CONNECTICUT RIVER FLOOD CONTROL PROJECT

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ANALYSIS OF DESIGN

FOR

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

ITEM C.3b - CONTRACT

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CONNECTICUT RIVER FLOOD CONTROL

/ANALYSIS OF DESIGN

DIKE SOUTH BANK OF CHICOPEE RIVER
AND DWIGHT PUMPING STATION

CHICOPEE, MASSACHUSETTS/

ITEM C.3b

CORPS OF ENGINEERS, UNITED STATES ARMY

UNITED STATES ENGINEER OFFICE PROVIDENCE, RHODE ISLAND

ANALYSIS OF DESIGN
CHICOPEE, MASSACHUSETTS
DIKE SOUTH BANK OF CHICOPEE RIVER AND
DWIGHT PUMPING STATION
Item C.3b

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CHICOPEE SOUTH BANK
Item C.3b
PERTINENT DATA

LOCATION. - South bank, Chicopee River, approximately one half mile from its confluence with the Connecticut River.

Area protected	25 acres
Type of property protected	Industrial

ELEVATIONS (above mean sea level datum). -

Top of dike at Station 0+00	76.0
Top of dike at Station 2+92	73.9
Top of wall at Station 2+92	71.9
Top of wall at Stations 31+79 and 40+00	70.6

EMBANKMENT AND FLOODWALL. -

Total length of wall	2,580 feet
Total length of dike	850 feet
Total impervious fill	14,350 c. y.
Total random fill	45,400 c. y.
Total steel sheet piling cut-off	22,050 s. f.
Total concrete	8,415 c. y.

MISCELLANEOUS. -

Size of Tailrace Gate No. 1	8'-0"x5'-6"
Size of Tailrace Gate No. 2	9'-0"x6'-6"
Size of the two Outlet Gates adjacent to Dwight Pumping Station	9'-0"x9'-0"
Number of 30" propeller pumps in Dwight Pumping Station	3

I. INTRODUCTION

I. INTRODUCTION

A. AUTHORIZATION AND PAST REPORTS. - The dike on the south bank of the Chicopee River, east of the Boston and Maine Railroad (Item C.3b), as shown on Plate No. 2, is a part of the Chicopee Dike project, which is authorized under the Flood Control Act approved June 28, 1938. It is a part of the Connecticut River Flood Control Plan recommended by the District Engineer in "Report of Survey and Comprehensive Plan for Flood Control in the Connecticut River Valley," dated March 20, 1937, approved by the Chief of Engineers November 29, 1937, and published as House Document No. 455, 75th Congress, 2d session.

B. NECESSITY FOR THE PROTECTION. - Nearly all of the area between the power intake canal and the Chicopee River from station 0+00 of the flood protection works to the Boston and Maine Railroad was inundated during the floods of 1936 and 1938, both of which caused extensive damages. This area, which is a part of the City of Chicopee, is fully occupied by industrial plants. Among the important properties in this section are the Ames Plating Company, A. G. Spalding Company, Springfield Gas Light Company, and the Industrial Buildings Corporation which owns and leases eight buildings in the flooded area to various manufacturing companies. In the protected area there are four active tailraces; three of which must be shut down during flood stage by closing the present head gates and the proposed tailrace gates in order to attain complete flood protection. While the tailrace gates are closed, the generators will be stopped and the water power normally developed will not be available to the local industrial plants. The tailrace for the

Dwight Power Station which generates about 60 percent of the total power available from the canal will be able to function at all times during flood stages.

To prevent the accumulation of water in the protected area during flood stages, the Dwight Pumping Station is to be constructed to discharge storm water, sewage, dike and canal leakage into the river. The highly industrially-developed drainage area is approximately 25 acres in extent. Pumping will be necessary when the Chicopee River exceeds Elevation 58.0 at the Dwight Pumping Station. During periods of normal river stage the drainage from the entire area will flow to the river by gravity.

C. DESCRIPTION OF EXISTING WATER POWER DEVELOPMENT. - Adjacent to the protected area, there exists a water development system owned and operated by the Turners Falls Power and Electric Company. This company owns the dam across the Chicopee River as shown on Plate No. 2 which diverts the water through a headgate structure of reinforced concrete into the power canal. The canal headgates are electrically operated with the equipment housed in a modern brick building. The power canal extends westerly behind and above the industrial plants and is provided with a relief spillway adjacent to and east of the Boston and Maine Railroad. The outlet of the power canal extends under the Boston and Maine Railroad in a conduit and to the Connecticut River in an open channel. The A. G. Spalding Company have water rights in the power canal totaling 100 c.f.s. for their two tailraces. The Turners Falls Power and Electric Company take 750 c.f.s. from the power canal for their Dwight Power Station. The tailrace approximately 260 feet west of the

Davitt Memorial Highway Bridge owned by Turners Falls Power and Electric Company has a capacity of 366 c.f.s. and is used intermittently when there is an excess of water in the canal. Some of the industries draw water from the canal for use in their manufacturing processes. All waters drawn from the canals are discharged finally into the pipe outlets and tailraces.

D. CONSULTATIONS WITH CITY AND OTHER OFFICIALS. - Before and during the actual design of the local protection works, consultations were held with representative officials of the City of Chicopee, the Turners Falls Power and Electric Company, the A. G. Spalding Company, the Ames Plating Company, and the Industrial Buildings Corporation. The alignment of the protection works, the tailraces and other related problems were the principal subjects of discussion. Track clearance for the short industrial railroad owned by and operated on the property of the Industrial Buildings Corporation was established. Methods of providing for the numerous drains from the industrial plants were discussed with the various engineers of the industrial buildings. The final designs for the protective works have been prepared with a view toward a minimum disturbance of the existing facilities of the industrial plants and due consideration has been given to the possible future development of the area.

E. DESCRIPTION OF THE PROTECTION WORKS.

1. General. - Plate No. 2 shows the general location of this project indicated as C.3b. The flood protection works for the south bank of the Chicopee River have been divided into two units for construction. Unit C.3a, which is now under construction with hired labor, serves to protect the area west of the Boston and

Maine Railroad. The railroad embankment is above the design elevation of the protection works. C.3a project consists essentially of a concrete wall approximately 580 feet long along the top of a blanketed riverbank changing to an earth dike which is about 1049 feet long, to high ground.

This project indicated as C.3b will serve to protect the area between the power canal and the Chicopee River from a point approximately 1150 feet east of the Davitt Memorial Bridge to the Boston and Maine Railroad. The Davitt Memorial Bridge approach is above the design elevation of the flood protection works. The total length of concrete wall will be approximately 2500 feet long with an average height of 16-1/2 feet and the earth dike will be approximately 860 feet with an average height of 25 feet. A steel sheet piling cut-off of a total length of 1320 linear feet is provided. There will be one pumping station, three tailrace gate structures, and one stop-log structure.

2. Area east of the Davitt Memorial Bridge. - Beginning at high ground approximately 1150 feet east of the highway bridge, the flood protection works will consist of an earthen dike which will extend westerly for a distance of approximately 292 feet and, then, will change to a concrete flood wall with its base resting on the river bottom. The wall, located about 18 feet from the face of the existing retaining wall, will continue downstream to station 9+00. At station 9+00 the concrete flood wall will cross the existing retaining wall and will extend to the bridge approach on the landside of and parallel to the present wall.

The earth dike will rest on rock ledge. The concrete flood wall is a cantilever type and will be founded on rock or on earth. The

base of the wall is four feet below the ground except where rock is encountered, and either a concrete or steel sheet piling cut-off is provided to ledge rock or to impervious material. The tailraces at stations 4+80 and 8+88 will be provided with gate structures to prevent damage during high water of the Chicopee River. Backfill behind the wall and dike will be brought to the elevation of the existing ground surface behind the retaining wall.

3. Area west of the Davitt Memorial Bridge to the Boston and Maine Railroad. - A concrete flood wall will extend westerly from the Davitt Memorial Bridge approach retaining wall along the permanent peninsular-like riverbank to station 23+94. An earthen dike will begin at station 23+94 and will extend westerly to station 29+52. A concrete flood wall will extend from station 29+52 to the railroad embankment at station 31+79.

From the Davitt Memorial Bridge approach retaining wall to station 13+20, the flood wall will have a concrete apron, placed on the face of the existing concrete wall, and will extend from the vertical stem of the flood wall to rock ledge. Elsewhere the wall will be of the cantilever type founded on earth with the base four feet below the ground surface and with either a concrete or steel sheet piling cut-off, where necessary, to rock or to an impervious material. A gate structure and pumping station will be built across the outlet of the storage pond. The gate structure will serve the active tailrace located about 260 feet west of the Davitt Bridge and also the discharges of the existing pipe outlets into the storage pond.

4. Area in the vicinity of the Depot Street Bridge. - A concrete wall will extend from station 40+00 to station 42+51 to prevent

the flooding of the protected area from backwater of the Connecticut River in the outlet channel of the canal. A stop-log structure is provided across the highway near the northerly end of Depot Street Bridge.

5. Provisions for handling water within the areas protected.

a. General. - The construction of the flood protection works will result in preventing natural drainage canal seepage and sewage from reaching the Chicopee River during high-water periods and in order to prevent the accumulation of these waters below damaging levels, the Dwight Pumping Station will be built to discharge the water into the Chicopee River. In Section IV, HYDROLOGY AND HYDRAULIC DESIGN, the quantity of the water to be pumped is discussed in detail.

b. Drainage systems. - The drainage system of the local protection works east of Davitt Memorial Bridge will consist of a vitrified clay pipe drain laid with open joints in a gravel trench which will follow the landside toe of the earth dike or concrete wall throughout their lengths and will discharge into the two tailraces. A reinforced concrete or vitrified clay pipe system laid with tight joints will collect and carry the discharge of the existing outlets to the two tailraces. The gates at the tailrace outlets will be closed when the river exceeds Elevation 58.0 and the discharge entering into the tailraces will be carried in a collector pipe westerly under the Davitt Memorial Bridge approach with an outfall about 260 feet west of the bridge, into the storage pond of the Dwight Pumping Station. Studies revealed that it was more economical to carry the discharge to the Dwight Pumping Station storage pond than to construct a separate pumping station to serve the area east of Davitt Memorial Bridge.

The drainage system of the local protection works between the Davitt Memorial Bridge and the Boston and Maine Railroad will consist of a gravel filled trench at the landside toe of the flood wall base from station 13+20 to the pumping station and will discharge into the storage reservoir. The flood wall and dike west of the pumping station will be provided with a vitrified clay pipe toe drain laid with open joints in a gravel trench and will discharge during low water stages into the river through the gated outlet at station 22+85. A reinforced concrete pipe system laid with tight joints will collect and carry the discharge of the existing outlets to the gated outlet at station 22+85 during low water stages of the Chicopee River. When the elevation of the Chicopee River exceeds Elevation 58.0 the outlet at station 22+85 will be closed and the discharge will be carried easterly in a short by-pass pipe over the Dwight Power Station tailrace to an outlet through a concrete wing wall into the storage pond. At stations 28+45 and 31+58 outlets under the flood protection works to the river will be constructed and will be provided with gates and flap valves.

The drainage system for the protection works in the vicinity of the power canal spillway will consist of a flood wall toe drain of vitrified clay pipe laid with open joints in a gravel trench and will discharge into manhole No. 19. A 12-inch pipe outlet, provided with a valve and flap valve, will be constructed for the 6-foot diameter old tailrace which is now used as an outlet for industrial water. During flood stages of the river, this outlet will be closed and its discharge will flow in an interceptor sewer to be constructed and connected to manhole No. 18 of the drainage system by local interests. Instead of

providing for a small local pumping station for this area, it was found economical to extend a collector pipe from manhole No. 19 to manhole No. 14 which will carry the discharge to the storage pond during flood periods when the Chicopee River exceeds Elevation 58.0.

c. Tailraces and tailrace gates. - The tailrace flood gates at stations 4+81, 8+88, and 20+61 were designed to pass the discharges detailed in Section IV, HYDROLOGY AND HYDRAULIC DESIGN, and will not raise the present tailwater elevations of the tailraces. The tailrace gates will be hand operated and will be closed when the elevation of the Chicopee River reaches 58.0 m.s.l.

The Dwight Power Station owned by Turners Falls Electric and Power Company is capable of being operated throughout all flood stages of the river and consequently the flood wall will be constructed on top of the tailrace structure. No gates are necessary as the tailrace is a solid reinforced concrete arch structure capable of safely withstanding the hydrostatic internal pressures developed by flood levels of the river.

d. Dwight Pumping Station. - The building which will house the pumps and other equipment will consist of a reinforced concrete substructure and a one-story superstructure, of structural steel and brick with glass block panels serving as windows. The lower portion of the west wall of the superstructure will be of reinforced concrete and will serve as a flood wall. The sloping concrete roof slab of the building will be covered directly with a 4-ply asphalt and gravel roof. The engine room will contain the gasoline engines and right angle gear units for the three 30-inch propeller type pumps and a small 100 g.p.m. sump pump. An overhead crane will be installed for handling equipment. The

concrete intake structure will be provided with trash racks and two electrically operated gates for the openings leading into the wet sump of the pumping station.

II. SELECTION OF ALIGNMENT AND TYPE OF PROTECTION

II. SELECTION OF ALIGNMENT AND TYPE OF PROTECTION

A. SELECTED ALIGNMENT. - The selected alignment of the flood protection works as described in Section I, Paragraph E, is considered to be the most economical and practical of the several alignments which were studied and are described in Paragraph B. The chosen alignment affords protection to all the plants in the area and utilizes the inlet behind the pumping station as a storage reservoir to increase the flexibility of the operation of the pumps.

B. OTHER ALIGNMENTS STUDIED. - In the area east of the Davitt Memorial Bridge, consideration was given to increasing the height of the existing retaining wall, strengthening the riverside walls of two buildings, and constructing a small pumping station, but this alignment proved to be more costly. Another alignment considered the abandonment of two four-story industrial buildings but the small savings to the Government could not justify this proposal.

In the area between the Davitt Memorial Bridge and the Boston-Maine Railroad, consideration was given to constructing a concrete wall along the top of the bank south of the storage pond but because of the steepness of the bank, which is composed of fill materials, an extensive drainage system and the shoring of existing structures, this alignment proved to be more costly than the selected alignment.

C. TYPE OF PROTECTION. - An earthen dike was selected wherever it proved to be more economical and where no encroachment upon the cross section of the Chicopee River occurred.

III. GEOLOGICAL INVESTIGATIONS

III. GEOLOGICAL INVESTIGATIONS

A. SITE AND FOUNDATION CONDITIONS.

1. General. - Foundation conditions vary considerably throughout the length of the project with portions of the structures resting directly on rock, on compact sandy glacial till, and on fill overlying an impervious silt layer. In general, the upper portion of the overburden is comprised of a fill of gravel, cinders, and brick fragments deposited on a lenticular formation of relatively impervious interstratified silt which increases in thickness toward the west or the main Connecticut River Valley. These conditions are discussed in more detail in the paragraph on Seepage, Section V, Paragraph C.

2. Dike and wall foundations. - The foundation of the dike and flood wall on the river bottom of the Chicopee River east of the Davitt Memorial Bridge consists of red shale covered with an overburden of sand, gravel, and debris about 3 feet thick. The rock is bedded and slightly inclined with a few seams and fractures; where this rock is exposed the surface is weathered. Between dike stations 5+00 and 8+00 a rock valley approximately 25 feet deep occurs. This valley has been filled with a dense, compact glacial till composed chiefly of classes 4, 5, 7, and 11. Laboratory tests prove this to be impervious and so compact that sheet piling could be driven through the material only with great difficulty.

Between the Davitt Memorial Bridge and the Dwight Pumping Station, the foundation of the wall rests on a fill of sand, gravel, cinders, and brick, which averages about 18 feet thick above rock. At the dike station 23+00 the rock surface dips down to below Elevation -10.

Between the Dwight Pumping Station and the Boston and Maine Railroad, the foundation for the wall and earth dike consists of fill materials and loose sand and gravel of varying depths from 6 to 20 feet above a thick stratum of impervious silt.

Foundation conditions were investigated by means of drive sample bore holes. The locations and records of these explorations are shown on Plates Nos. 6, 7, 8, and 9. Table No. 1 gives the soils classification adopted by the Providence District.

3. Foundation of pumping station. - Foundation conditions under the Dwight Pumping Station are shown in the Soils Section on Plate No. 12. The station rests on a stratum of silty gravel, probably fill, which is quite pervious and will therefore be cut off by sheet piling. Below this is a layer, approximately 5 feet thick, of moderately compressible gray silt, interstratified with layers of lean clay. Except for one other small silt lens the remaining material above rock is compact, sandy, glacial till which is relatively impervious. The silt layer is so thin and the underlying granular till so compact that no measurable settlements are anticipated.

B. BORROW AREAS. - Two borrow areas are proposed as shown on Plate No. 10, entitled "Borrow Areas." Area "J" contains a medium sand, quite uniform, which is an excellent pervious to semi-pervious material. This area is proposed for random pervious in the embankment and for backfill. In Area "Z" the upper two to five feet is a fine to medium sand which is proposed for random. Underlying this sand is a thick deposit of coarse to fine silt, interstratified with layers of lean clay which is proposed for impervious embankment material.

TABLE NO. 1

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

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

Satisfactory impervious material is relatively scarce within economical haul. The available impervious material is generally an interstratified silt deposit which is frequently quite wet, with water contents considerably above that for optimum compaction. The silt in Area "Z" is not as wet as the other areas explored and consequently this area has been selected as the most suitable source of impervious material.

Table No. 2, entitled "Summary of Borrow Materials Available," balances materials required against those available and shows important soils characteristics of the borrow area materials. Typical grain-size curves for the borrow materials are shown in Plates Nos. 14 and 15.

