CHIEF, F. C. ENGINEERING DIV.

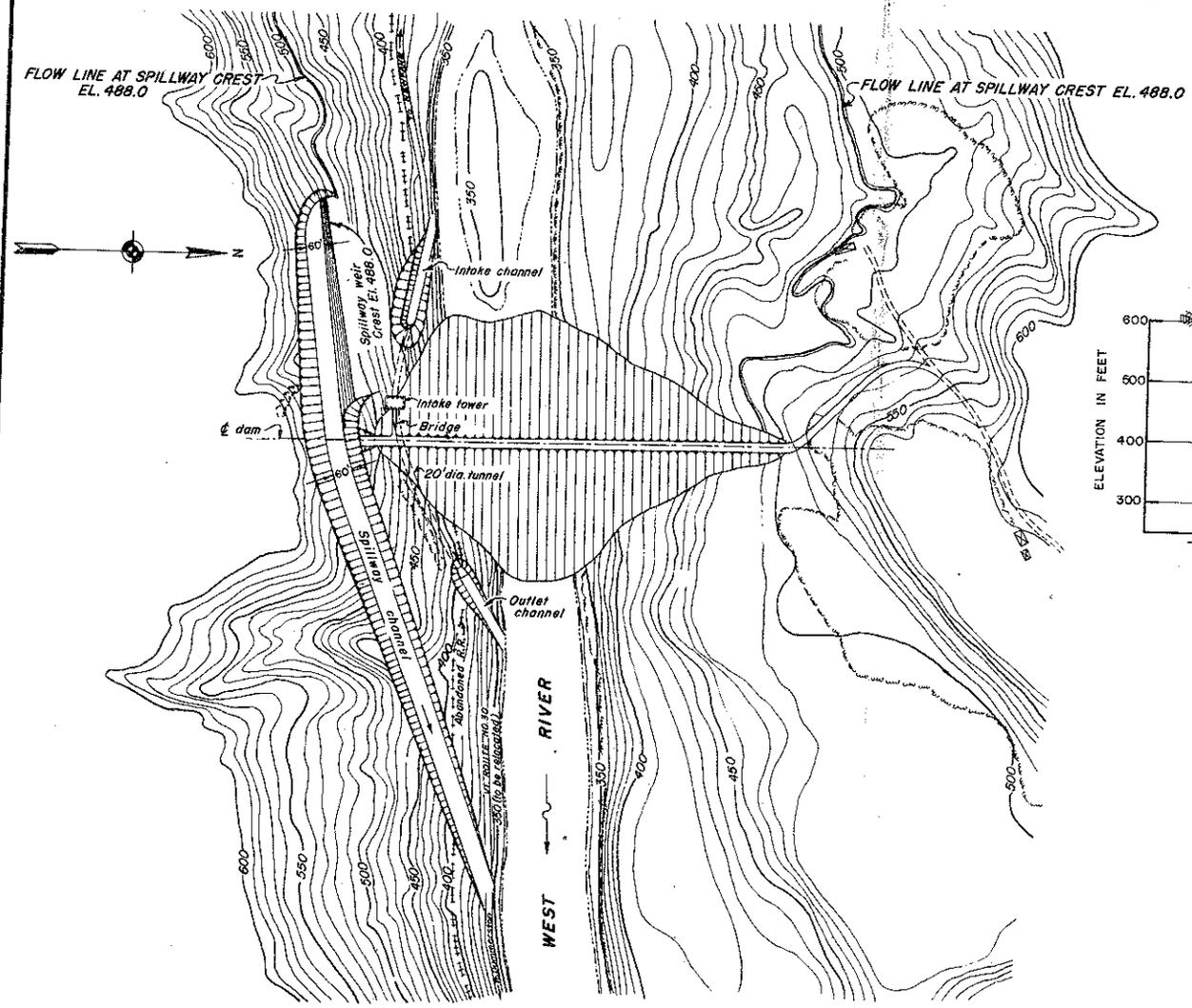
APPROVED: LT. COL. CORPS OF ENGINEERS DISTRICT ENGINEER

DESIGNED: A. P. Mugnier ASSOC. ENGINEER

DRAWN: F. J. G. TRACED: W. R. H. CHECKED: G. W. H.

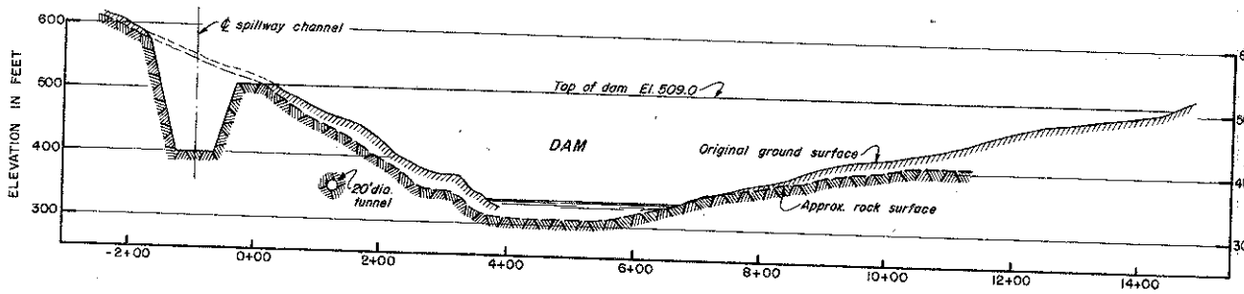
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-1462



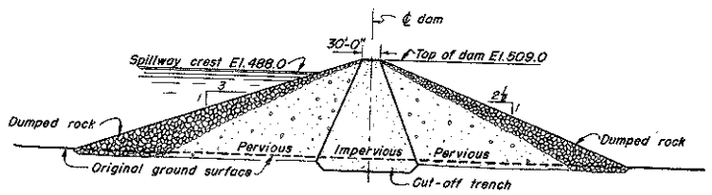
PLAN

SCALE: 1" = 200'



PROFILE ON ℄ DAM

SCALE: 1" = 100'



TYPICAL SECTION THRU DAM

SCALE: 1" = 100'

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

WILLIAMSVILLE DAM

GENERAL PLAN

WEST RIVER — VERMONT

IN 2 SHEETS — SCALE AS SHOWN — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R.I., DEC. 1944

SUBMITTED: PRINCIPAL ENGINEER PROJECT ENGINEER

APPROVAL RECOMMENDED: HEAD ENGINEER CHIEF, ENGINEERING DIV.

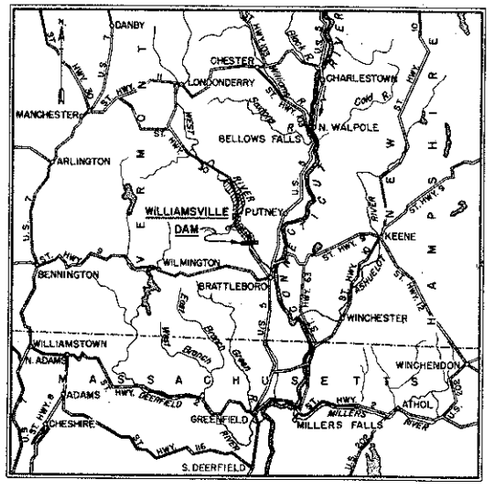
APPROVED: COL. CORPS OF ENGINEERS DISTRICT ENGINEER

PREPARED: PROJECT UNIT NO.

DRAWN: C.W.H.
TRACED: D.H.R.
CHECKED:

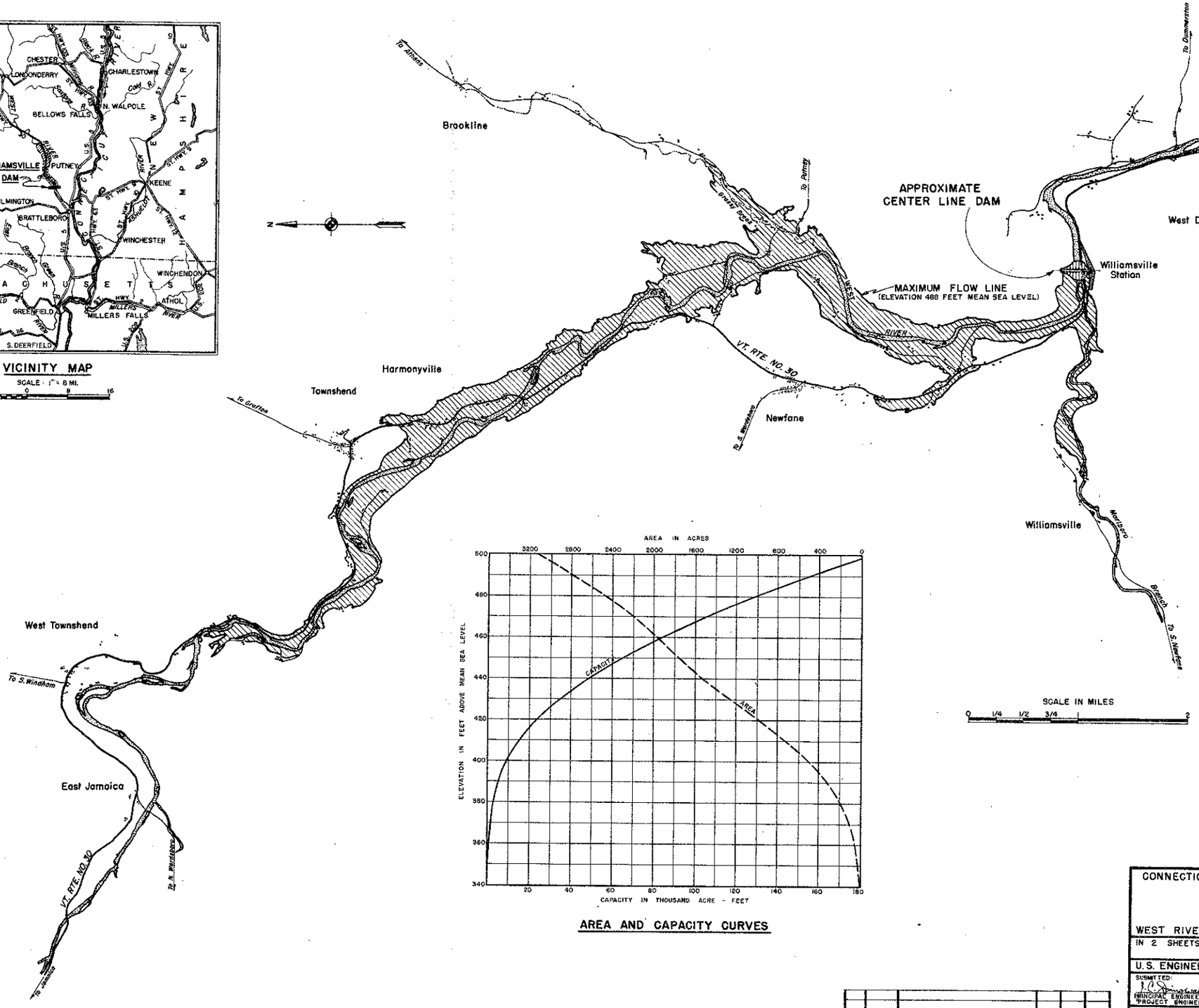
TO ACCOMPANY REPORT DATED FEB. 26, 1940

FILE NO. CT-1-1776



VICINITY MAP

SCALE: 1" = 8 MI.



AREA AND CAPACITY CURVES

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

WILLIAMSVILLE DAM

RESERVOIR MAP

WEST RIVER — VERMONT

IN 2 SHEETS — SCALE AS SHOWN — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R.I., DEC. 1944

SUBMITTED: PRINCIPAL ENGINEER, PROJECT ENGINEER

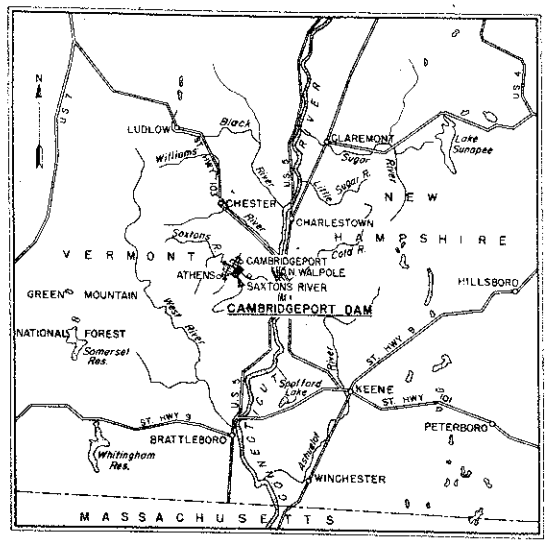
APPROVAL RECOMMENDED: HEAD ENGINEER, CHIEF, ENGINEERING DIV.

APPROVED: COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

PREPARED: PROJECT UNIT NO. 1

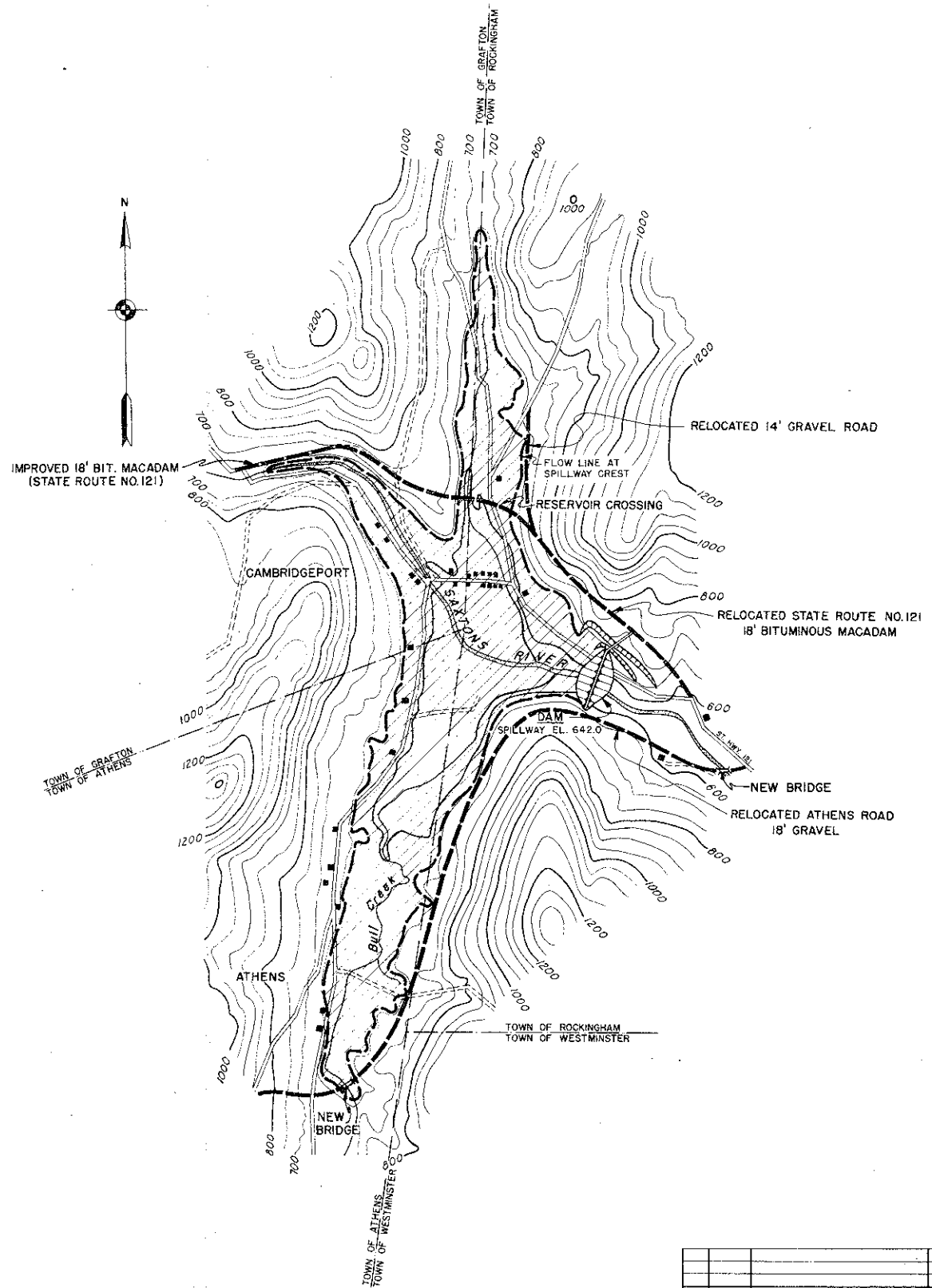
DRAWN: H.A.Y.
TRACED: D.H.R.
CHECKED:

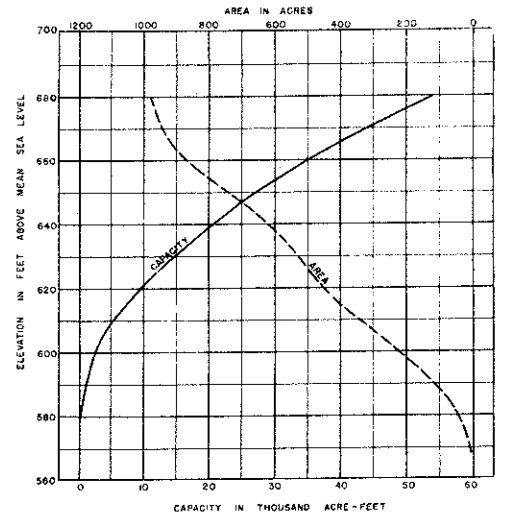
TO ACCOMPANY REPORT DATED FEB. 28, 1940
FILE NO. CT-1-1775



VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (Indicated by Δ)	REV. BY	CH. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

CAMBRIDGEPORT DAM

RESERVOIR MAP

SAXTONS RIVER — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 1000 FT. — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

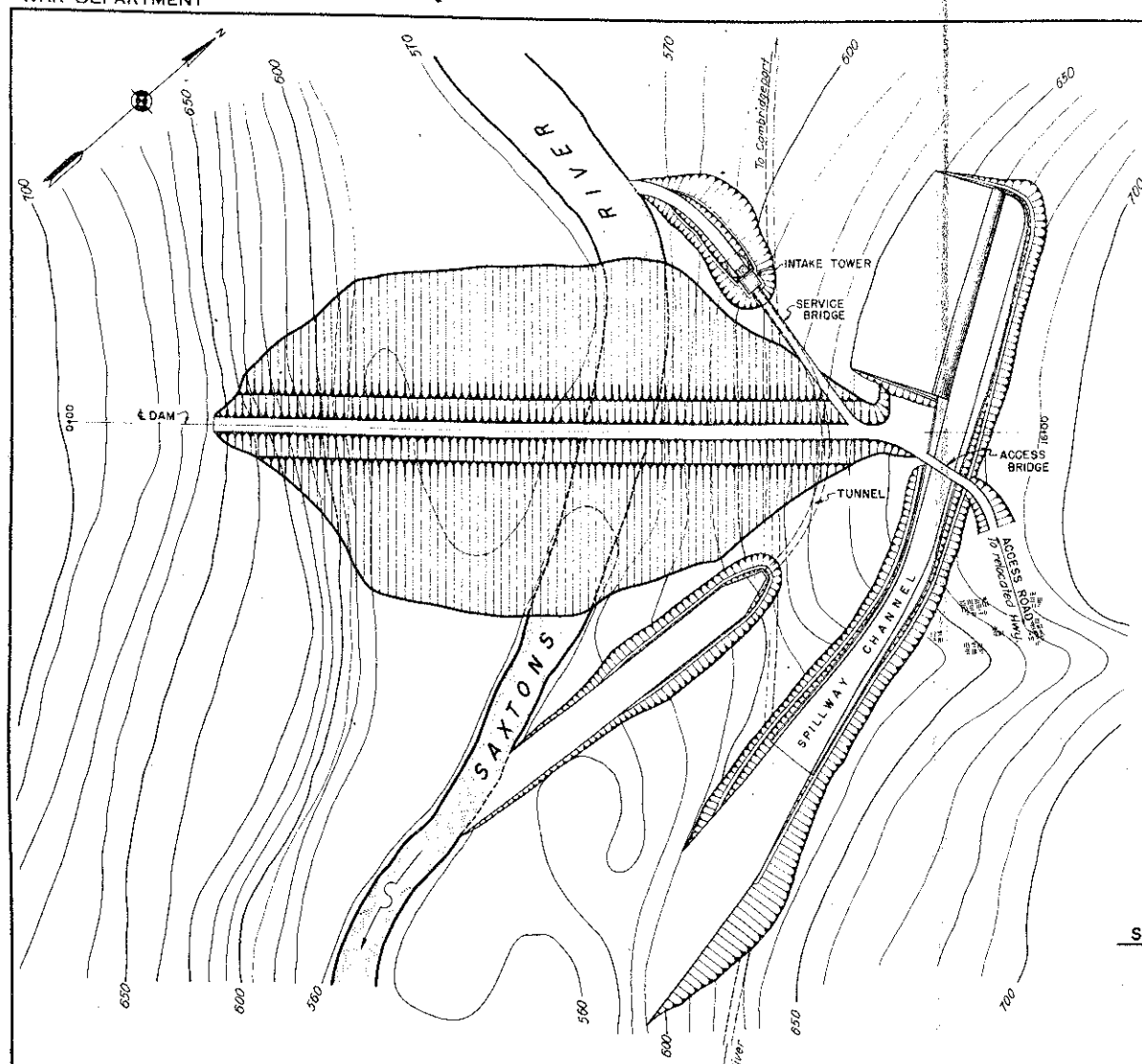
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. D. Mugnin, ASSOC. ENGINEER

DRAWN: H.A.V. TRACED: H.A.V. CHECKED:

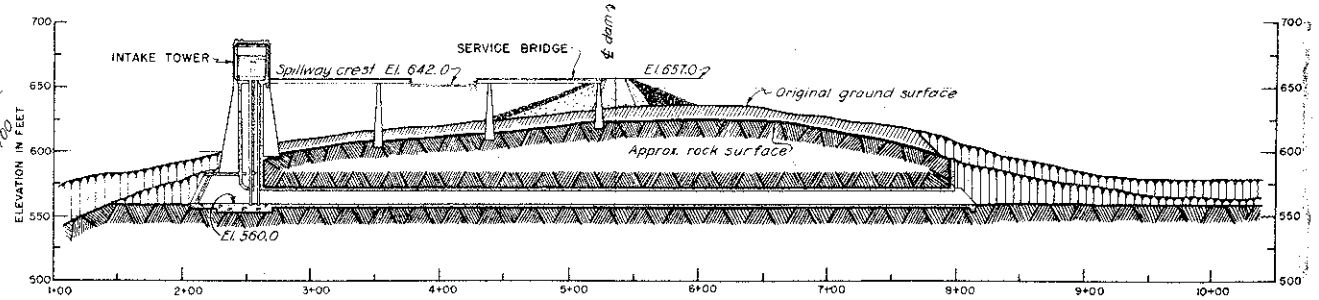
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-1426



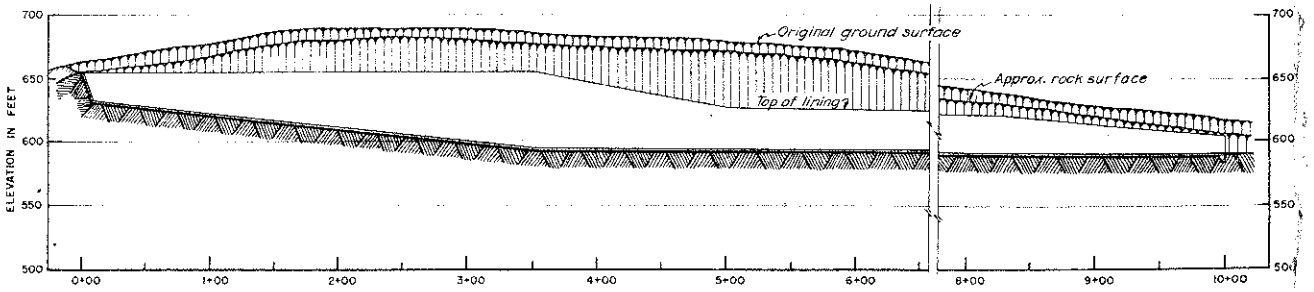
PLAN

SCALE: 1" = 100'



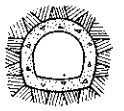
PROFILE ON ℄ TUNNEL

SCALE: HOR. - 1" = 50'
VERT. - 1" = 50'



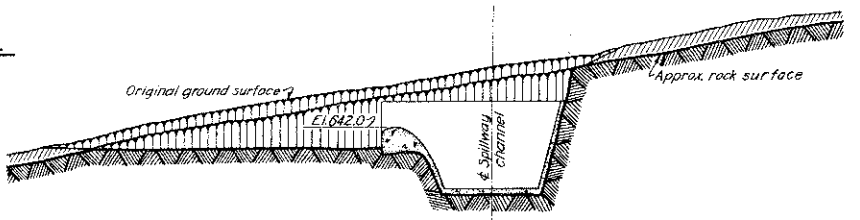
PROFILE ON ℄ SPILLWAY CHANNEL

SCALE: HOR. - 1" = 50'
VERT. - 1" = 50'



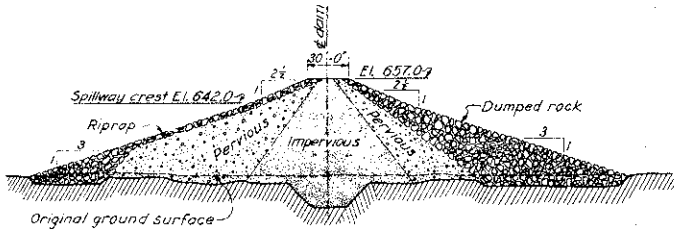
SECTION THRU TUNNEL

SCALE 1" = 10'



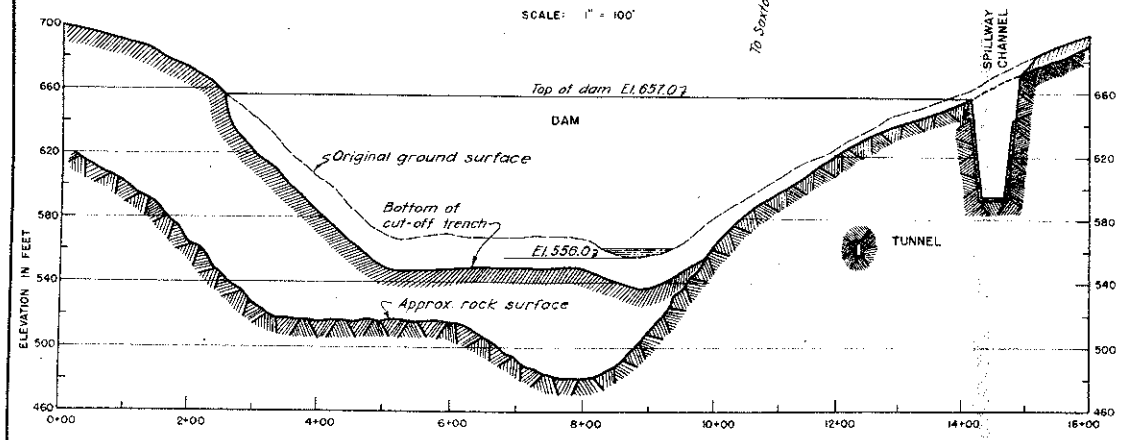
SECTION THRU SPILLWAY WEIR

SCALE: 1" = 30'



TYPICAL SECTION THRU DAM

SCALE: 1" = 40



PROFILE ON ℄ DAM

SCALE: HOR. - 1" = 100'
VERT. - 1" = 40'

NOTE

Elevations refer to Mean Sea Level Datum

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

CAMBRIDGEPORT DAM

GENERAL PLAN

SAXTONS RIVER — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 100 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

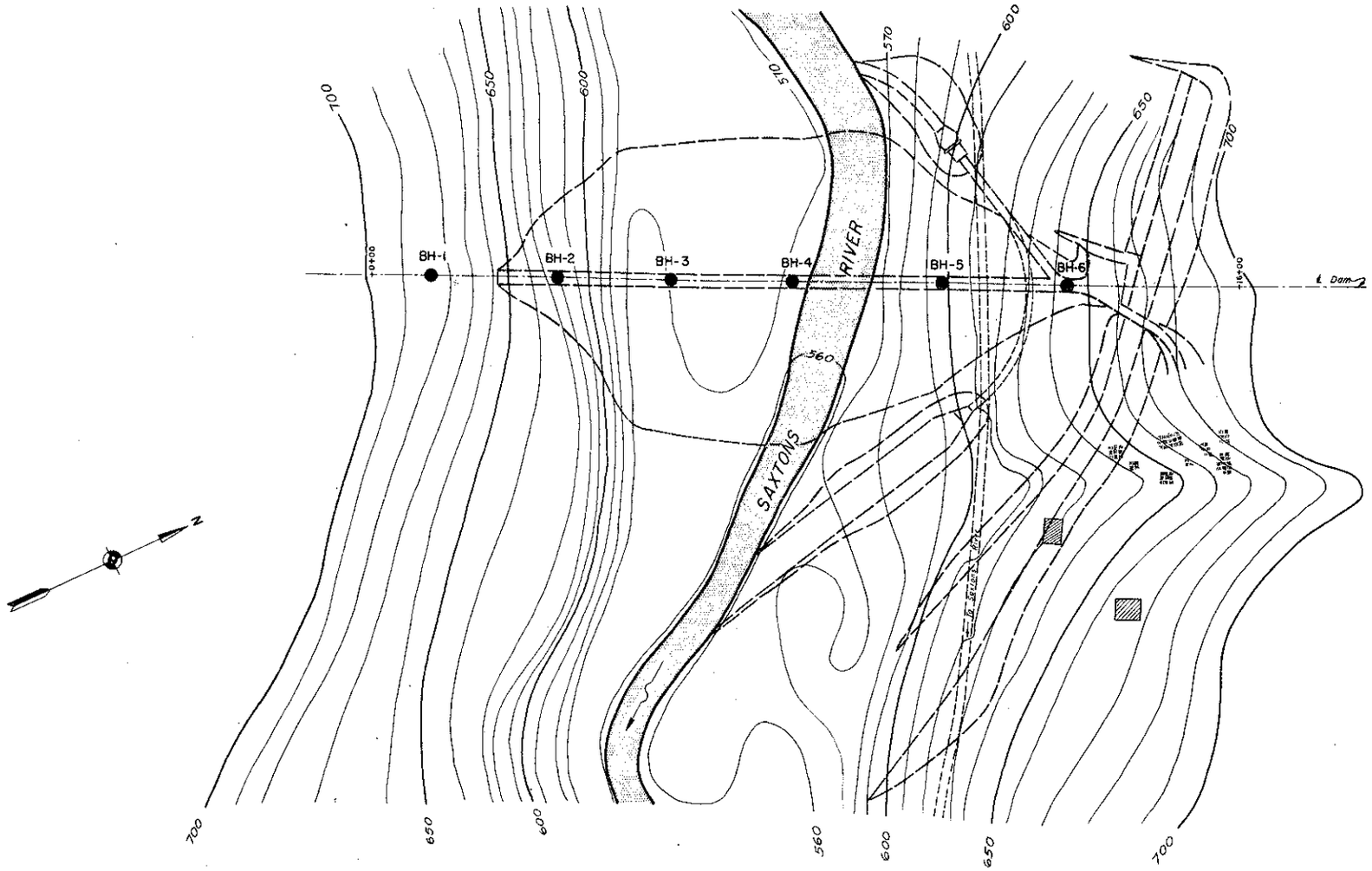
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

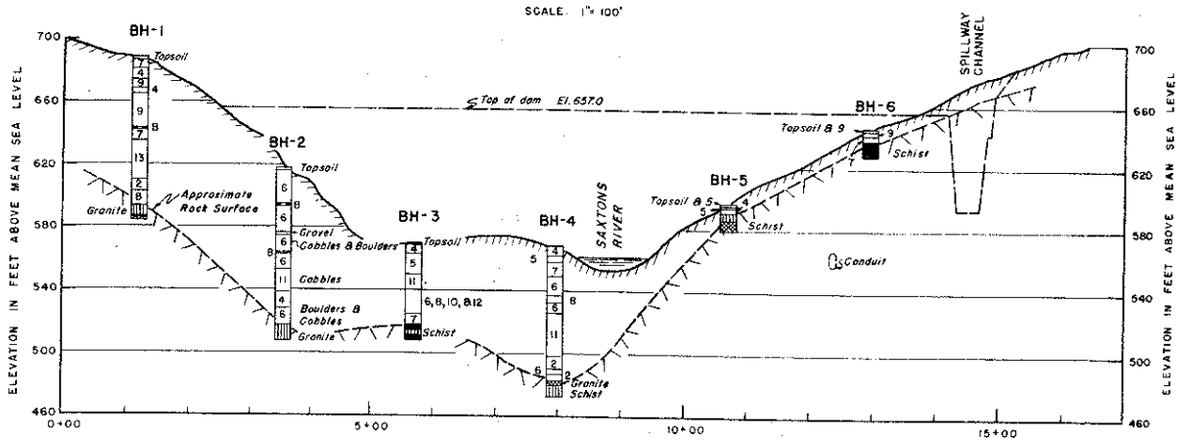
DRAWN P. A. B.
TRACED D. L. B.
CHECKED

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-1-1458



PLAN

SCALE: 1" = 100'



PROFILE ON ℄ DAM

SCALES: HOR. 1" = 100'
VERT. 1" = 40'

SOURCES OF BORROW

Pervious material available within 1.0 miles upstream.