TABLE NO. 2

SUMMARY OF BORROW MATERIALS AVAILABLE

Materials Required		Materials Available								
						Shearing Resistance		Compaction Characteristics		
Type	Quantity cu. yds.	Source	Quantity cu. yds. Excav. Meas.	Class and Type	Permeability Coefficient K - cm/sec. x 10^{-4}	Angle of Internal Friction ø	Cohesion T/sq.ft.	Optimum Water Content W %	Compacted Dry Weight lbs/cu.ft.	Natural Water Content W %
Impervious (central core in dike)	15,000 Fill Meas. 18,000 Excav. Meas.	Borrow Area "Z" (1/2 mi. haul)	18,000	Medium to fine silt interstratified with layers of lean clay. Cl. 8, 10, and 12C	0.01	26°-32°	0.20-0.40	21-25	95-103	25-36
Random (shells of dike and backfill)	60,000 Fill Meas. 68,000 Excav. Meas.	Borrow Area "Z" (1/2 mi. haul)	11,000	Medium to silty sand Cl. 4 and 6 Occurs in top 1'-5' of area overlying impervious silt.	0.5-5	33°	0	- - -	102-108	- - -
		Use as a random impervious material								
		Borrow Area "J" (3/4 mi. haul)	80,000	Medium sand, very uniform Cl. 4 and 6-4	40-70	35°-37°	0	- - -	98-102	6-10
		Use as a pervious material								

IV. HYDROLOGY AND HYDRAULIC DESIGN

IV. HYDROLOGY AND HYDRAULIC DESIGN

A. FLOOD WALL AND DIKE. - The local protection works consisting of a concrete flood wall and earth dike will prevent flood waters from entering the area to be protected. The proposed works will begin at high ground approximately 1150 feet east of the Davitt Memorial Bridge and will extend to the Boston and Maine Railroad embankment near the mouth of the Chicopee River.

1. Design flood. - This project is so close to the mouth of the Chicopee River that flood stages are determined by Connecticut River backwater. The dike design flood for the Connecticut River at the mouth of the Chicopee is based on the maximum predicted flood reduced by 20 reservoirs comprised in the Comprehensive Plan of Flood Control for the Connecticut River Basin. The determination of the maximum predicted flood is discussed in Appendix 1 of "The Report of Survey and Comprehensive Plan for the Connecticut River", dated March 20, 1937, and published as House Document No. 455. It has a peak discharge at Chicopee of 312,000 c.f.s., approximately 15 percent greater than the maximum flood of record. A stage duration curve for existing conditions is shown on Plate No. 38.

2. Freeboard. - In accordance with a recommendation of the Board of Engineers for Rivers and Harbors, a minimum freeboard of 5 feet is provided on all earth dikes. Concrete walls are designed with a 3-foot freeboard.

3. Design grades. - From measurements on floods of record, it was possible to determine the flood profile on the Chicopee River for the design flood. Having established this flood profile, dike grades were

selected to comply with the minimum freeboard requirement. The following table gives a summary of the dike grades:

Location	Approximate project station	Top of earth dike
Upstream end of dike	0 + 00	76.0
50 feet downstream of old Ames Co. Dam	1 + 10	74.0
Davitt Memorial Highway Bridge	12 + 00	73.6
Boston and Maine Railroad Bridge	31 + 80	72.6

Where a concrete wall is used, two feet is subtracted from the grade established in the foregoing table. A short length of flood wall, located near the downstream end of the power intake canal, was investigated separately. A top elevation of 70.6 is satisfactory, assuming the most adverse operating conditions.

B. DESCRIPTION OF AREA PROTECTED. - The area isolated by the proposed protection works is located on the south bank of the Chicopee River near its mouth. The flood plain at this point is very narrow, being approximately 300 feet in width. Average ground surface is at elevation 62±. Development of the area is complete and consists entirely of industrial establishments. It is bounded on the land side by a power canal, and on the river side by the proposed dike which starts at the Boston and Maine Railroad embankment, and ties into high ground approximately 1150 feet upstream of the Davitt Memorial highway bridge.

1. Existing drainage facilities. - Since the area is narrow the sewerage system consists principally of a number of comparatively short

sewers and drains running normal to the long axis of the area, and discharging directly into the Chicopee River.

a. Storm drains. - A large percentage of the precipitation is concentrated into roof gutters and thence into cast iron drains leading to the river. Surface run-off is not a serious problem and is provided for by a few strategically located catch basins and by flow over the surface of the ground which naturally slopes toward the river channel.

b. Sanitary sewers. - An insignificant number of sanitary sewers serve the factory buildings and discharge the raw sewage directly into the river.

c. Industrial wastes. - A few of the industrial establishments contribute appreciable amounts of waste water to the existing sewer system. The heaviest contributor is a laundry and its waste water now flows through an abandoned tailrace, discharging into the retreat channel of the power canal wasteway.

2. New sewers to be constructed. - Provision is made for collecting the discharge from all existing sewers and drains. One collector drain will be interconnected with tailraces No. 1 and No. 2, and serve the area east of the highway bridge. This drain will pass under the Davitt Memorial Bridge approach and discharge, indirectly, into the storage pond. Another collector drain will intercept all existing sewers and drains in the area west of Dwight Power Station, and carry the sewage over the Dwight Station tailraces to the storage pond. The small area between the highway bridge and the Dwight Power Station needs no new sewers. The existing pipes will continue to discharge directly into the open tailrace No. 3 which is being utilized as a storage pond. All dikes and flood walls

are being provided with adequate toe drains.

a. Normal operation. - For low river stages the sewer system is so designed that all sewers will discharge with free outlets. Naturally, it is economically desirable to hold the number of openings through the flood wall or dike down to a minimum. Where feasible, gated tailrace openings are used for the discharge of sewage into the Chicopee River. One low-flow sewer by-pass (provided with a sluice gate) is required downstream of Dwight Power Station tailraces. A drain leading from a low coal well adjacent to the Boston and Maine Railroad embankment is allowed to pass through the dike and is provided with a valve and with a flap gate at the outfall.

b. Flood stage operation. - When the Chicopee River rises above Elevation 58, all openings through dike and flood walls will be closed. The sewer system is designed so as to conduct all the water from the drainage area to the storage pond, from which it will be pumped against head into the Chicopee River. Most of the sewers are below Elevation 58, and under flood-stage operation (pumping interval Elevation 55 to Elevation 58) they will be flowing full. An investigation of the area and the buildings therein indicates that water may be backed up into the sewer system to Elevation 60 without causing damage. For any reasonable combination of operating conditions the provided sewer system is adequate.

C. TAILRACE FLOOD GATES. - There are four intakes on the canal, which supply water to hydraulic turbines located in the protected area. Each one of these units has a tailrace returning to the Chicopee River. Tailraces Nos. 1, 2, and 3 (in downstream order) require gates to allow operation during normal river stages. It will be necessary for these units

to shut down when the flood gates are closed. Tailrace No. 4 of the Dwight Power Station which has its exit portal outside the dike, will not be provided with gates as it will be able to operate during flood stages. The tailrace flood gates are designed to be large enough so that the unobstructed waterway is adequate and will not, under any operating conditions, encroach upon the hydrostatic head available at these sites. The gate sill lengths and elevations are adjusted so that the maximum discharge may be passed without adverse effect on the minimum tailwater elevation. Pertinent data are as follows:

Tailrace No.	Maximum Discharge Capacity	Minimum tailwater elev.	Invert elevation of gate opening	Gate Opening	
				Width	Height
1	49 c.f.s.	52.5	50.9	8.0	5.5
2	63 "	52.2	50.5	9.0	6.5
3	366 "	44.5	40.5	18.0 *	9.0

* 2 gates, each 9' x 9'

D. DWIGHT PUMPING STATION. - A single pumping station will serve the drainage area of 25 acres. The flood wall alignment and pumping station location are selected so as to make possible the utilization of the open tailrace (No. 3) as a storage pond.

1. Storage pond. - While the pond created is not large, its capacity between Elevation 55 and Elevation 58 is 3.2 acre-feet, or 1.5 inches on the drainage area tributary to the pumping station. Low water elevation at 47.0 for the pond will nominally be held and the storage at this level will be 8.5 acre-feet. The advantage of a storage pond of this nature is that it absorbs abrupt variations in inflow, thereby allowing

smoother pump operation. A capacity curve of the storage pond is shown on Plate No. 39.

2. Determination of pump capacity. - When the Chicopee River reaches flood stage all openings through the flood wall and dike will be closed. During these periods the pump will be required to expel all water from the protected area so that damage by inundation is eliminated, and normal operation of the industrial establishments within the area is maintained as far as practicable. The various ways water may enter the diked area during flood periods are: (1) precipitation, (2) leakage through existing headgate structures, (3) seepage through the canal embankment, (4) seepage through dike and under flood wall, (5) leakage through the Dwight Power Station's tailrace conduits which will operate under pressure during floods, (6) industrial water, and (7) leakage through new tailrace flood gates.

a. Precipitation. - The drainage area (25 acres) is small and highly developed, with a time of concentration of approximately 10 minutes. It is possible to have a storm of cloudburst proportions on an area this size. The high improbability of having an extreme storm coincident with maximum river stages, and the effect of pond storage in reducing the peak of the inflow hydrograph, makes the provision for a storm of maximum intensity economically unjustified. A precipitation rate of one inch per hour was selected as a rational figure, and the run-off coefficient was taken as 100 percent.

b. Headgate leakage. - There is no "hard and fast" rule to follow in computing headgate leakage, and it is necessary to make certain rational assumptions to enable estimation of this quantity. For

headgates No. 1 and No. 2 (in area east of the Davitt Memorial Bridge) it is assumed that a 1/8-inch crack around the entire periphery of each gate exists, and that headgate No. 2 (larger of the two) is opened one inch from the bottom. Headgate No. 3 serves an auxiliary power unit which is not operated regularly. Data presented by the Turners Falls Power Co. indicate that leakage through this gate, which is of the cylinder type, is approximately 10 c.f.s. Since this gate has been in service for several years, the leakage has been arbitrarily increased to 15 c.f.s. A recapitulation is as follows:

Headgate	Size	Estimated leakage
No. 1	5' x 5'	1.6 c.f.s.
No. 2	9' x 9'	15.2 c.f.s.
No. 3	(cylinder)	15.0 c.f.s.

c. Seepage from canal. - Normal water level in the power intake canal is Elevation 78.4, and the top of the canal wall is at Elevation 81.0. The ground surface falls sharply from the canal wall down to the flood plain. There will be some seepage from the power canal into the protected area. It is not possible to compute the amount of this seepage. However, from general consideration of field conditions, and from data presented by local interests, a seepage of 2/3 c.f.s. per 100 feet of canal was estimated. Thus, for the 3000 foot length, a total of 20 c.f.s. has been assumed.

d. Flood wall and dike seepage. - All flood walls and dikes are provided with toe drains which will serve to collect seepage water. Seepage from the proposed dike was estimated after the following assumptions were made:

Area upstream of the highway bridge (short length earth dike on ledge, remainder concrete wall founded on earth and rock) = 0.10 c.f.s. per 100 feet (total length = 1200 ft.).

Area downstream of the highway bridge (concrete wall and earth dike on rock and earth foundation) = 0.15 c.f.s. per 100 feet (total length = 2000 ft.).

e. Leakage from tailrace, (Dwight Power Station). - As mentioned in the foregoing discussion, the flood wall alignment permits Dwight Power Station to operate during flood stages. Under such conditions the tailrace conduit is subjected to hydrostatic pressure from within, and it is anticipated that some leakage will be experienced. Information presented by a representative of the Turners Falls Power Co., and data gathered by way of field inspection, lead to an estimated maximum leakage of 10 c.f.s.

f. Industrial water. - Benefit derived from the proposed local protection works includes the maintenance of industrial activities during flood stages. There are a few establishments within the area that will contribute measurable amounts of waste water. Existing drains were investigated with a view to determining their carrying capacity. With this information and other helpful data, it is estimated that a discharge of 15 c.f.s. will adequately provide for the disposal of industrial water.

g. Tailgate leakage. - The tailrace flood gates will be new and of modern construction, and unquestionably will operate effi-

ciently. However, it is possible that some small obstruction might prevent complete and tight closure. For this reason it is assumed that each gate is opened 1/8 inch from the bottom. A computation of discharge through such an opening yields a leakage of approximately 1 c.f.s. per gate.

h. Summary of capacity. - It is estimated that the pumping capacity of the Dwight Pumping Station is 110 c.f.s., which is subdivided in the following table:

Item	Spalding Area	Dwight Area
Storm run-off	9 c.f.s.	16 c.f.s.
Headgate leakage	16.8 c.f.s.	15 c.f.s.
Canal seepage	6.0 c.f.s.	14 c.f.s.
Flood wall and dike seepage	1.3 c.f.s.	3 c.f.s.
Seepage from Dwight Power Station	0	10 c.f.s.
Industrial water.	5.0 c.f.s.	10 c.f.s.
Tailrace gates.	2.0 c.f.s.	2 c.f.s.
Subtotals . . .	40.0 c.f.s	70 c.f.s.
Total . . .		110 c.f.s.

The A. G. Spalding Company area includes the area east of the Davitt Memorial Bridge and discharge from this area will flow through a collector drain to the storage pond as described in Section I, Paragraph 5b.

The Dwight area includes the area between the Davitt Memorial Bridge and the Boston and Maine Railroad and its drainage system is described in Section I, Paragraph 5b.

Three pumps, each capable of expelling 50 c.f.s. against a hydrostatic head of 13 feet (storage pond Elevation 55 to maximum predicted flood stage Elevation 68), are provided. The increase in capacity over the estimated storage pond inflow is necessary to provide greater dependability and flexibility of operation.

i. Operation of Dwight Pumping Station. - When the river reaches Elevation 58.0, all the openings through the dike and flood walls will be closed and the pumps will begin to operate. The water surface in the storage pond behind the pumping station may be drawn down to a minimum elevation of 47.0. The pumps will have such a capacity that the water surface elevation of the storage pond will not ordinarily exceed Elevation 55.0 following initial pumping operations which will begin with the water at 58.0. No appreciable property damage will occur in the protected areas with backwater up to Elevation 60.0.

V. DIKE DESIGN CRITERIA AND GENERAL DESIGN

V. DIKE DESIGN CRITERIA AND GENERAL DESIGN

A. GENERAL. - After a thorough study of the conditions at the site and consideration of such factors as economy, good engineering practice and the type of embankment materials available in nearby borrow areas, it was determined to modify the standard earth dike section of the Providence District which consists essentially of a large section of random or pervious material covered on the riverside by a blanket of impervious material. The revised earth dike design provides for an impervious center core covered on both the riverside slope and landside slope with a section of random materials. The general design criteria include safety, stability and reduction of seepage and are enumerated as follows:

1. The crest of the dikes is at such grade that overtopping at design flood and by wave action is eliminated.

2. a. The slopes of the dike are such that with the materials used in construction they will be stable under all conditions.

b. After a study of the flow of flood waters in the Chicopee River, 12-inch hand-placed riprap over a 6-inch gravel bed was required over the entire waterside slope of the dikes to prevent scour.

3. a. The line of saturation is well within the landside toe.

b. The dike is designed for a fairly low line of saturation and analyzing the Chicopee dike sections, the flood water will seep through the riverside random section, then more slowly through the impervious section of low permeability to the landside random section where, because of a somewhat greater permeability, together with the influence of the toe drain, the line of saturation will drop below the

landside toe. The velocity of the seepage water will be so low that there will be no movement of any of the dike and foundation materials.

4. Seepage and surface run-off behind the dike are collected by the toe drain and existing catch basins. Such seepage through the dike as may occur will have a very low velocity and will be collected by the toe drain. The toe drain is connected to a collector pipe which carries the entire flow to the pumping station.

5. There is no possibility for free passage of water from riverside to landside.

6. No material soluble in water is used in any part of the dike and soils laboratory tests have been made of borrow materials for solubility. (See Paragraph B-8.)

7. The foundation under the dike is sufficiently stable to resist stresses due to the embankment load. (See Paragraph B-6).

B. LABORATORY INVESTIGATIONS.

1. Classification of materials. - The Providence District has adopted a convenient system of soil classification having rigidly standardized terms. In this classification soils are divided into 16 classes as shown graphically on Plate No. 11 and described in Table No. 1. Soils of uniform grain size are designated by even numbers, soils of variable grain size by odd numbers and grain size limits of materials follow the M. I. T. Classification except that the size demarcation between silt and coarse clay is not 0.002 mm. but varies from 0.006 mm. to 0.0006 mm.

2. Grain-size analysis. - Grain-size curves of samples were obtained by sieve and hydrometer tests run on representative samples for each stratum encountered in each exploration. These materials were

classified and grouped into sedimentary units as shown on Plate No. 13, entitled "Geologic Section". Plates Nos. 14 and 15 show typical grain size curves for embankment materials.

3. Water content and void ratio. - Water contents and void ratios were determined on 1-1/2" diameter paraffined cores of foundation strata. In addition, these tests were run on samples representative of borrow areas.

4. Permeability. - Permeabilities for borrow materials have been obtained from falling head tests run with deaerated water.

5. Consolidation. - Consolidation tests were run on undisturbed samples obtained in one 6" bore hole, BH-74, which represents the heavy silt layer portions of the foundation. Consolidation characteristics for a typical sample are shown on Plates Nos. 19 and 20.

6. Shear. - Tests to determine the shearing resistance of foundation and embankment materials were made by the direct shear method allowing complete consolidation under normal loads with horizontal strain at a constant rate of 0.06" per minute. Typical results for the random pervious and impervious embankment materials are shown in Plates Nos. 17 and 18.

7. Compaction. - Compaction tests based on the Proctor analysis procedure and on Terzaghi's relative density method were performed on impervious and on random pervious embankment materials respectively. Plate No. 16 is a typical compaction curve for the impervious material. Compaction characteristics are also summarized in Table No. 2 "Summary of Materials Available."

8. Other tests. - Tests for extraction for solubility and

specific gravity were performed.

C. SEEPAGE. - Security against under seepage has been provided for by toe drains and by sheet pile cut-offs to impervious material in the foundation. Between stations 0+00 and 2+90 the earth dike rests on rock. From station 2+90 to 9+20 the concrete wall is also founded directly on rock, except for a short distance between station 5+00 and 8+40 where the wall rests on very compact formation of semi-impervious sandy till. From approximately station 9+20 to 18+50 the wall is founded on relatively pervious gravel and cinder fill which has been cut off by sheet piling driven to rock. In the remaining sections of the project an effective cut-off has been secured by a cut-off trench under the earth dike core and by sheet piling to the underlying impervious silt. Seepage through these various sections has been analyzed by flow nets and is estimated at 0.2 cubic feet per second for the entire project from station 0+00 to station 31+80. Table No. 3 is a summary of this seepage estimate.

The line of seepage in the earth dike section is contained well within the landside shell as shown on Plate No. 13. Plate No. 13 presents a generalized section through the major portion of the earth dike and shows the types of embankment materials and their relative permeabilities.

D. STABILITY OF FOUNDATION. - The section considered in analysis is shown on Plate No. 13 where a layer of silt about 30 to 40 feet thick underlies the structure. This silt is only slightly compressible and based on consolidation tests an ultimate settlement of 5 inches has been estimated. This settlement will occur rapidly at approximately the same

rate as load is added.

Shearing stresses induced by the dike are less than the natural shearing resistance of this silt foundation. Consolidation of the silt occurs so rapidly that adjustment of stresses keeps pace with the rate of addition of load. The dike is considered adequately stable under all conditions.

TABLE NO. 3
SEEPAGE ESTIMATE

Section Sta. to Sta.	Type of Structure and Foundation	Length of Section L ft.	Seepage per lin. ft. q C.F.S./ft.	Total Seepage for Section Q = q x L C.F.S.
0+00 - 2+90	Earth dike resting on rock	290	10×10^{-6}	0.003
2+90 - 5+00 and 8+40 - 9+20	Concrete wall on rock	290	20×10^{-6}	0.006
5+00 - 8+40	Concrete wall on semi-impervious foundation of sandy till	340	150×10^{-6}	0.050
9+20 - 18+50	Concrete wall with sheet piling to rock	930	100×10^{-6}	0.093
18+50 - 24+00	Concrete wall with sheet piling to impervious silt or till	550	50×10^{-6}	0.028
24+00 - 29+50	Earth dike with cut-off trench to impervious silt	550	20×10^{-6}	0.011
29+50 - 31+80	Concrete wall with foundation or sheet piling to impervious silt	230	30×10^{-6}	0.006
			Total	0.197 cu.ft. per sec.

Total Seepage through Dikes and Walls Sta. 0+00 to 31+80 estimated as 0.20 c.f.s. or 130,000 gal. per day.

VI. MECHANICAL DESIGN

VI. MECHANICAL DESIGN

A. FLOOD GATES. - Under existing conditions, backwater due to flood stages in the Connecticut River produce reverse flow in the tailrace conduits discharging from the plants. To prevent this reverse flow and subsequent inundation of the buildings due to flood heights in the river, gates will be provided in Tailraces Nos. 1 and 2 and at the outlet structure of the Dwight Pumping Station. The gates will be of the plain vertical slide type controlled by manually-operated hoists located on top of the outlet structures.

It is assumed that the tailrace flood gates will be closed under balanced or nearly balanced head conditions for when the river reaches a critical stage and it becomes necessary to close the tailrace gates the head and turbine gates in the plant will be closed first. The stoppage of flow will result in the water surface becoming practically level in the tailrace conduits at an elevation equal to the river stage. It is also assumed that the gates will be raised under approximate balanced head conditions. This is true since the protection afforded the inclosed area would be lost if they were raised while any considerable head of water was imposed on them by the river. Should a head of water be built up against the gates from the tailrace side, the gates will be pushed from the guide seals and the leakage would equalize the water surfaces on either side of the gate in a short period of time.

The gates are designed for maximum head conditions assuming that the river is at flood stage and the tailrace conduit dry. The gates will be rectangular in shape and made up of a series of horizontal wide flange beams or channels to which the skin plate is attached. No member will be

stressed more than 16,000 pounds per square inch under full load conditions. Seals will consist of removable brass strips. The gates will be operated in structural steel guides securely embedded in the concrete.

Each gate will be connected to two pedestal type hand-operated hoists by means of threaded stems. The hoists will be connected to each other by a cross-connecting shaft to insure uniform raising and lowering of the gates.

B. DWIGHT PUMPING STATION. -

1. General. - The Dwight Pumping Station is one of seven pumping stations to be constructed in Chicopee. Prior to the design of any of the stations an investigation was made of the available electric power facilities with the view of employing electric motor drive for the pumps. The results of the investigation indicated that suitable power was available. However, the City of Chicopee was unable to come to an agreement with the power companies on the question of electric rates for standby service and consequently requested this office to provide gasoline engine drive for the pumps. (See Analysis of Design, Jones Ferry Pumping Station, Chicopee, Mass.).

The gasoline engines for the Dwight Pumping Station will be of the heavy-duty industrial type capable of continuously driving the pumps at their rated speed under any head condition developed. The engines will not use over 85 percent of their developed horsepower. They will be mounted on concrete bases and directly connected through flexible couplings to the right angle gear units.

2. Pumps. - From the pumping station capacity of 110 c.f.s. at 13 ft. static head, adopted as outlined in Section IV, it was deter-

mined that three pumps be installed. A larger number of pumps could be installed at a greater station cost without material operating advantage, while a smaller number of pumps would seriously limit the flexibility and reliability of station operation. For example, with a two-pump installation, the failure of one pump would reduce the station capacity by one half. Section IV shows no provision for possible mechanical failure of equipment. To provide for such a contingency it is established that any two pumps should be capable of delivering about 85 percent of the 110 c.f.s. or 94 c.f.s. This factor raises the total station capacity to 141 c.f.s. A study of equipment indicated that three 30-inch pumps would be required, each pump to have a capacity of 21,150 g.p.m. or 47 c.f.s. against a total head of 17 feet. The small amount of sewage to be pumped at times when the river is at flood stage made the installation of a separate sewage pump unnecessary.

3. Right angle gear units. - The gear units will be of the self-contained type designed for transmitting the power from the horizontal engine shaft through a gear train to the vertical pump shaft. The units will be enclosed in a cast iron and structural steel housing and will have a service factor of not less than 1.25 times the maximum power required to drive the pumps under any condition of head.

4. Crane. - A five-ton overhead crane will be installed in the engine room to facilitate the repairing of any items of equipment. The crane will be of standard construction and hand-operated throughout.

5. Sluice gates. - Two electric motor-operated sluice gates will be located at the entrance to the pump sump. These gates will normally be kept closed to prevent sewage and debris from collecting in

the sump. They will be opened only at such periods when it is necessary to operate the pumps.

6. Water system. - The City water supply will be connected to the pumping station. The water will be used for cooling the gasoline engines as well as for station service. In addition, there will be provided for emergency use an electric motor-driven sump pump. Water for this pump will be obtained from the tailrace via the wet sump.

7. Sump pump. - A motor-operated sump pump of 100 g.p.m. capacity will be provided in the wet sump for the purpose of unwatering the sump after the pumping station has been in operation. It will also be used for supplying water from the wet sump to the gasoline engines in the event of a failure of the City water supply.

8. Valves. - A gate valve and a flap valve will be installed in each pump discharge line to facilitate the starting of the pump and to prevent backflow when the river is at flood stage.

9. Gasoline system. - Gasoline will be stored in a 2200-gallon tank buried in the ground adjacent to the pumping station. Each engine will be supplied with gasoline through an individual line running directly to the tank. Drip pans will be provided on each engine and connected to a common header running back to the tank. All gasoline piping will be 3/4" I.D. copper tubing with flared joint connections. At such points where the gasoline lines are imbedded in concrete or pass through beams, they will be protected by wrought iron pipe sleeves.

The gasoline tank will be located approximately 6 feet from the pumping station. It will be set on a concrete cradle and be securely anchored. Double elbows are provided at the tank connection to provide for any

settlement of the tank.

10. Fire extinguishing system. - A carbon dioxide fire extinguishing system will be installed and so arranged that any gasoline engine can be blanketed with carbon dioxide gas by tripping a valve located just inside the main entrance to the building. A portable extinguisher will be provided to take care of minor emergencies.

11. Heating system. - The heating system will consist of an oil-burning heater of the cabinet type with a built-in electrically-driven blower; a 150-gallon fuel storage tank and an electrically-driven fuel pump which feeds oil from the storage tank to the constant level valve in the heater.

All piping from the tank to the fuel pump will be copper tubing with flared joint connections. At such points where the fuel lines pass through the engine room floor they will be protected by wrought iron sleeves.

The fuel tank will be suspended by hangers in the sump room from the engine room floor directly below the heater and fuel pump.

12. Electric lighting and power system. - Electrical energy for power and lighting will be supplied from an outside commercial power source at 230-volts, 3-phase, 60-cycles, A. C. All power and lighting circuits will be fed from the switchboard. The switchboard will control the feeders to the gate-hoist motors, sump-pump motor, and floodlights, and will contain the battery-charging equipment, lighting transformer and lighting panelboard, providing controls for the battery-charging system and the lighting system. In case of an interruption in the power supply, emergency lighting will be provided for by individual lights on each engine panel, and the gate hoists will be capable of manual operation.

VII. STRUCTURAL DESIGN

VII. STRUCTURAL DESIGN

A. GENERAL INFORMATION

1. Location, head and loading. - The reinforced concrete flood walls will extend between the following stations: - Station 2+62 to the east side Memorial Highway Bridge approach (Station 11+46±); the west side of the Memorial Highway Bridge approach (Station 12+05±) to outlet structure (Station 20+19±); south side of the Dwight Pumping Station (Station 21+15±) to the dike (Station 24+27±); from the dike (Station 29+18±) to the Boston and Maine Railroad embankment (Station 31+79±) and from Station 40+00± to Station 42+51± near Depot Street and the power intake canal.

Tailrace No. 1 gate structure is at Station 4+80±; tailrace No. 2 gate structure is at Station 8+88±; the outlet structure is between Stations 20+19± and 20+49±; the Dwight Pumping Station is between Stations 20+49± and 21+15±, and the Depot Street stop-log structure is between Stations 41+91± and 42+27±.

The structures are designed to resist a principal load coming from the assumed head of water taken to the top of the walls which is greater than the design flood stage, which is 3 feet below the top of the walls. This design head is in accordance with instructions from the Office of the Chief of Engineers. The walls vary in height from 6'-0" to 30'-8".

2. Type of wall. - The "T" type cantilever wall was selected as being the most economical for the height of wall needed under the existing conditions. Concrete facing walls were used at locations of existing ramps.

3. Tailrace gate structures. - The concrete tailrace structures were designed to resist a load coming from a head of water, equivalent to that used in the design of the walls. The structures were investigated for stability for two conditions of loading; one with the river at flood stage and one with the river down. The conduit portions of the structures were designed as rigid boxes loaded with maximum pressures obtainable.

4. Pumping station. - In the following design analysis, the outlet structure is considered an integral part of the Dwight Pumping Station.

The pumping station will be a flat-roofed, brick and glass block structure 24 feet by 42 feet overall. The 12.5-inch brick walls, capped with a cast stone coping, extend above the roof slab to form a parapet wall around the entire roof. A flat type roof was chosen as being economical and in keeping with the architectural design, as well as serving as a location for the engine exhaust mufflers. The roof system consists of steel beams encased in concrete and supported by steel columns. The roof slab will be 5.5 inches thick, covered with a cinder concrete fill sloped to drain. There are no outside pilasters. Inside the building there are pilasters at the chimney and at each structural steel column, the pilasters forming fire-proof column encasements. The engine room floor will be a 7-1/2-inch structural concrete slab, with a monolithic finish. A hand-operated traveling crane of 5 tons lifting capacity will operate for the full length of the building and will be used for installing and moving pumps and machinery. Access for the crane

hoist to the pump room will be had through openings in the engine room floor, these openings being normally covered with removable checkered floor plates.

There will be no window sash in the building. Light will be admitted through large glass block panels, glass blocks being chosen in preference to sash because of the exposed location of the pumping station near the river banks. The well-diffused and uniform light which they provide and their appearance is also in keeping with the architectural design. To provide ventilation, movable louvres have been placed low in the brick walls and a motor operated exhaust ventilator has been placed on the roof.

Two doors give access into the building. A main entrance door, 6' wide by 9' high, consists of two leaves of hollow steel construction, gives entrance directly to the engine room floor. It is large enough to provide adequate clearance for any replacement of mechanical equipment which may be required in the future. A small steel door on the east side of the building provides passage to the intake and outlet structure.

5. Architecture. - The pumping station and gate structures and walls will be of modern and simple design in keeping with the architectural treatment used on similar projects elsewhere on the Connecticut River. This design will give a pleasing appearance without undue emphasis being placed on purely decorative features.

B. GENERAL DESIGN DATA

1. General. - The structural design of the structures has been executed in accordance with standard practice. The specifications which follow cover the conditions affecting the design of the reinforced

concrete and structural steel.

2. Unit weights. - The following unit weights for material were assumed in the design of the structure:

Water	62.5# per cubic foot
Dry earth	100 # " " "
Saturated earth	125 # " " "
Concrete	150 # " " "

3. Earth pressures. - In computing active earth pressures, equivalent fluid pressures computed by the use of Rankine's formula were used. They are as follows: -

Equivalent liquid pressure of dry earth = 35 pounds per cubic foot.

Equivalent liquid pressure for saturated earth = 80 pounds per cubic foot.

In computing passive resistances, Rankine's formula was used with the coefficient of internal friction = 35 degrees.

4. Hydrostatic uplift. -

a. Riverside of sheet piling

Full head due to headwater.

b. Landside of sheet piling

(1) At landward toe, full head due to tailwater.

(2) At sheet piling, full head due to tailwater plus one-half the difference between headwater and tailwater.

(3) At intermediate points, the uplift was assumed to vary uniformly with the distance from the toe.

(4) Walls on rock, the hydrostatic uplift shall vary from 50 percent headwater at the riverside toe of the base to 50 percent tailwater at the landside toe of the base.

5. Overturning. - The resultant of all external loads, including hydrostatic uplift and excluding base pressure, does not fall within the middle third under every condition but under no condition is the allowable bearing value of the soil exceeded.

6. Sliding. - In general, the total horizontal forces due to external loads shall not exceed the resistance available from friction and passive resistance. The coefficient of friction used is 0.50. At the pumping station and wing walls, steel Z piling was driven behind the base to supplement the frictional resistance of the soil.

7. Bearing. - The total bearing pressure, equal to the sum of hydrostatic pressure plus the remaining effective base pressure, shall in no case exceed the maximum allowable soil pressure.

8. Frost cover. - All footing bases shall lie at least 4 feet beneath the ground surface to avoid heaving by frost action.

9. Path of percolation. - Except where the steel sheet piling is either driven to rock or extended a minimum distance of 3 feet into an underlying stratum of impervious clay, the minimum path of percolation shall be four times the head of water.

10. Structural steel. - The design of structural steel was carried out in accordance with the Standard Specifications for Steel Construction for Buildings of the American Institute of Steel Construction.

11. Reinforced concrete. - In general, all reinforced concrete was designed in accordance with the "Joint Committee on Standard Specifications for Concrete and Reinforced Concrete" issued in January 1937, and with the "Joint Code of the American Concrete Institute and the Reinforcing Steel Institute for the Design of Concrete and Reinforced Concrete" issued in 1928.

a. Allowable working stress. - The allowable working stress in concrete used in the design is based on a compressive strength of 3,000 pounds per square inch in 28 days.

b. Flexure (f_c). - Lbs. per sq. in.

Extreme fibre stress in compression 800

c. Shear (v). -

Beams with no web reinforcement and without special anchorage 60

Beams with no web reinforcement but with special anchorage of longitudinal steel 90

Beams with properly designed web reinforcement but without special anchorage of longitudinal steel 180

Beams with properly designed web reinforcement and with special anchorage of longitudinal steel 270

d. Bond (u). -

In beams, slabs, and one way footings 150

Where special anchorage is provided 300

The above stresses are for deformed bars.

e. Bearing (f_c). -

Where a concrete member has an area at least twice the area in bearing 500

f. Axial compression (f_c). -

Columns with lateral ties 450

g. Steel stresses. -

Tension 18000

Web reinforcement 16000

h. Protective concrete covering. -

Type of members	Minimum cover in inches
Interior slabs	1-1/2
Interior beams	2
Members poured directly against the ground	4
Members exposed to earth or water but poured against forms	3

For secondary steel, such as temperature and spacer steel, the above minimum cover may be decreased by the diameter of the temperature or spacer steel rods.

C. BASIC ASSUMPTIONS FOR DESIGN

1. Pumping station and tailrace gate structures.

a. Stability. - The stability of the pumping station and gate structures as a unit was investigated for the worse condition of loading, namely, with the river at flood stage and also with the river at low stage. In all conditions of loading, the base pressures were held below the allowable.

b. Roof slab of pumping station. - The roof slab is of reinforced concrete. It is designed to carry the full dead load plus a live load of 40# per square foot of roof surface.

c. Roof beams. - The roof beams are of structural steel encased in concrete fireproofing. They are designed to carry the full dead load, plus the full live load of 40# per square foot of roof surface. In addition to taking up the roof load, these beams, together with the columns to which they are connected, form portal frames which take up wind load and crane thrusts on the building. The end connections are designed to take up all such horizontal loads.

d. Columns. - Structural steel columns in the side walls and end walls of the superstructure take up the direct roof loads as well as all wind loads on the sides of the superstructure. In addition, the columns in the side walls carry crane brackets which support the crane runway. These columns are designed to carry full live and dead load from the roof; dead load, live load and impact effect from the traveling crane; bending due to eccentrically applied loads, and bending due to wind load on the building. No point of inflection was considered in the column design, a pin-ended condition at the base being assumed.

e. Engine room floor of pumping station. - The engine room floor is designed to carry all engines, motors, etc., actually to be placed on that floor, as well as a uniform load.

The following assumptions were made for design purposes:

(1) For the floor slab, the design loads are the estimated dead loads plus a uniform live load of 300# per square foot.

(2) For the removable steel floor plates, the design loads are the estimated dead load plus a uniform load of 300# per square foot.

(3) For the floor beams, the design loads are the estimated dead loads, the actual machinery loads, a concrete base slab load under the gasoline engine and right angle gear units, and a uniform load of 250# per square foot on the unoccupied portion of the floor slabs which contribute loads to the beams under consideration. For the machinery loads, an impact factor of 100 percent has been added.

f. Pump room side walls. -

(1) The station is so located that the building and

its adjoining flood walls form a part of the flood protection dikes. The riverside wall was therefore designed of reinforced concrete to Elevation 71.17 and made a continuation of the concrete flood walls. Above Elevation 71.17 the riverside wall is of brick. The other three walls are of reinforced concrete to Elevation 63.55 and of brick and steel construction from thereon up.

(2) In designing the pump room side walls, careful account was taken of the effect of the thrust of the water against the building with the river at flood stage. This thrust against the riverside wall was assumed to be carried by the floor beams to the rear wall. The rear wall is stiffened by the intake buttresses and is properly reinforced to carry the thrust load down into the base. The large holes for the discharge pipes in the river wall tend to localize the stresses to the section of unbroken concrete between the pipe openings, so the reinforcement was designed to meet with this condition. To assure a fair degree of certainty as to the action of the structure it was decided to design it as a transverse rigid frame.

(3) The portion of the riverside wall extending from the engine room floor to high water at Elevation 71.17 was designed as a cantilever wall.