Impervious material available within 0.5 miles upstream on right bank.

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%
- Weathered and fractured bedrock, core recovery between 50% and 75%
- Less weathered and fractured bedrock, core recovery more than 75%
- BH Drive sample bore hole
- Ledge outcrop

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A.

KEY	DATE	REVISION (Indicated by Δ)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

CAMBRIDGEPORT DAM

GEOLOGY

SAXTONS RIVER — VERMONT

IN 3 SHEETS — SCALE: 1 IN = 100 FT. (100' 0' 100' 200') — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION

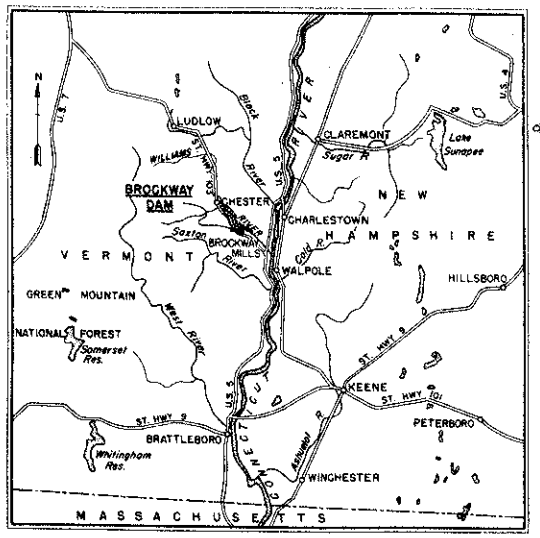
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASST. ENGINEER

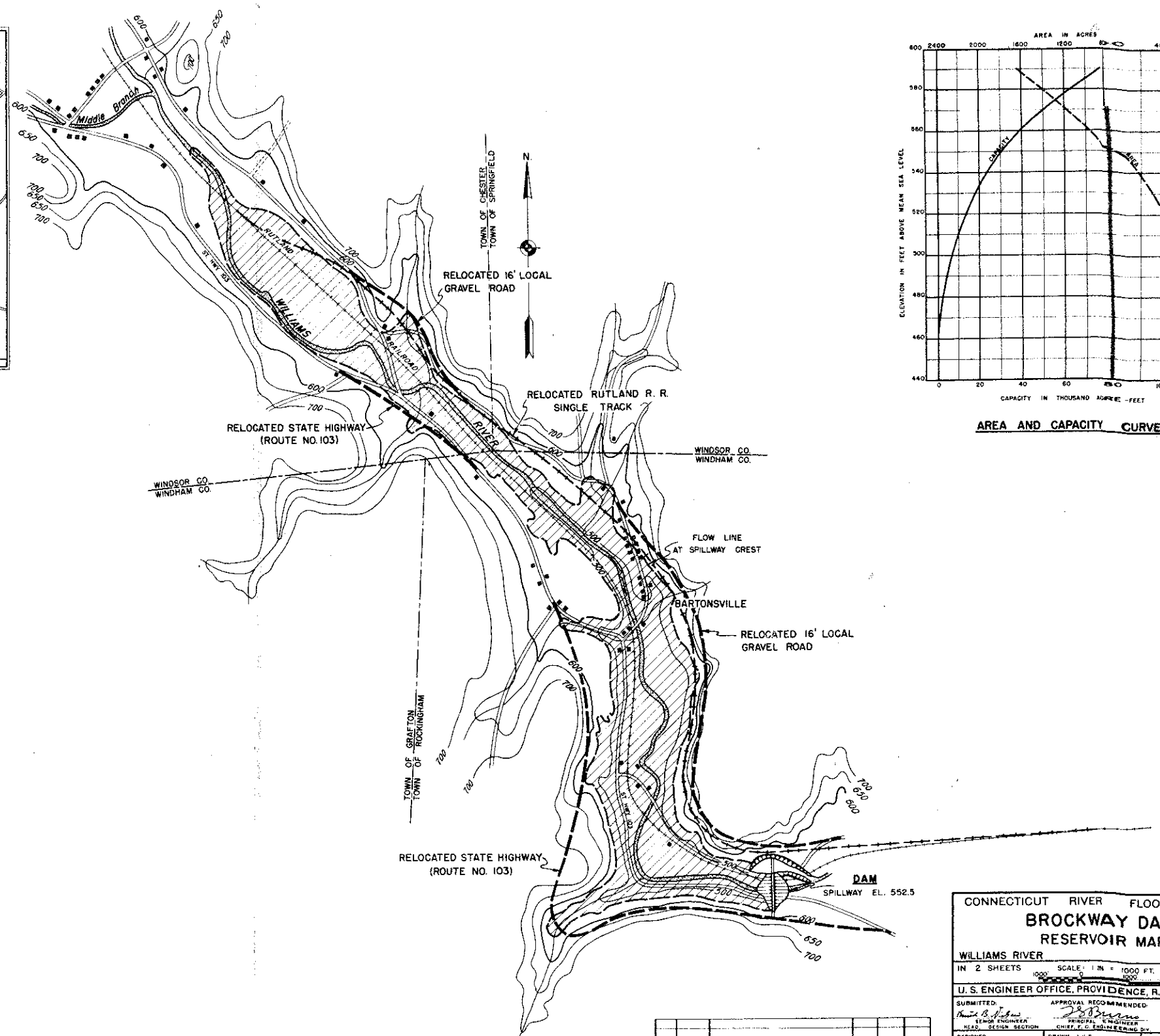
DRAWN: R. R. L.
TRACED: E. A. H.
CHECKED:

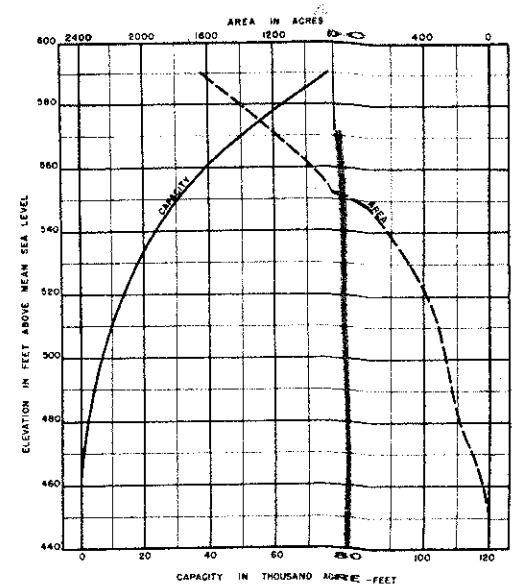
TO ACCOMPANY REPORT DATED: FEB. 26 1940
FILE NO. CT-2-1243



VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

BROCKWAY DAM
RESERVOIR MAP

WILLIAMS RIVER — VERMONT

IN 2 SHEETS — SCALE: 1 IN = 1000 FT. — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

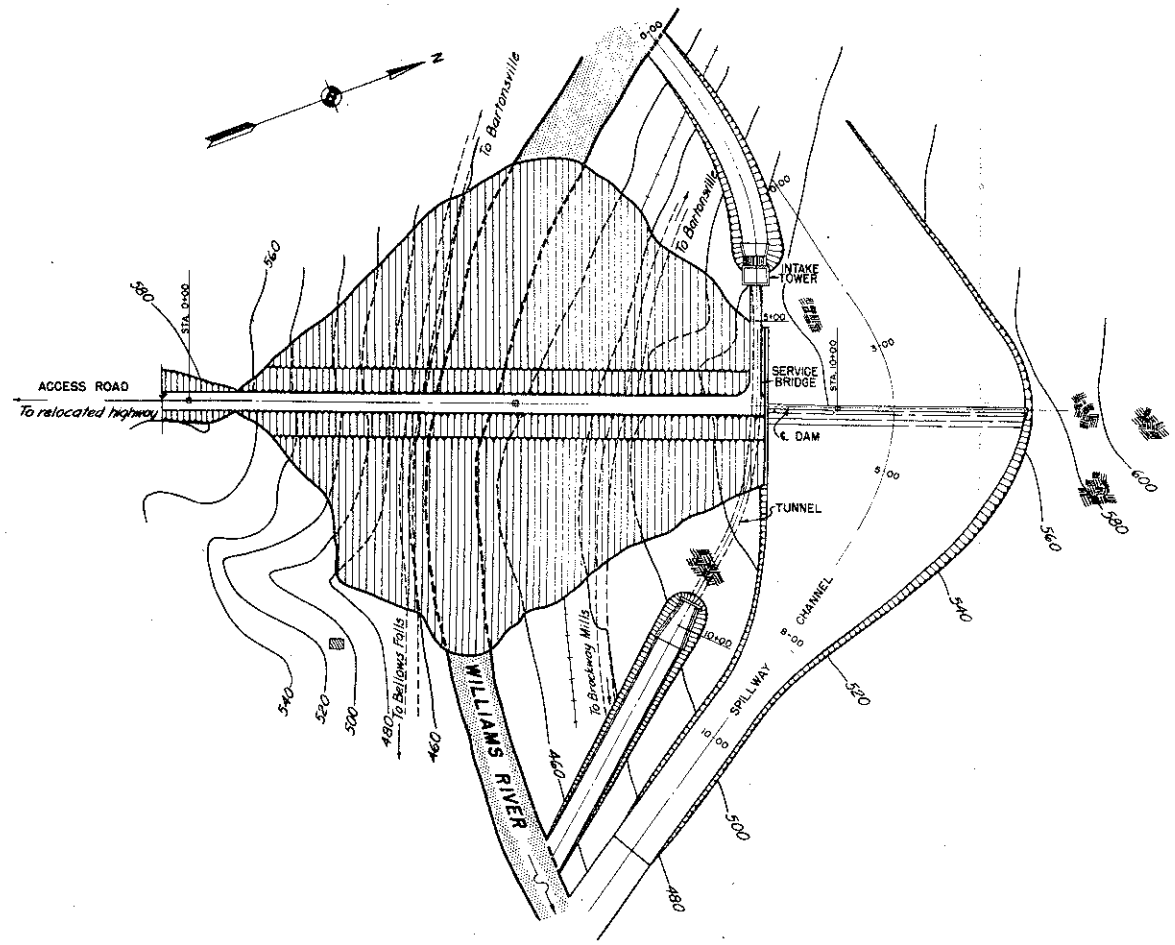
APPROVED: LIEUT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. J. Mangin, ASSOC. ENGINEER

DRAWN: L.V.P. TRACED: L.V.P. CHECKED:

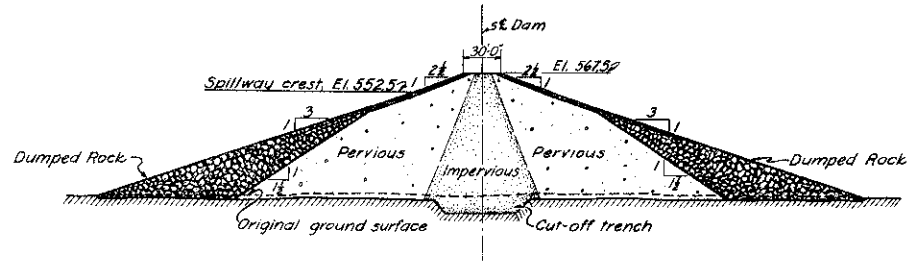
TO ACCOMPANY REPORT DATED: FEB 28, 1940

FILE NO. CT-1-1425



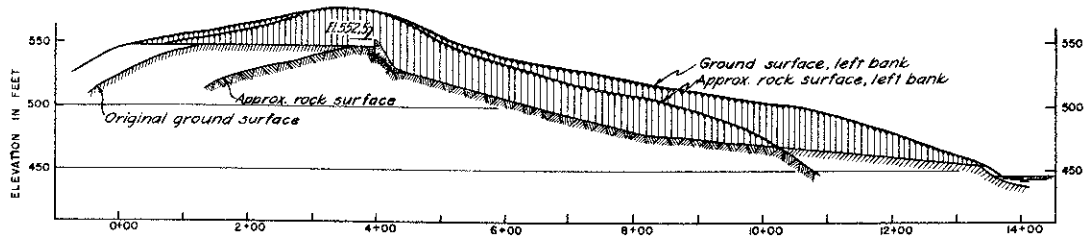
PLAN

SCALE 1" = 100'



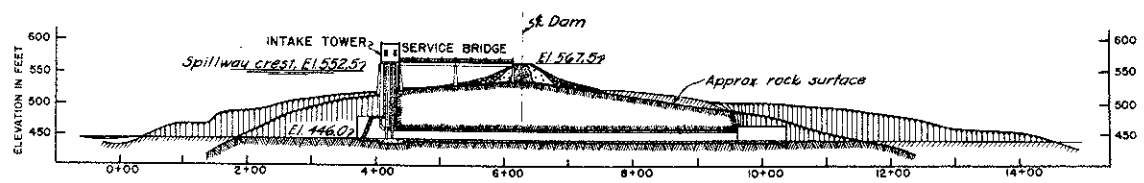
TYPICAL SECTION THRU DAM

SCALE 1" = 50'



SECTION ON ℄ SPILLWAY CHANNEL

SCALE: HOR. 1" = 100'
VERT. 1" = 50'

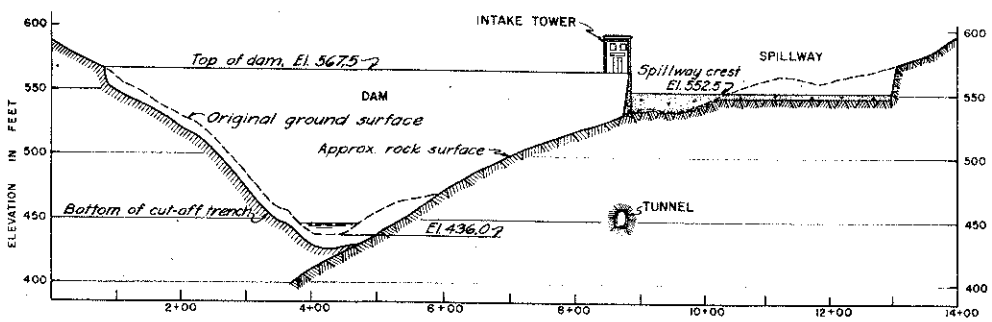


SECTION ON ℄ TUNNEL

SCALE 1" = 100'

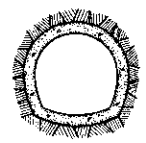
NOTE

Elevations refer to Mean Sea Level Datum.



PROFILE ON ℄ DAM

SCALE: HOR. 1" = 100'
VERT. 1" = 50'



SECTION THRU TUNNEL

SCALE 1" = 10'

KEY	DATE	REVISION (indicated by Δ)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

BROCKWAY DAM

GENERAL PLAN

WILLIAMS RIVER — VERMONT

IN 2 SHEETS — SCALE: 1 IN. = 100 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

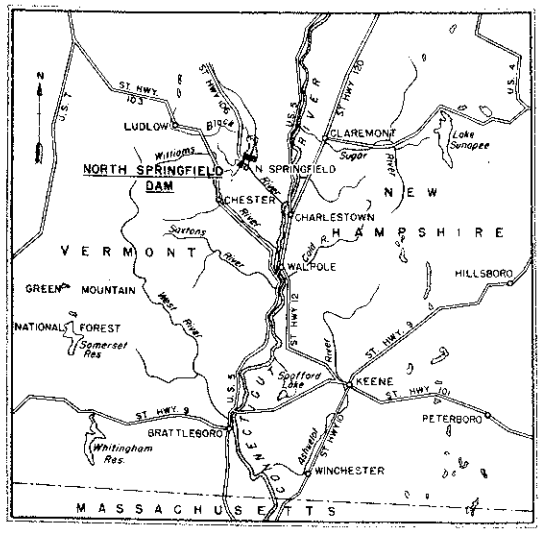
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LIEUT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

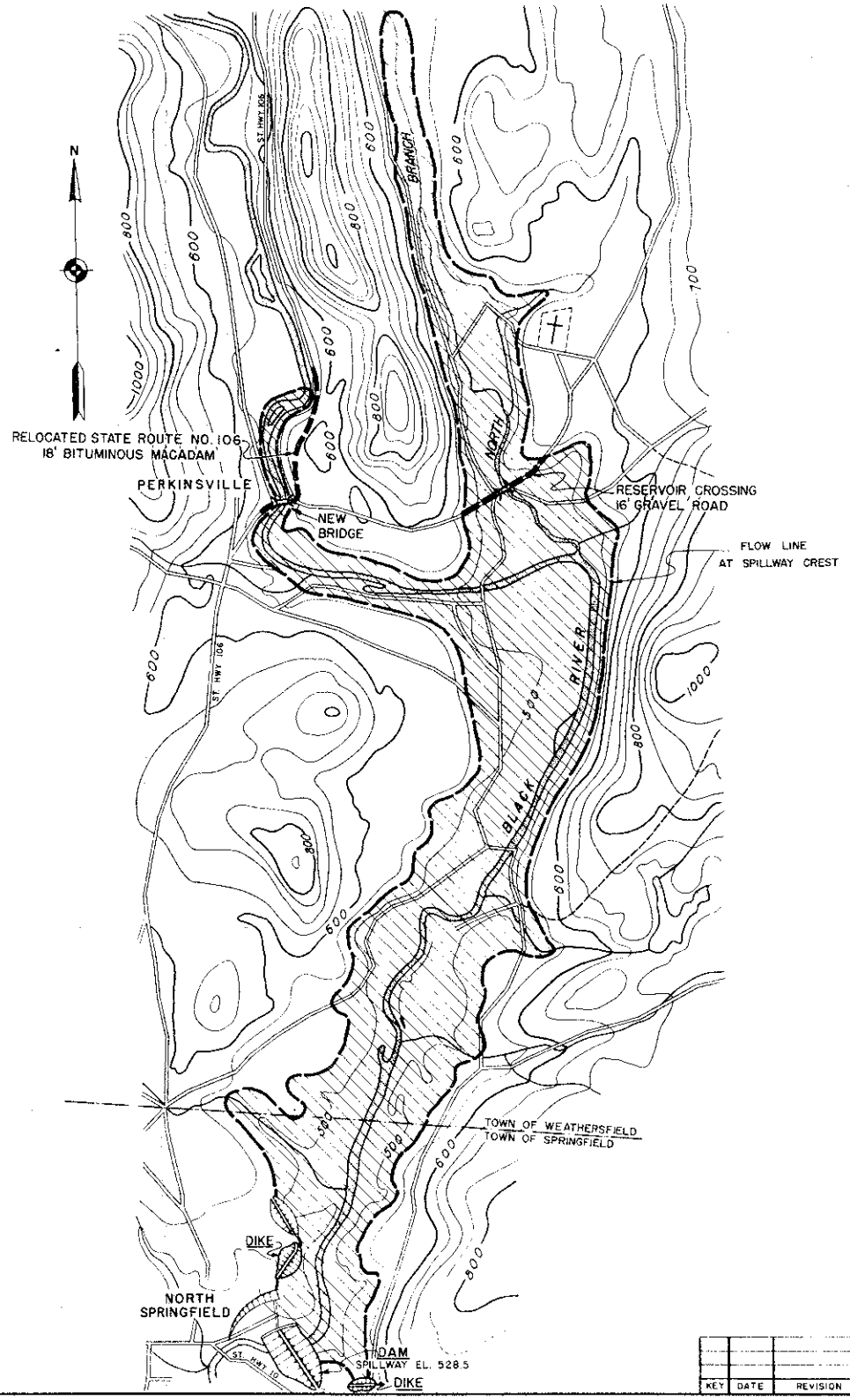
DRAWN: H. S. P.
TRACED: L. J. B.
CHECKED:

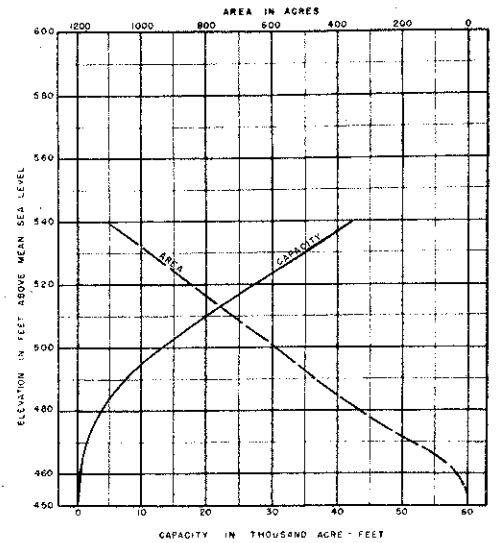
TO ACCOMPANY REPORT
DATED: FEB. 28, 1940
FILE NO. CT-1-1461



VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (Indicated by △)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH SPRINGFIELD DAM

RESERVOIR MAP

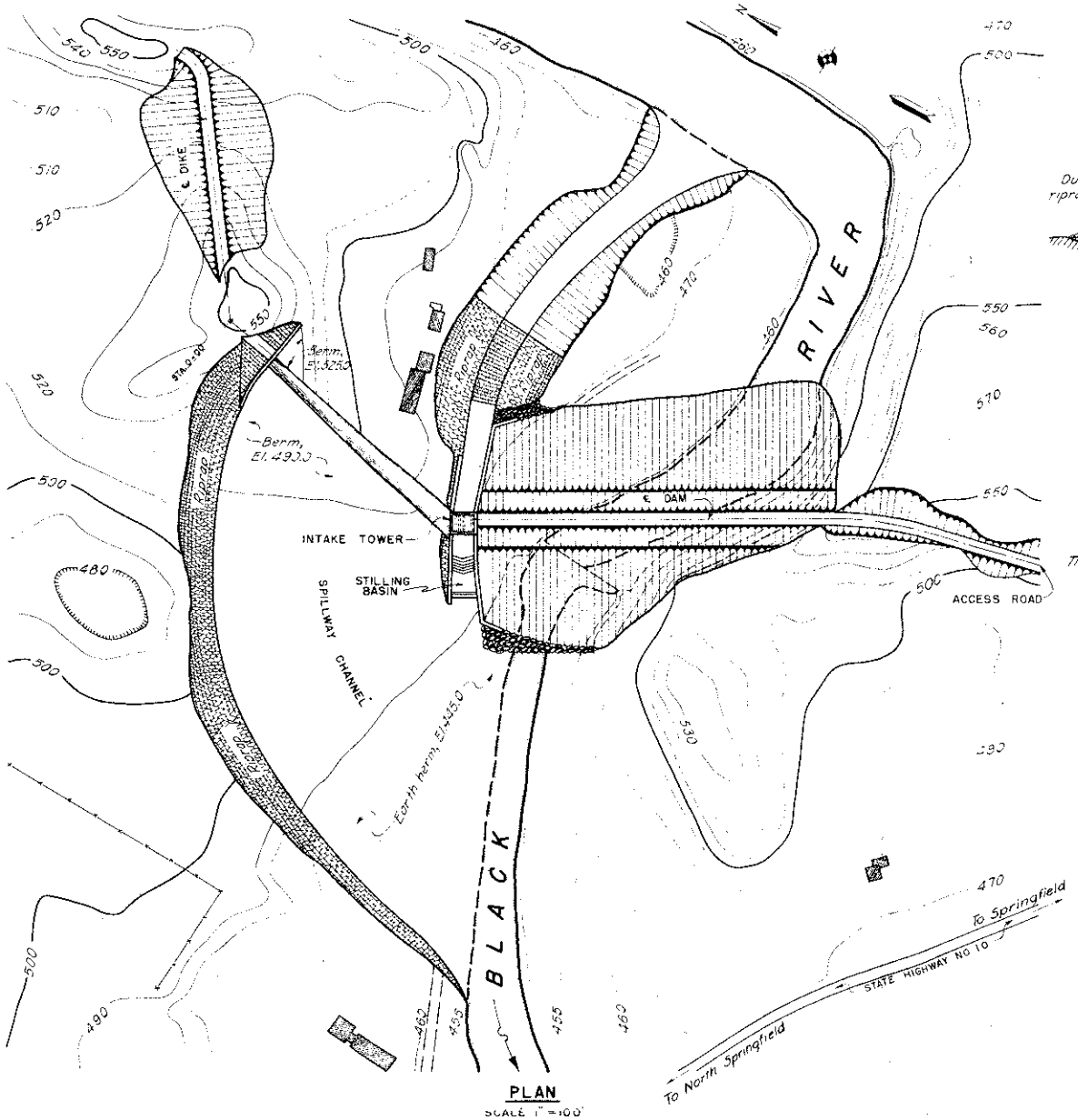
BLACK RIVER — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 1000 FT. — SHEET NO. 1

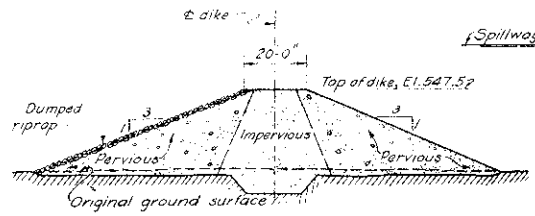
U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTR. OF ENGINEER

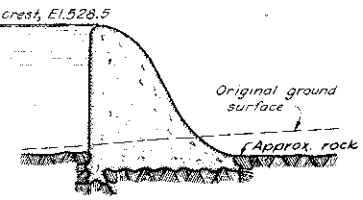
DESIGNED: A. D. Mugnier, ASSOC. ENGINEER — DRAWN: H. A. V. TRACED: H. A. V. CHECKED: — TO ACCOMPANY REPORT DATED: FEB. 28, 1940 FILE NO. CT-1-1423



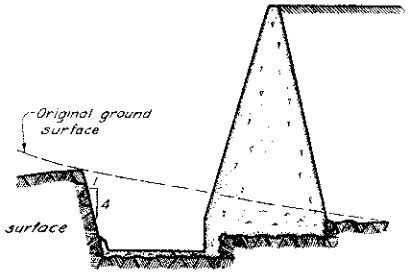
PLAN
SCALE 1" = 100'



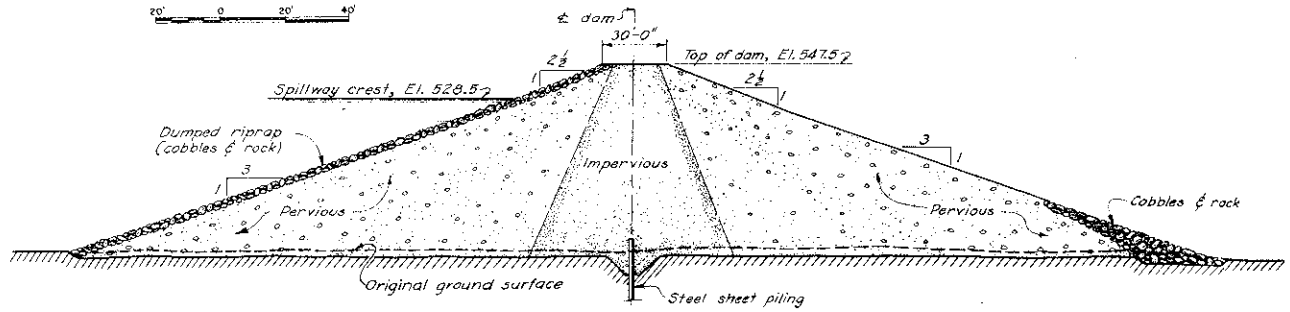
SECTION THRU DIKE
SCALE 1" = 20'



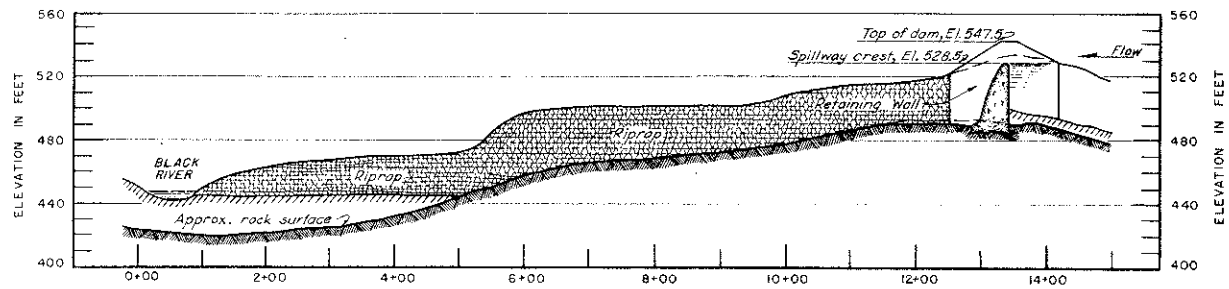
SECTION THRU SPILLWAY WEIR
SCALE 1" = 20'



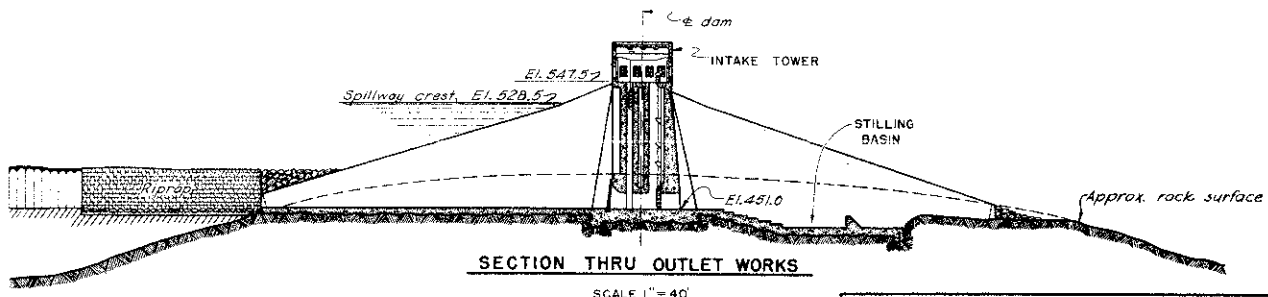
SECTION THRU RETAINING WALL
SCALE 1" = 20'



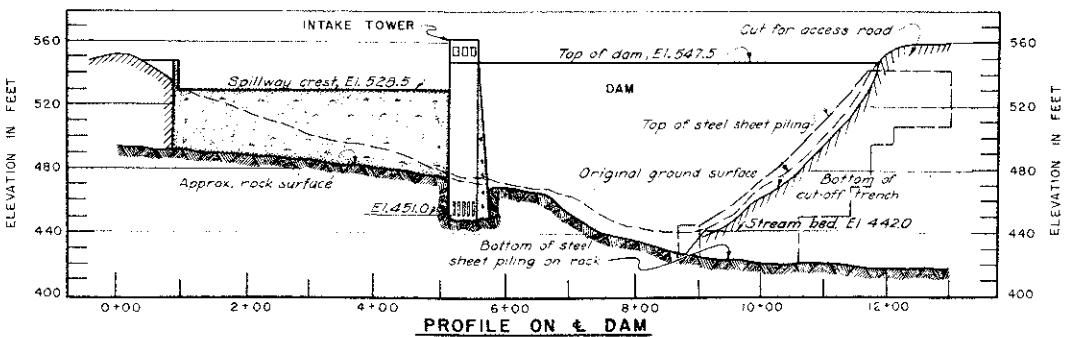
TYPICAL SECTION THRU DAM
SCALE 1" = 20'



PROFILE ON ℄ SPILLWAY CHANNEL
SCALE HOR. = 1" = 100' VERT. = 1" = 40'



SECTION THRU OUTLET WORKS
SCALE 1" = 40'



PROFILE ON ℄ DAM
SCALE HOR 1" = 100' — VERT. 1" = 40'

NOTES

Elevations refer to Mean Sea Level Datum.
See Plate No. 62 for location of additional dikes.

KEY	DATE	REVISION (Indicated by △)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL
NORTH SPRINGFIELD DAM
GENERAL PLAN

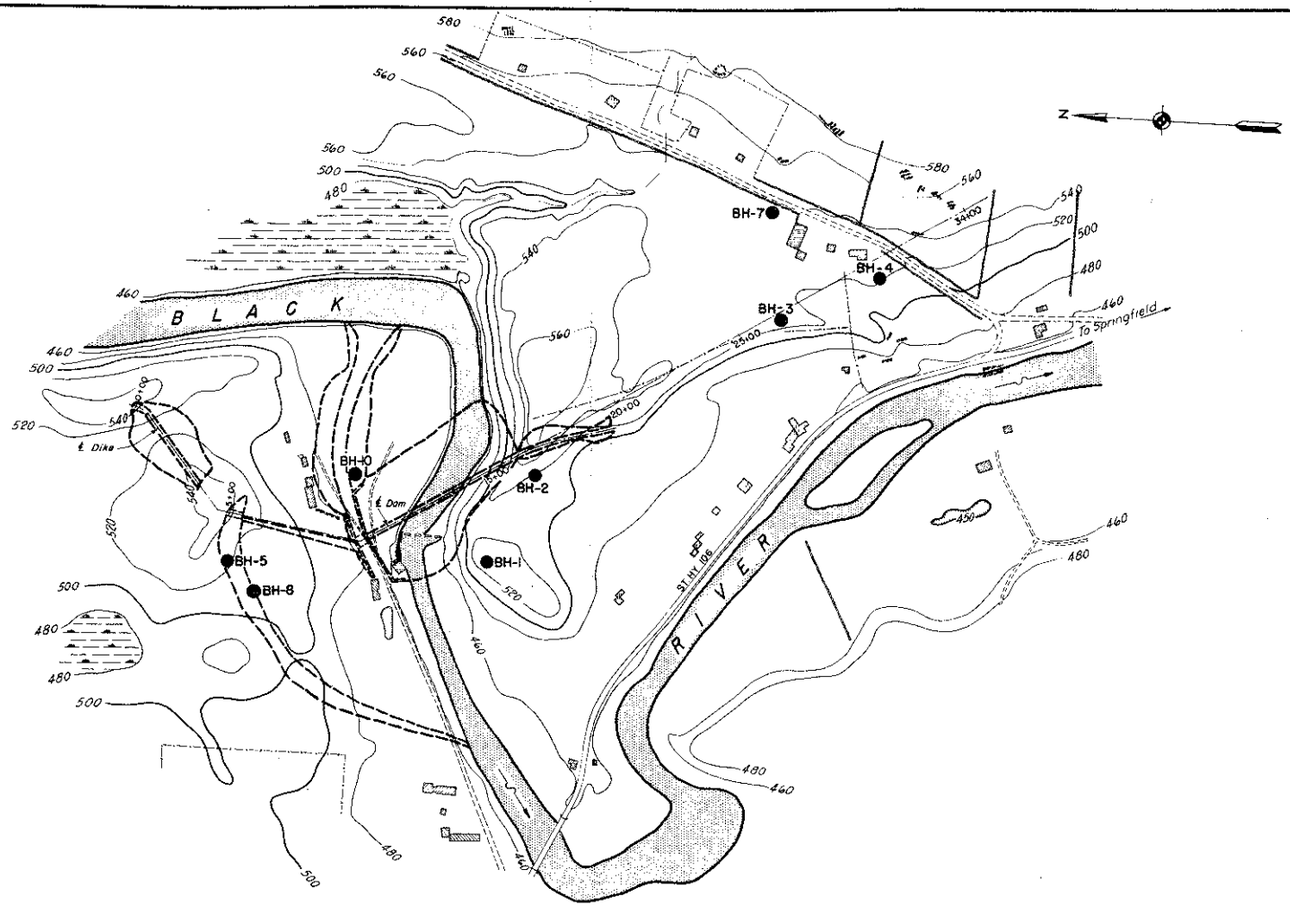
BLACK RIVER — VERMONT

IN 3 SHEETS — SCALE 1 IN. = 100 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. D. Magnier, ASSOC. ENGINEER — DRAWN: D.P. TRACED: P.J.G. CHECKED: — TO ACCOMPANY REPORT DATED FEB. 26, 1940 FILE NO. CT-1-1447



PLAN

SCALE: 1" = 200'

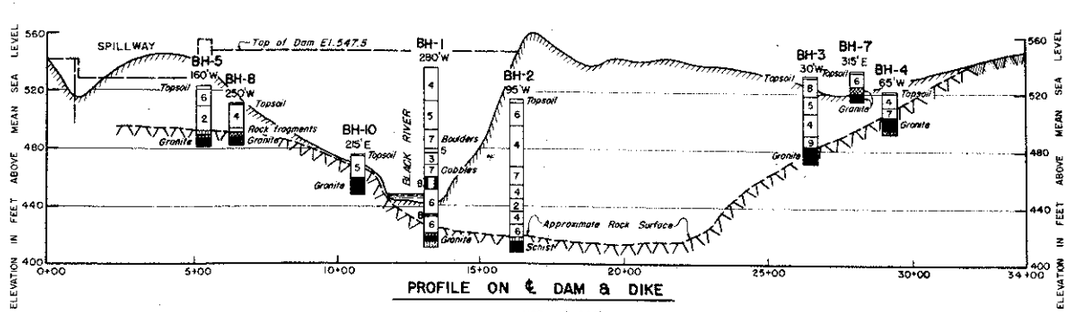
SOURCES OF BORROW

Pervious material available within 0.5 miles upstream on left bank.

Impervious material available within 0.5 miles upstream on left bank.

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%
- Weathered and fractured bedrock, core recovery between 50% and 75%
- Less weathered and fractured bedrock, core recovery more than 75%
- BH Drive sample bore hole.
- E. East of dam ℄
- W. West of dam ℄
- Ledge outcrop



PROFILE ON ℄ DAM & DIKE

SCALES: HOR. 1" = 200'
VERT. 1" = 40'

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH SPRINGFIELD DAM

GEOLOGY

BLACK RIVER — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 200 FT. — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION

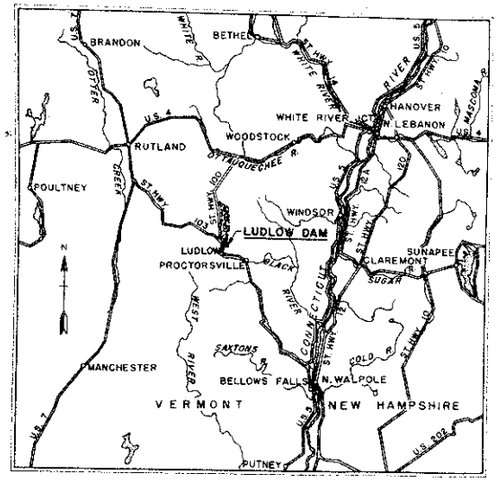
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASS'T. ENGINEER

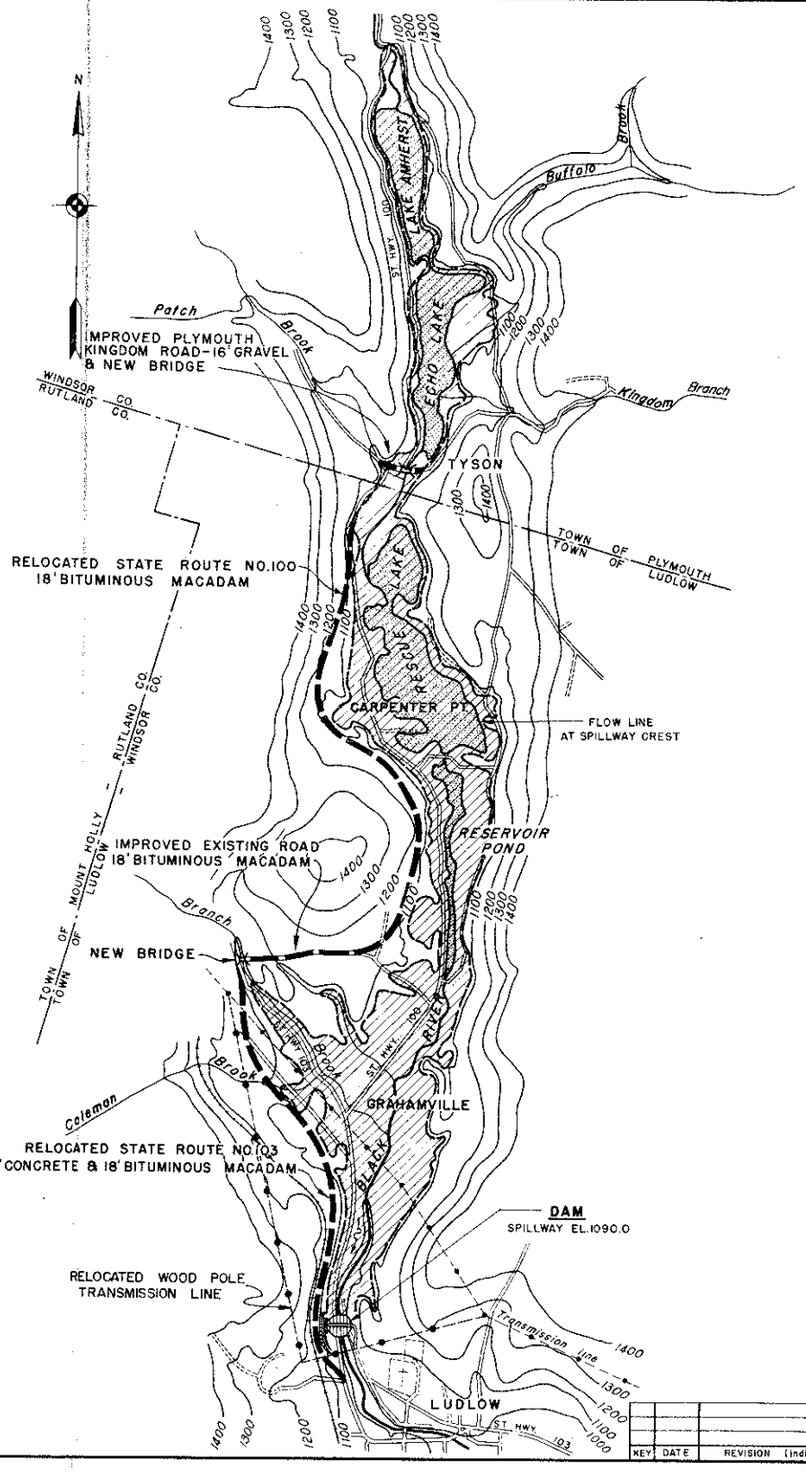
DRAWN: R. R. L.
TRACED: J.S.
CHECKED: U.H.J.

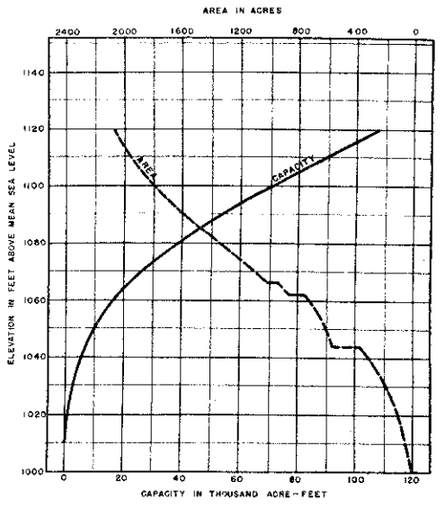
TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-2-1226



VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (indicated by △)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

LUDLOW DAM

RESERVOIR MAP

BLACK RIVER — VERMONT

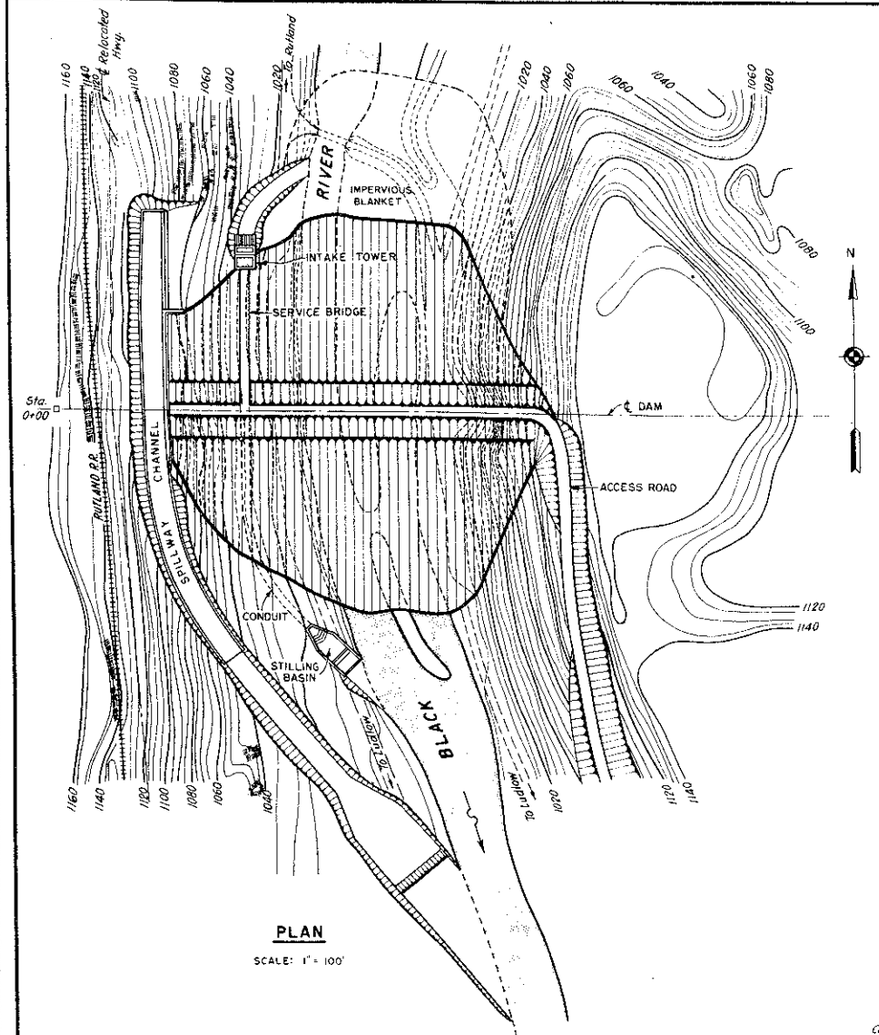
IN 3 SHEETS — SCALE 1 IN = 1500 FT. (1500' 0 1500' 3000') — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

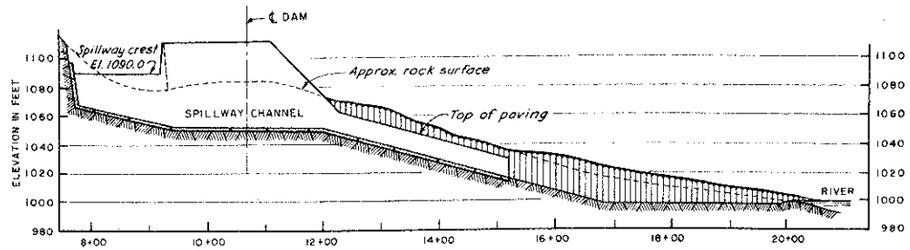
DESIGNED: A. D. Murphy, ASSOC. ENGINEER — DRAWN J. T. — TRACED J. T. — CHECKED

TO ACCOMPANY REPORT DATED: FEB. 28, 1940 — FILE NO. CT-1-1422



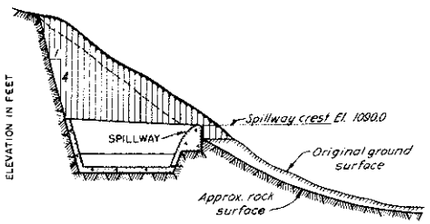
PLAN

SCALE: 1" = 100'



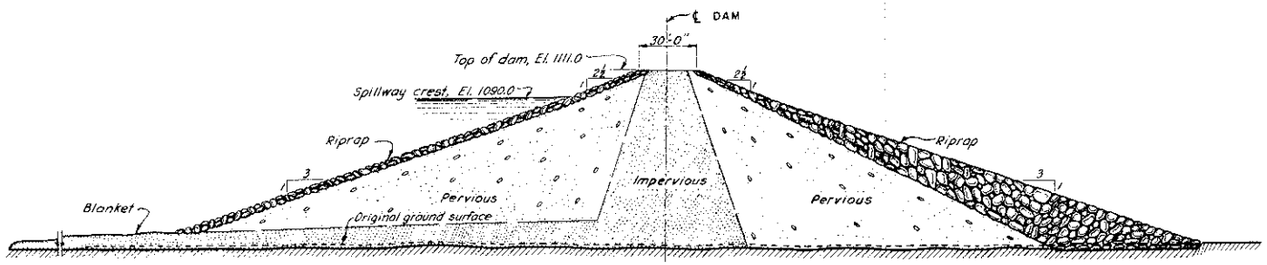
PROFILE ON ℄ SPILLWAY CHANNEL

SCALE: HORIZ. - 1" = 100'
VERT - 1" = 40'



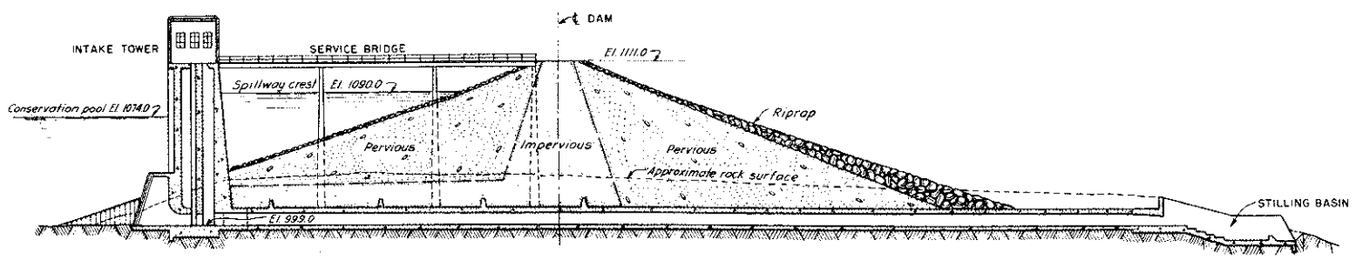
SECTION THRU SPILLWAY

SCALE: 1" = 20'



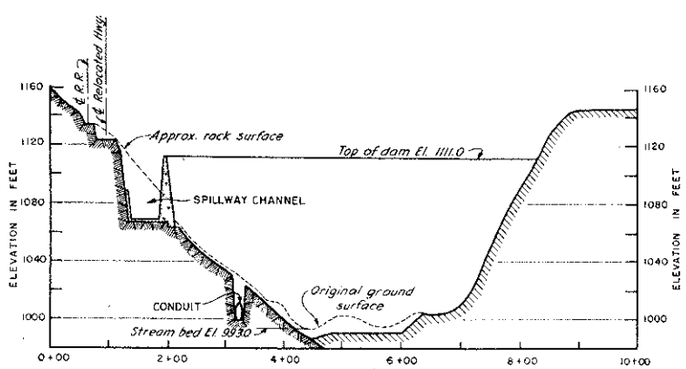
TYPICAL SECTION OF DAM

SCALE: 1" = 20'



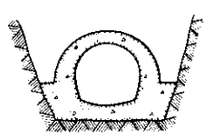
SECTION ON ℄ CONDUIT

SCALE: 1" = 40'



PROFILE ON ℄ DAM

SCALE: HORIZ. - 1" = 100'
VERT. - 1" = 40'



SECTION THRU CONDUIT

SCALE 1" = 10'

NOTE:
Elevations refer to Mean Sea Level Datum

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

LUDLOW DAM
GENERAL PLAN

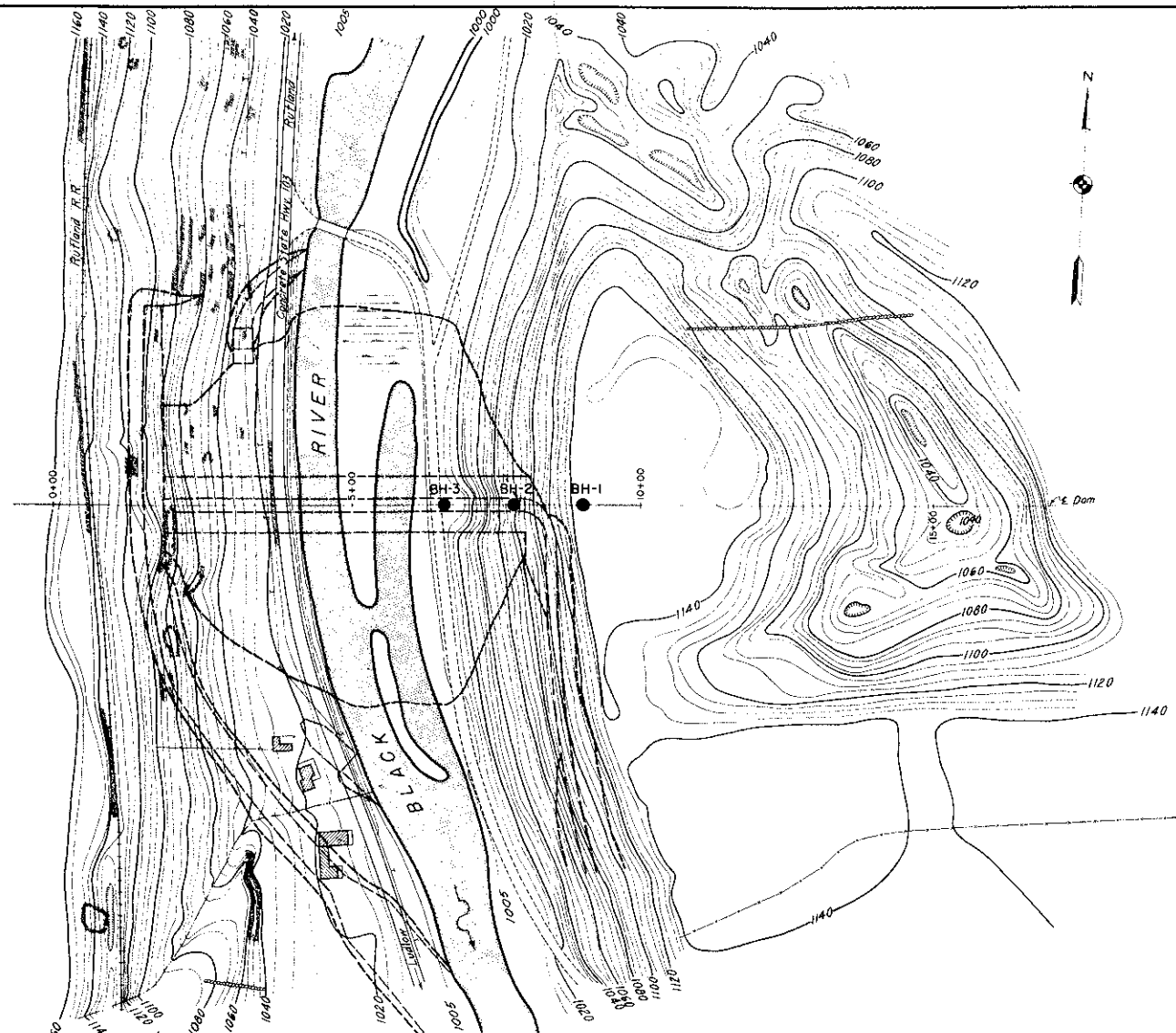
BLACK RIVER, VERMONT

IN 3 SHEETS — SCALE 1 IN. = 100 FT. — SHEET NO. 2

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — FEB. 1940

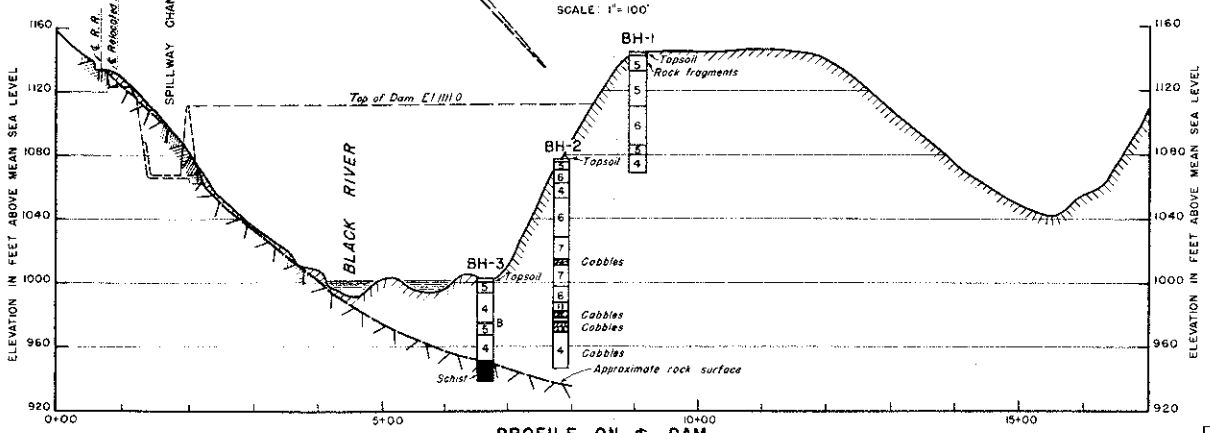
SUBMITTED: Senior Engineer, Head, Design Section
APPROVAL RECOMMENDED: Principal Engineer, Chief, F.C. Engineering Div.
APPROVED: Lt. Col. Corps of Engineers, District Engineer

DESIGNED: Assoc. Engineer
DRAWN: P.A.B.
TRACED: C.J.M.
CHECKED:
TO ACCOMPANY REPORT DATED FEB. 28, 1940
FILE NO. CT-1-1445



PLAN

SCALE: 1" = 100'



PROFILE ON ℄ DAM

SCALES: HOR. 1" = 100'
VERT. 1" = 40'

SOURCES OF BORROW

Pervious material available within 0.5 miles upstream on left bank.
Impervious material available within 0.5 miles upstream on left bank.

LEGEND

- B — Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%.
- Weathered and fractured bedrock, core recovery between 50% and 75%.
- Less weathered and fractured bedrock, core recovery more than 75%.
- BH — Drive sample bore hole.
- Ledge outcrop

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

LUDLOW DAM

GEOLOGY

BLACK RIVER — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 100 FT. (100' 0 100' 200') — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: Harold Fellquist, SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION

APPROVAL RECOMMENDED: J. B. Burns, PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: R. W. Hayes, LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

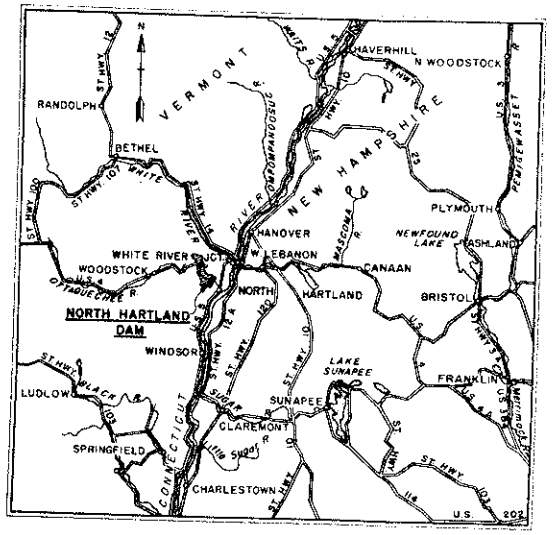
COMPILED: Wm. A. Hayes Jr., ASST. ENGINEER

DRAWN: R. R. L.
TRACED: W. E. L.
CHECKED: Wm. A. Hayes Jr.

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-2-1231

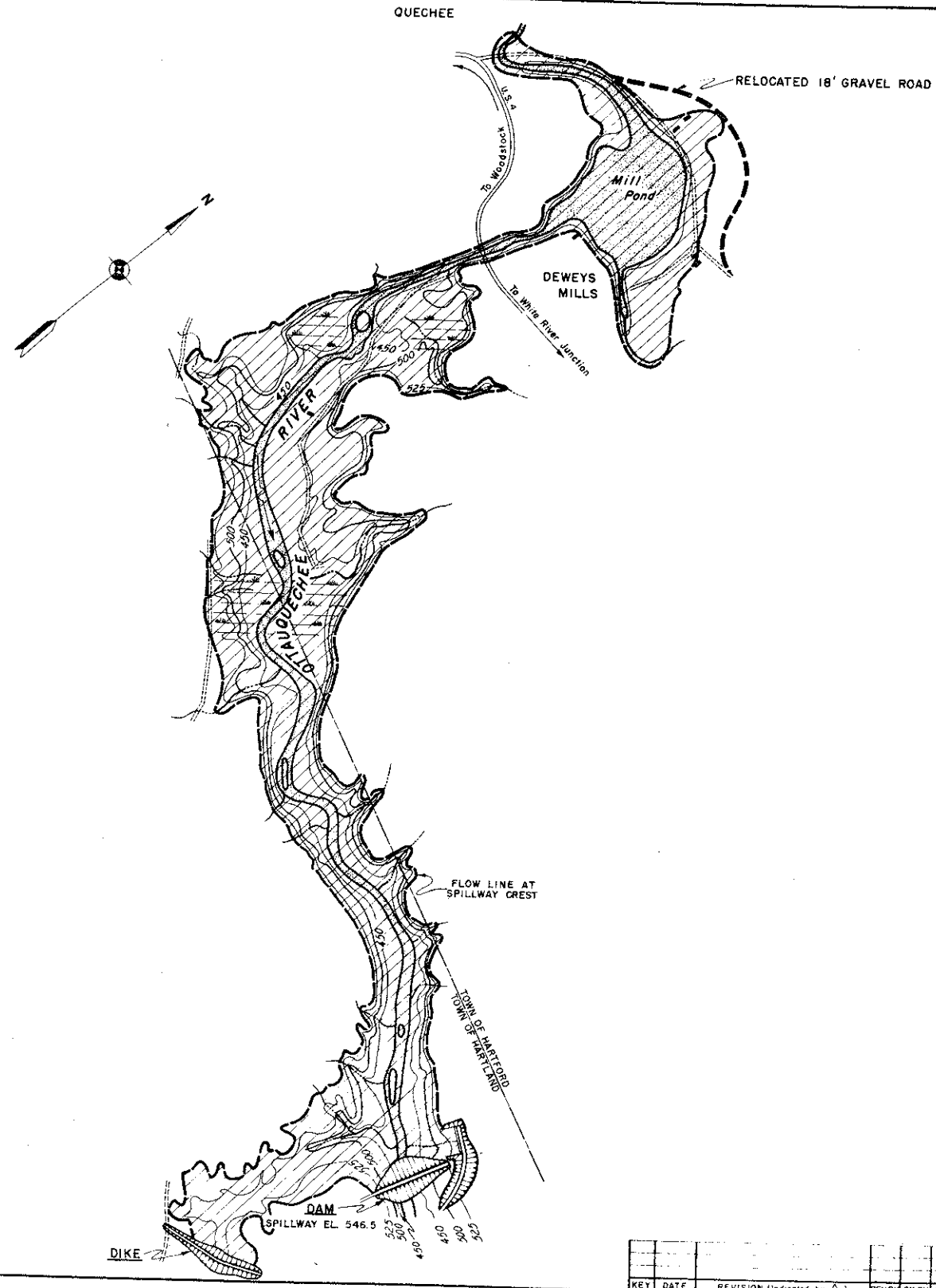
WAR DEPARTMENT

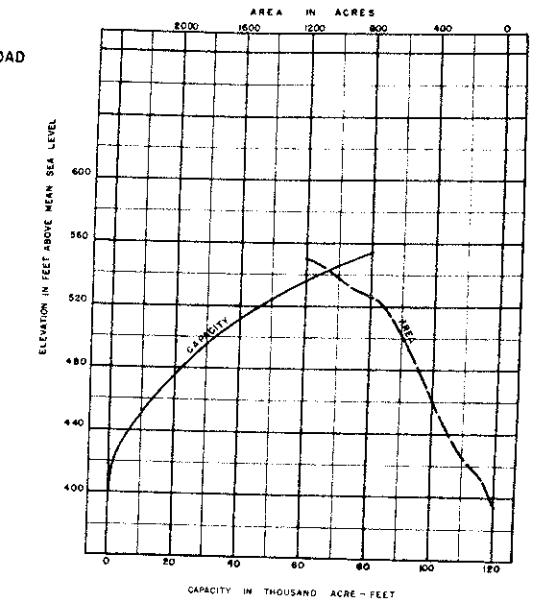
CORPS OF ENGINEERS, U. S. ARMY



VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH HARTLAND DAM

RESERVOIR MAP

OTTAUQUECHEE RIVER — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 1000 FT. — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, C. & E. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

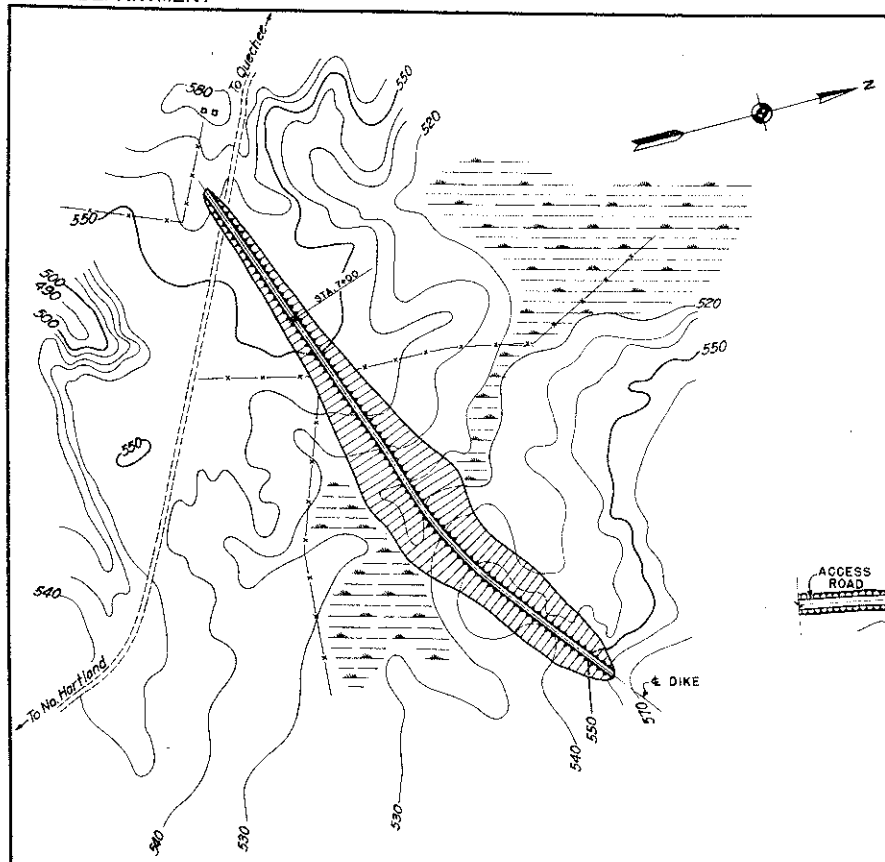
DESIGNED: ASSOC. ENGINEER

DRAWN: N. M. V.
TRACED: N. M. V.
CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 28, 1940