(4) The assumption was made that the side walls are simply supported at the engine room floor and fixed at the base.

(5) The loading consisted of the vertical loads due to the weight of the structure; the vertical live and impact loads from the engine room floor; the roof live load; and the thrusts against the walls from high water on the riverside and saturated earth pressures on

the landside.

From the loadings noted, bending moments were computed in the walls, pump room floor slab and engine room floor beams.

g. Pump room end walls. - The pump room end walls were designed to resist earth pressure at the south end and hydrostatic pressure at the gate structure.

h. Intake structure. - The intake structure is constructed adjacent to but independent of the pumping station to eliminate the effect of hydrostatic loading from the pumping station. The intake structure is designed, as a double box section, for earth loading on one side and for its own dead weight.

i. Trash racks. - There are two trash racks located in the intake structure passages. Each rack consists of two sections supported on a structural steel frame anchored into the side walls of the intake passages. The trash racks are made of structural channel frame which support 4 x 3/8 inch round edge grating bars. These bars are spaced 3 inches in the clear and welded to the channel frame. The trash racks are designed on the assumption of stoppage of 50 percent of flow with the water level above the top of the racks.

j. Stairways and ladders. - A concrete stairway leads from the engine room floor to the wet sump room. A hatchway is provided in the engine room floor for removing machinery from the wet sump. A steel ladder is provided on the outside of the building for access to the roof of the pumping station. Another concrete stairway on the outside of the building leads to the top of the outlet structure.

k. Conduits. - The conduit portions of the tailrace struc-

tures were designed as rigid frames to carry the maximum possible loads from earth cover, horizontal earth thrust and maximum base pressure.

1. Walls.

(1) The rear wall of the gate structures was designed to resist an earth load from the fill on the landside and a water load from the riverside.

(2) The front curtain wall of the gate structures was designed to resist an ice pressure of 1,000 pounds per square foot assumed to act over two feet giving a loading of 500 pounds per foot.

m. Buttresses. - The buttresses of the outlet structure and gate structures were designed as cantilever beams carrying a load of one-half the span of the conduit. The outer buttress wall on the outlet structure was designed to resist hydrostatic loading to the top of the wall.

2. Flood walls. - The reinforced concrete flood walls were assumed to act as cantilever walls. The restraint of the sheet piling was neglected.

a. Wall stem. - The stem was designed as a cantilever beam fixed at the top of the base support to carry the differential load due to water pressure and earth pressure. The landside face of the stem was designed to carry the load from the backfill for those sections of the wall where these loads exist.

b. Base slab. - Both riverside and landside footings were designed as cantilever beams fixed at the face of the stem.

c. Dike abutments. - The dike abutments were designed as counterforted sections.

d. Depot Street stop-log structure. - The structure has a 36-foot opening spanned by two sections of wooden stop-logs. These logs are held in place by abutments at the ends and by a removable steel H-beam in the middle of the street. The base is designed to take up stresses transmitted to it by the supports which act as counterfort sections.

VIII. CONSTRUCTION PROCEDURE

VIII. CONSTRUCTION PROCEDURE

A. SEQUENCE OF OPERATIONS. - The contract for the work will be let on or before June 30, 1940, and construction will commence about July 10, 1940. It is contemplated that the entire work will be completed by June 30, 1941. It is desirable to complete the earth dike sections before November 15, 1940, since the placing of earth dike embankment will be prohibited during freezing weather. No concrete work will be permitted between November 15, 1940 and April 1, 1940, without adequate cold weather protection.

B. STAGE HYDROGRAPHS. - Stage hydrographs for the Connecticut and Chicopee Rivers, which cover periods of 20 years and 10 years, respectively, are given on Plates Nos. 3,4, and 5. The hydrographs for the Connecticut River are based on readings recorded at the City of Springfield river gage and are to be corrected for the Chicopee area as indicated on the sheets. The hydrograph for the Chicopee River is based on the records kept by the United States Geological Survey at the gage established at Bircham Bend located on the Chicopee River approximately 4 miles upstream from the Davitt Memorial Bridge and are corrected to Station 0+00 of the protection works.

C. CONSTRUCTION SCHEDULE. - It is proposed to have the construction work adhere as nearly as possible to the following schedule:

(Schedule on following page.)

CONSTRUCTION PROGRAM

Item	Quantity	Time Limit of Operations (Calendar Years 1940 and 1941)	No. of Working Days	Daily Rate of Construction
Preparation of site		July 10-Aug. 10	20	--
Common excavation	22,200 c.y.	July 15-Oct.20	70	340 c.y.
Placing of embankment	59,870 c.y.	Aug. 1-Nov. 15	75	850 c.y.
Concrete	8,415 c.y.	Aug. 1-May 10	200	42 c.y.
Steel Sheet Piling	24,135 sq.ft.	Aug. 1-Nov. 15	75	320 sq.ft.
Tailrace Gate Structure No. 1	-	Sept. 1-Sept.25	15	
Installing Tailrace Gate No. 1	-	May 10-May 18	6	
Tailrace Gate Structure No. 2	-	Oct. 15-Nov. 1	15	
Installing Gate Structure No. 2	-	May 20-May 28	6	
Dwight Pumping Station Substructure and outlet structure	-	Sept. 1-Jan. 15	90	
Dwight Pumping Station Superstructure & Equipment	-	Mar. 10-June 30	75	

D. CONSTRUCTION OPERATIONS

1. Tailrace Gate Structures No. 1 and No. 2. - The A. G. Spaulding Company have indicated their willingness to shut down the tailraces for a period of fifteen calendar days during construction of each gate structure and they will bear the expense of loss of power normally generated. In no case will both tailraces be closed down at the same time. The normal industrial water of 1 c.f.s. for tailrace No. 1 and 2 c.f.s. for tailrace No. 2, together with a negligible amount of headgate leakage will be bypassed at all times throughout the construction period by

means of pipe flumes or pumping. The construction of the gate structures will consist of rock excavation, concrete, reinforcement and miscellaneous iron and steel. A second shut-down for eight calendar days for each tail-race in sequence has been agreed upon when the gates are being installed.

2. Dwight Pumping Station and Outlet Structure. - It is proposed to maintain an outlet capable of discharging 366 c.f.s. from the tailrace located about 200 feet west of Davitt Memorial Bridge by excavating a channel around the north side of the outlet structure 18 feet wide to Elevation 40.5 m.s.l. Part of this excavation may be used for the concrete flood wall foundation and the balance will be backfilled. It is proposed to inclose the entire foundation of the Dwight Pumping Station and Outlet Structure with a cofferdam of piling and then the inclosed area will be dewatered and excavated. The concrete will be poured directly on the soil subfoundation which is composed of Class No. 5 material.

3. Earth dike east of the Davitt Memorial Bridge. - The earth dike is founded on rock ledge which is either exposed or covered with debris and the embankment will be placed in the dry. The major portion of the foundation is above the river water surface during the low stages of the Chicopee River. It is proposed to form a low earth cofferdam throughout the length of the dike with the excavated materials of debris, sand and gravel and to keep the area dewatered.

4. Earth dike west of the Davitt Memorial Bridge. - The earth dike is founded on the river bottom which is of pervious sand and gravel. Approximately six feet below the river bottom there underlies a deep stratum of impervious silt. During low stages of the river the water

varies from 1 to 4 feet in depth in this area. It is proposed to construct the rock toe of the dike, then to excavate a cut-off trench to the impervious stratum under the center impervious core of the dike and to place the sand and gravel together with some random material adjacent to the rock toe to form a low earth cofferdam around the toe of the dike. The area will be dewatered and the earth embankment will be placed in the dry.

5. Concrete wall east of the Davitt Memorial Bridge. - That portion of the proposed wall resting on the river bottom is founded either on rock covered with two or three feet of sand and gravel or on compact impervious earth. During low stages of the Chicopee River, the area under the concrete wall is dry. It is proposed to excavate the overlying sand and gravel to form a low earth cofferdam for the entire length of wall and to dewater the area during the construction of the flood wall.

E. LABORATORY AND FIELD TESTS DURING CONSTRUCTION

1. Embankment construction. - The Soils Laboratory at Providence, Rhode Island, and the field soils laboratory at West Springfield, Massachusetts, will perform the necessary tests to investigate and record the characteristics of the types of soil used in construction. Tests will be performed to determine the grain size classification of soils, water contents and density of material in place and compaction characteristics of borrow materials. Supplementary shear and permeability tests will also be made. The materials used for embankment and their placement will be subject to close control before and during construction. Screened gravel for the toe-drain and riprap backing will be obtained from commercial sources and will not be subject to rigid laboratory tests.

2. Concrete construction.

a. Composition of concrete. - The concrete will be composed

of cement, fine aggregate, coarse aggregate, and water so proportioned and mixed as to produce a plastic, workable mixture. All concrete will be Class "A", as designated in the specifications, and will have an average compressive stress of not less than 3,000 lbs. per square inch, in accordance with a standard 28-day test. Concrete aggregates will have to be of suitable quality and will be tested by the Central Concrete Testing Laboratory at West Point.

b. Laboratory control. - A small concrete testing laboratory will be set up at the site to be used principally to control the quality of concrete during construction. The tests performed here will supplement those made at the Central Laboratory of the North Atlantic Division. Facilities will be available for testing the grading of aggregates, designing concrete mixtures, mixing of trial concrete batches for the purpose of developing actual relations between compressive strength and water cement ratio, controlling workability of concrete by slump tests, and casting of concrete cylinders for compressive strength tests.

(1) Cement. - Cement will be tested by the Central Laboratory and results of these tests shall be known before the cement is used. True Portland cement of a well-known and acceptable brand will be used throughout.

(2) Fine aggregate. - Natural sand will be used as fine aggregate. The aggregate will be subject to careful, thorough analysis, including magnesium sulphate soundness tests, and tests made on mortar specimens for compressive strength.

(3) Coarse aggregate. - Washed gravel or crushed stone of required sizes will be used as coarse aggregate. It must con-

sist of hard, tough and durable particles free from adherent coating and must be free from vegetable matter. Only a small amount of soft, friable, thin or elongated particles will be allowed. The aggregate will be subject to freezing and thawing tests and to careful, thorough analysis, including magnesium sulphate tests for soundness.

(4) Water. - The amount of water used per bag of cement for each batch of concrete will be predetermined; in general, it will be the minimum amount necessary to produce a plastic mixture of the strength specified. Slump tests will be required in accordance with specifications.

c. Field control.

(1) Storage. - The concrete components will be stored in a thoroughly dry, weather-tight, and properly ventilated building. The fine and coarse aggregates will be stored in such manner that inclusion of foreign material will be avoided.

(2) Mixing. - The exact proportions of all materials in the concrete will be predetermined. The mixing will be done in approved mechanical mixers of a rotating type, and there must be adequate facilities for accurate measurement and control of each of the materials used in the concrete. Mixing will be done in batches of sizes as directed and samples will be taken for slump tests and for compressive strength tests. Inspectors will at all times supervise and inspect the mixing procedure.

(3) Placing. - Concrete will be placed before initial set has occurred. Forms will be clean, oiled, rigidly braced and of ample strength. Concrete poured directly against the ground will be placed on clean damp surfaces. Mechanical vibrators will be used, and forking or

hand-spading will be applied adjacent to forms on exposed surfaces to insure smooth, even surfaces. Location of vertical and horizontal construction joints, as well as contraction and expansion joints and location of copper water stops, are indicated on the drawings. The locations of construction joints are tentative and may be changed to suit conditions in the field. Before placing concrete, all reinforcing steel will be inspected and pouring of the concrete will be supervised and directed by Government inspectors. Adequate precautions will be taken if concrete is to be placed in cold or hot weather.

IX. SUMMARY OF COSTS

IX. SUMMARY OF COSTS

The grand total cost of the Chicopee Dike, Item C.3b has been estimated at $460,500, which includes 10 percent for contingencies and 15 percent for engineering and overhead. This cost has been distributed as follows:

1. For construction contract bid: -

a.	Embankment	$ 38,400
b.	Concrete features.	236,200
c.	Drainage	39,000
d.	Steel sheet piling	33,200
e.	Riprap, hand-placed	20,000
f.	Miscellaneous	56,700
	Total (C.3b Construction contract)	423,500

2. For equipment to be furnished by the United States 37,000

Grand total cost (C.3b) $460,500

1. a. The embankment item consists of all borrow excavation and fill for the dike, rock fill, topsoil, sodding and seeding, and surfacing for top of dike.

b. The concrete features consist of common and rock excavation, backfill, timber sheet piling, cement, steel reinforcement, and copper water stops.

c. The drainage item consists of excavation and backfill, gravel for drains, V. C. Pipe, reinforced concrete pipe, cast-iron pipe, gates, valves, control of water and sewage, and manholes.

d. Steel sheet piling includes furnishing, placing, and

driving the piles.

e. The hand-placed riprap consists of gravel bedding and furnishing and placing the rock for riprap.

f. The miscellaneous item includes preparation of site, stripping, removal of existing structures, and all other items not included in above Items a, b, c, d, and e.

2. a. The equipment furnished by the Government includes the following:

3 - 30" pumps complete, with flap valves, flexible couplings and gate valves with floor stands.

3 - Gasoline engines with mufflers.

3 - Right angle gear units.

Discharge piping.

X. PLATES

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2	General Plan
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4	Connecticut River Hydrograph No. 2
5	Chicopee River Hydrograph
6	Subsurface Explorations No. 1
7	Subsurface Explorations No. 2
8	Subsurface Explorations No. 3
9	Subsurface Explorations No. 4
10	Borrow Areas
11	Providence District Soil Classification
12	Geologic and Soil Section Dwight Pumping Station
13	Geologic and Soil Section Station 21+00 to Station 27+00
14	Grain Size Curves Random Pervious Material in Borrow Area "J"
15	Grain Size Curves Random and Impervious Material in Borrow Area "Z"
16	Compaction Characteristics Impervious in Borrow Area "Z"
17	Shear Test Random Pervious in Borrow Area "J"
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19	Consolidation Characteristics Interstratified Silt in Foundation No. 1

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Interstratified Silt in Foundation No. 2

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25 Drainage Details No. 1

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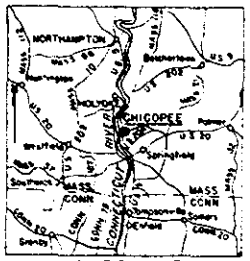
39 Storage Pond Capacity Curve

40 Output of Pumps

41 Organization Chart

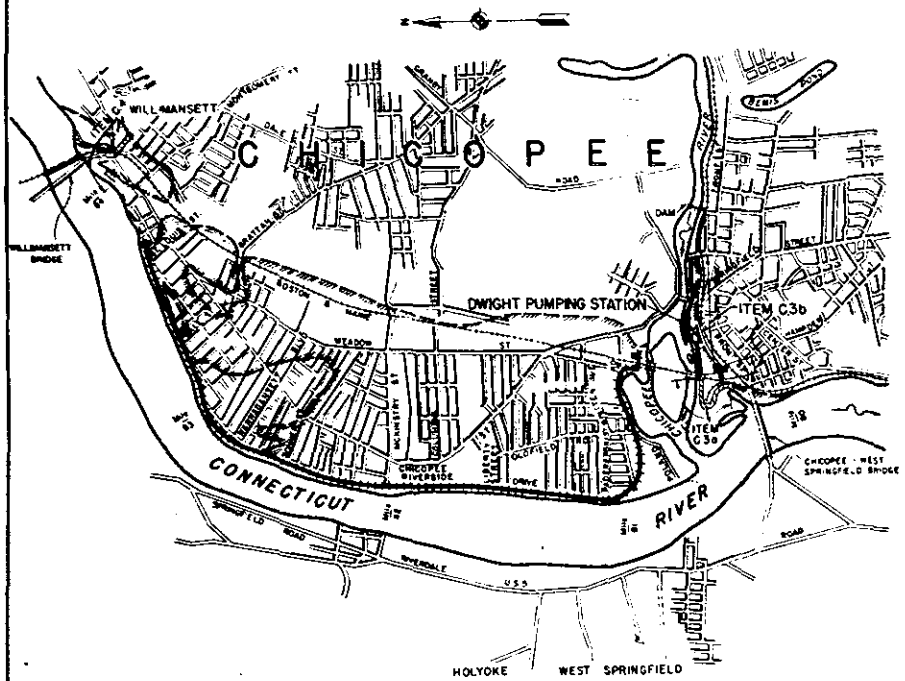
WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



LOCATION MAP

SCALE 1"=8 MILES



VICINITY MAP

SCALE 1"=1500

LEGEND

- Dikes completed Item C1 and C2
- Item C3a Fiscal Year 1940 Unit, West of B&M RR South Bank Chicopee River, under construction
- Item C3b Fiscal Year 1940 Unit, South Bank Chicopee River
- Item C4 Fiscal Year 1940 Section Willimansett Dike
- Overflow Limits, March 1936 Flood