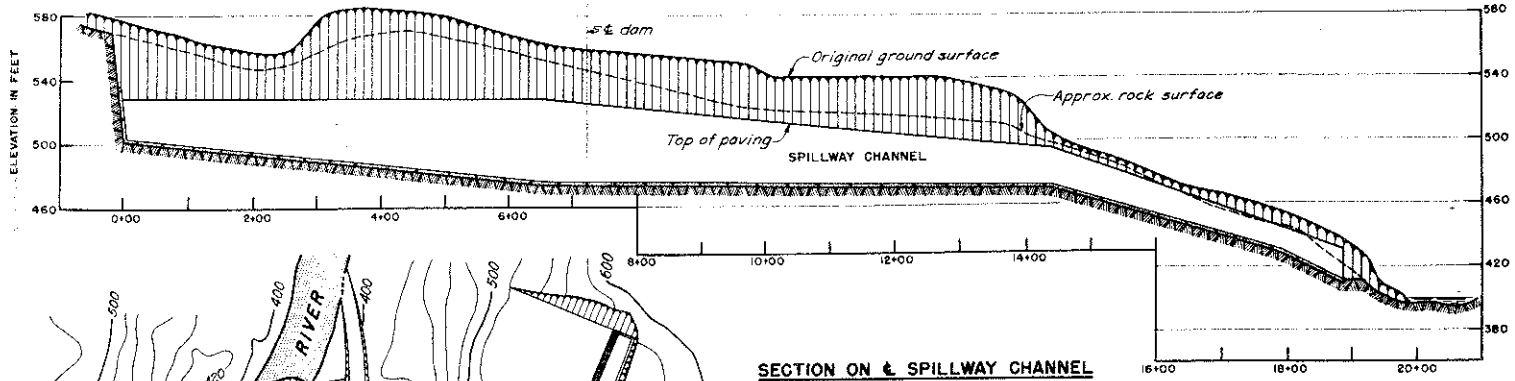
FILE NO. CT-(-142)

APPENDIX PLATE NO. 6



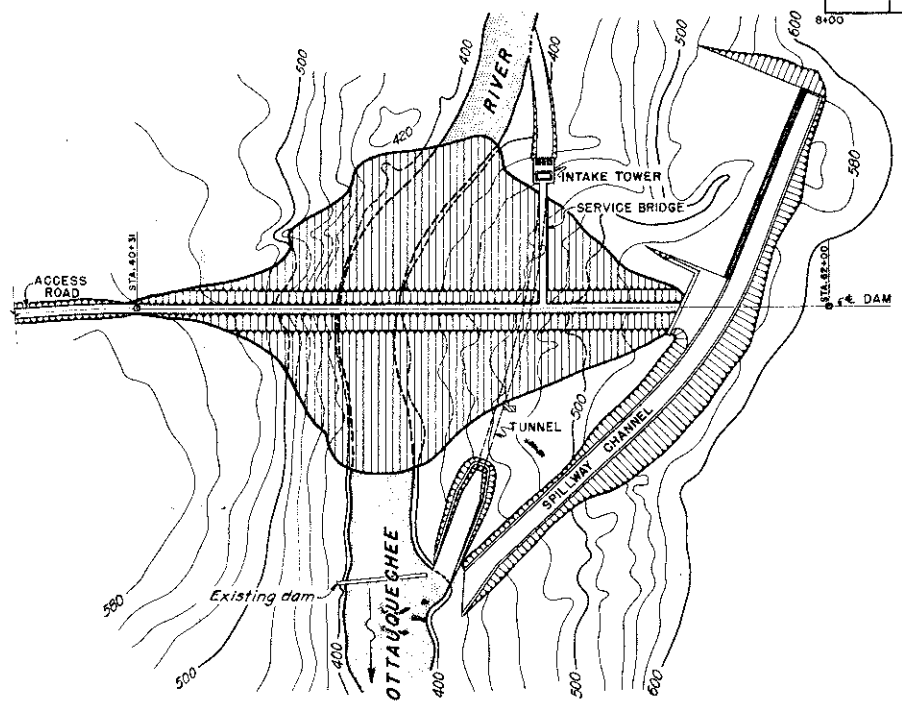
PLAN OF DIKE

SCALE: 1" = 200'



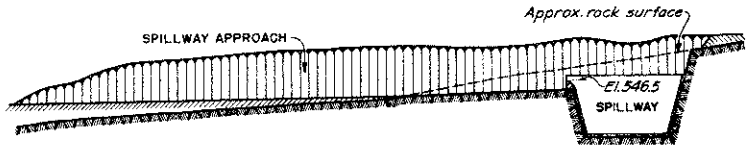
SECTION ON ℄ SPILLWAY CHANNEL

SCALE: 1" = 100'



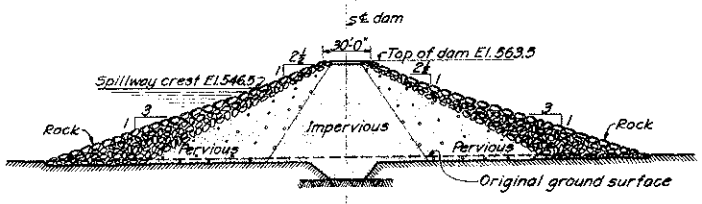
PLAN OF DAM

SCALE: 1" = 200'



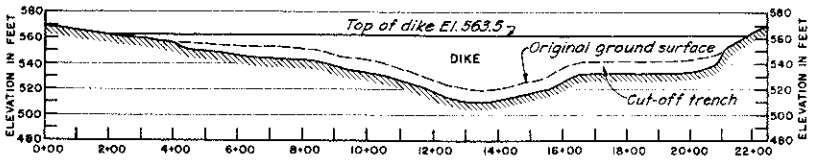
SECTION THRU SPILLWAY

SCALE: 1" = 40'



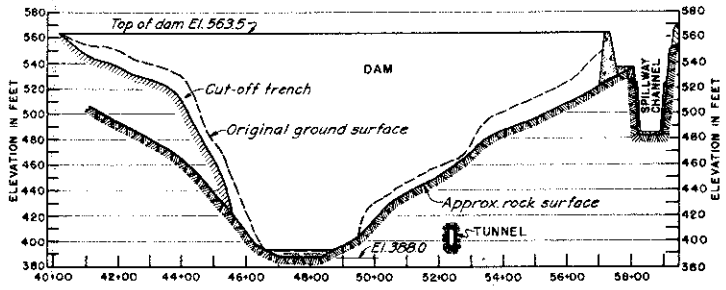
TYPICAL SECTION THRU DAM

SCALE: 1" = 40'



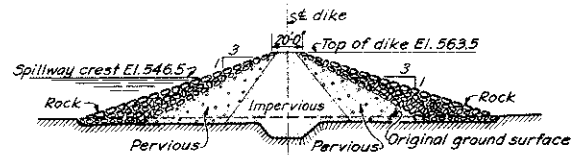
PROFILE ON ℄ DIKE

SCALE: HOR: 1" = 200' VERT: 1" = 50'



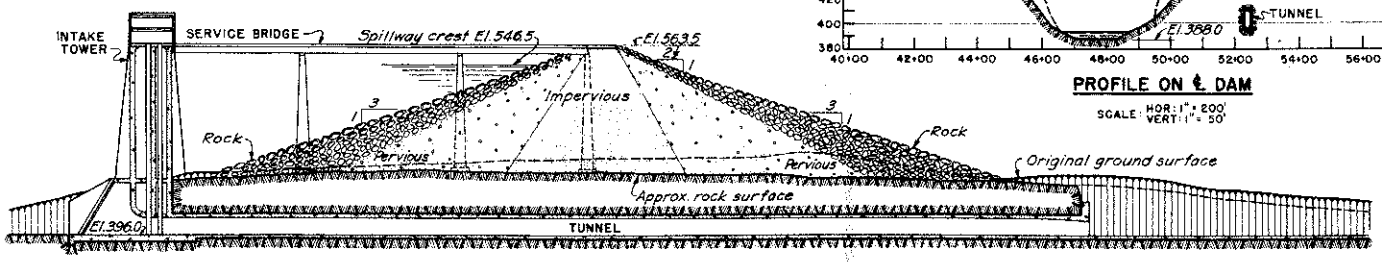
PROFILE ON ℄ DAM

SCALE: HOR: 1" = 200' VERT: 1" = 50'



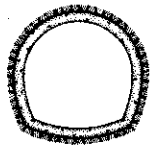
TYPICAL SECTION THRU DIKE

SCALE: 1" = 40'



SECTION ON ℄ TUNNEL

SCALE: 1" = 50'



SECTION THRU TUNNEL

SCALE: 1" = 10'

NOTE

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by Δ)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH HARTLAND DAM

GENERAL PLAN

OTTAUQUECHEE RIVER — VERMONT

IN 3 SHEETS — SCALE 1 IN. = 200 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

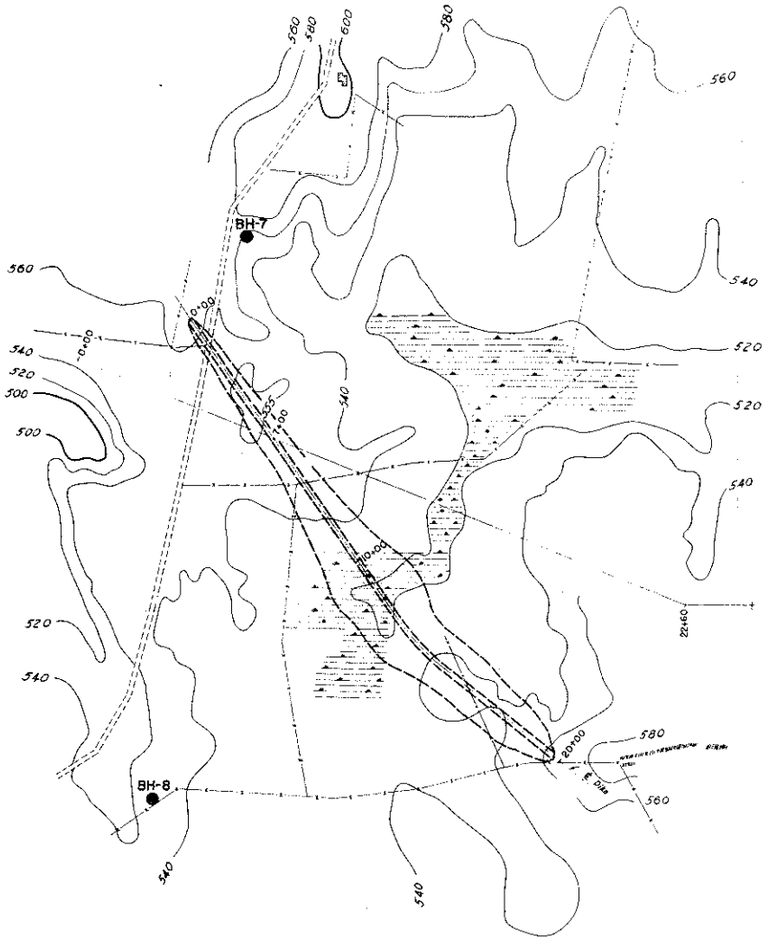
APPROVED: COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

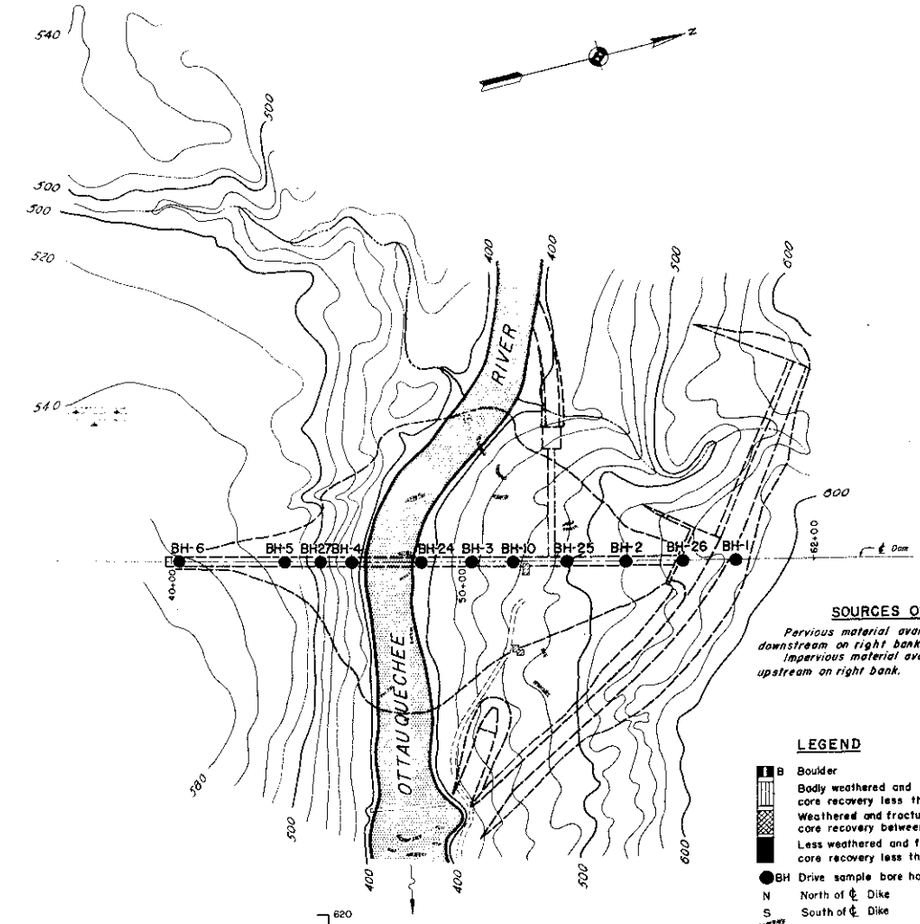
DESIGNED: ASSOC. ENGINEER

DRAWN: A. S. TRACED: F. R. M. CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-1446





PLAN

SCALE: 1" = 200'

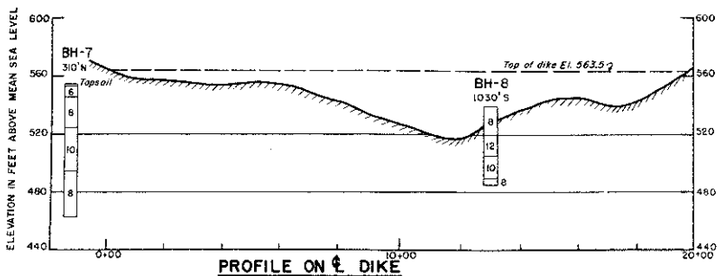
SOURCES OF BORROW

Pervious material available within 1.0 miles downstream on right bank.

Impervious material available within 0.5 miles upstream on right bank.

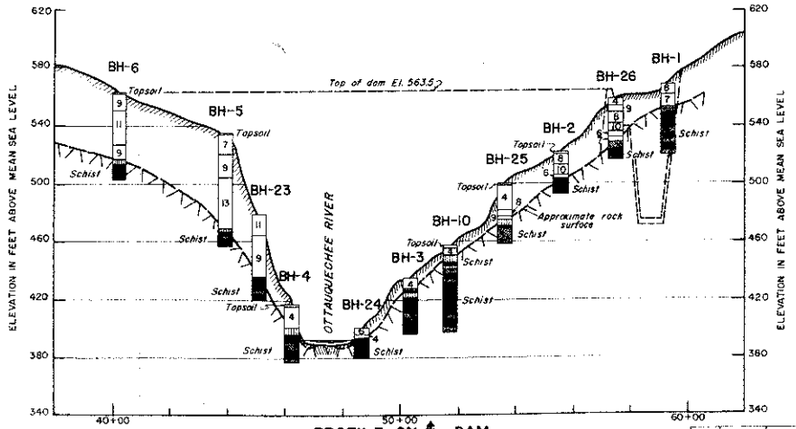
LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%.
- Weathered and fractured bedrock, core recovery between 50% and 75%.
- Less weathered and fractured bedrock, core recovery less than 75%.
- BH Drive sample bore hole
- N North of ℄ Dike
- S South of ℄ Dike
- Ledge outcrop



PROFILE ON ℄ DIKE

SCALES: HOR. 1" = 200'
VERT. 1" = 40'



PROFILE ON ℄ DAM

SCALES: HOR. 1" = 200'
VERT. 1" = 40'

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A.

KEY	DATE	REVISION (Indicated by Δ)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH HARTLAND DAM

GEOLOGY

OTTAUQUECHEE RIVER — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 200 FT. — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION

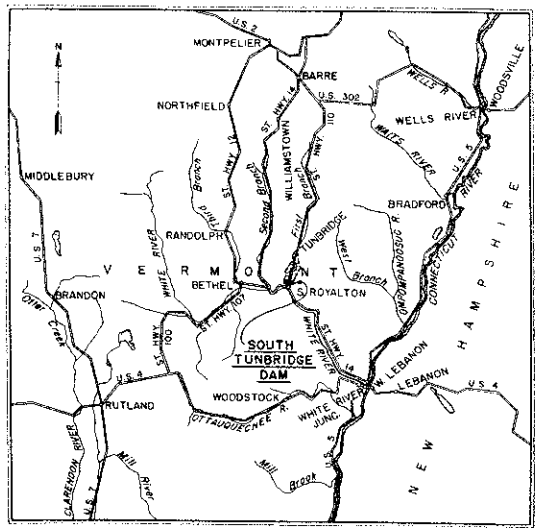
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LEGAL CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASS'T ENGINEER

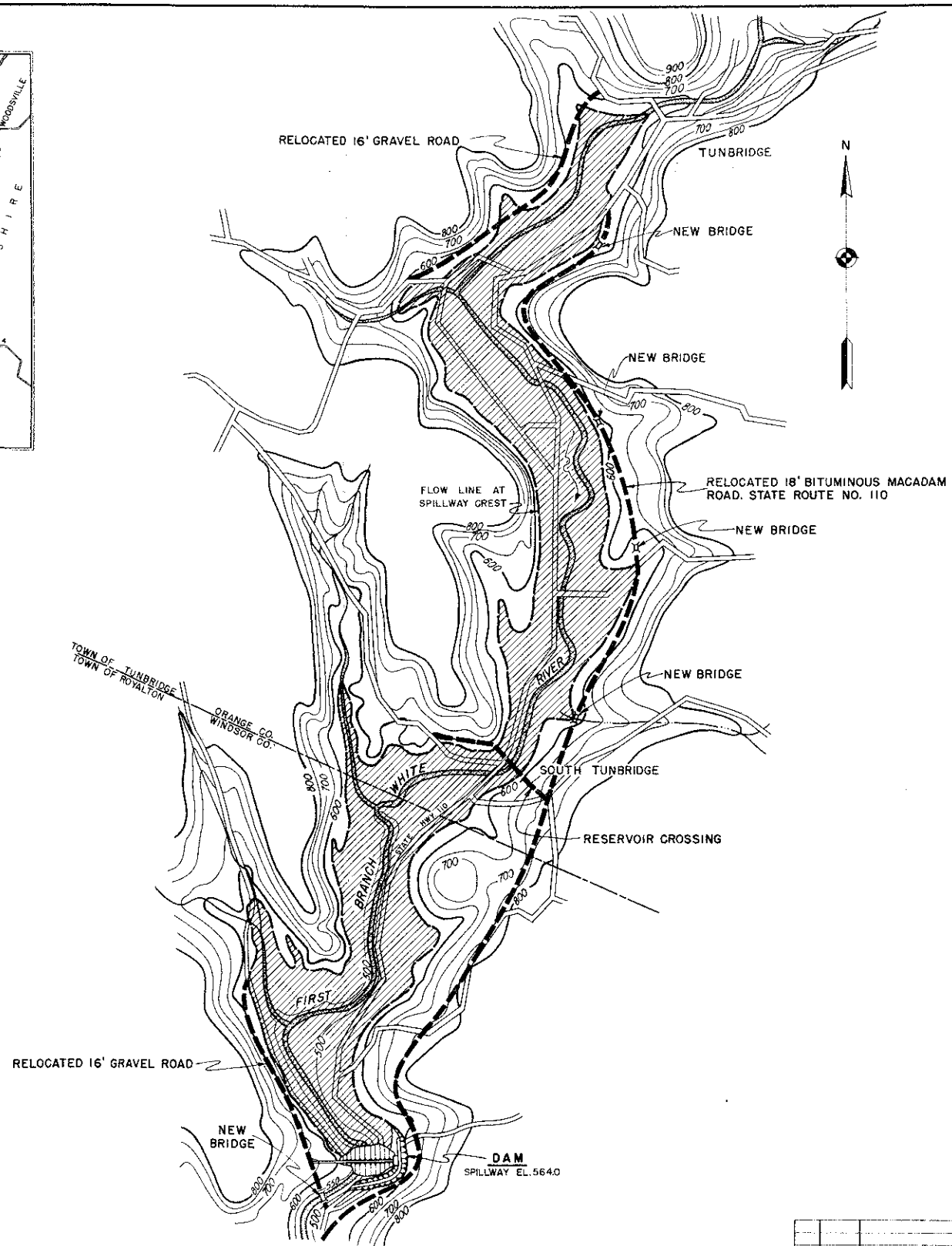
DRAWN: R. R. L.
TRACED: A. J. H.
CHECKED:

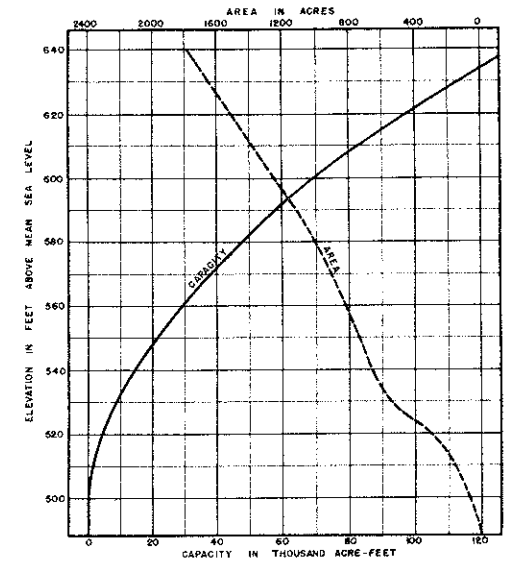
TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-2-1228



VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (Indicated by Δ)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

SOUTH TUNBRIDGE DAM

RESERVOIR MAP

FIRST BRANCH, WHITE WATERSHED — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 1000 FT. — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 194

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

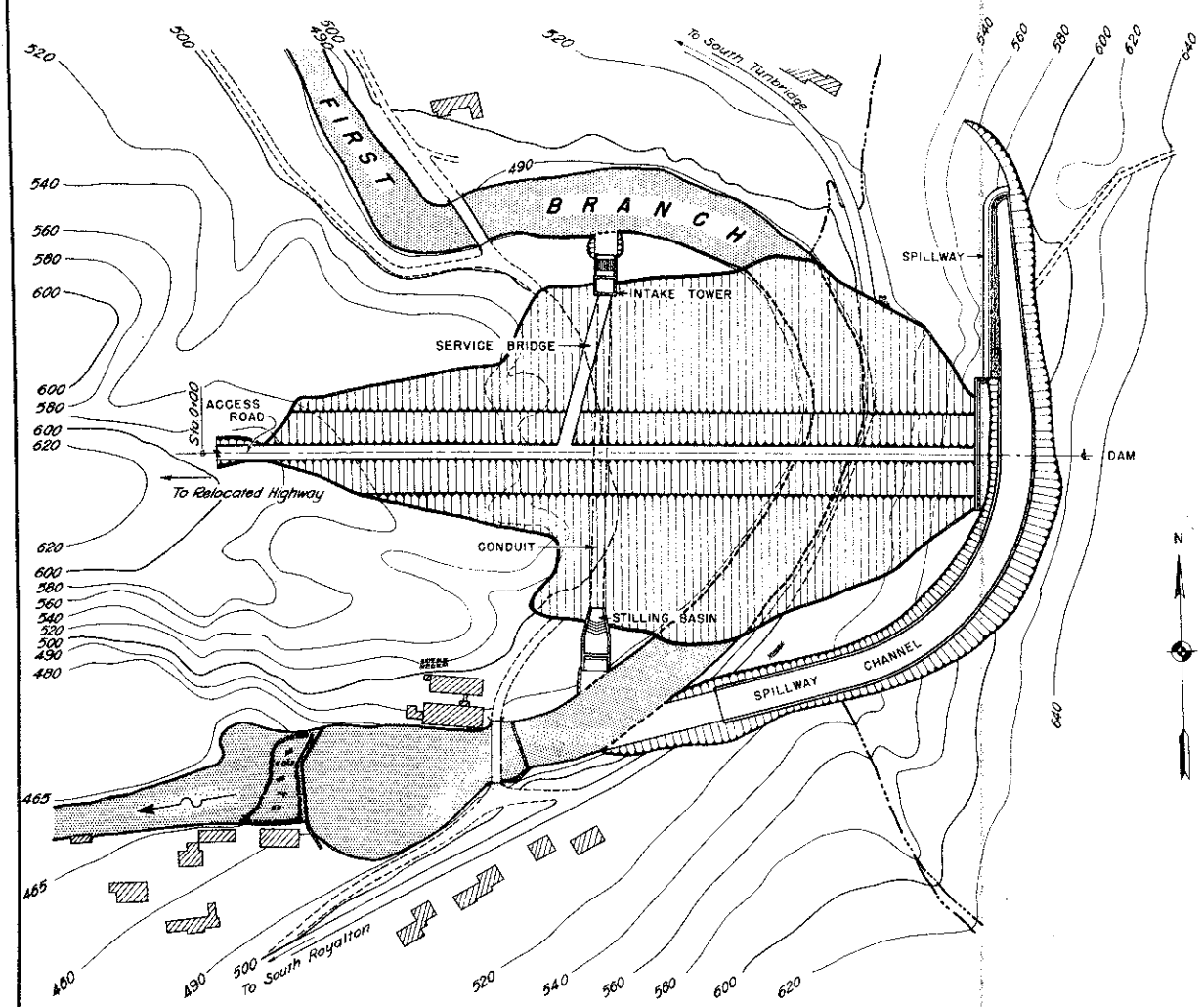
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

DRAWN: G.F.B. TRACED: G.F.B. CHECKED: M.D.K.

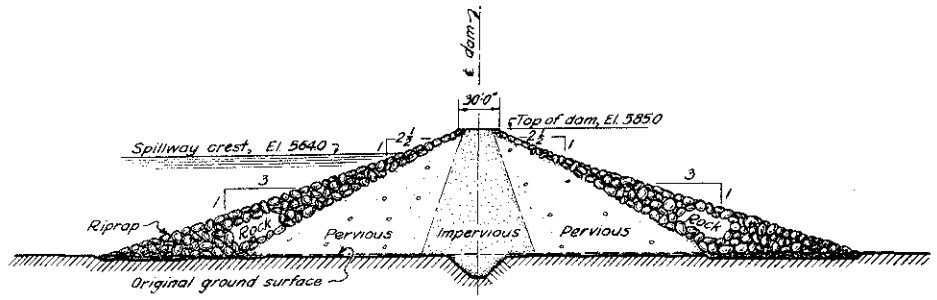
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-1417



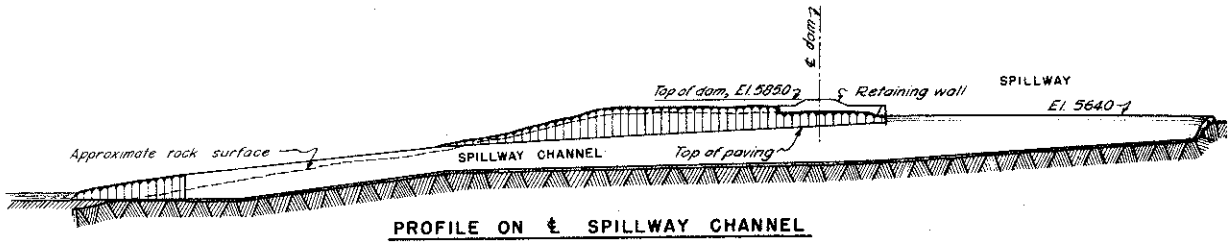
PLAN

SCALE: 1"=100'



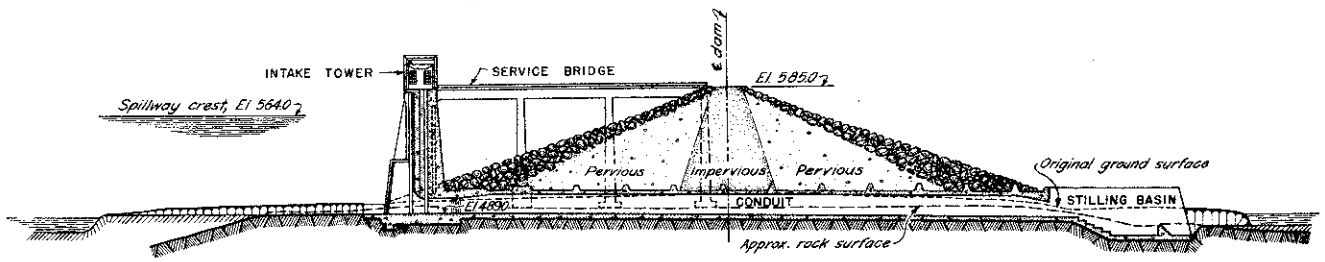
TYPICAL SECTION OF DAM

SCALE 1" = 40'



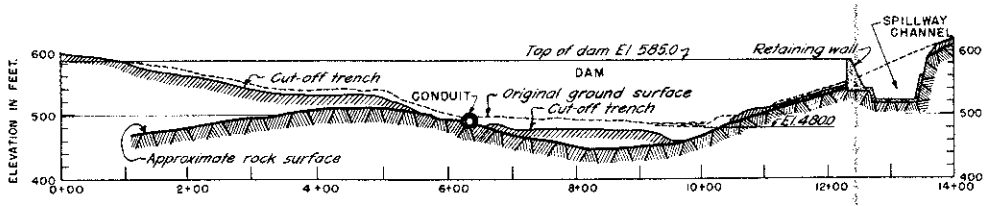
PROFILE ON ℄ SPILLWAY CHANNEL

SCALE 1" = 60'



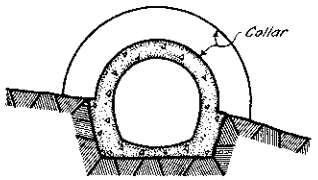
SECTION ON ℄ CONDUIT

SCALE 1" = 40'



PROFILE ON ℄ DAM

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



SECTION THRU CONDUIT

SCALE 1" = 10'

NOTE

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

SOUTH TUNBRIDGE DAM

GENERAL PLAN

FIRST BRANCH, WHITE WATERSHED — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 100 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 194

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

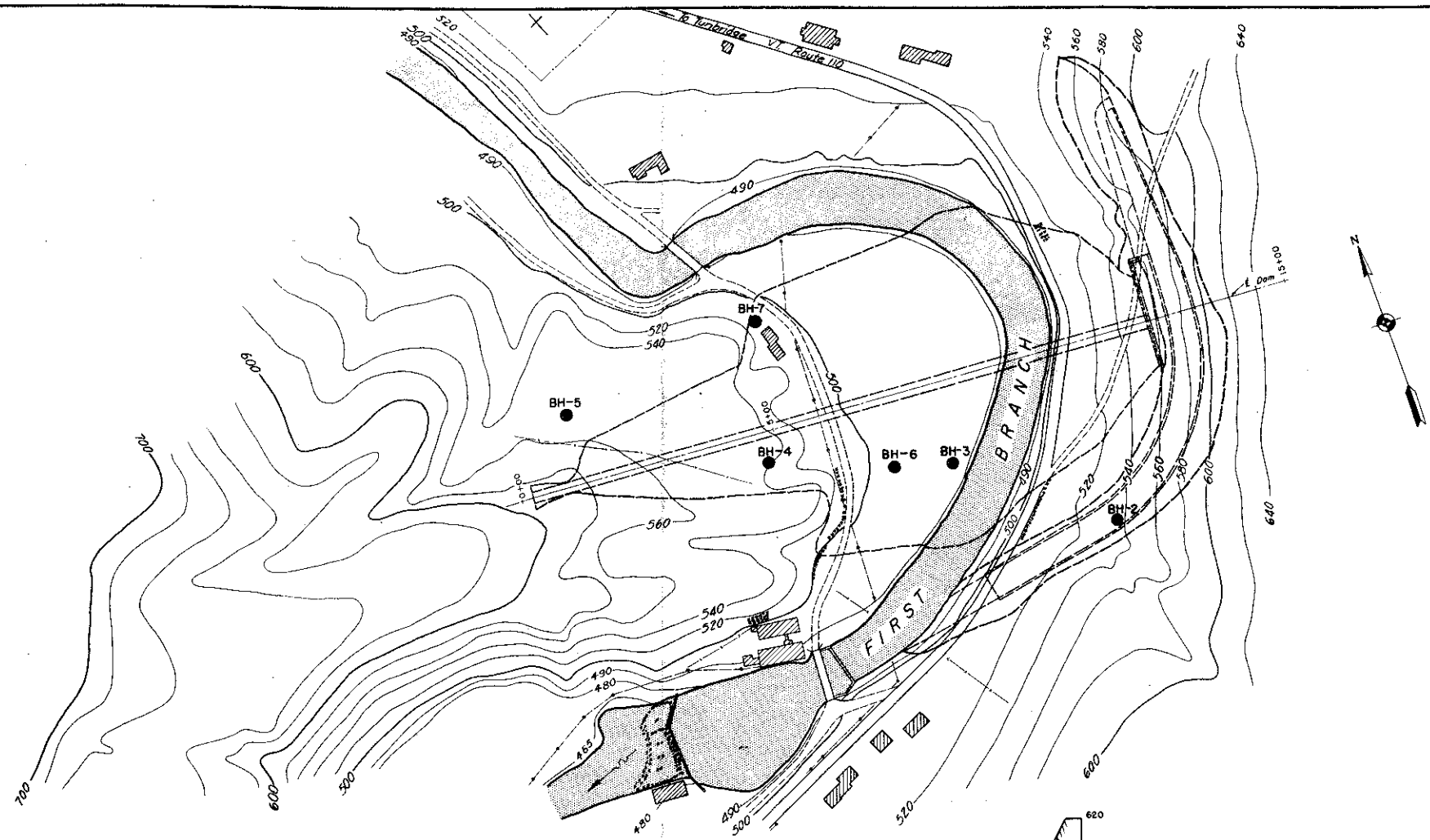
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. P. Mugnier, ASSOC. ENGINEER

DRAWN: N. B. TRACED: F. C. K. CHECKED: M. D. K.