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

PROJECT LOCATION AND INDEX

CONNECTICUT RIVER — CHICOPEE, MASS

IN SHEETS — SCALE 1"=1500 FT — SHEET NO. 1

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

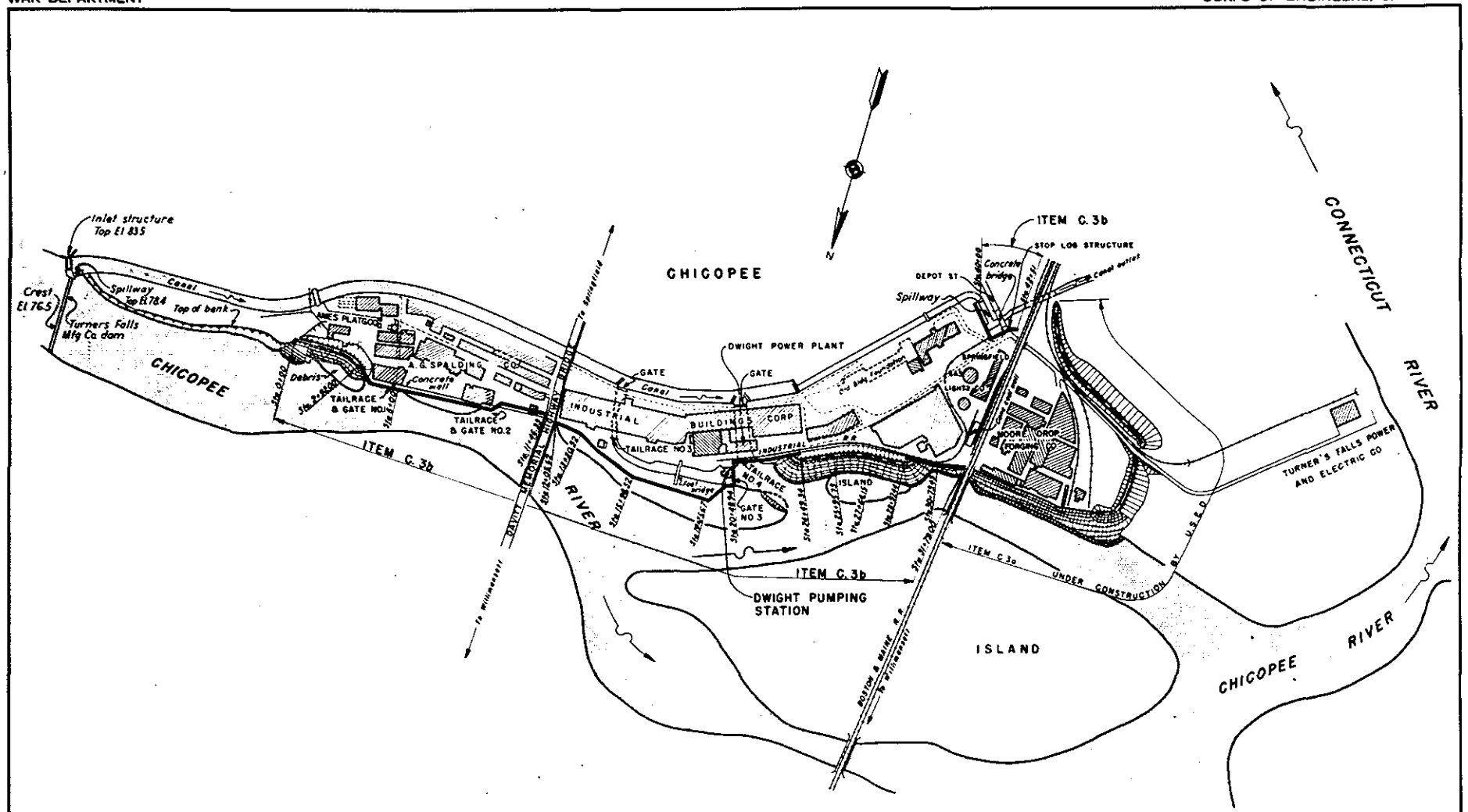
SUBMITTED: SENIOR ENGINEER, HEAD DESIGN SECTION — APPROVED RECOMMENDED: PRINCIPAL ENGINEER, CHIEF FLOOD CONTROL ENGINEER — APPROVED: DISTRICT ENGINEER

DESIGNED: — DRAWN: — TRACED: — CHECKED: — FISCAL YEAR 1940 — FILE NO. CT-4-2322

C 3b

1

PLATE NO. 1



EXPLANATION OF SECTION DESIGNATION

The section designations used are represented by fractions the numerator of which is the section reference and the denominator the sheet number on which the section is taken or shown

Example Section "B" is taken on Sheet No.11, and the section is actually shown on Sheet No.22 On Sheet No.11 the section reference would be noted $\frac{B}{22}$ and on Sheet No.22 the section would be noted $\frac{B}{11}$

KEY	DATE	REVISION - Indicated by △	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

GENERAL PLAN

CONNECTICUT RIVER — CHICOPEE, MASS.

IN 105 SHEETS — SCALE 1 IN = 200 FT — SHEET NO 2

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

SUBMITTED: Chief, Design Section — APPROVED & RECOMMENDED: Chief, Design Section — APPROVED: Lt. Col. Corps of Engineers, District Engineer

SIGNED: Chief, Design Section

DRAWN W.B.S. TRACED C.H.S. DESIGNED C.C.F.

FISCAL YEAR 1940

FILE NO. CT-4-2323

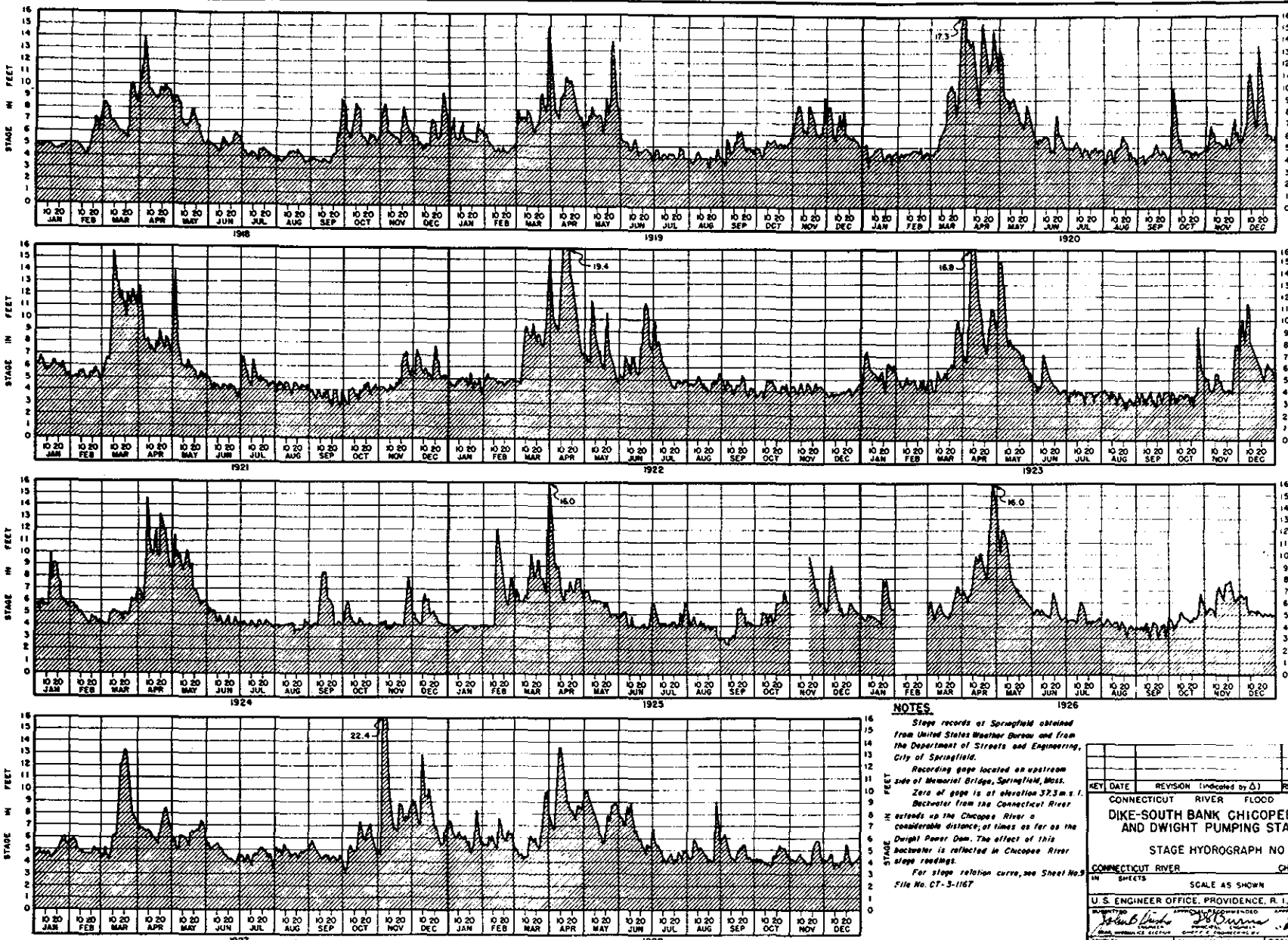
C3b

(2)

PLATE NO. 2

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



NOTES

Stage records at Springfield obtained from United States Weather Bureau and from the Department of Streets and Engineering, City of Springfield.

Recording gage located on upstream side of Memorial Bridge, Springfield, Mass.

Zero of gage is at elevation 37.3 m.s.l.

Backwater from the Connecticut River extends up the Chicopee River a considerable distance; at times as far as the Dwight Power Dam. The effect of this backwater is reflected in Chicopee River stage readings.

For stage relation curve, see Sheet No. 9

File No. CT-3-1167

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

STAGE HYDROGRAPH NO 1

CONNECTICUT RIVER — CHICOPEE, MASS

IN SHEETS — SHEET NO. 8

SCALE AS SHOWN

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

SUBMITTED — APPROVAL RECOMMENDED — APPROVED

COMPILED — DRAWN — TRACED — CHECKED

FISCAL YEAR 1940

FILE NO. CT-3-1166

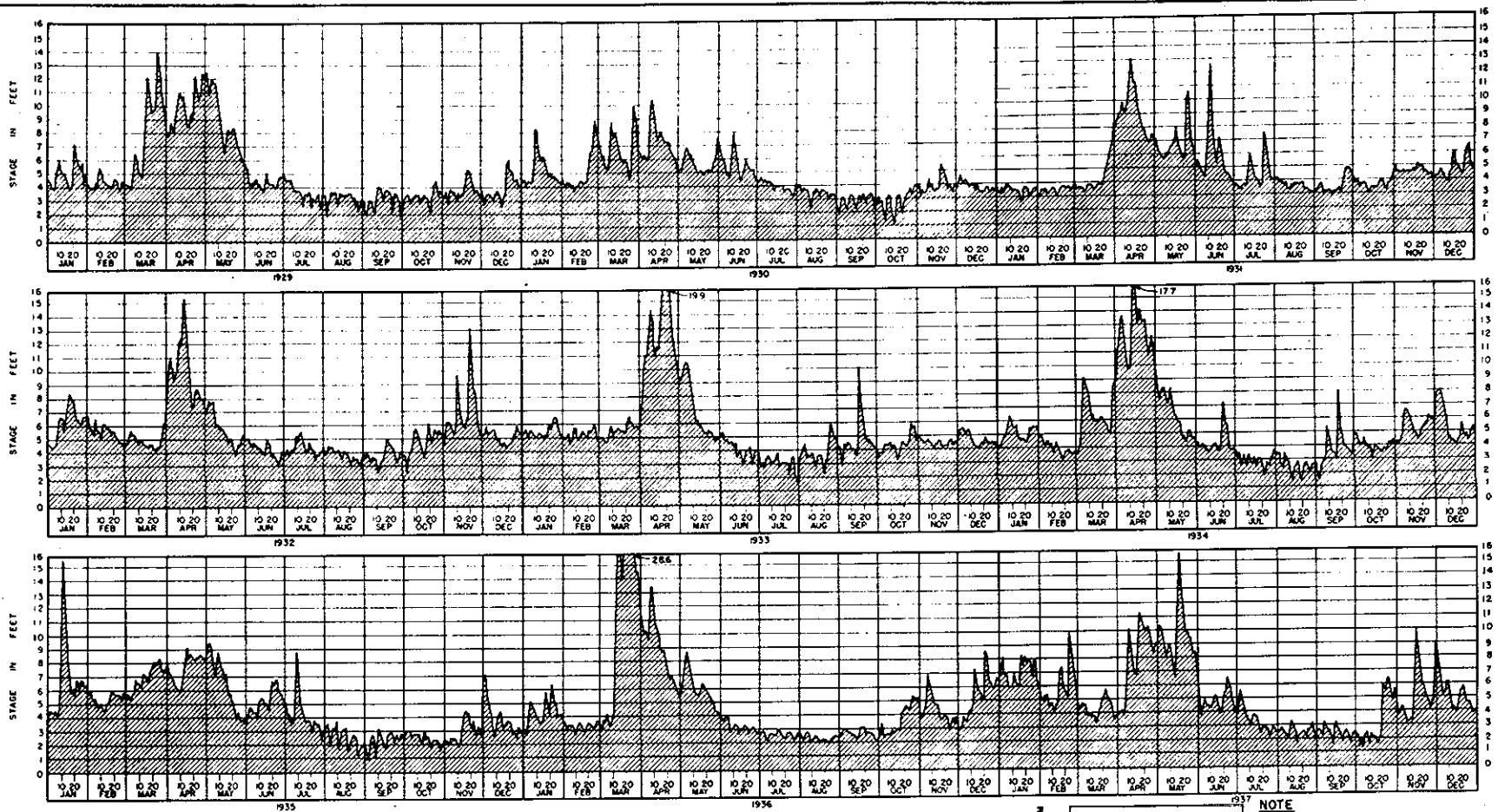
PLATE NO. 3

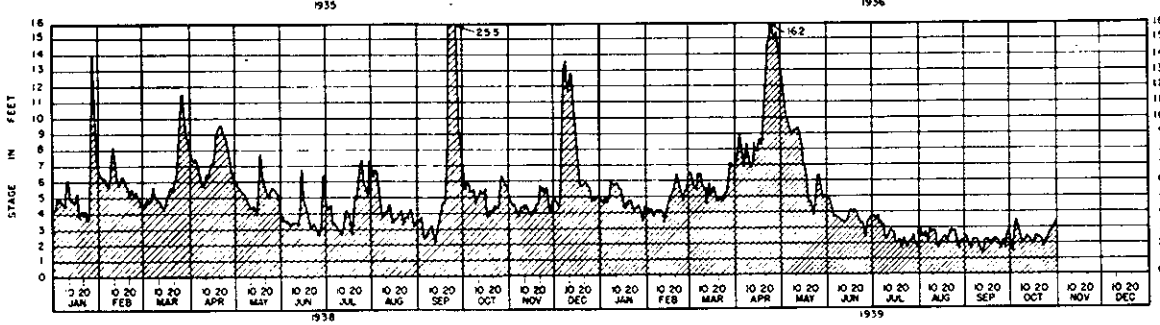
C.3b

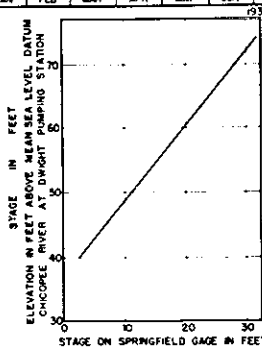
8

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY







NOTE

For notes pertaining to this sheet see Sheet No. 8 File No. CT-3-1166.

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

STAGE HYDROGRAPH NO 2

CONNECTICUT RIVER — CHICOPEE, MASS

IN SHEETS — SHEET NO 9

SCALE AS SHOWN

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

SUBMITTED: John B. Drisko, ENGINEER — APPROVAL RECOMMENDED: [signature], PROVINCE ENGINEER — APPROVED: [signature], DISTRICT ENGINEER

COMPILED: [signature] — DRAWN W.C.H. & G.A.L. — TRACED F.B.M. — CHECKED E.R.

FISCAL YEAR 1940

FILE NO CT-3-1167

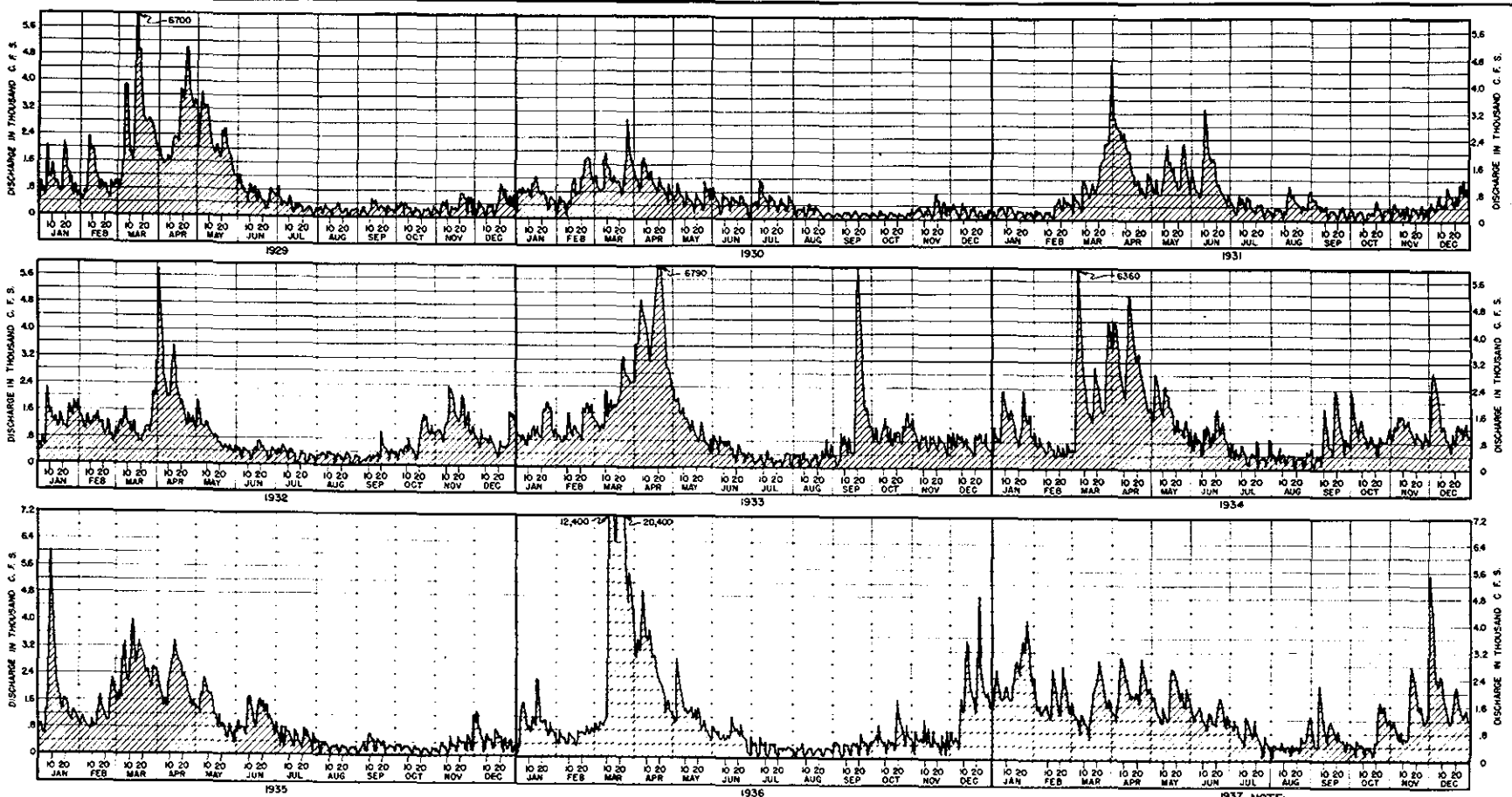
PLATE NO. 4

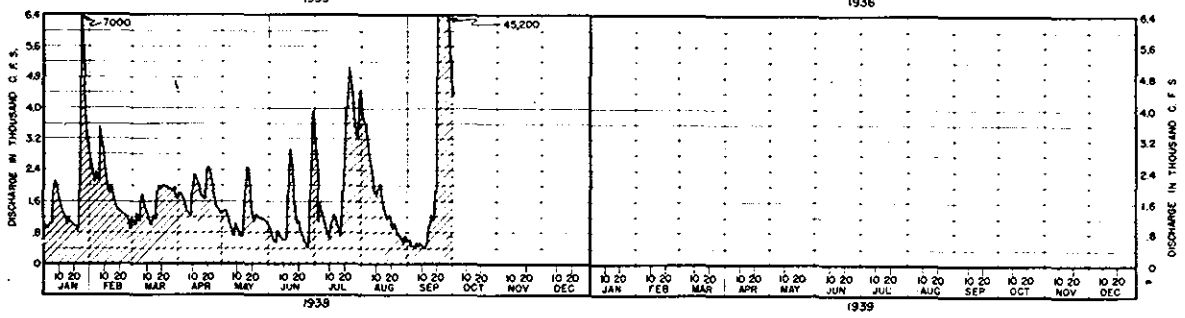
C.3b

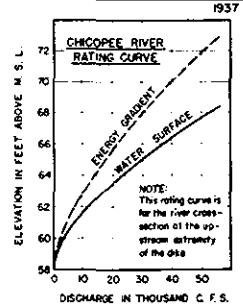
(9)

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY







NOTE:

The rating curve shown was computed from rational assumptions. It may be used only when the Chicopee River at that point is unaffected by Connecticut River backwater. Hydrograph plotted from discharge records at Bircham Bend (D.A. = 703 Sq. Mi.). Drainage area at mouth of Chicopee River is 721 Sq. Mi. See Sheet No. 9, CT-3-1167 if river stage is controlled by Connecticut River

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

DISCHARGE HYDROGRAPH

CHICOPEE RIVER — CHICOPEE, MASS.

IN 105 SHEETS — SCALE AS SHOWN — SHEET NO. 10

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

SUBMITTED: ENGINEER, HEAD INTERIOR, 105 SECTION — APPROVAL RECOMMENDED: PROFESSIONAL ENGINEER, CHIEF, F.C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASSOC. ENGINEER — DRAWN: W.C.R. & R.C.P. — TRACED: R.H.J. — CHECKED: C.R.L. — FISCAL YEAR 1940 — FILE NO. CT-3-1168

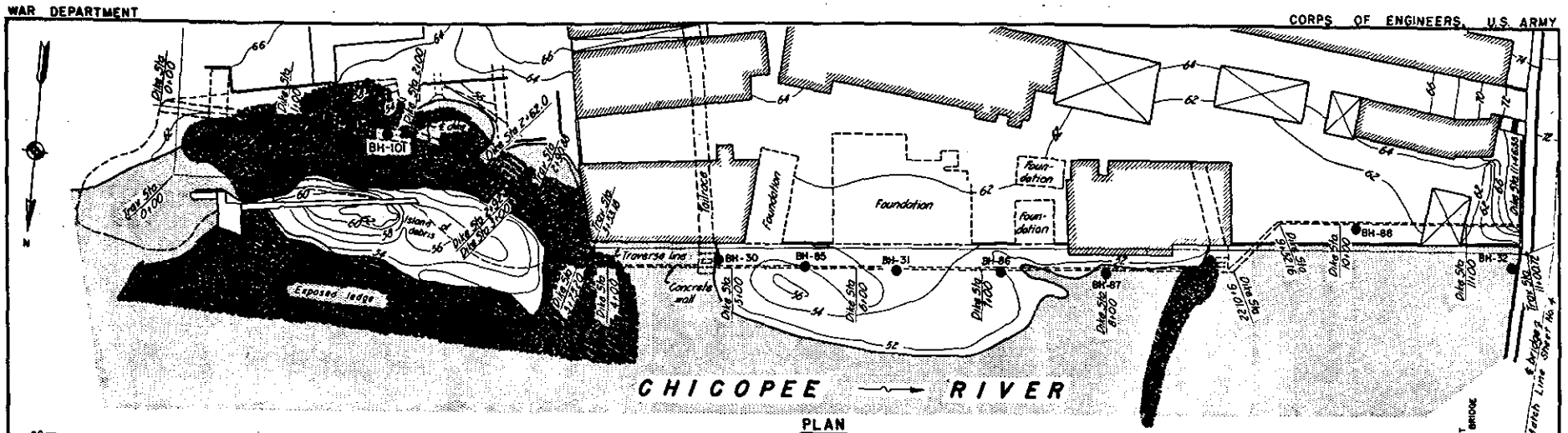
C. 3b

(10)

PLATE NO. 5

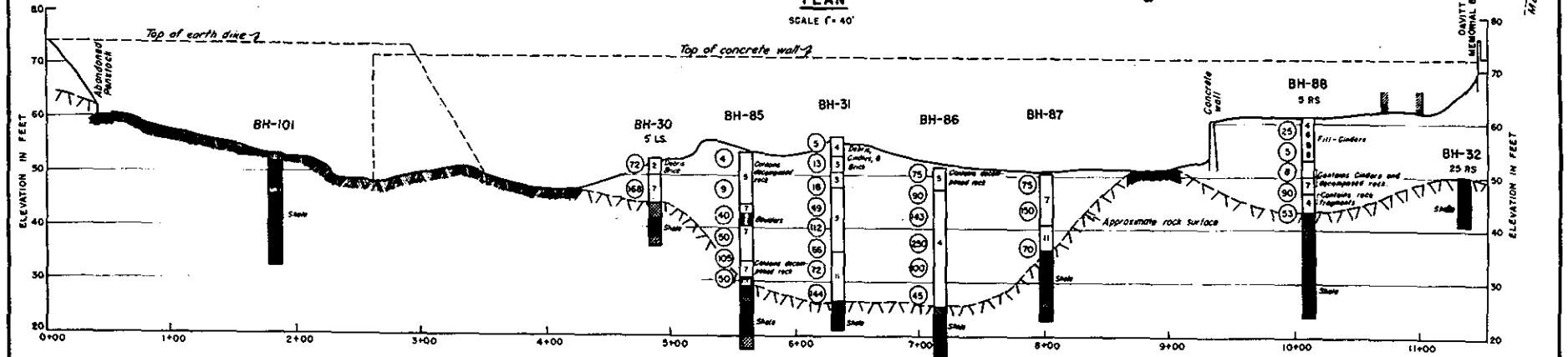
WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



PLAN

SCALE 1" = 40'



PROFILE ALONG ℄ DIKE

SCALE HOR. 1" = 40' VERT. 1" = 10'

DESCRIPTION OF SOIL CLASSES

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

LEGEND

BH *Drive sample bore hole*

n *Porosity in natural state* = $\frac{\text{Volume of voids}}{\text{Total volume}}$

w *Water content in natural state* = $\frac{\text{Weight of water}}{\text{Weight of solids}}$

LS *Landside of ℄ dike*

RS *Riverside of ℄ dike*

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 greater than 75%

NOTES

Numbers in circles indicate the number of blows required to drive 2" O.D. sample spoon one foot with 300 pound hammer dropped 18".

The logs, samples, and test results pertaining to the above investigations may be inspected at the United States Engineer Office, Providence, Rhode Island.

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by Δ)	REV.BY	CH.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

SUBSURFACE EXPLORATIONS NO. 1

CONNECTICUT RIVER CHICOPEE, MASS

IN SHEETS SCALE 1 IN = 40 FT SHEET NO.

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. MAY 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

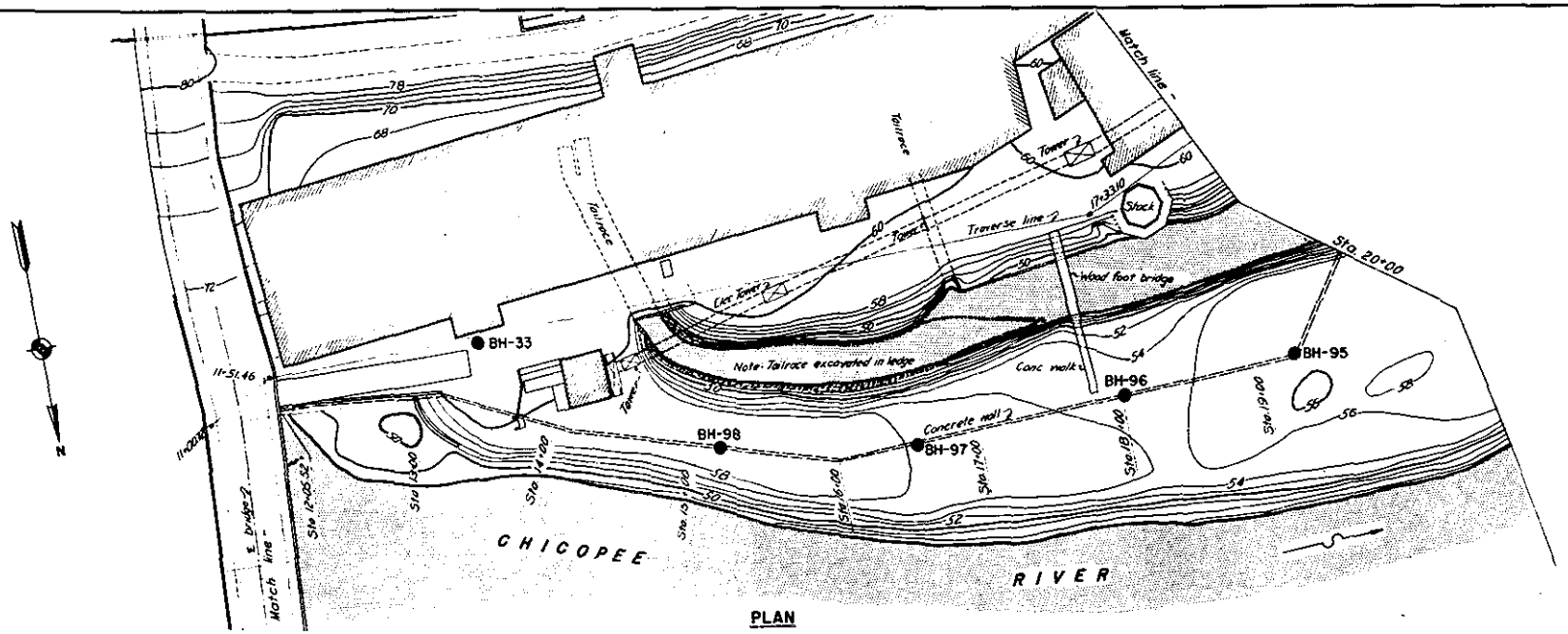
DRAWN: GAL - F.S.F. TRACED: L.A.D. CHECKED: [illegible]

FISCAL YEAR 1940

FILE NO. CT-2-1281

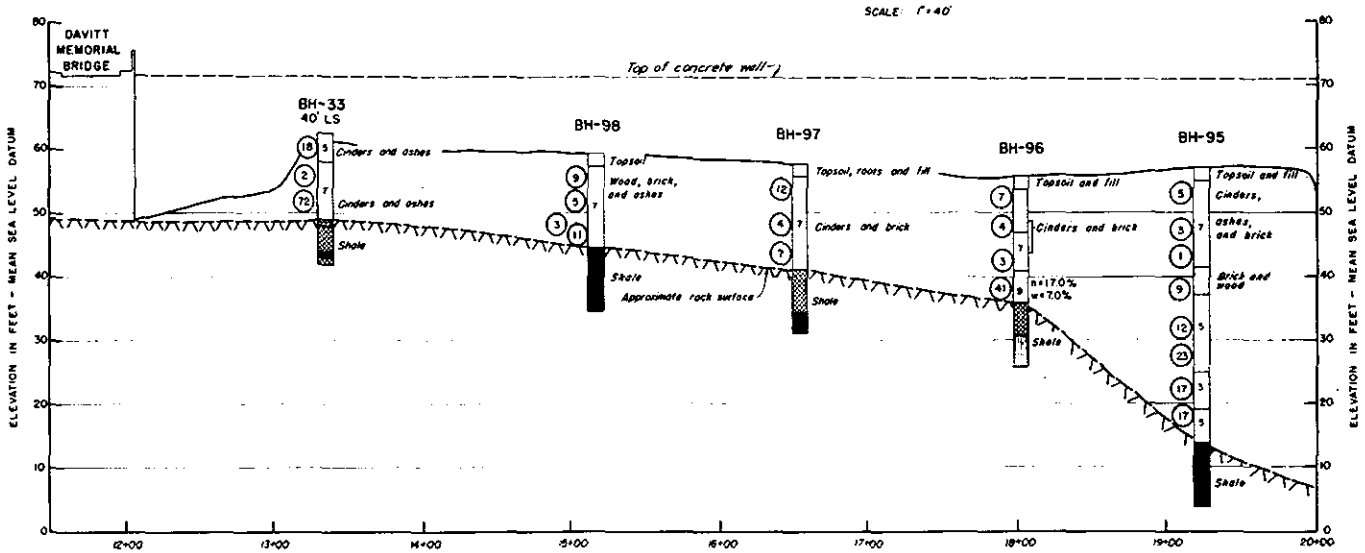
PLATE NO. 6

A. of D. C 3b



PLAN

SCALE: 1" = 40'



PROFILE ALONG ℄ WALL

SCALE: HOR. 1" = 40' VERT. 1" = 10'

NOTE

For general notes, legend and description of soil classes, see No.

KEY	DATE	REVISION - Indicated by Δ	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

SUBSURFACE EXPLORATIONS NO. 2

CONNECTICUT RIVER — CHICOPEE, MASS

IN SHEETS — SCALE 1 IN. = 40 FT. — SHEET NO.

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

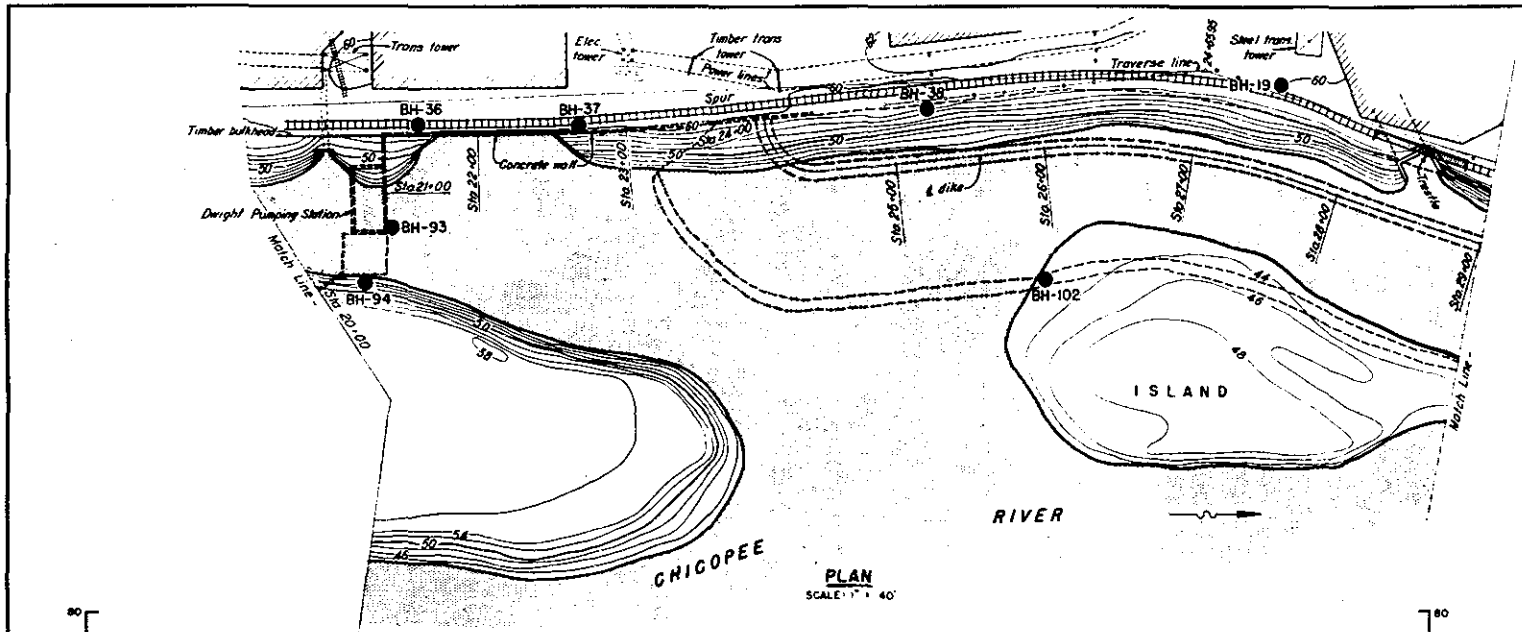
SUBMITTED: Samuel Tolbert, Senior Geologist, Head, Geology Section — APPROVAL RECOMMENDED: J. S. Bruce, Principal Engineer, Chief, Foundations Br. — APPROVED: H. Conley, Lt. Colonel, Corps of Engineers, District Engineer

COMPILED: H. W. Lloyd, Asst. Engineer — DRAWN: R.L. — TRACED: F.O.B. — CHECKED: G.A.L. — FISCAL YEAR 1940 — FILE NO. CT-E-1262

PLATE NO. 7

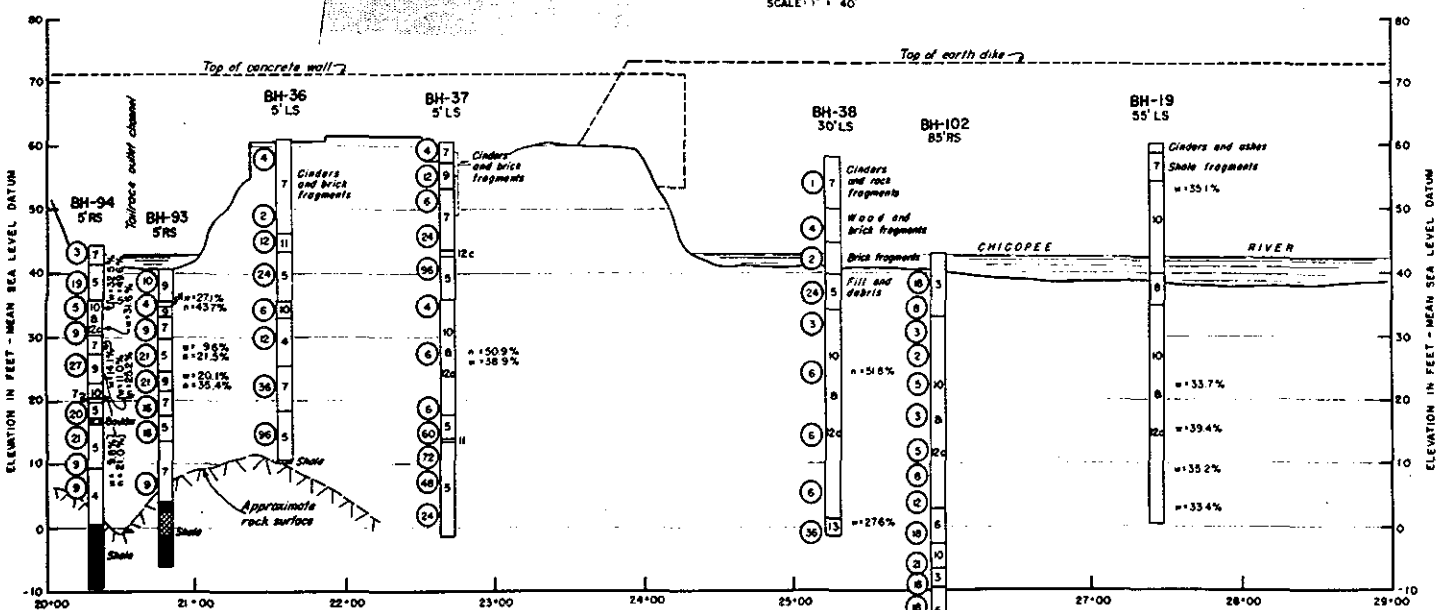
WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



PLAN

SCALE: 1" = 40'



PROFILE ALONG ℄ DIKE

SCALE HOR 1" = 40' VERT 1" = 10'

NOTES

For general notes, legend, and description of soil classes, see No.