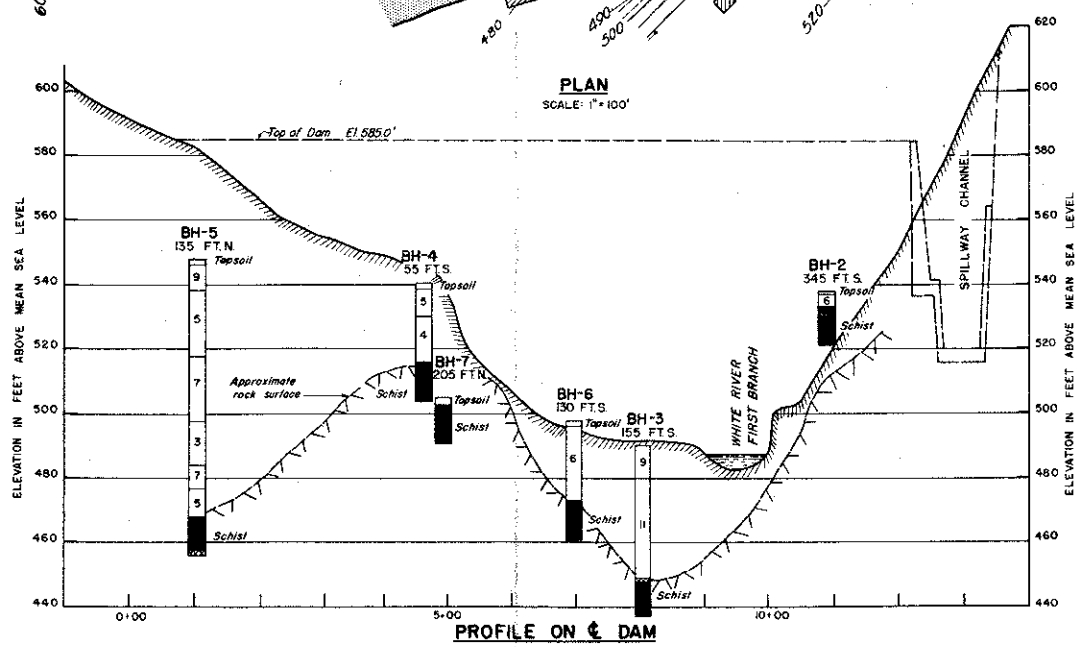
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-1459



PLAN

SCALE: 1" = 100'



PROFILE ON ℄ DAM

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

SOURCES OF BORROW

Pervious material available within 0.25 miles downstream on right bank

Impervious material available within 0.5 miles upstream on right bank

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%.
- Weathered and fractured bedrock, core recovery between 50% and 75%.
- Less weathered and fractured bedrock, core recovery more than 75%.
- BH Drive sample bore hole
- N. North of ℄ dam
- S. South of ℄ dam
- Ledge outcrop

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14 A.

KEY	DATE	REVISION (Indicated by △)	REV.BY	CK.BY	AP.BY
△					

CONNECTICUT RIVER FLOOD CONTROL

SOUTH TUNBRIDGE DAM

GEOLOGY

FIRST BRANCH, WHITE WATERSHED VERMONT

IN 3 SHEETS SCALE: 1 IN. = 100 FT. SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 194

SUBMITTED: SENIOR GEOLOGIST, HEAD GEOLOGY SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

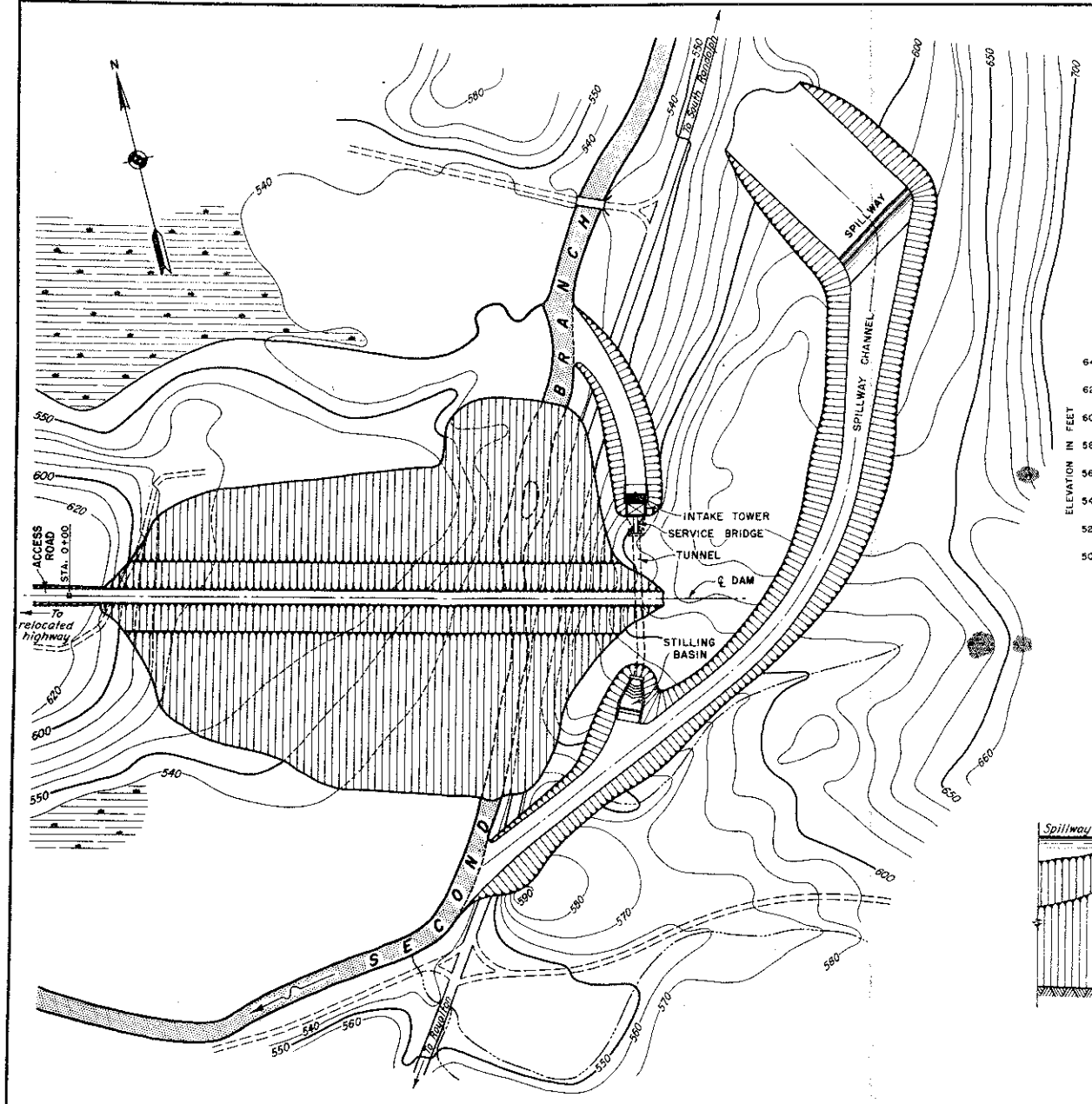
APPROVED: LT. COL., CORPS OF ENGINE, DISTRICT ENGINEER

COMPILED: ASS'T ENGINEER

DRAWN: R.P.L. TRACED: A.J.Z. CHECKED:

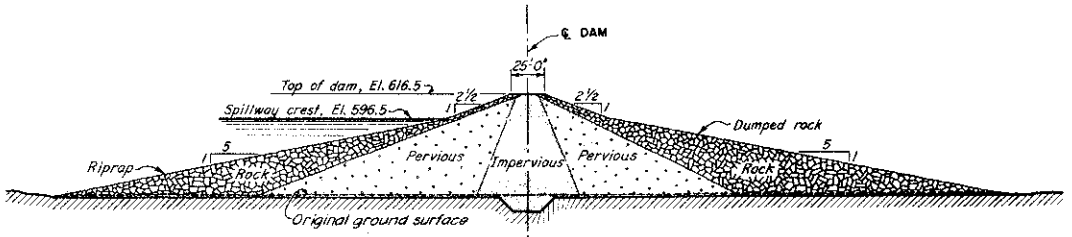
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT.-2-1229



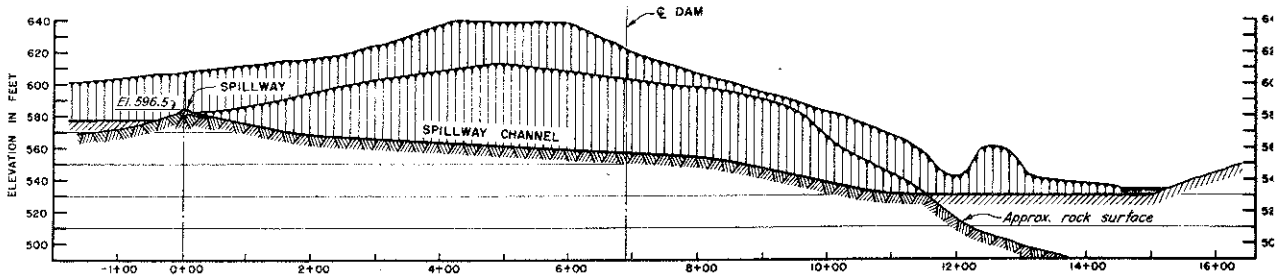
PLAN

SCALE 1" = 100'



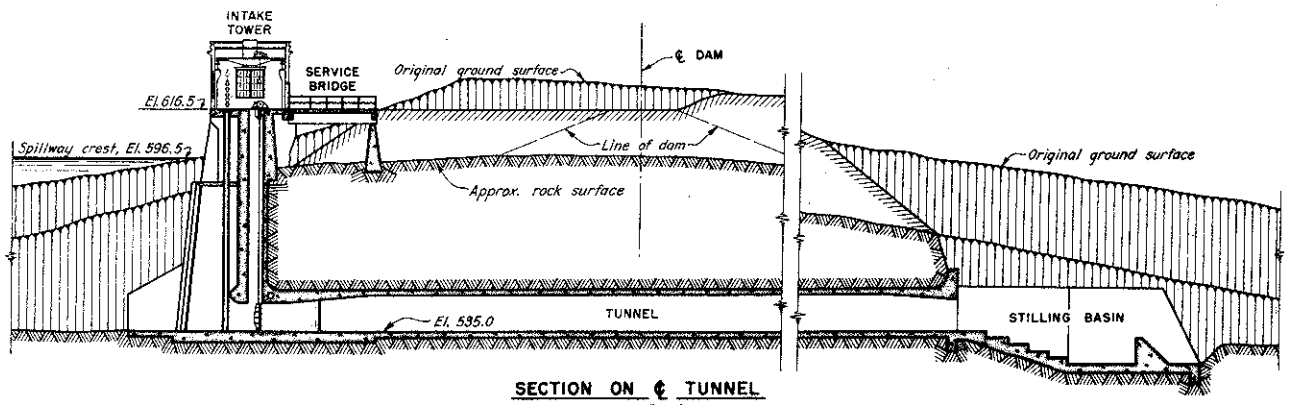
TYPICAL SECTION THRU DAM

SCALE 1" = 40'



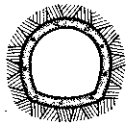
SECTION ON ℄ SPILLWAY CHANNEL

SCALE 1" = 100'



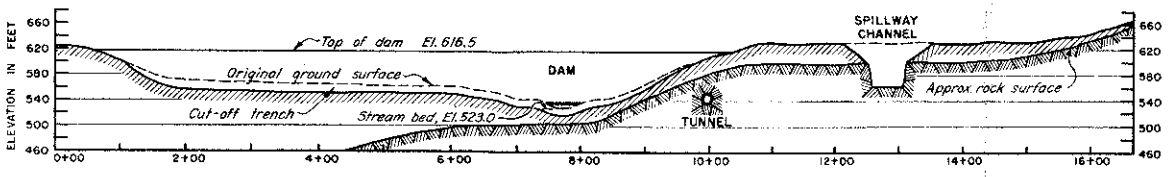
SECTION ON ℄ TUNNEL

SCALE 1" = 20'



SECTION THRU TUNNEL

SCALE 1" = 10'



PROFILE ON ℄ DAM

SCALE 1" = 100'

NOTE

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by Δ)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

SOUTH RANDOLPH DAM

GENERAL PLAN

SECOND BRANCH, WHITE WATERSHED — VERMONT

IN 3 SHEETS — SCALE 1 IN. = 100 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 194

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

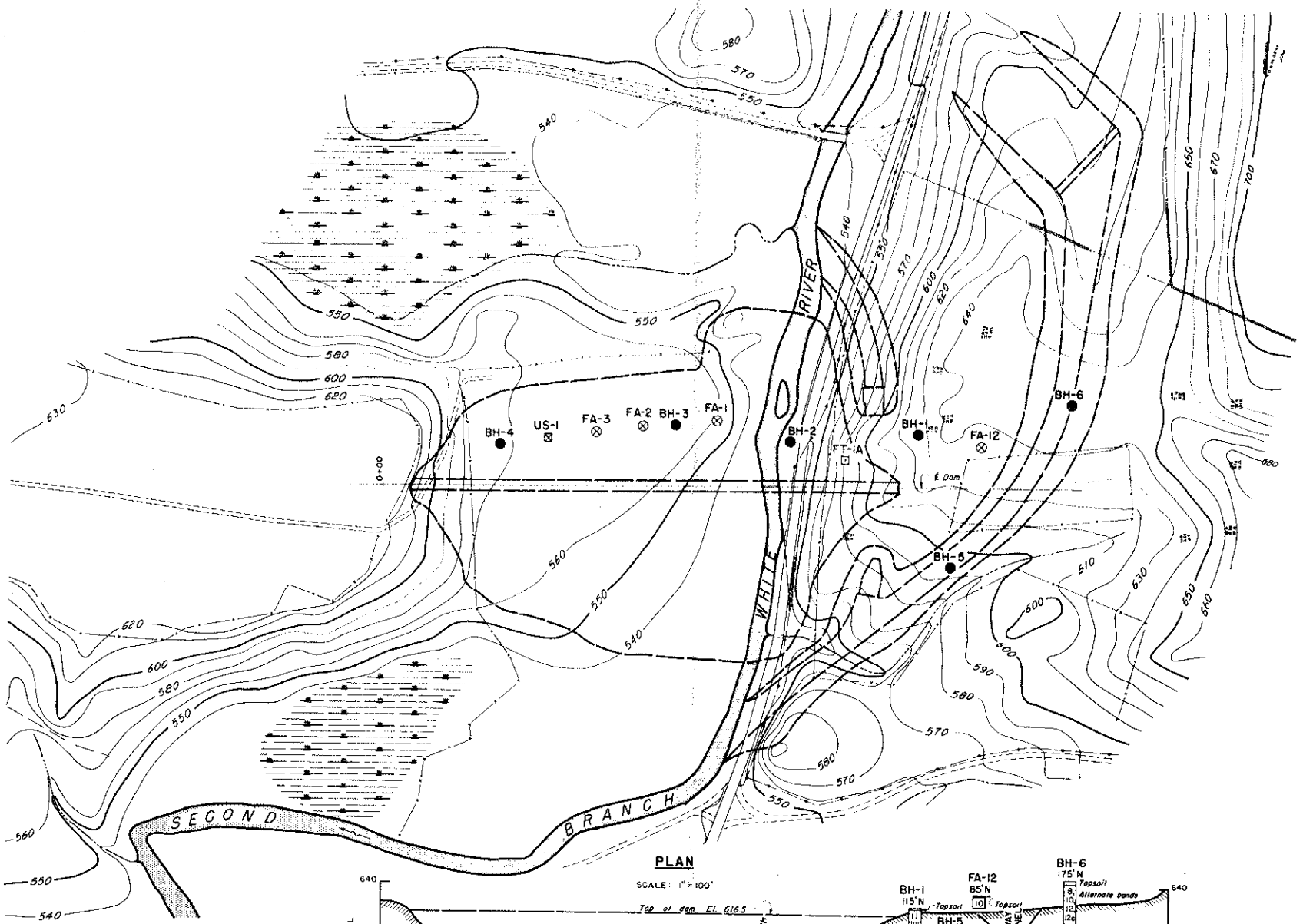
APPROVED: COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. D. Margin, ASSOC. ENGINEER

DRAWN: K.B. TRACED: L.F.D. CHECKED: M.D.K.

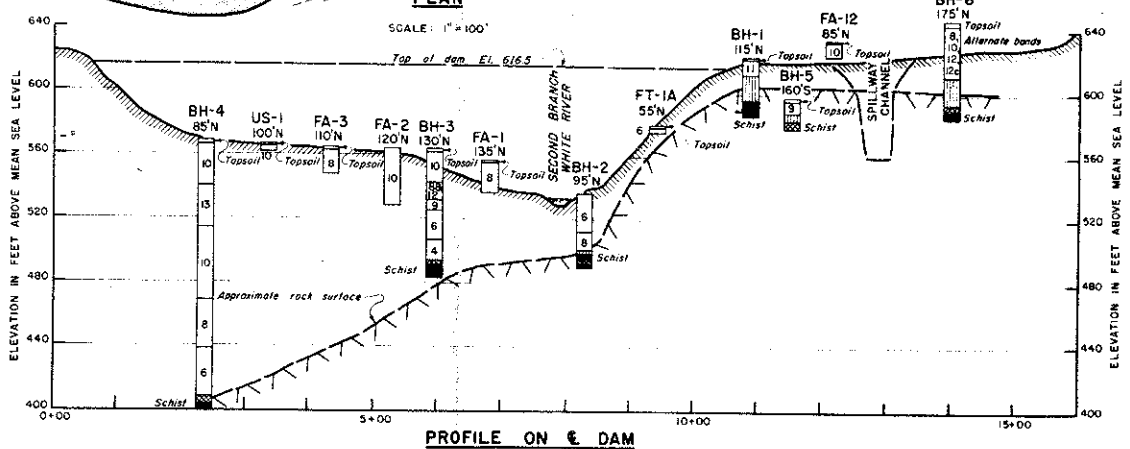
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-1456



PLAN

SCALE: 1" = 100'



PROFILE ON ℄ DAM

SCALES: HOR. 1" = 100'
VERT. 1" = 40'

SOURCES OF BORROW

Pervious material available within 1.0 miles downstream on left bank.
Impervious material available within 0.5 miles upstream and downstream on right bank.

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%
- Weathered and fractured bedrock, core recovery between 50% and 75%
- Less weathered and fractured bedrock, core recovery more than 75%
- BH Drive sample bore hole
- FA Foundation auger boring
- FT Foundation test pit
- US Undisturbed sample
- N North of ℄ dam
- S South of ℄ dam

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14 A.

KEY	DATE	REVISION (indicated by △)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

SOUTH RANDOLPH DAM

GEOLOGY

SECOND BRANCH, WHITE WATERSHED — VERMONT

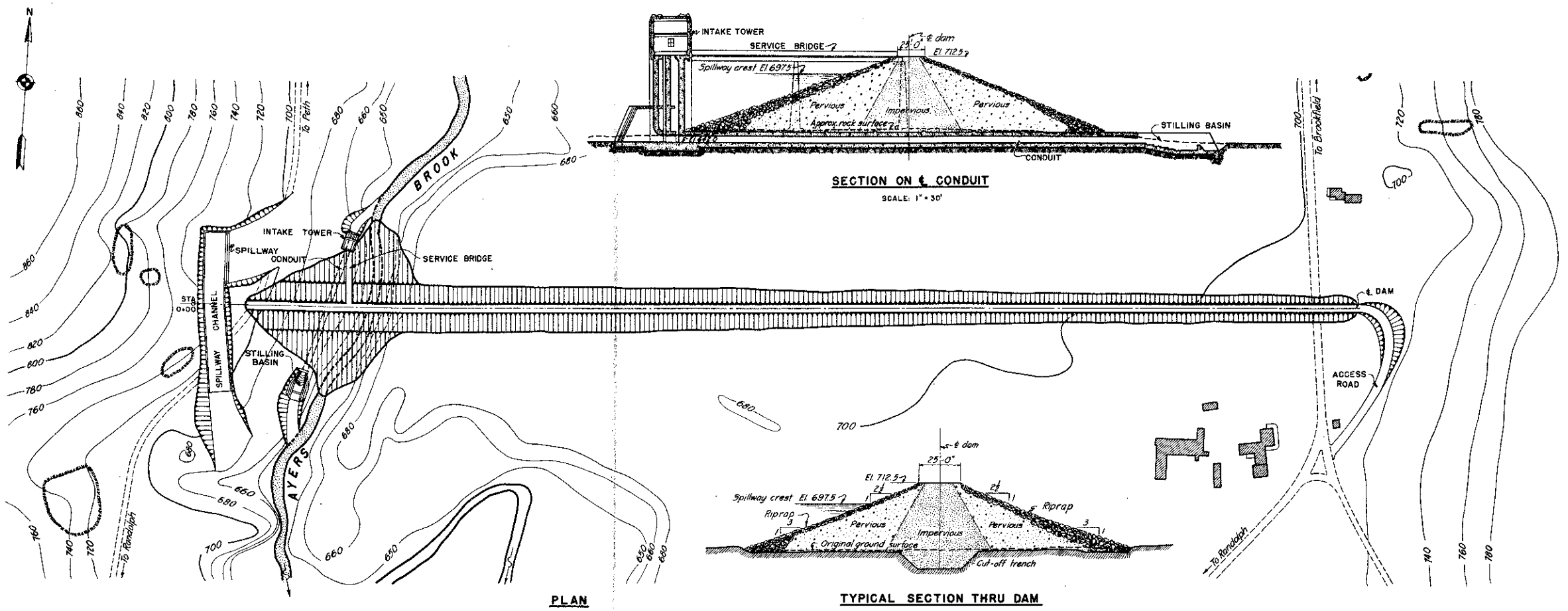
IN 3 SHEETS — SCALE: 1IN.=100 FT. — SHEET NO. 3

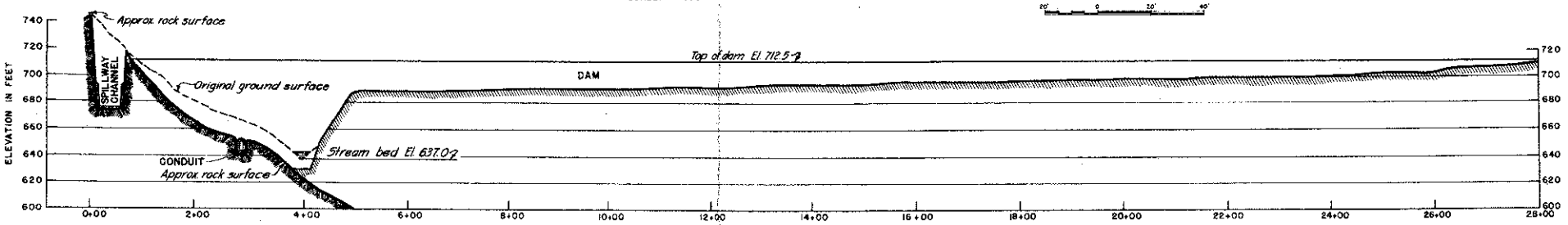
U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASS'T. ENGINEER — DRAWN: R. R. L. TRACED: C. B. B. CHECKED:

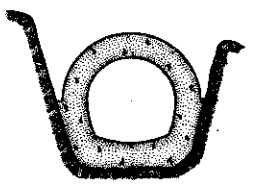
TO ACCOMPANY REPORT DATED FEB. 28, 1940
FILE NO. CT-2-1245





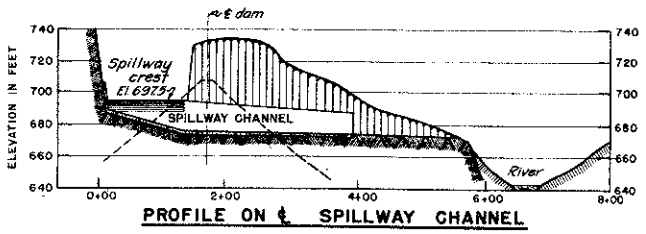
PROFILE ON ℄ DAM

SCALES: HOR. 1" = 100'
VERT. 1" = 40'



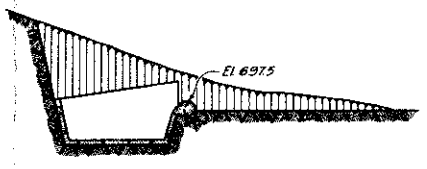
SECTION THRU CONDUIT

SCALE: 1" = 5'



PROFILE ON ℄ SPILLWAY CHANNEL

SCALES: HOR. 1" = 100'
VERT. 1" = 40'



SECTION THRU SPILLWAY WEIR

SCALE: 1" = 30'

NOTE

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by △)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

AYERS BROOK DAM

GENERAL PLAN

AYERS BROOK, WHITE WATERSHED — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 100 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 194

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

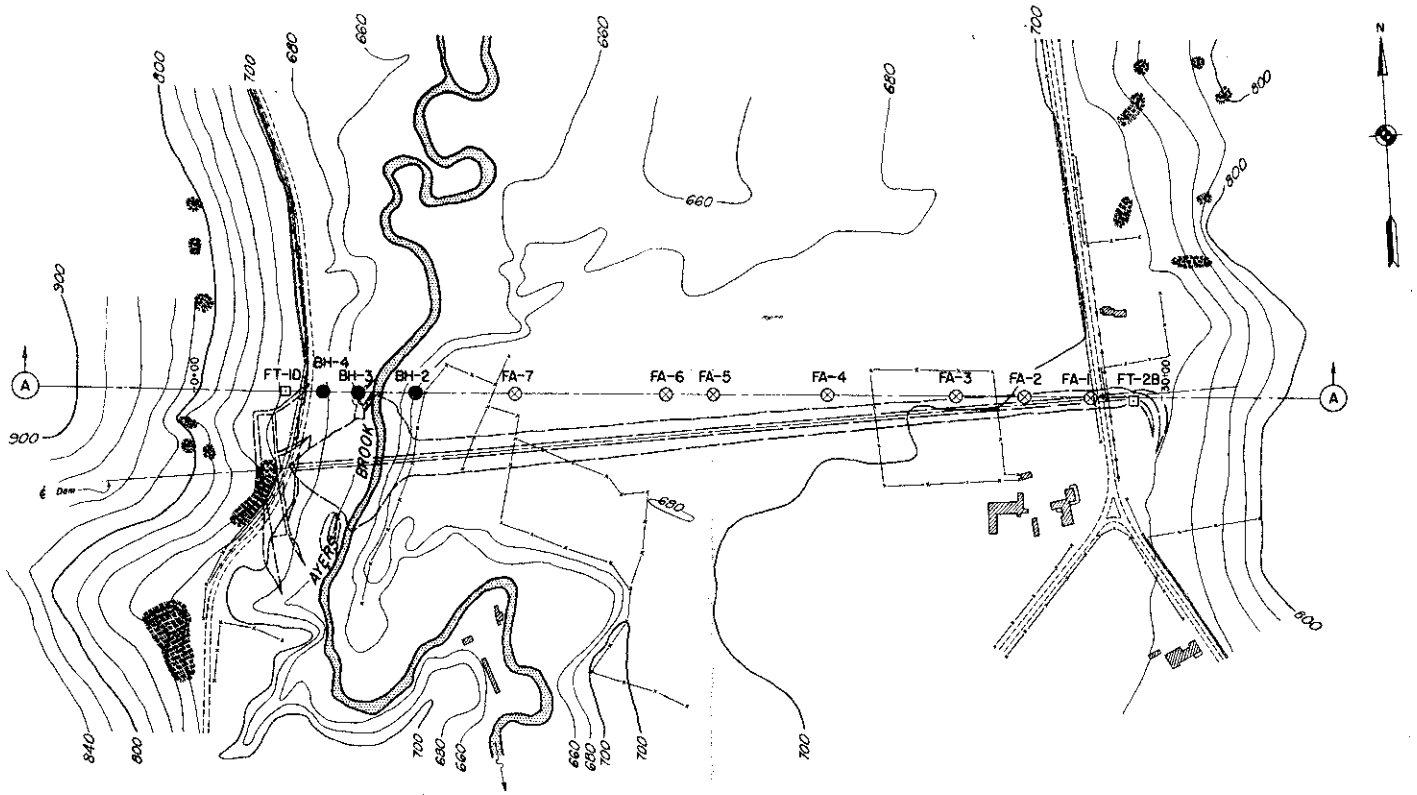
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

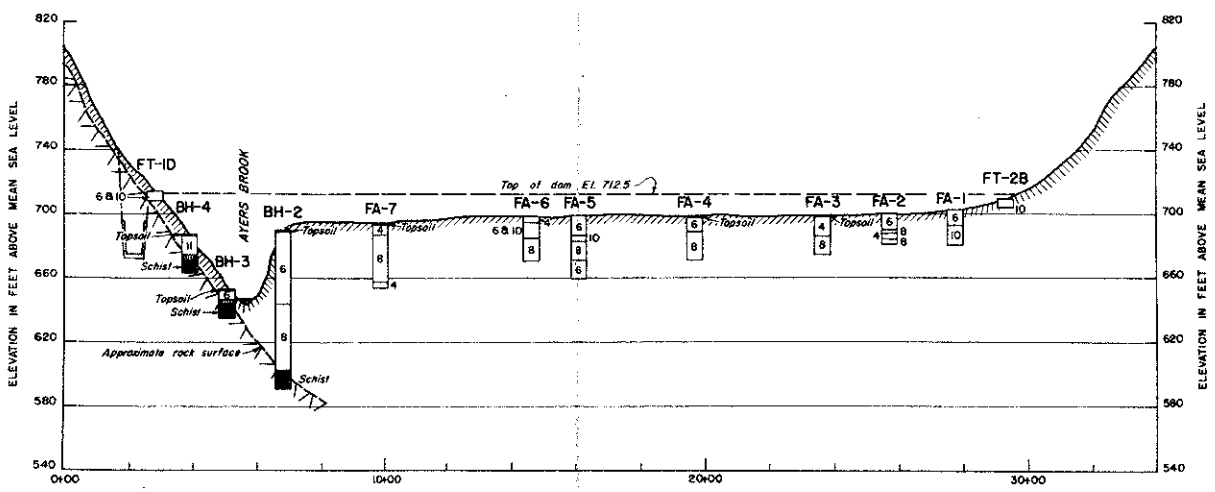
DRAWN: W.A.G.
TRACED: L.A.O.
CHECKED:

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-1-1451



PLAN

SCALE 1" = 200'



PROFILE ON LINE A-A

SCALES: HOR. 1" = 200'
VERT. 1" = 40'

SOURCES OF BORROW

Pervious material available within 0.5 miles downstream on right bank.
Impervious material available within 0.5 miles upstream and downstream on left bank.

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%
- Weathered and fractured bedrock, core recovery between 50% and 75%
- Less weathered and fractured bedrock, core recovery more than 75%
- BH Drive sample bore hole.
- FA Foundation auger boring.
- FT Foundation test pit.
- Ledge outcrop.