Classes 10 and 12c indicated in bore hole records generally occur in alternating bands, having thin layers of clay interbedded with thicker layers of coarse to fine silt.

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

SUBSURFACE EXPLORATIONS NO. 3

CONNECTICUT RIVER — CHICOPEE, MASS.

IN SHEETS — SCALE: 1 IN. = 40 FT. — SHEET NO.

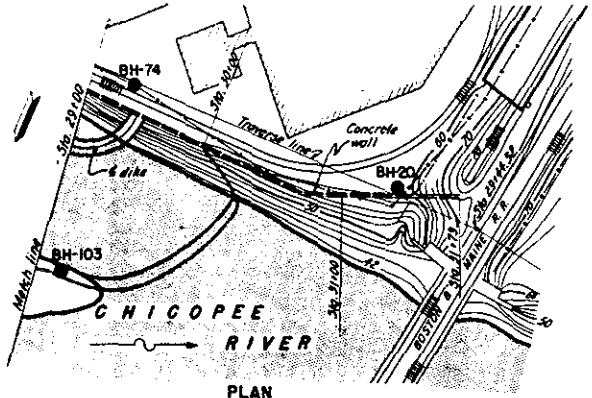
U. S. ENGINEER OFFICE, PROVIDENCE, R.I., MAY 1940

SUBMITTED: SENIOR GEOLOGIST, HEAD GEOLOGY SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV. — APPROVED: LEGAL CORPS OF ENGINEERS, DISTRICT ENGINEER

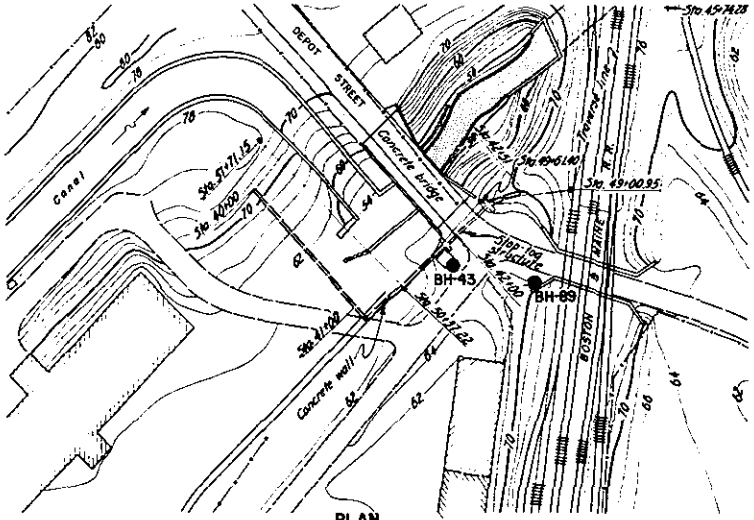
COMPILED: ASST. ENGINEER — DRAWN: R.R.L. — TRACED: R.R.L. — CHECKED: — FISCAL YEAR 1940 — FILE NO. CT-2-1283

A. of D. C3b

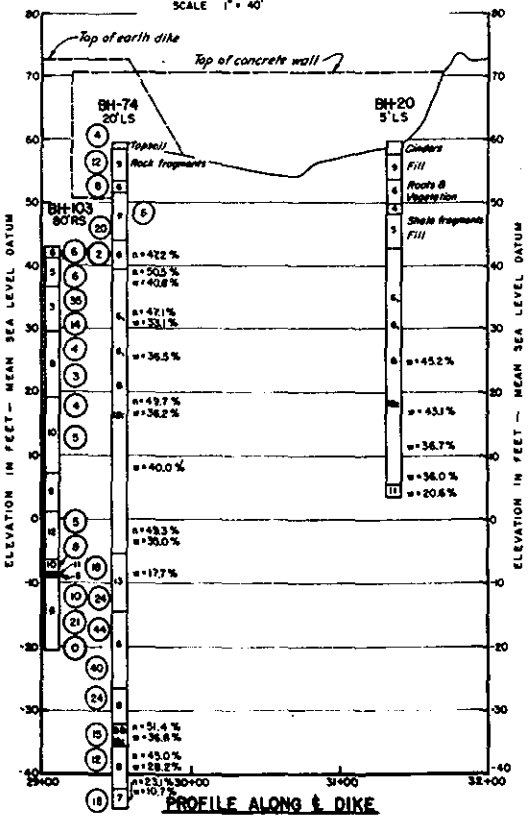
PLATE NO. 8



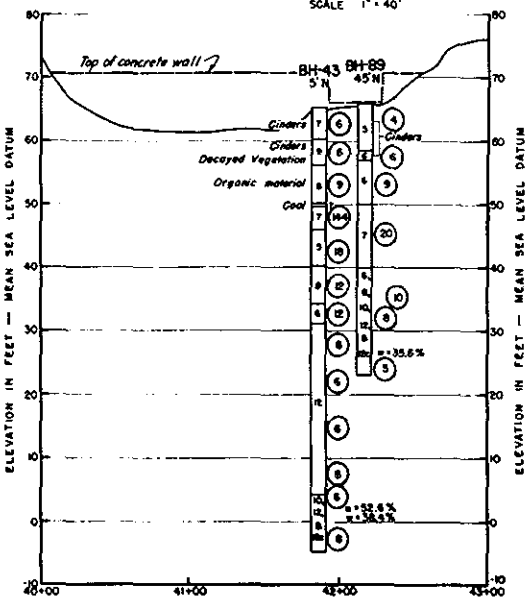
PLAN
SCALE 1" = 40'



PLAN
SCALE 1" = 40'



PROFILE ALONG ℄ DIKE
SCALE: HOR. 1" = 40'
VERT. 1" = 10'



PROFILE ALONG ℄ WALL @ STOP-LOG STRUCTURE
SCALE: HOR. 1" = 40'
VERT. 1" = 10'

NOTES

For general notes, legend, and description of soil classes, see No.
N indicates north of wall ℄
Classes 6, 8, 10, 12 and 12c indicated in bore hole records generally occur in alternating bands, having thin layers of clay interbedded with thicker layers of fine sand and silt.

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

SUBSURFACE EXPLORATIONS NO. 4

CONNECTICUT RIVER — CHICOPEE, MASS.

SHEETS — SCALE 1 IN = 40 FT. — SHEET NO.

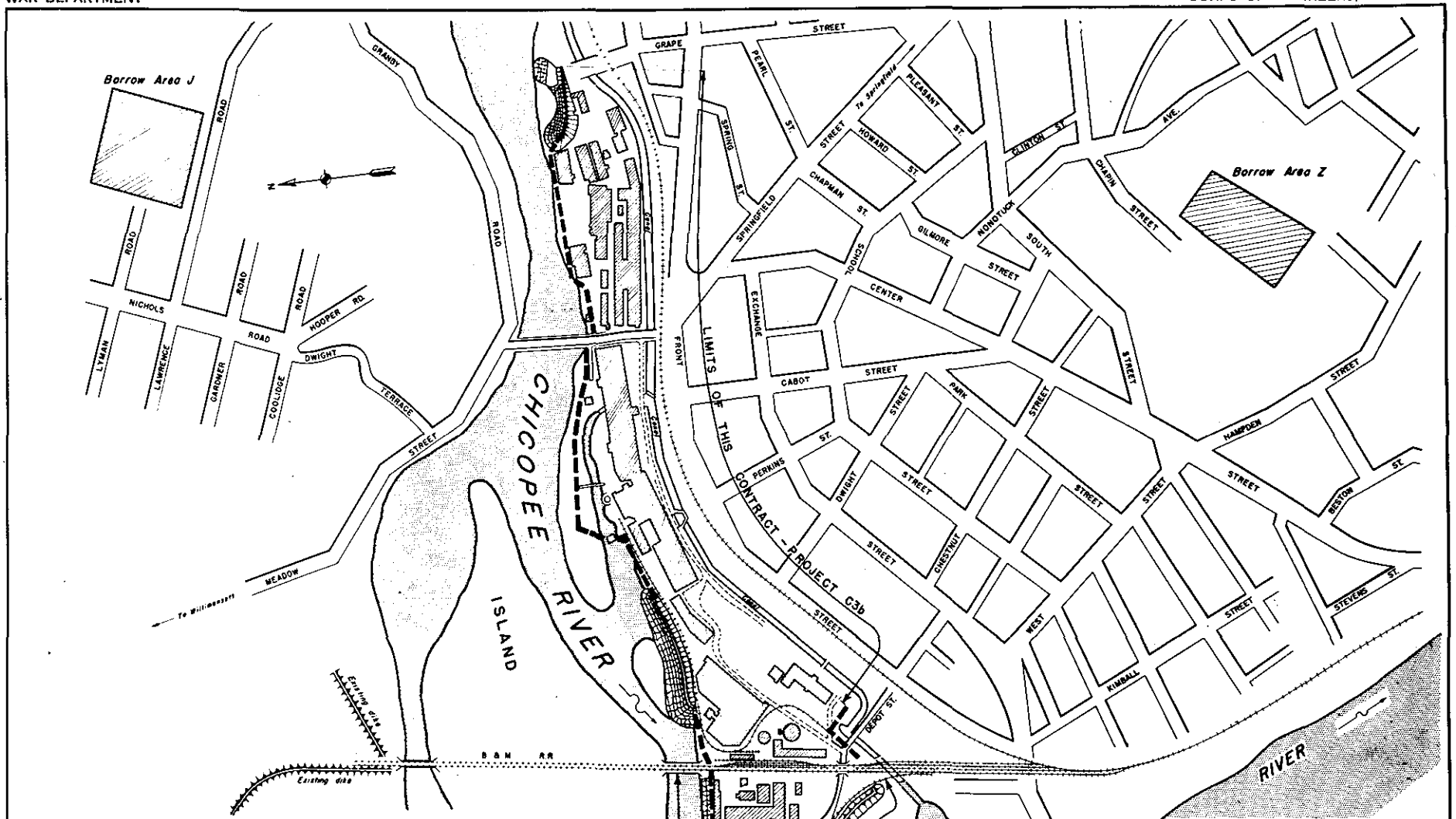
U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — MAY 1940

FISCAL YEAR 1940

FILE NO. CT-2-1284

A. of D. — C. 3b

PLATE NO. 9



AVAILABLE SOURCES OF EMBANKMENT MATERIALS

BORROW AREA J	BORROW AREA Z
Formation approximately 15 feet thick composed chiefly of coarse to medium sand with minor amounts of gravel and fine sand. Suitable for pervious and random embankment construction	*Formation composed of two types: (1) Medium to fine sand varying in thickness from 1 ft. to 6 ft. and underlain by (2) coarse to fine silt. Type (2) is suitable for impervious embankment construction; type (1) is suitable only for random embankment construction.*

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

BORROW AREAS

CONNECTICUT RIVER — CHICOPEE, MASS.

IN 105 SHEETS — SCALE: 1 IN = 200 FT. — SHEET NO. 7

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

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

Asst. Engineer — TRACED: R.N.S. — CHECKED: R.N.S.

FISCAL YEAR 1940

FILE NO. CT-2-1272

C.3b

PLATE NO. 10

PROVIDENCE DISTRICT SOIL CLASSIFICATION

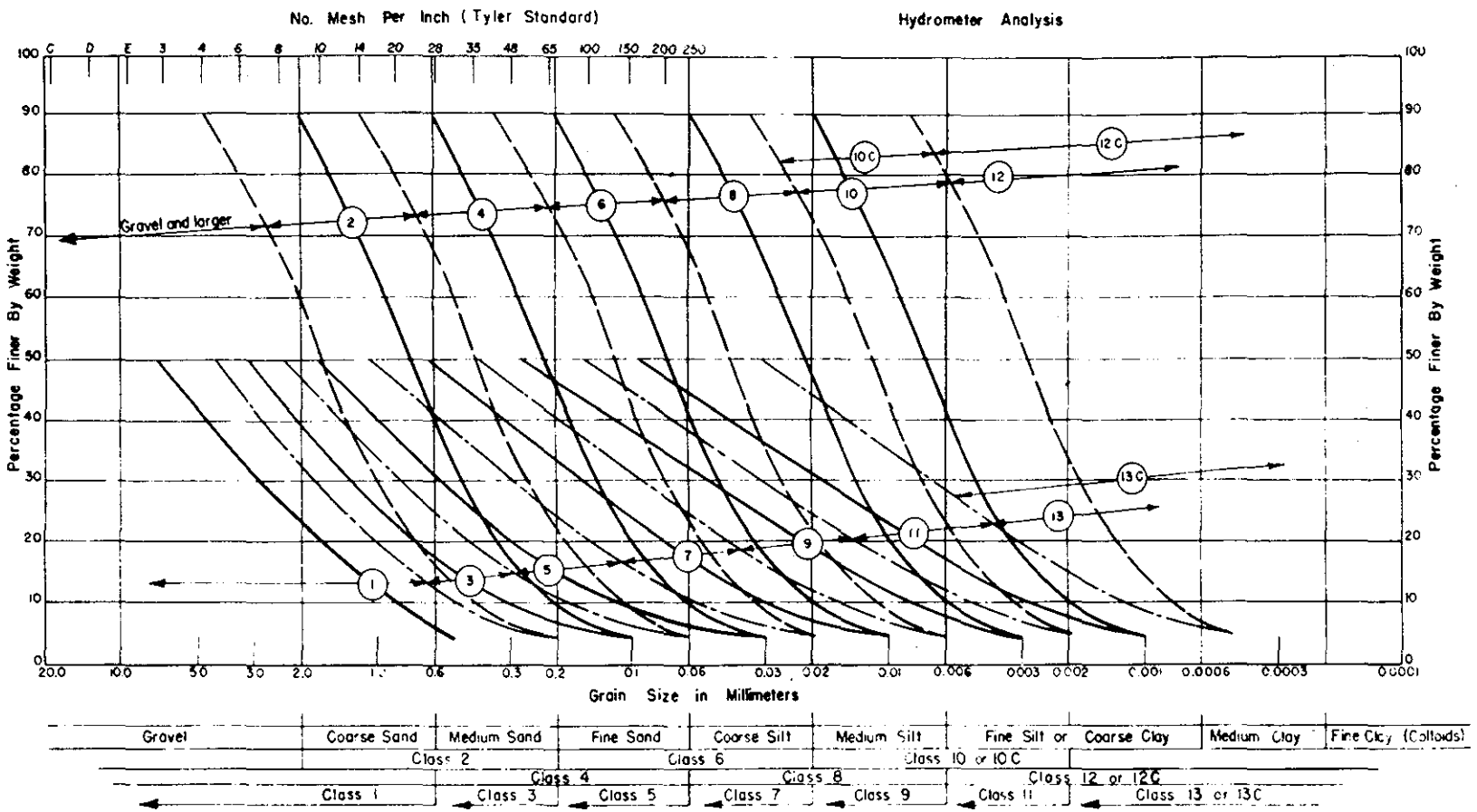
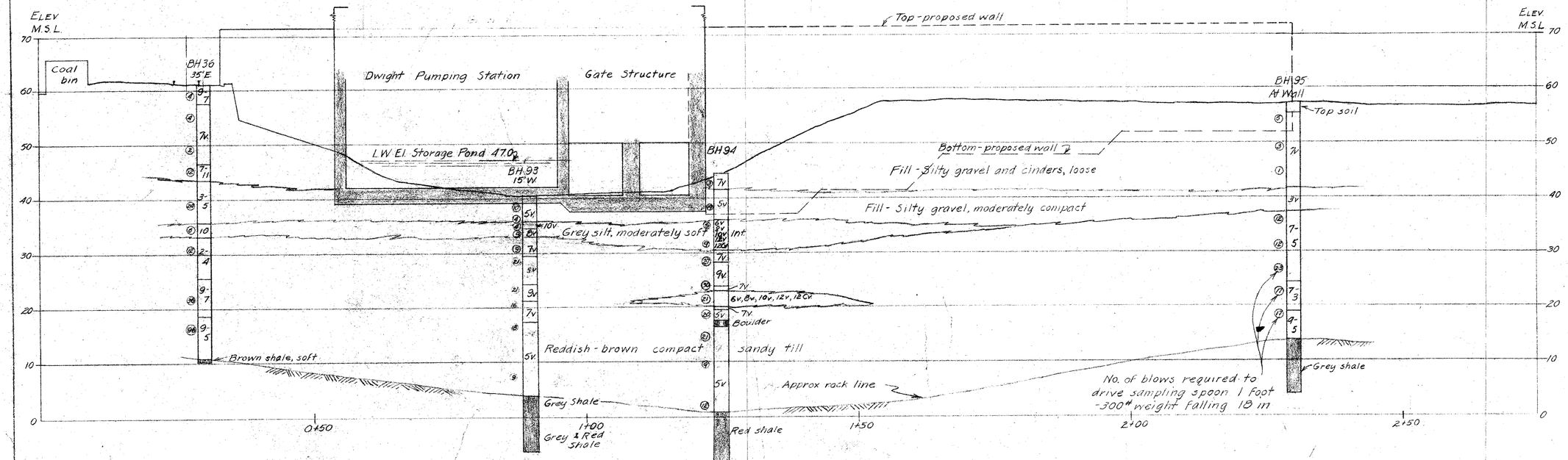