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

AYERS BROOK DAM

GEOLOGY

AYERS BROOK, WHITE WATERSHED — VERMONT

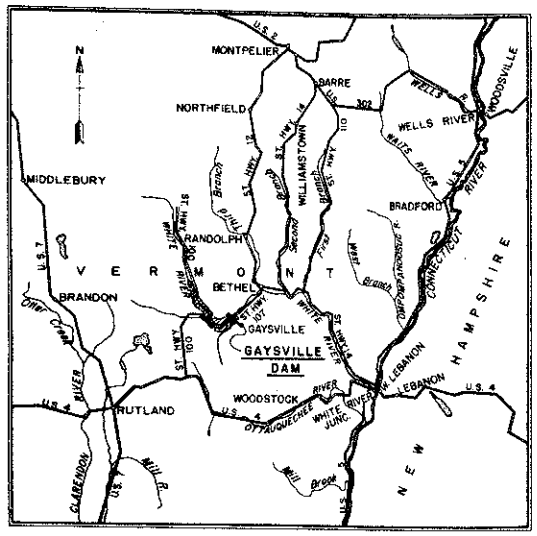
IN 3 SHEETS — SCALE: 1 IN = 200 FT. (200 0 200 400) — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 194

SUBMITTED: Senior Geologist, Head, Geology Section
APPROVAL RECOMMENDED: Principal Engineer, Chief, F. C. Engineering Div.
APPROVED: Lt. Col., Corps of Engineers, District Engineer

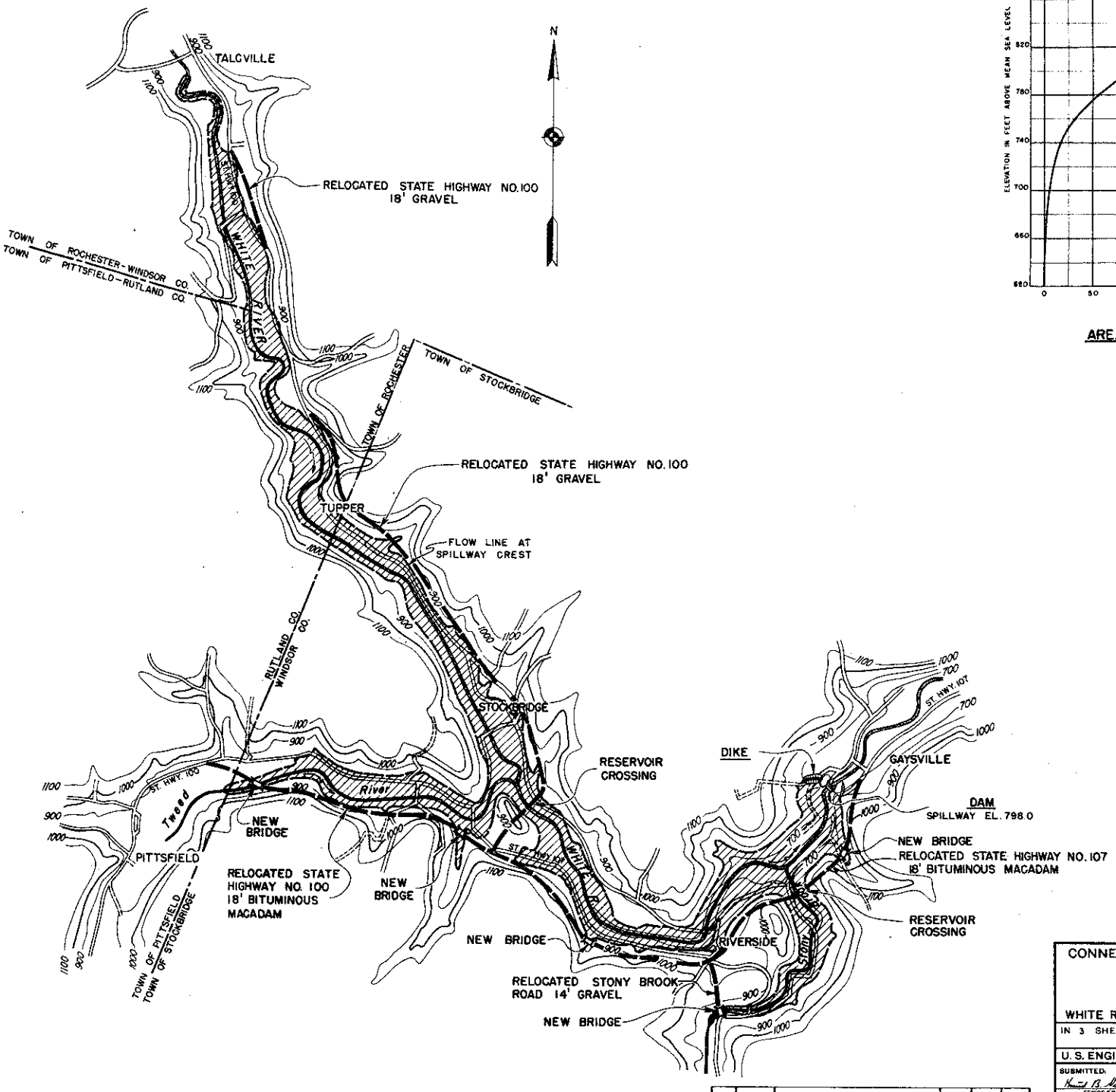
COMPILED: Ass't Engineer
DRAWN: R. R. L.
TRACED: H. R. L.
CHECKED

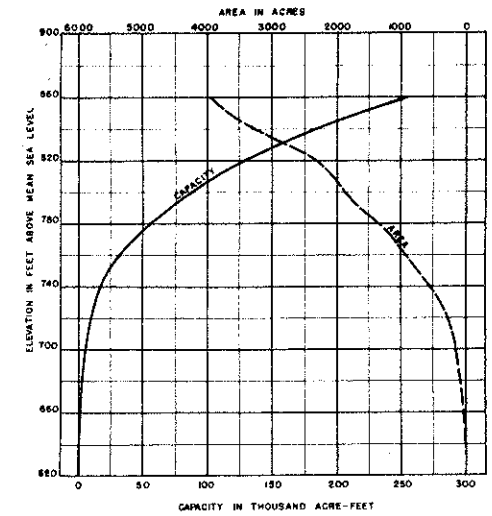
TO ACCOMPANY REPORT DATED FEB. 28, 1940
FILE NO. CT-2-1237



VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (Indicated by Δ)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

GAYSVILLE DAM

RESERVOIR MAP

WHITE RIVER — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 2000 FT. (2000' 0 2000' 4000') — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 19

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

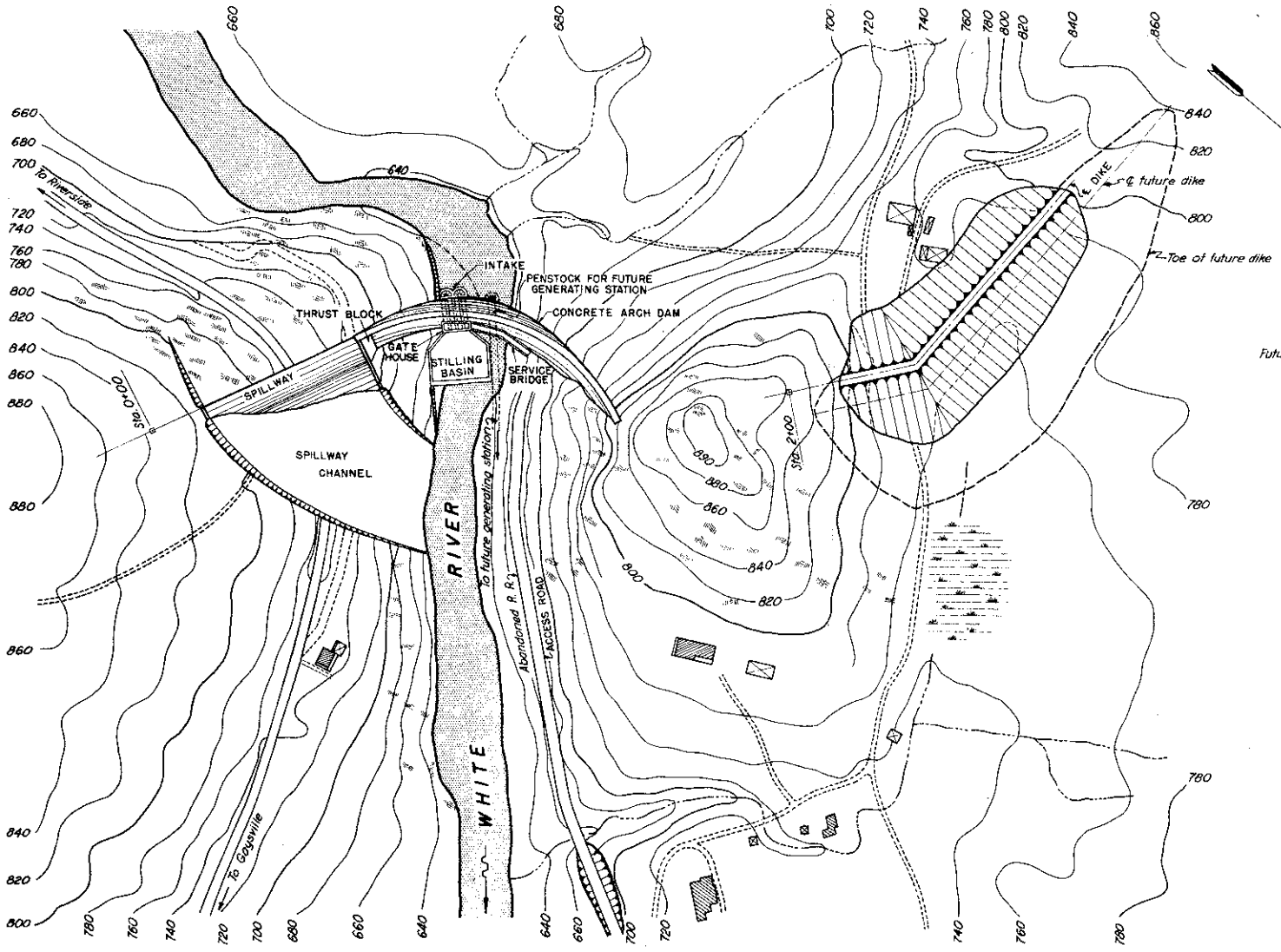
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINE, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

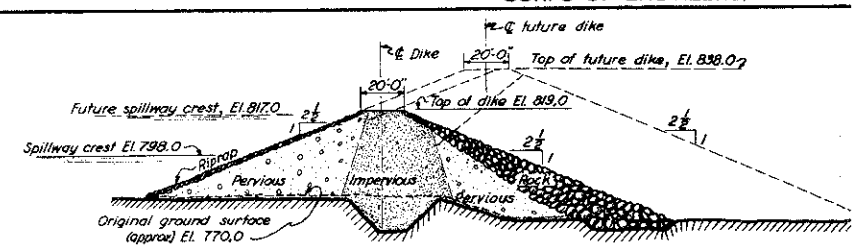
DRAWN: G.F.S.
TRACED: G.F.S.
CHECKED:

TO ACCOMPANY REPORT
DATED: FEB. 28, 1940
FILE NO. CT-1-1919



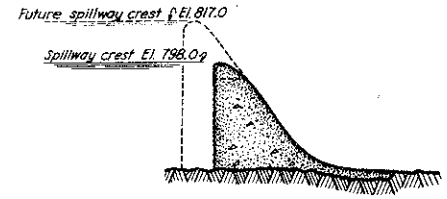
PLAN

SCALE 1" = 100'



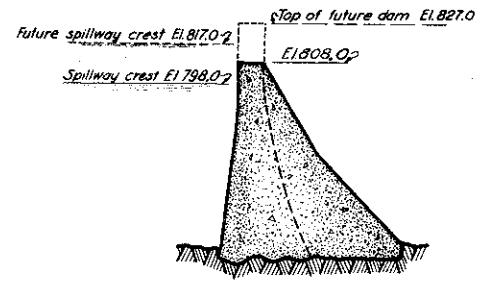
TYPICAL SECTION THRU DIKE

SCALE 1" = 30'



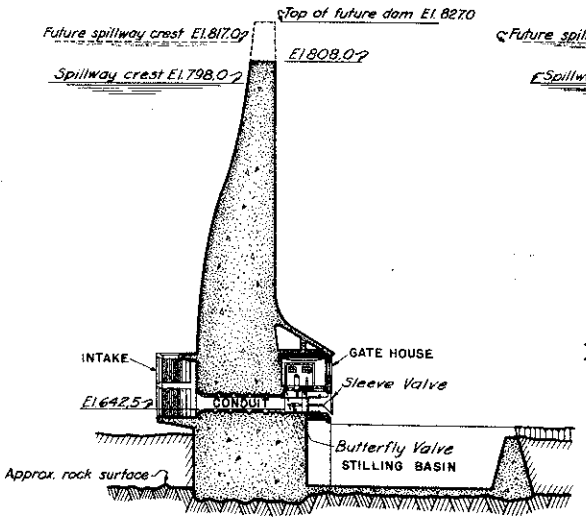
SECTION THRU SPILLWAY WEIR

SCALE 1" = 30'



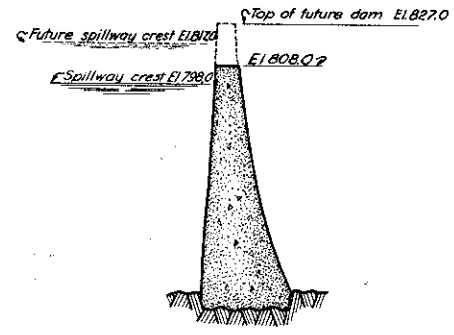
SECTION THRU THRUST BLOCK

SCALE 1" = 30'



SECTION THRU OUTLET

SCALE 1" = 30'

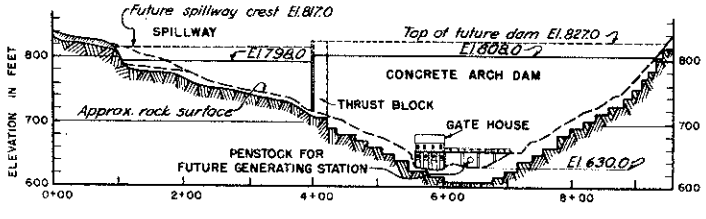


TYPICAL SECTION THRU ARCH

SCALE 1" = 30'

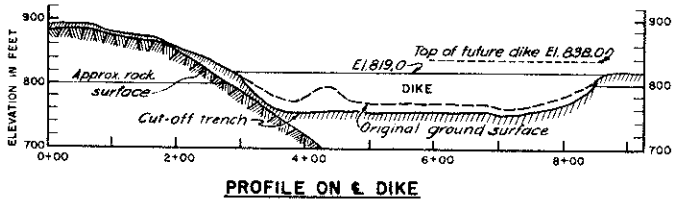
NOTE

Elevations refer to Mean Sea Level Datum.



DOWNSTREAM ELEVATION (DEVELOPED)

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



PROFILE ON ℄ DIKE

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

KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

GAYSVILLE DAM

GENERAL PLAN

WHITE RIVER — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 100 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 194

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

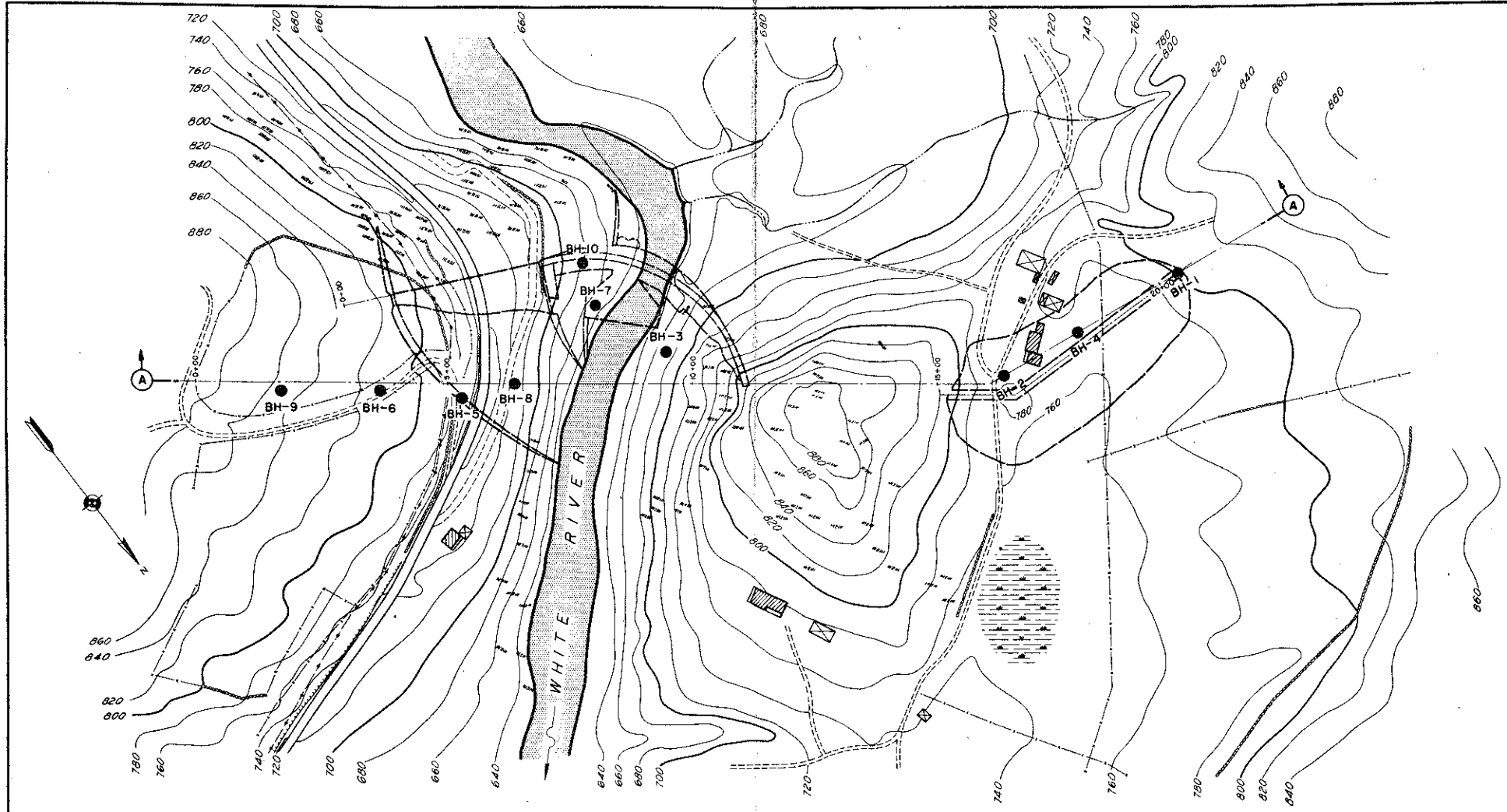
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

DRAWN: P.A.B. TRACED: E.E. & L.J.B. CHECKED: G.W.H.

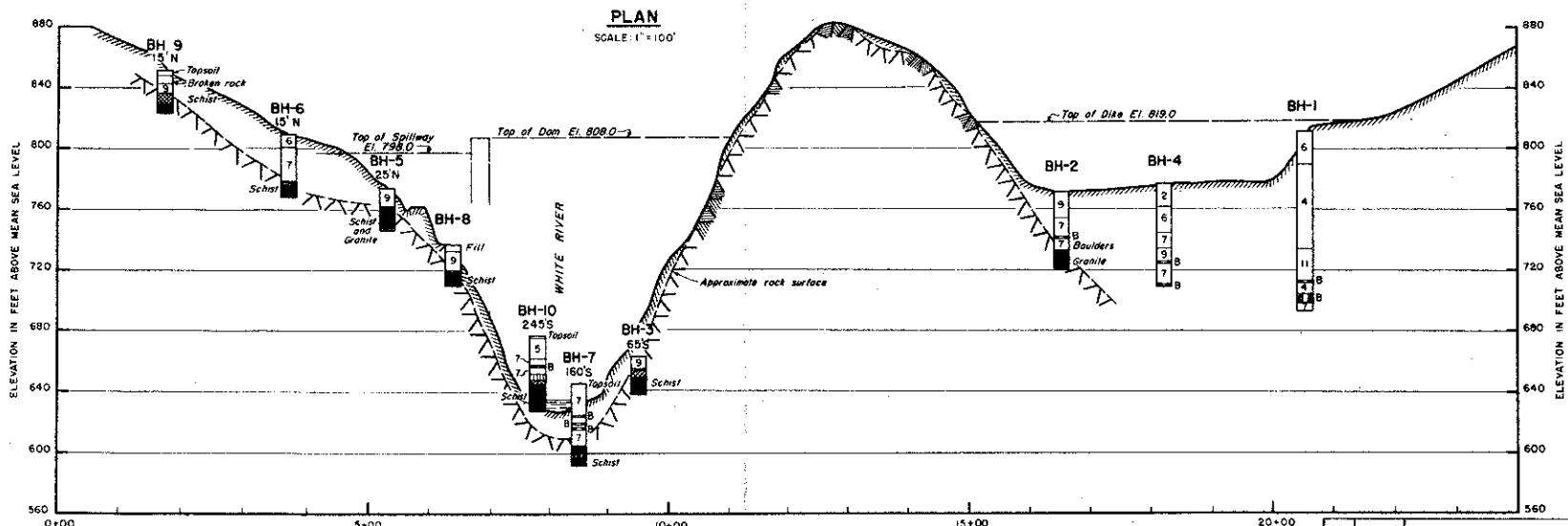
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

FILE NO. CT-1-1449



PLAN

SCALE: 1" = 100'



PROFILE ON LINE "A-A"

SCALES VERT. 1" = 40' HOR. 1" = 100'

SOURCES OF BORROW

Pervious material available within 0.5 miles of dike site.
Impervious material available within 0.5 miles of dike site.

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%
- Weathered and fractured bedrock, core recovery between 50% and 75%
- Less weathered and fractured bedrock, core recovery more than 75%
- BH Drive sample bore hole
- N North of line A-A
- S South of line A-A
- Rock outcrop

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

GAYSVILLE DAM

GEOLOGY

WHITE RIVER — VERMONT

IN 3 SHEETS — SCALE: 1 IN = 100 FT. — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 194

SUBMITTED: SENIOR GEOLOGIST, HEAD GEOLOGY SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

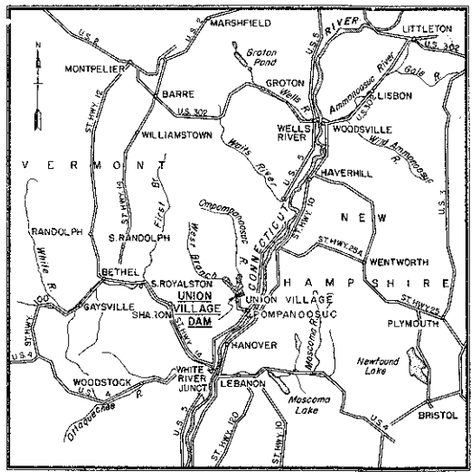
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASST. ENGINEER

DRAWN: R.R.L.
TRACED: O.A.K.
CHECKED:

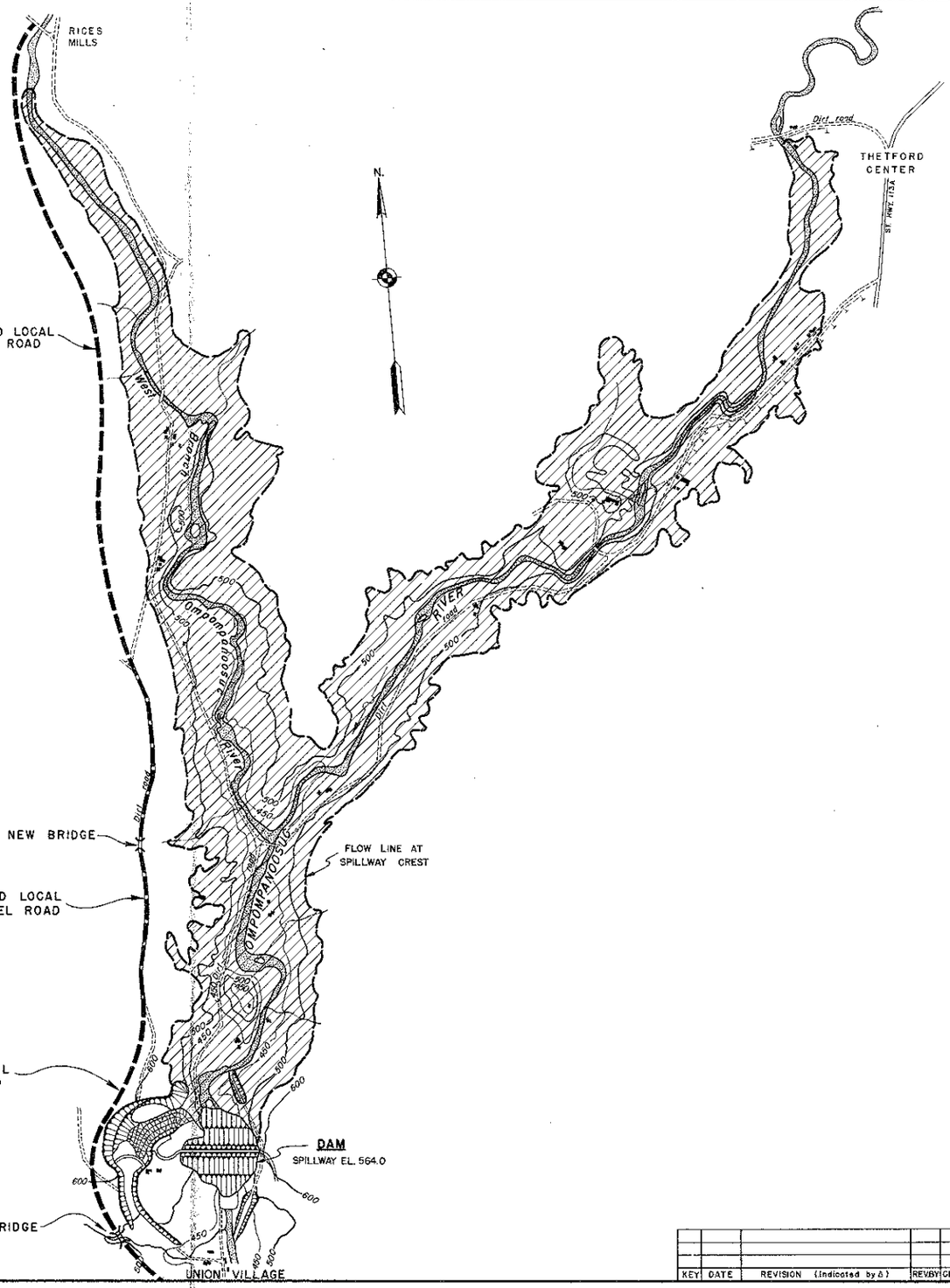
TO ACCOMPANY REPORT DATED: FEB. 28, 1940

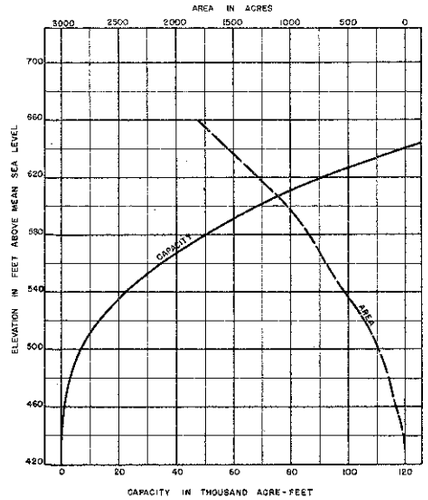
FILE NO. CT-2-1230



VICINITY MAP

SCALE: 1" = 8 MI.





AREA AND CAPACITY CURVES

KEY	DATE	REVISION (Indicated by Δ)	REV BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

UNION VILLAGE DAM

RESERVOIR MAP

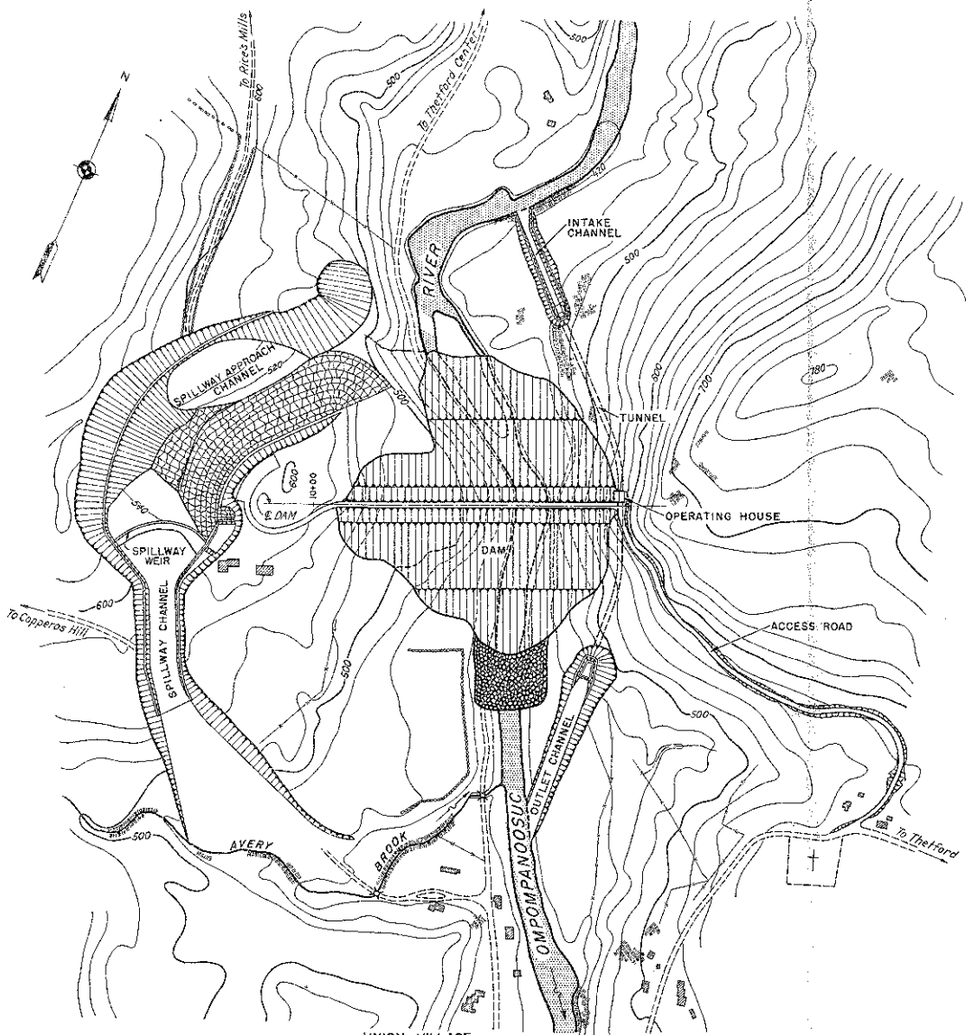
OMPOMPANOOSUC RIVER — VERMONT

IN 4 SHEETS — SCALE: 1 IN. = 600 FT. (600 0 600 1200) — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

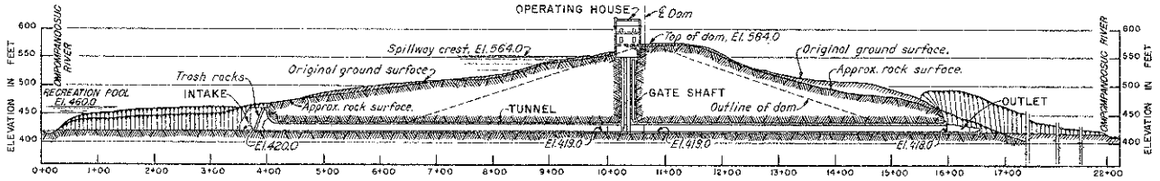
SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER — DRAWN: L.V.F. TRACED: L.V.F. CHECKED: M.D.K. — TO ACCOMPANY REPORT DATED FEB. 28, 1940 FILE NO. CT-1-1418



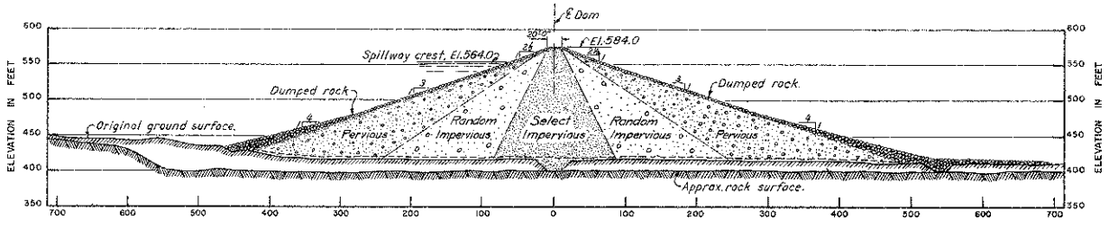
PLAN

SCALE: 1" = 200'



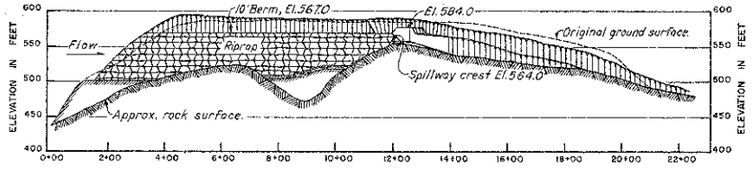
SECTION ON ℄ TUNNEL

SCALE: 1" = 100'



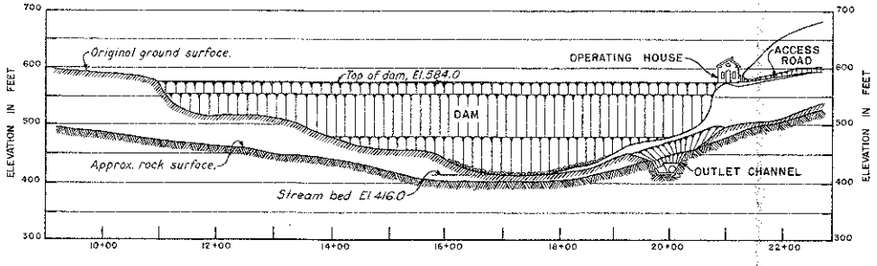
TYPICAL DAM SECTION

SCALE: 1" = 80'



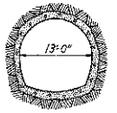
PROFILE ON ℄ SPILLWAY CHANNEL

SCALES: HOR. 1" = 200' VERT. 1" = 80'



DOWNSTREAM ELEVATION OF DAM

SCALE: 1" = 100'



TYPICAL TUNNEL SECTION

SCALE: 1" = 10'

NOTES

All elevations refer to Mean Sea Level Datum.
Superseded by Plate No. 84 H for high dam.
Spillway crest El. 564.0.

KEY	DATE	REVISION (indicated by △)	REV BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

UNION VILLAGE DAM

LOW DAM

GENERAL PLAN

OMPOMPANOOSUC RIVER — VERMONT

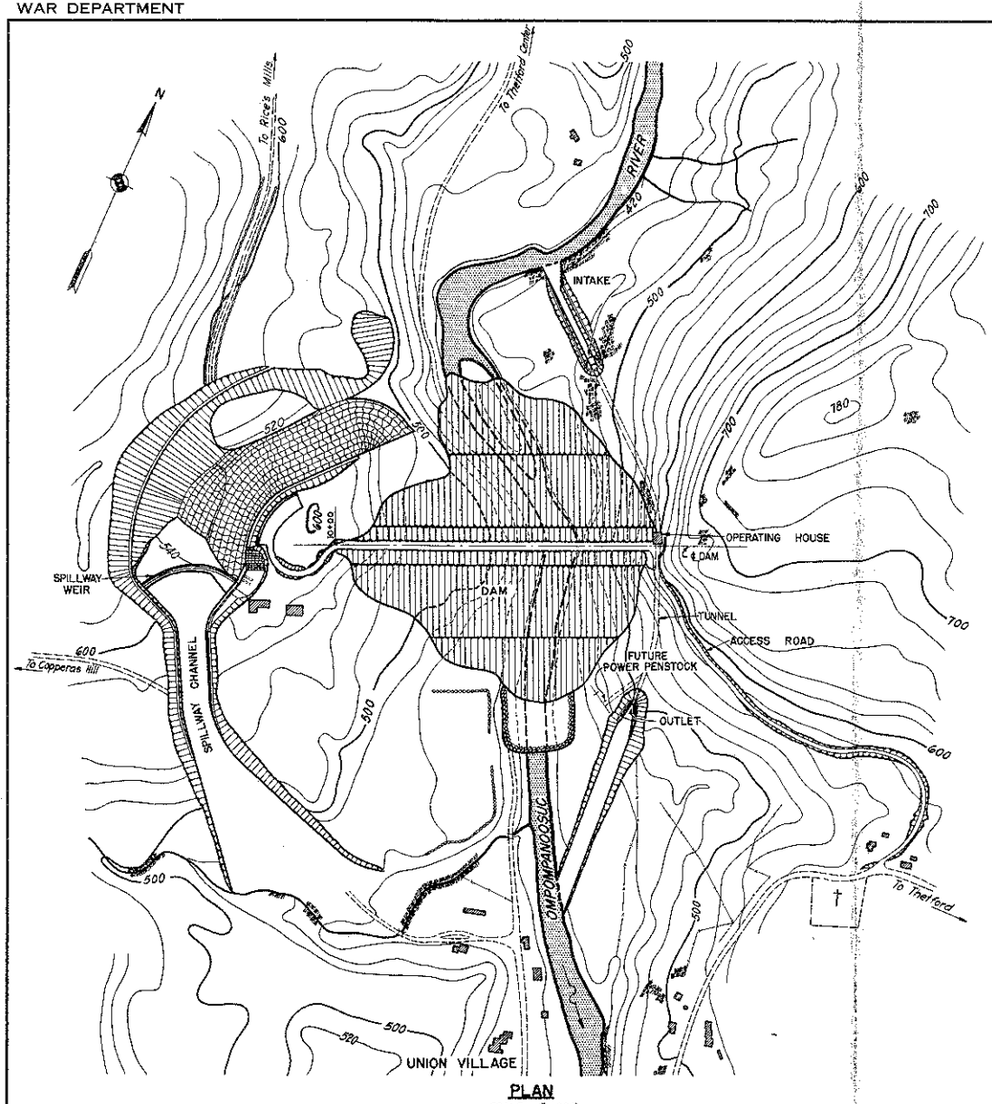
IN 4 SHEETS — SCALE: 1 IN. = 200 FT. — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.S. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

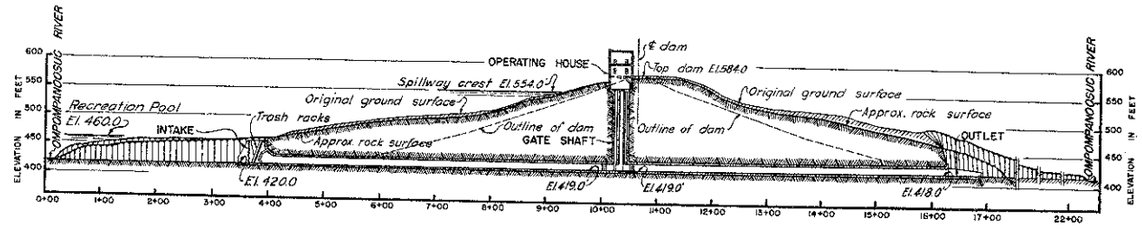
DESIGNED: ASSOC. ENGINEER — DRAWN: C.K.M. TRACED: T.C.M. CHECKED: M.D.K.

TO ACCOMPANY REPORT DATED: FEB. 28, 1940 FILE NO. CT-1-1472



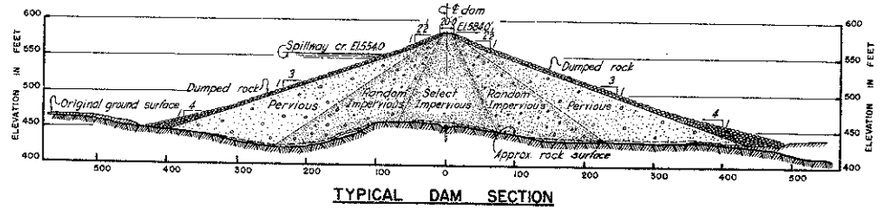
PLAN

SCALE: 1" = 200'



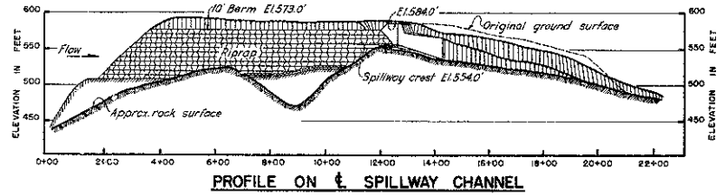
SECTION ON ℄ TUNNEL

SCALE: 1" = 100'



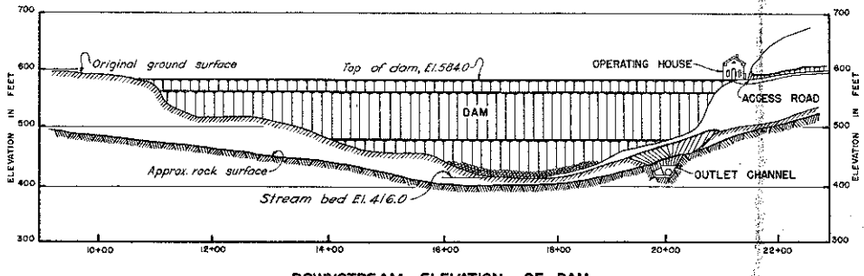
TYPICAL DAM SECTION

SCALE: 1" = 80'



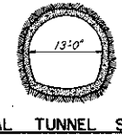
PROFILE ON ℄ SPILLWAY CHANNEL

SCALES: HOR. 1"=200' VERT. 1"=80'



DOWNSTREAM ELEVATION OF DAM

SCALE: 1" = 100'



TYPICAL TUNNEL SECTION

SCALE: 1" = 10'

NOTES

Elevations refer to Mean Sea Level Datum.
Spillway crest revised to El. 564.0.

KEY	DATE	REVISION (Indicated by Δ)	REV BY	CK BY	AR BY

CONNECTICUT RIVER FLOOD CONTROL

UNION VILLAGE DAM

HIGH DAM

GENERAL PLAN

OMPOMPANOOSUC RIVER — VERMONT

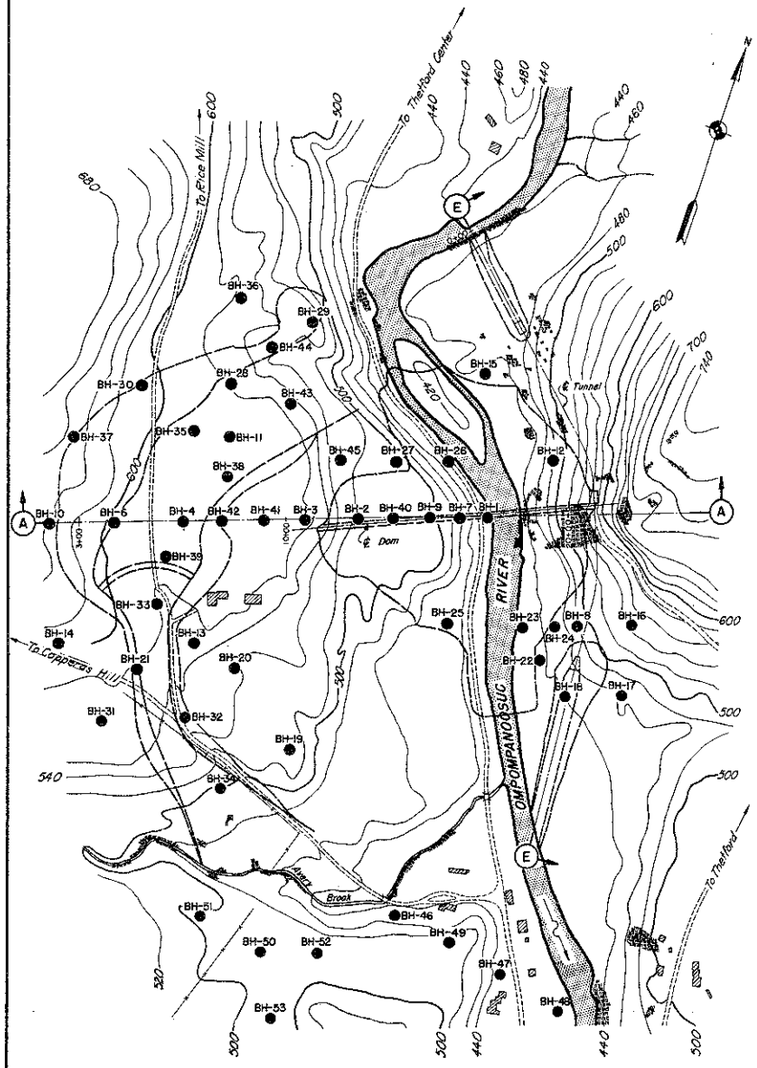
IN 4 SHEETS — SCALE: 1 IN. = 200 FT. — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: Senior Engineer, Head, Design Section — APPROVAL RECOMMENDED: Principal Engineer, Chief, R. C. Engineering Div. — APPROVED: Lt. Col., Corps of Engineers, District Engineer

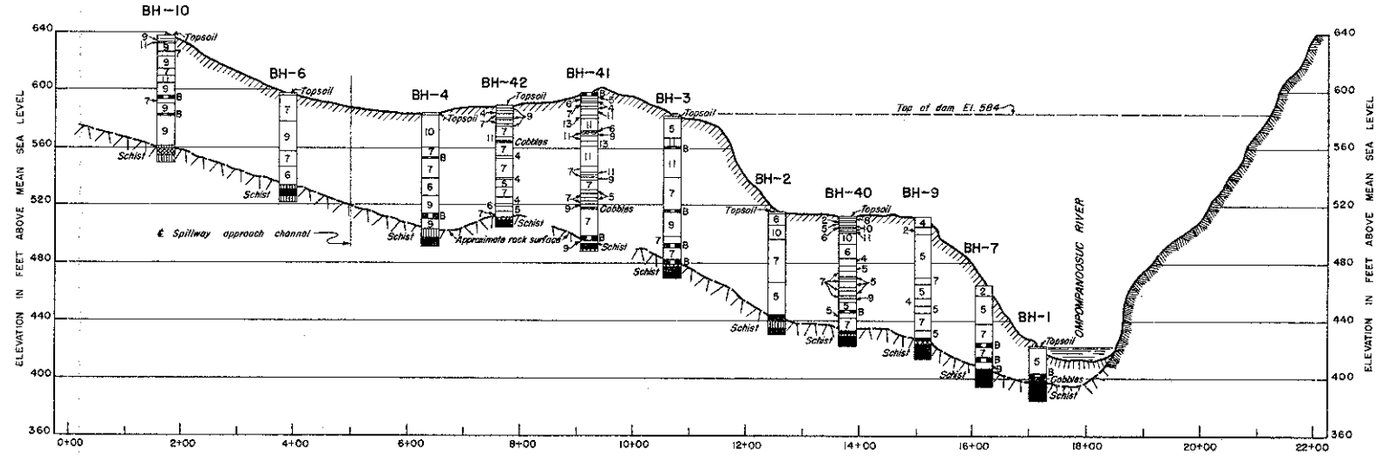
DESIGNED: Assoc. Engineer — DRAWN: C.E.M. — TRACED: J. S. — CHECKED: — TO ACCOMPANY REPORT DATED: FEB. 20, 1940

FILE NO. CT-1-1443



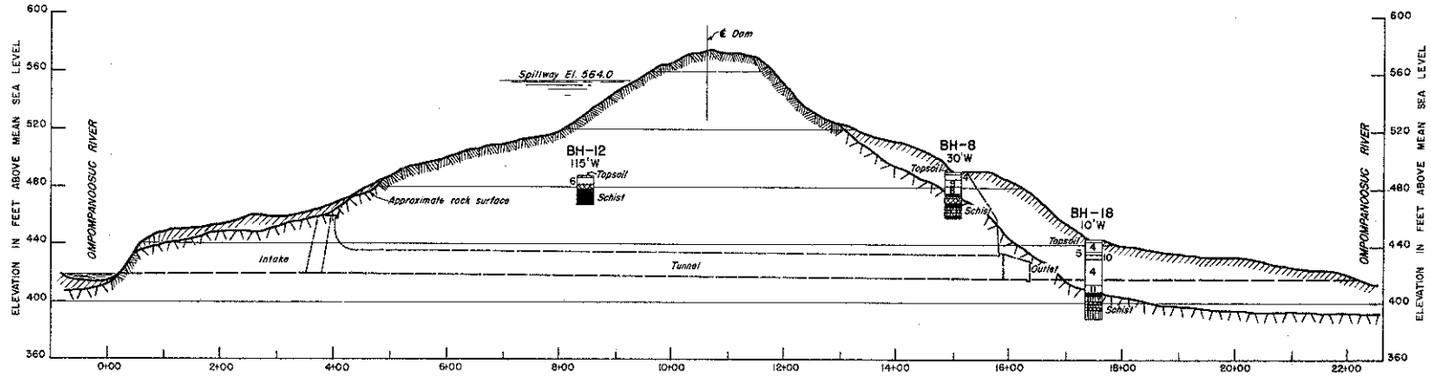
PLAN

SCALE: 1" = 200'



PROFILE ON LINE A-A LOOKING UPSTREAM

SCALES: HOR. 1" = 100'
VERT. 1" = 40'



PROFILE ON LINE E-E, ℄ TUNNEL

SCALES: HOR. 1" = 100'
VERT. 1" = 40'

SOURCES OF BORROW

Pervious material available on the site in spillway area, may be supplemented by other similar materials located in right bank within 0.5 miles.

Impervious material also available on the site in spillway and adjacent area.

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%.
- Weathered and fractured bedrock, core recovery between 50% and 75%.
- Less weathered and fractured bedrock, core recovery more than 75%.
- BH Drive sample bore hole.
- W West of ℄ tunnel.
- Ledge outcrop.

NOTE

For description and limits of numerical soil classes, see Table XXXVI and Plate No. 14 A.

KEY	DATE	REVISION (Indicated by Δ)	REVBY	CKBY	APBY

CONNECTICUT RIVER FLOOD CONTROL

UNION VILLAGE DAM

GEOLOGY

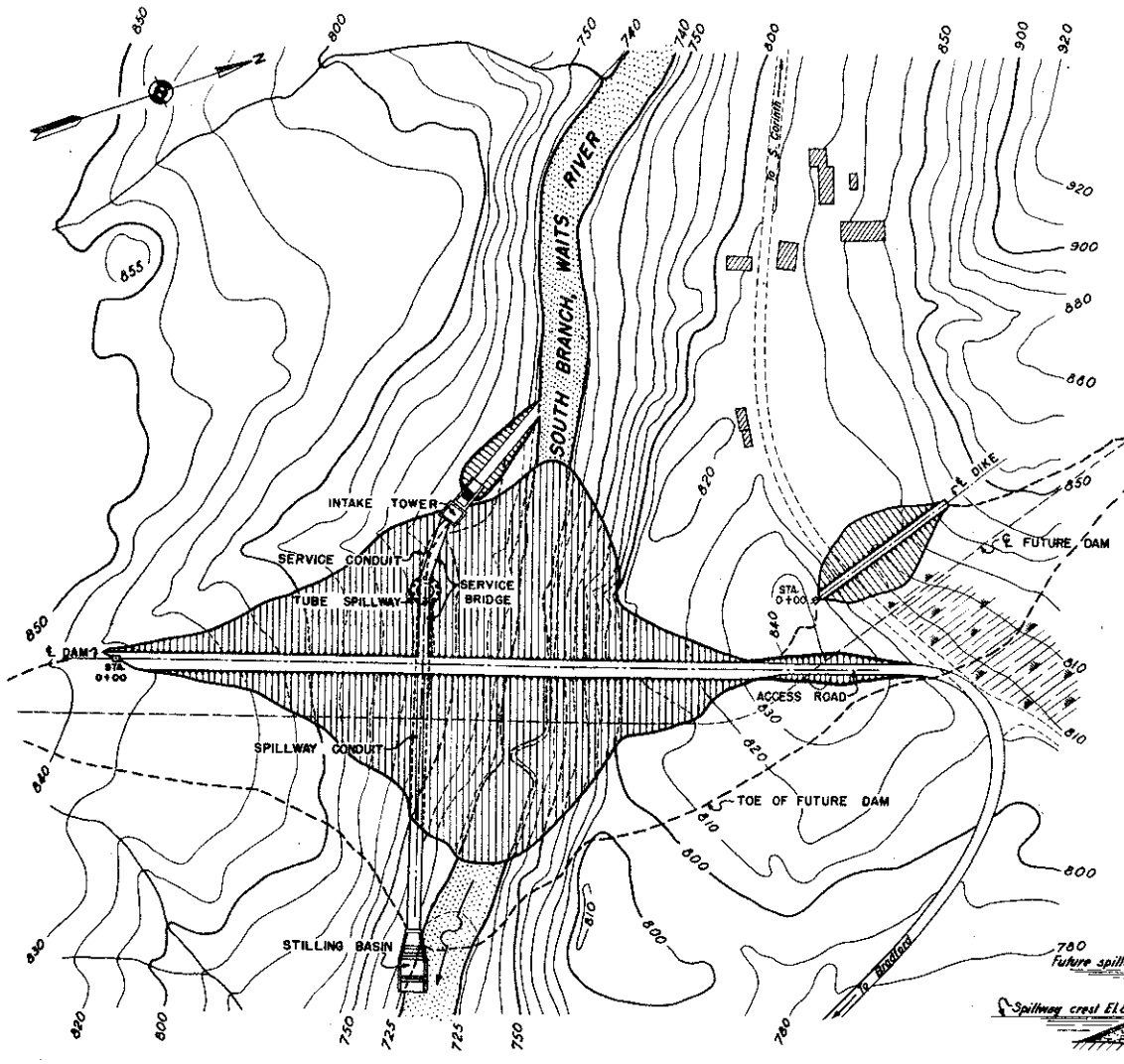
OMPOMPANOOSUC RIVER — VERMONT

IN 4 SHEETS — SCALE: 1 IN. = 200 FT. (200' 0 200' 400') — SHEET NO. 4

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

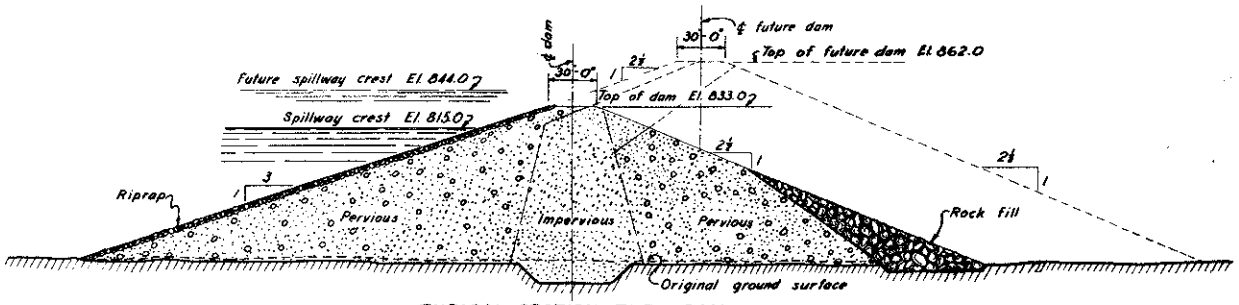
SUBMITTED: Senior Geologist, Head, Geology Section — APPROVAL RECOMMENDED: Principal Engineer, Chief, F. C. Engineering Div. — APPROVED: Lt. Col., Corps of Engineers, District Engineer

COMPILED: Asst. Engineer — DRAWN: R. R. L. TRACED: H. O. L. CHECKED: — TO ACCOMPANY REPORT DATED FEB. 28, 1940 — FILE NO. CT-2-1248



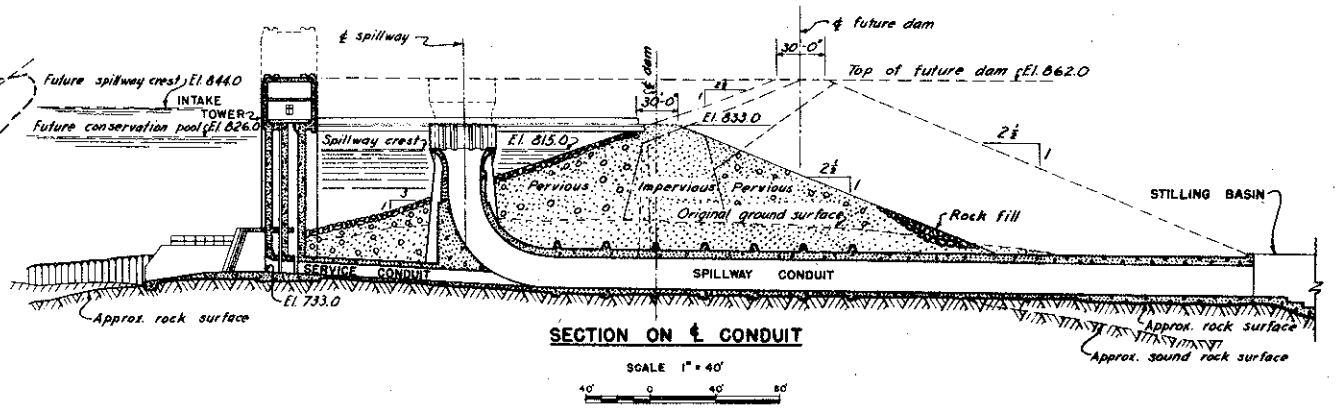
PLAN

SCALE 1" = 100'



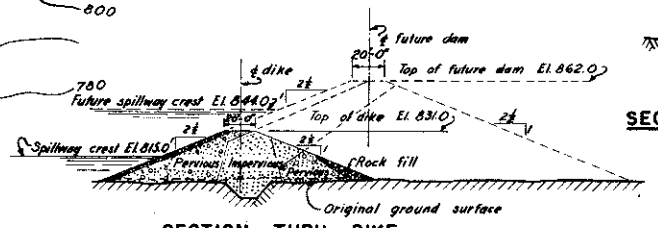
TYPICAL SECTION THRU DAM

SCALE 1" = 40'



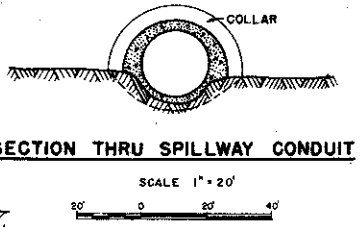
SECTION ON ℄ CONDUIT

SCALE 1" = 40'



SECTION THRU DIKE

SCALE 1" = 40'



SECTION THRU SPILLWAY CONDUIT

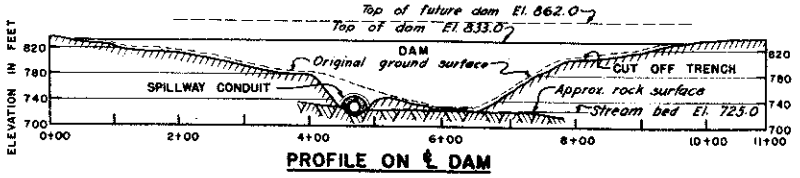
SCALE 1" = 20'

SECTION THRU SERVICE CONDUIT

SCALE 1" = 20'

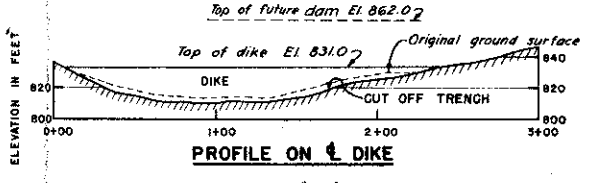
NOTE

Elevations refer to Mean Sea Level Datum.



PROFILE ON ℄ DAM

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



PROFILE ON ℄ DIKE

SCALE 1" = 40'

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

SOUTH BRANCH DAM.

GENERAL PLAN

SOUTH BRANCH, WAITS WATERSHED — VERMONT

IN 3 SHEETS — SCALE 1" = 100' — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 1940

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

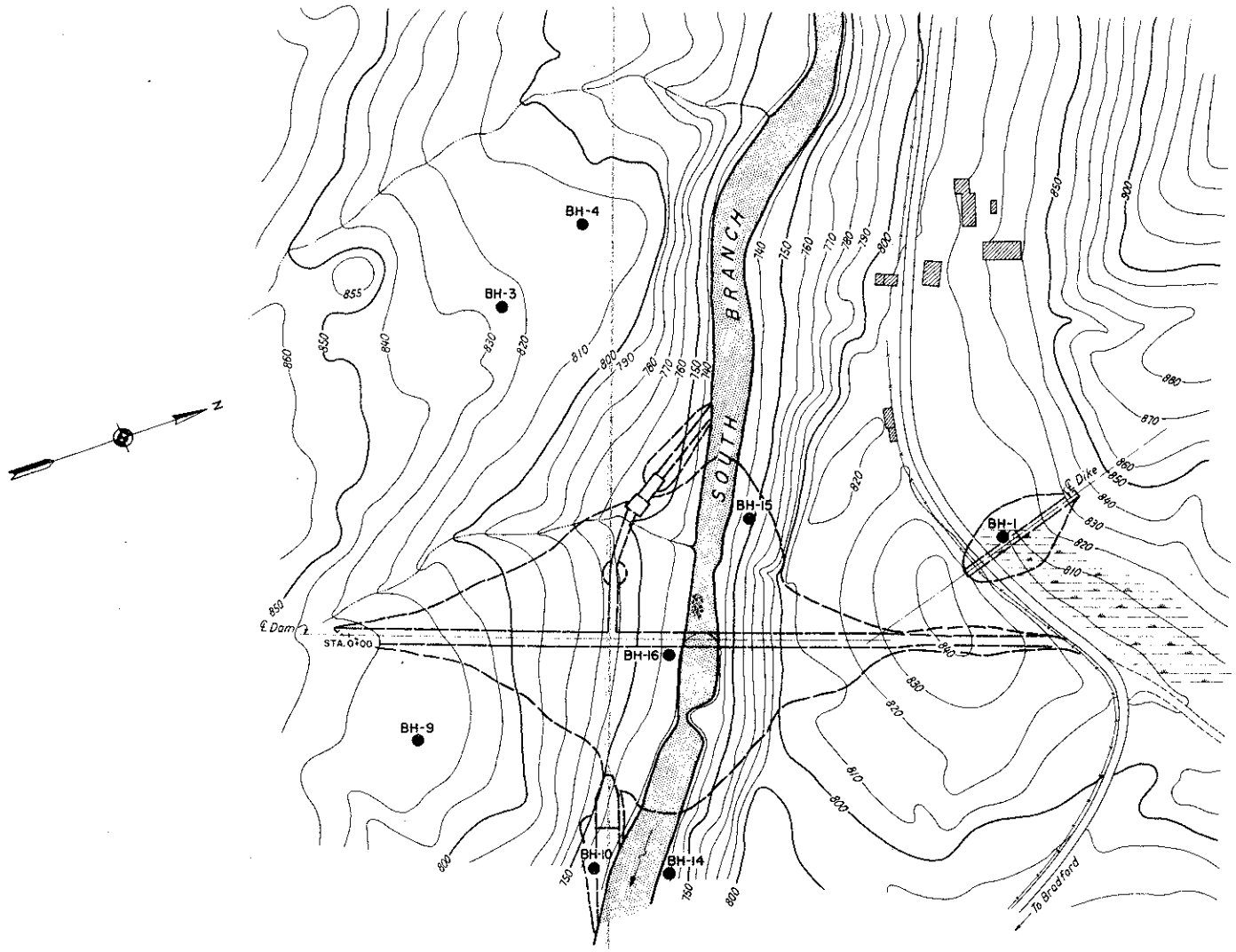
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

DRAWN: R.S.S. TRACED: G.B. CHECKED:

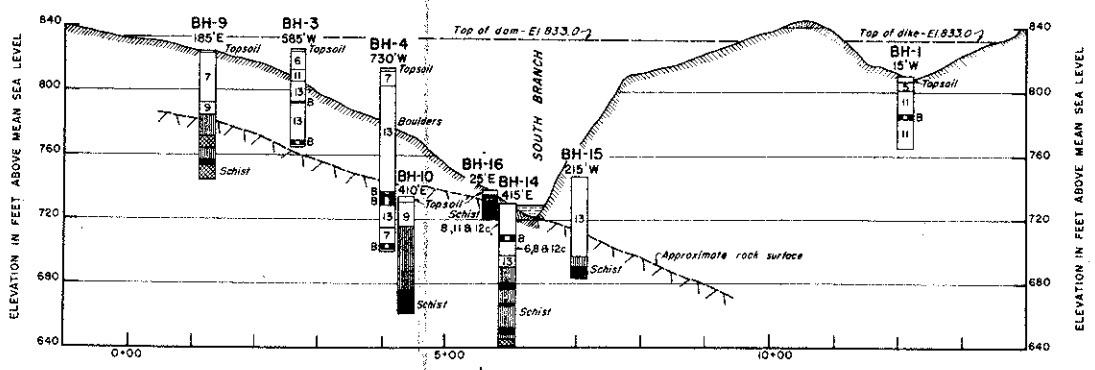
TO ACCOMPANY REPORT DATED: FEB. 26, 1940

FILE NO. CT-1-1454



PLAN

SCALE: 1" = 100'



PROFILE ON ℄ DAM AND DIKE

SCALES: HOR. 1" = 100'
VERT. 1" = 40'

SOURCES OF BORROW

Pervious material available within 0.5 miles upstream and downstream.

Impervious material available within 0.5 miles upstream and downstream.

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%.
- Weathered and fractured bedrock, core recovery between 50% and 75%.
- Less weathered and fractured bedrock, core recovery more than 75%.
- BH Drive sample bore hole.
- E. East of ℄ dam.
- W. West of ℄ dam.
- Ledge outcrop.

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14A.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

SOUTH BRANCH DAM

GEOLOGY

SOUTH BRANCH, WAITS WATERSHED — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 100 FT. (100' 0 100' 200') — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 194

SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION

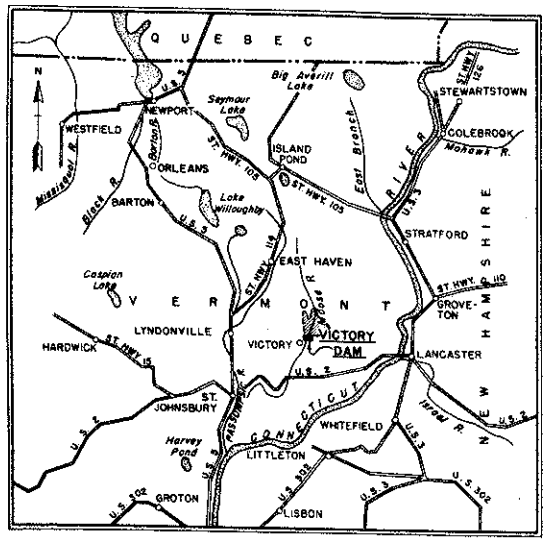
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASST. ENGINEER

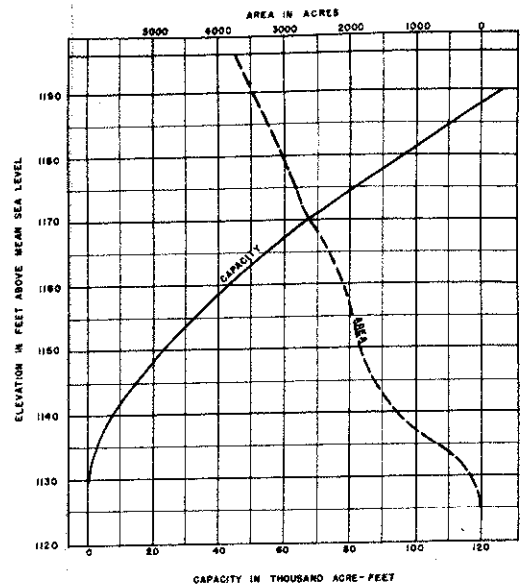
DRAWN: R.R.L.
TRACED: T.C.W.
CHECKED:

TO ACCOMPANY REPORT
DATED: FEB. 25, 1940
FILE NO. CT-2-1247

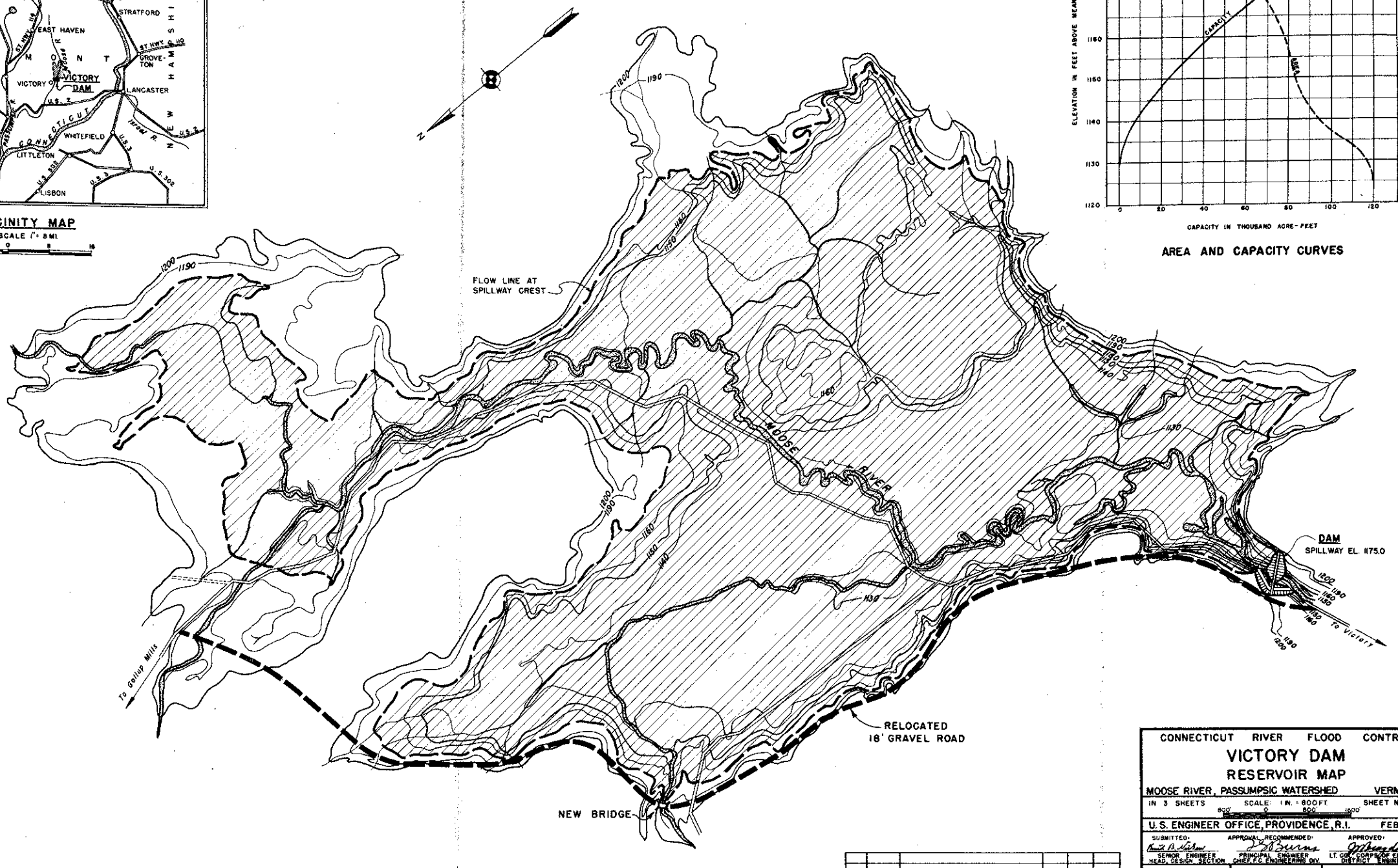


VICINITY MAP

SCALE 1" = 8 MI.



AREA AND CAPACITY CURVES



KEY	DATE	REVISION (Indicated by △)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

VICTORY DAM

RESERVOIR MAP

MOOSE RIVER, PASSUMPSIC WATERSHED — VERMONT

IN 3 SHEETS — SCALE: 1 IN. = 800 FT. — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R.I. — FEB., 194

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

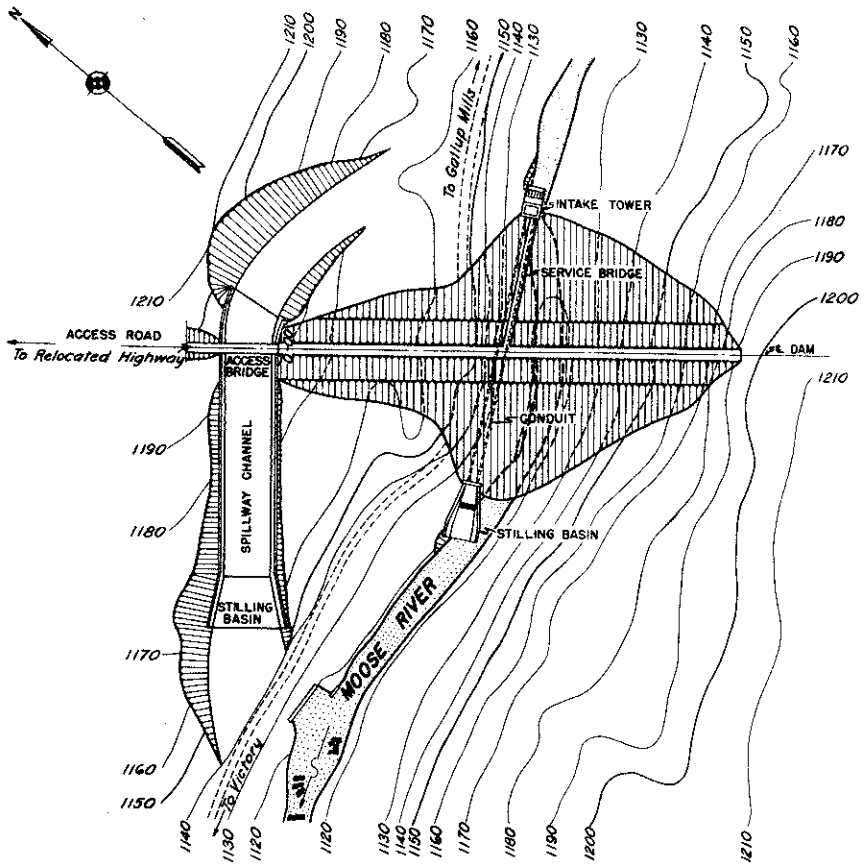
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

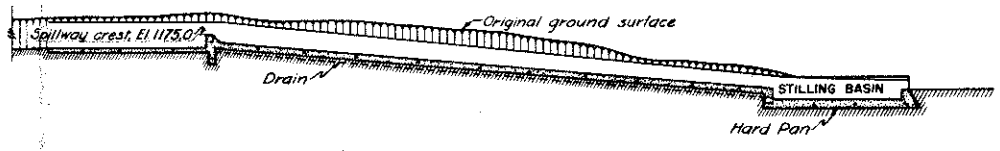
DRAWN: L.V.P.
TRACED: F.H.W.
CHECKED: H.S.K.

TO ACCOMPANY REPORT DATED: FEB., 28, 1940
FILE NO. CT-1-1410



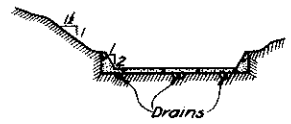
PLAN

SCALE 1" = 100'



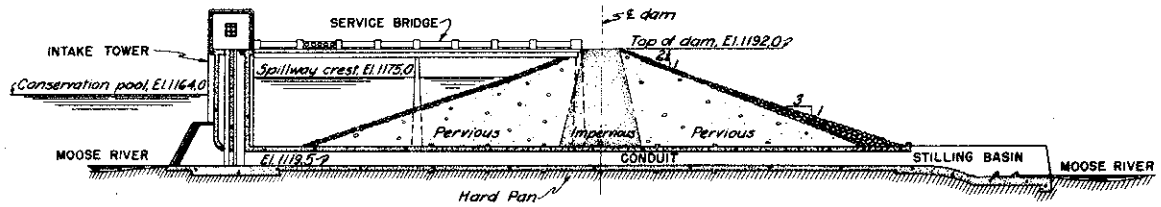
SECTION ON ℄ SPILLWAY CHANNEL

SCALE 1" = 40'



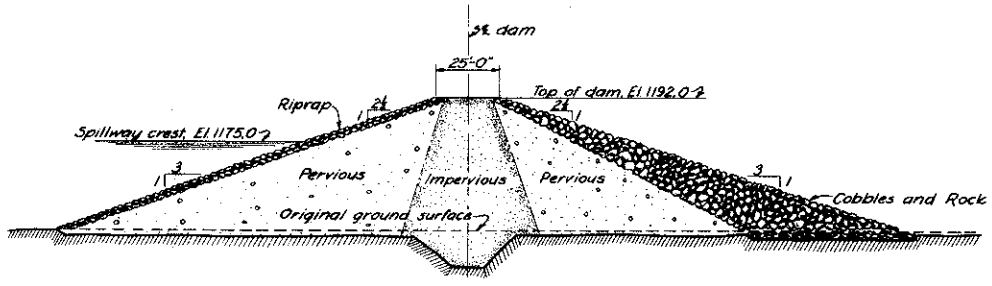
SECTION ACROSS SPILLWAY CHANNEL

SCALE 1" = 40'



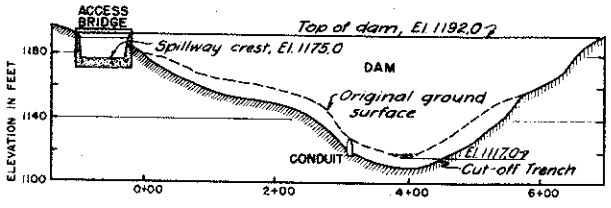
SECTION ON ℄ CONDUIT

SCALE 1" = 40'



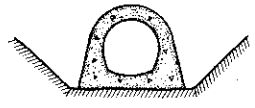
TYPICAL SECTION OF DAM

SCALE 1" = 20'



PROFILE ON ℄ DAM

SCALE: HOR. 1" = 100'
VERT. 1" = 40'



SECTION THRU CONDUIT

SCALE 1" = 10'

NOTE
Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

VICTORY DAM
GENERAL PLAN

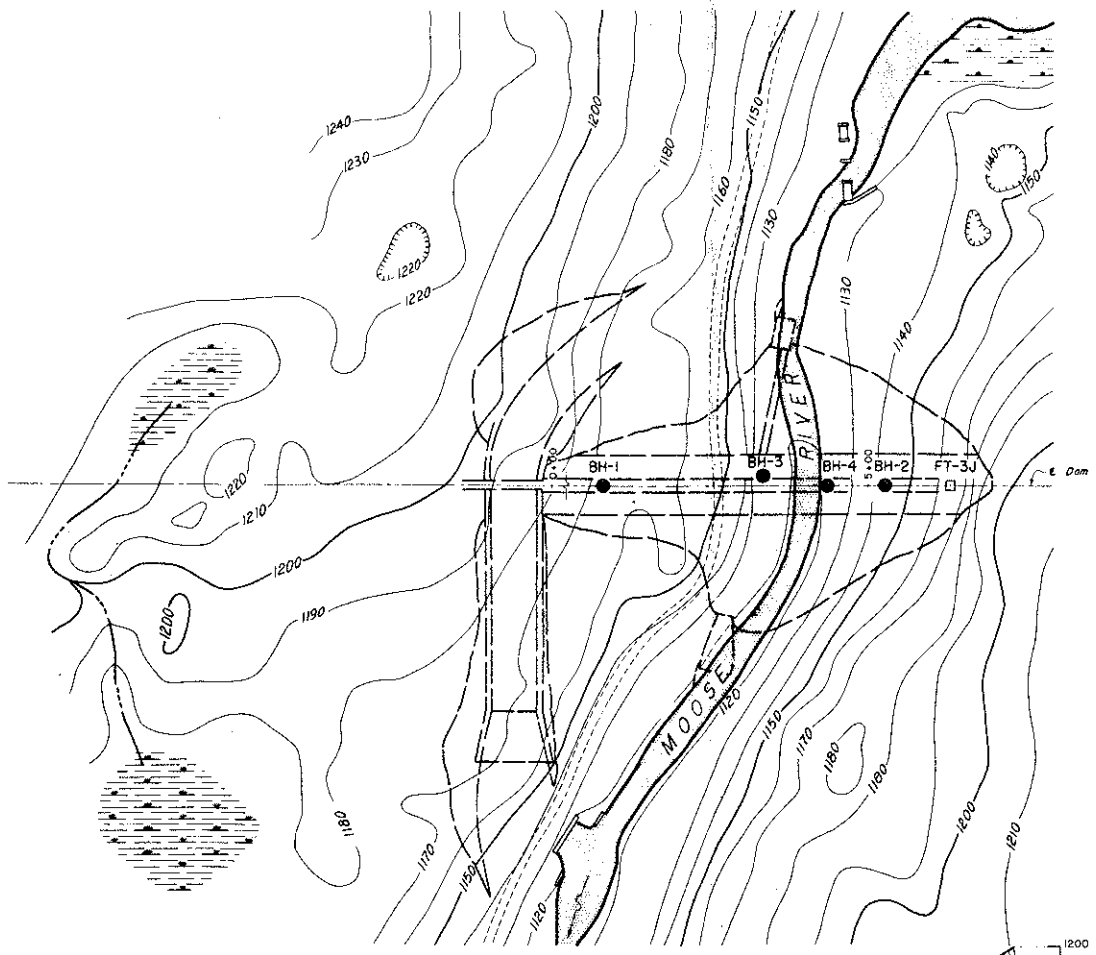
MOOSE RIVER, PASSUMPSIC WATERSHED — VERMONT

IN 3 SHEETS — SCALE: 1 IN = 100 FT. — SHEET NO. 2

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — FEB. 194

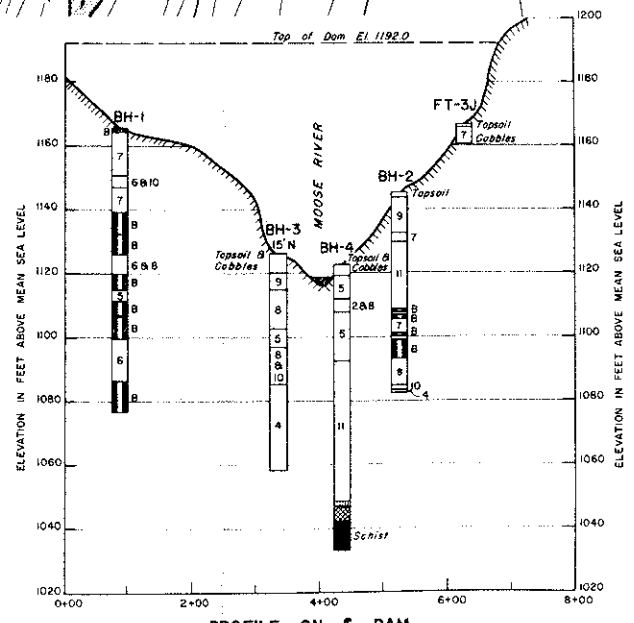
SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV.
APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: A. D. Morgan, ASSOC. ENGINEER
DRAWN: N.B.
TRACED: L.J.B.
CHECKED: M.D.K.
TO ACCOMPANY REPORT DATED FEB. 29, 1940
FILE NO. CT-1-1453



PLAN

SCALE: 1" = 100'



PROFILE ON ℄ DAM

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

SOURCES OF BORROW

Pervious material available within 0.5 miles downstream on right bank.
Impervious material available within 0.5 miles upstream on right bank.

LEGEND

- B Boulder
- Badly weathered and fractured bedrock, core recovery less than 50%
- Weathered and fractured bedrock, core recovery between 50% and 75%
- Less weathered and fractured bedrock, core recovery more than 75%
- BH Drive sample bore hole
- FT Foundation test pit
- N North of ℄ dam

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14 A

KEY	DATE	REVISION (Indicated by △)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

VICTORY DAM

GEOLOGY

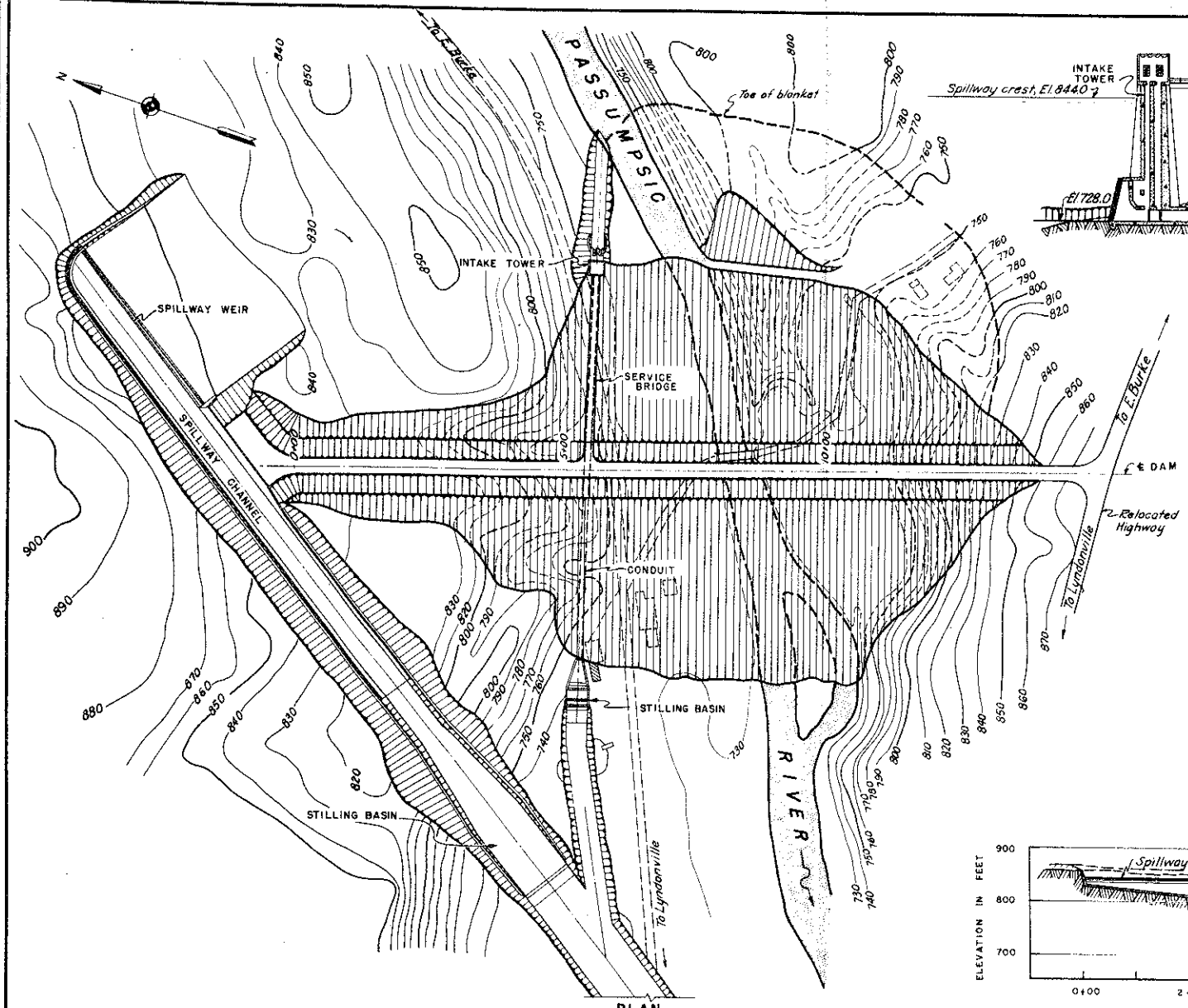
MOOSE RIVER, PASSUMPSIC WATERSHED VERMON

IN 3 SHEETS — SCALE: 1 IN = 100 FT. (100' 0' 100' 200') — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., FEB. 194

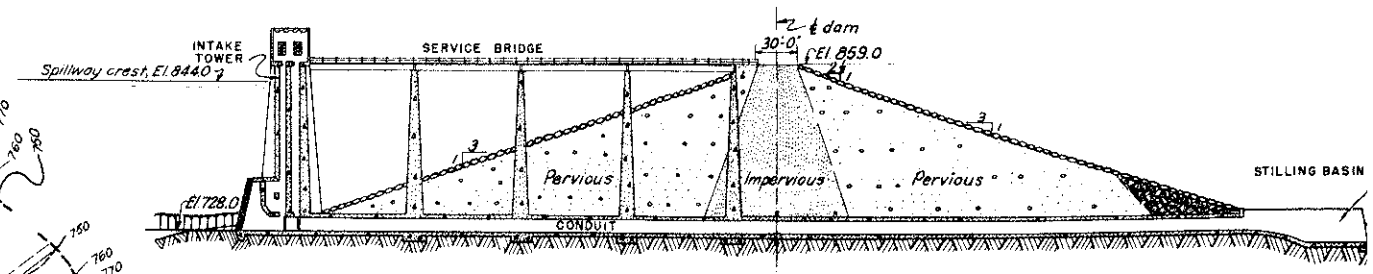
SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINE, DISTRICT ENGINEER

COMPILED: ASST. ENGINEER — DRAWN: R.R.L. TRACED: C.W.B. CHECKED: — TO ACCOMPANY REPORT DATED: FEB. 28, 1940 — FILE NO. CT-2-1238



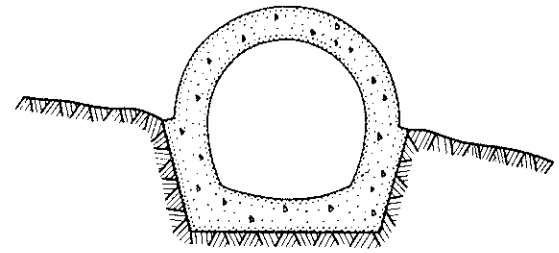
PLAN

SCALE 1" = 100'



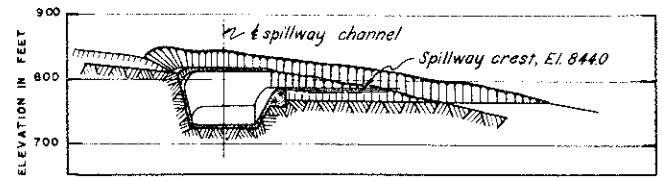
SECTION ON ℄ CONDUIT

SCALE 1" = 50'



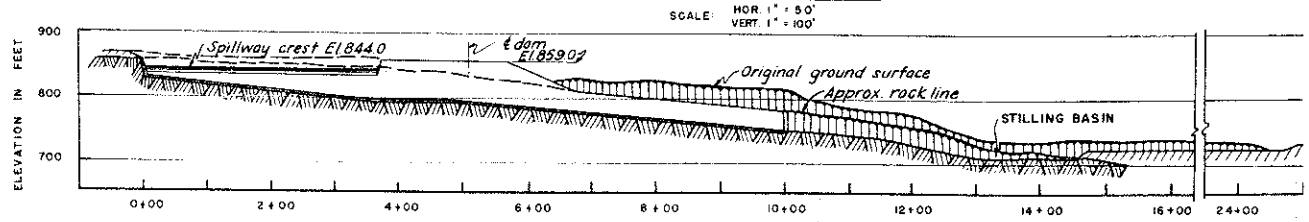
SECTION THRU CONDUIT

SCALE 1/4" = 1'-0"



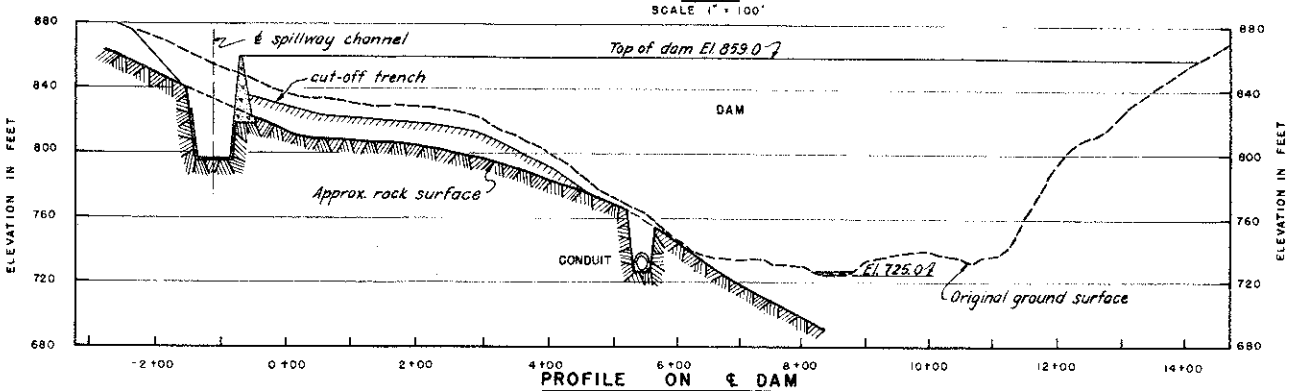
SECTION THRU SPILLWAY

SCALE: HOR. 1" = 50' VERT. 1" = 100'



PROFILE ALONG SPILLWAY CHANNEL

SCALE 1" = 100'



PROFILE ON ℄ DAM

SCALE HOR. 1" = 100' VERT. 1" = 40'

NOTE

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by △)	REV BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

LYNDONVILLE DAM
GENERAL PLAN

PASSUMPSIC RIVER — VERMON

IN 3 SHEETS — SCALE: 1 IN. = 100 FT. (100' 0 100' 200') — SHEET NO. 2

U. S. ENGINEER OFFICE, PROVIDENCE, R.I. — FEB. 194

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV.

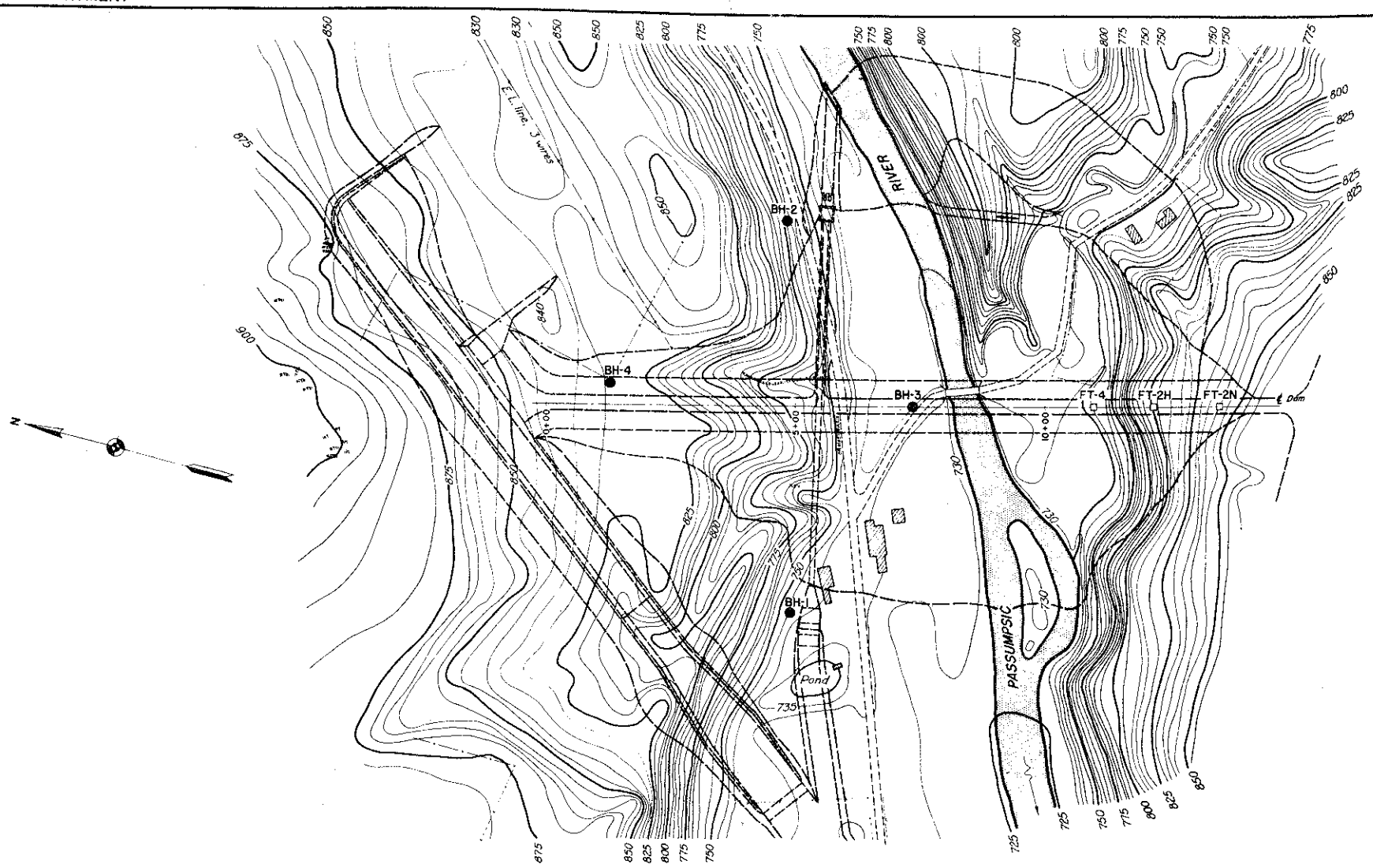
APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

DRAWN: D. P. TRACED: W. R. K. CHECKED: D.K.

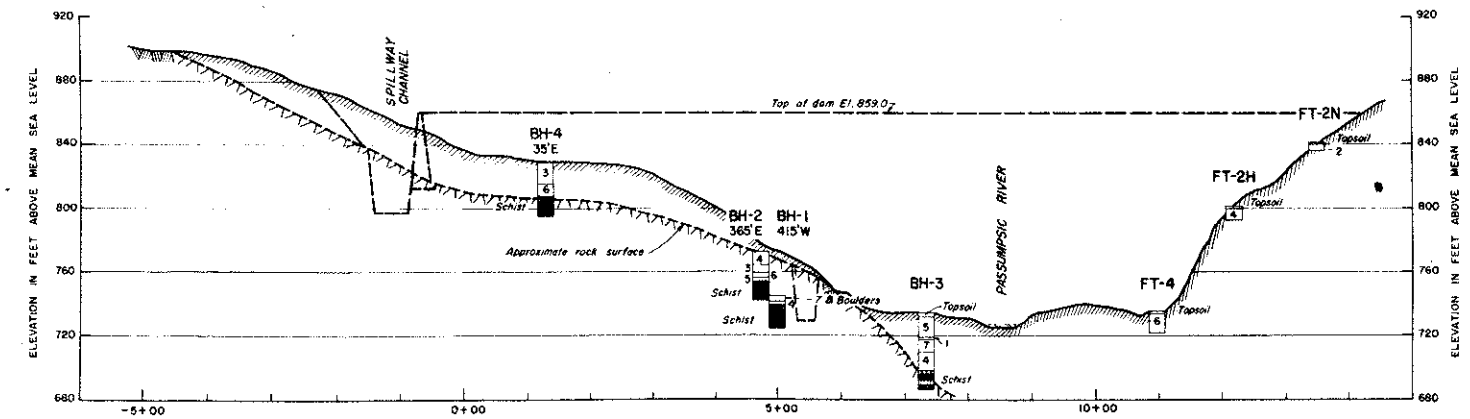
TO ACCOMPANY REPORT DATED FEB. 28, 1940

FILE NO. CT-1-1471



PLAN

SCALE: 1" = 100'



PROFILE ON ℄ DAM

SCALES: HOR. 1" = 100'
VERT. 1" = 40'

SOURCES OF BORROW

Pervious material available within 0.5 miles upstream on left bank.

Impervious material available within 1.0 miles upstream on left bank.

LEGEND

- B Boulder.
- Badly weathered and fractured bedrock, core recovery less than 50%.
- Weathered and fractured bedrock, core recovery between 50% and 75%.
- Less weathered and fractured bedrock, core recovery more than 75%
- ● BH Drive sample bore hole.
- □ FT Foundation test pit.
- Ledge outcrop.
- E East of ℄ dam.
- W West of ℄ dam.

NOTE

For description and limits of numerical soil classes see Table XXXVI and Plate No. 14 A.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTRO

LYNDONVILLE DAM
GEOLOGY

PASSUMPSIC RIVER — VERMO

IN 3 SHEETS — SCALE: 1 IN. = 100 FT. — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — FEB. 19

SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINE, DISTRICT ENGINEER

COMPILED: ASST. ENGINEER

DRAWN: F. Z. F.
TRACED: J. C.
CHECKED: H. A. J. Jr.

TO ACCOMPANY REPORT DATED: FEB. 28, 1940
FILE NO. CT-2-1250