DIAGRAM SHOWING LIMITS OF SOIL CLASSES

PLATE NO. 11

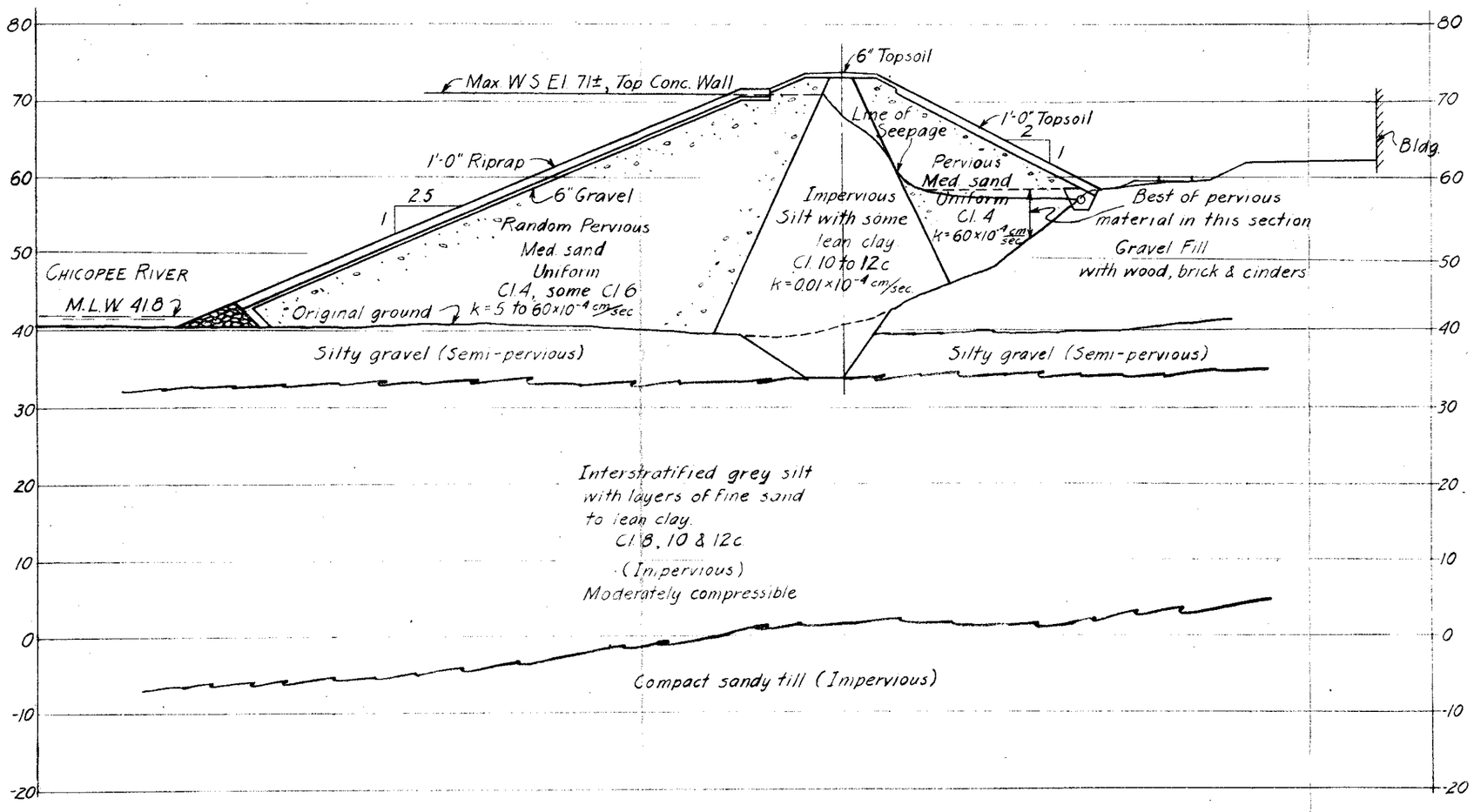


NOTE:
Classes shown on BH-93 and BH-94, preliminary as determined by laboratory inspection

NOTE:
Section taken looking West. (Downstream)

GEOLOGIC AND SOIL SECTION DWIGHT PUMPING STATION CHICOPEE, MASSACHUSETTS	
FLOOD CONTROL ENG. DIV, SOILS LABORATORY	
U.S. ENGINEER OFFICE,	PROVIDENCE, R.I.
DATE APRIL 8, 1940	SCALE: 1" = 10'
SUBMITTED BY	
ANALYSIS BY	S.L. No. C.3b-A2d.
DRAWN BY RDS	PLATE No.

PLATE NO. 12



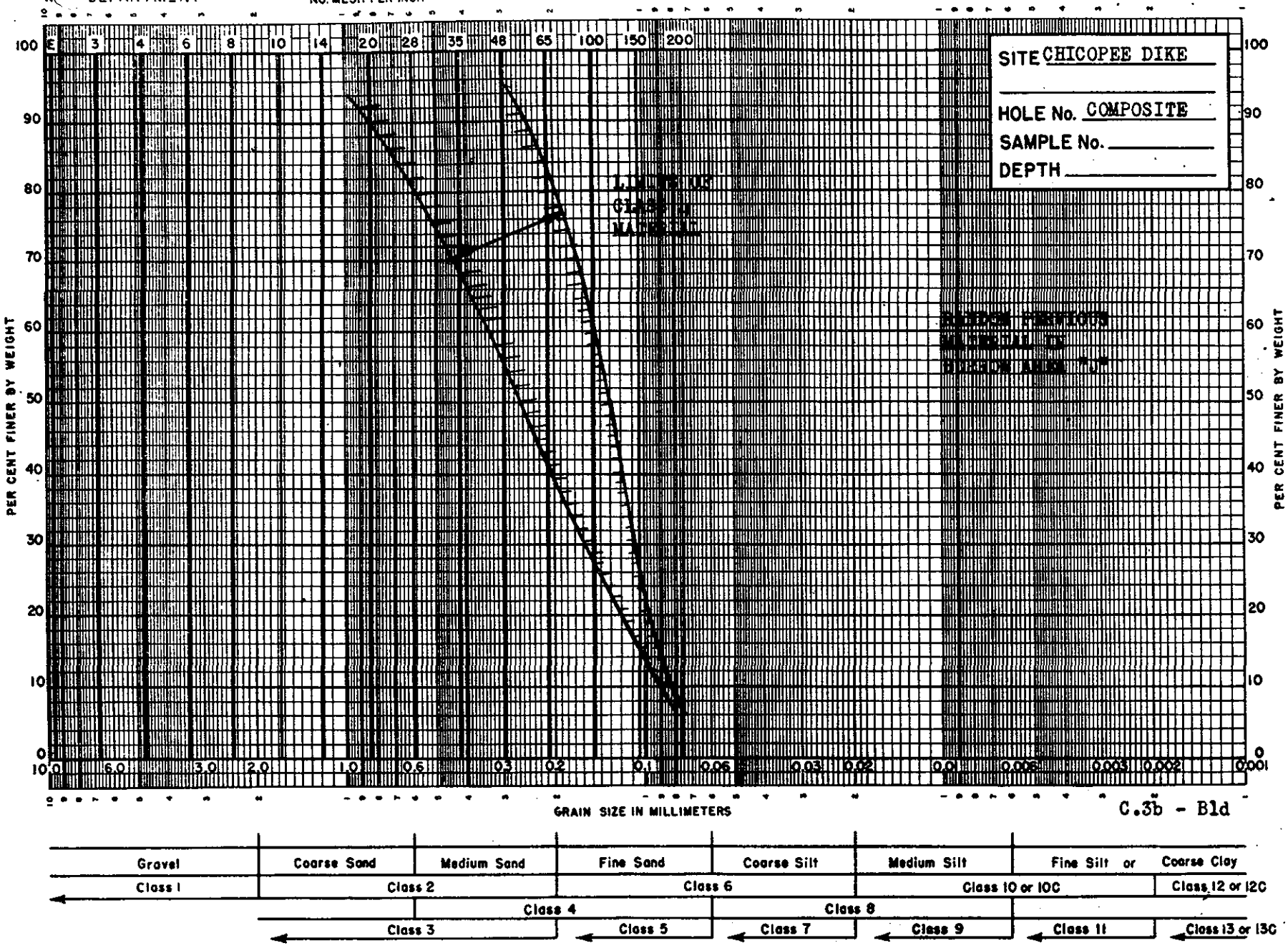
SECTION - STATION 23+00

GENERALIZED SECTION DIKE - SOUTH BANK OF CHICOPEE R. STA. 21+00 to STA. 27+00	
CHICOPEE, MASS.	C.3b.
FLOOD CONTROL ENG. DIV., SOILS LABORATORY	
U.S ENGINEER OFFICE, PROVIDENCE, R. I.	
DATE: MAY 3, 1940	SCALE: AS SHOWN 20FT. 10FT 0 20FT.
SUBMITTED BY KSL	
ANALYSIS BY KSL	S.L. No. C.3b.-A3d
DRAWN BY R.D.S.	PLATE No.

PLATE NO. 13

W DEPARTMENT

CORPS OF ENGINEERS, U. S. AR...



C.3b - Bld

SOILS LABORATORY

MECHANICAL ANALYSIS

PROVIDENCE, R.I.

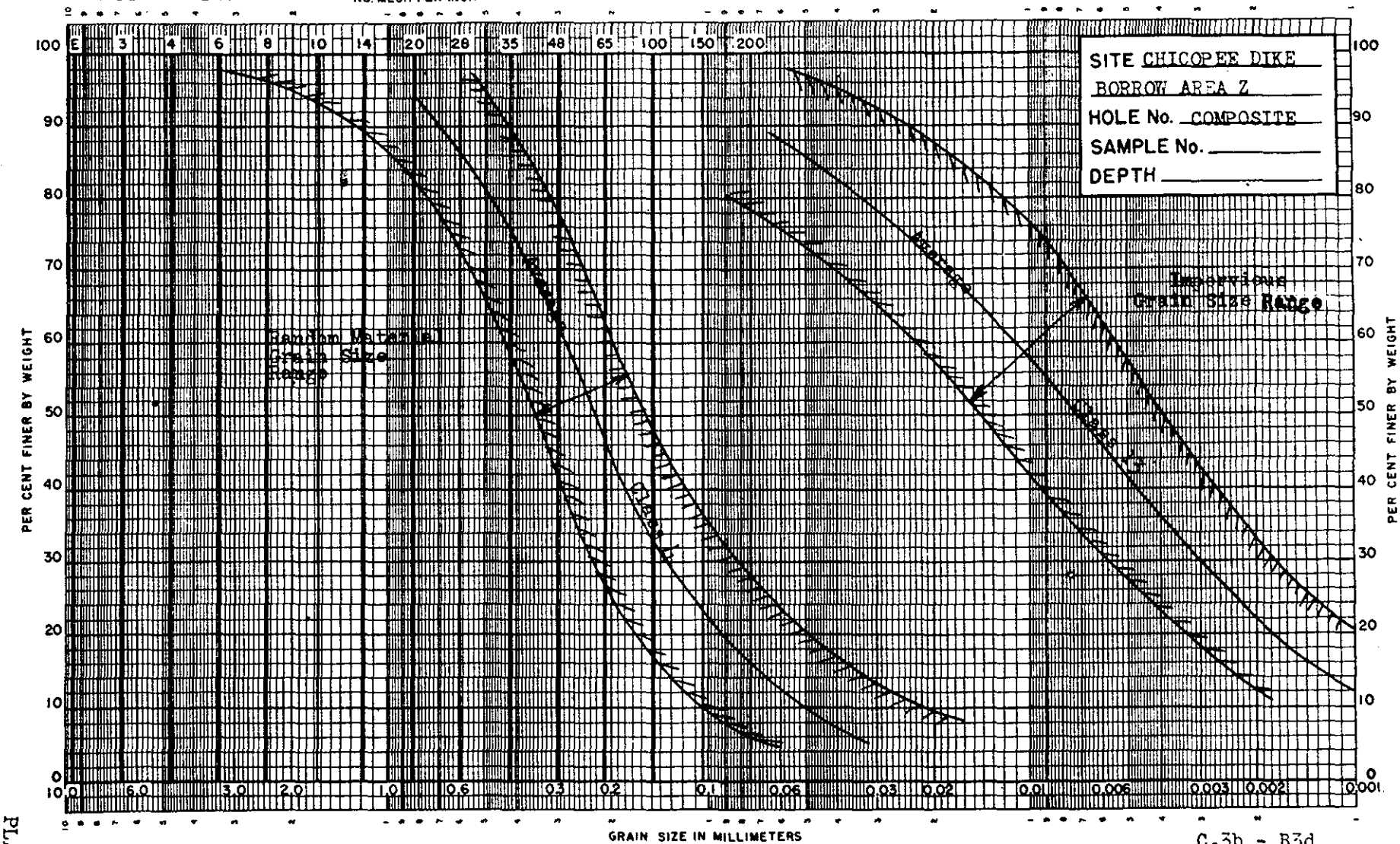
S.L. FORM NO. 80

U. S. GOVERNMENT PRINTING OFFICE 140625

PLATE NO. 14

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



C.3b - B3d

Gravel	Coarse Sand	Medium Sand	Fine Sand	Coarse Silt	Medium Silt	Fine Silt or	Coarse Clay
Class 1	Class 2		Class 6		Class 10 or 10C		Class 12 or 12C
		Class 4		Class 8			
	Class 3		Class 5	Class 7	Class 9	Class 11	Class 13 or 13C

SOILS LABORATORY

MECHANICAL ANALYSIS

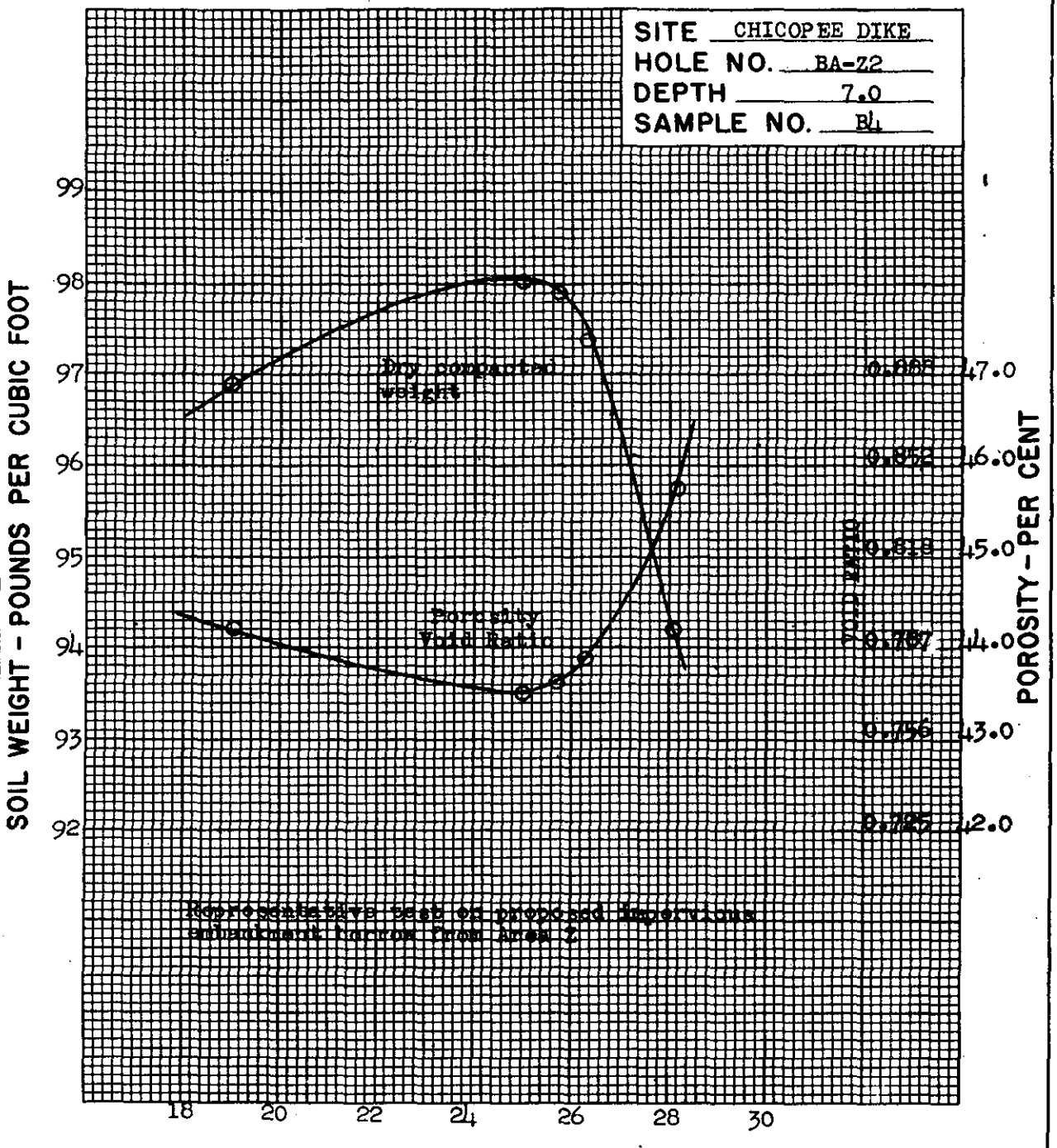
PROVIDENCE, R.I.

S.L. FORM NO. 88

U. S. GOVERNMENT PRINTING OFFICE 140625

PLATE NO. 15

COMPACTION CHARACTERISTICS



C.3b.C1d

Class 13

MATERIAL SCREENED OUT

Minimum Size, mm. _____

Per Cent by weight - -

No. Blows/Layer 25

Area of Tamper, sq. in. 3.14

Weight of Tamper, lbs. 5.5

Fall of Tamper, in. 12.0

e at w(opt) = 0.770

PLATE NO. 16

U. S. GOVERNMENT PRINTING OFFICE 1946-O-149027

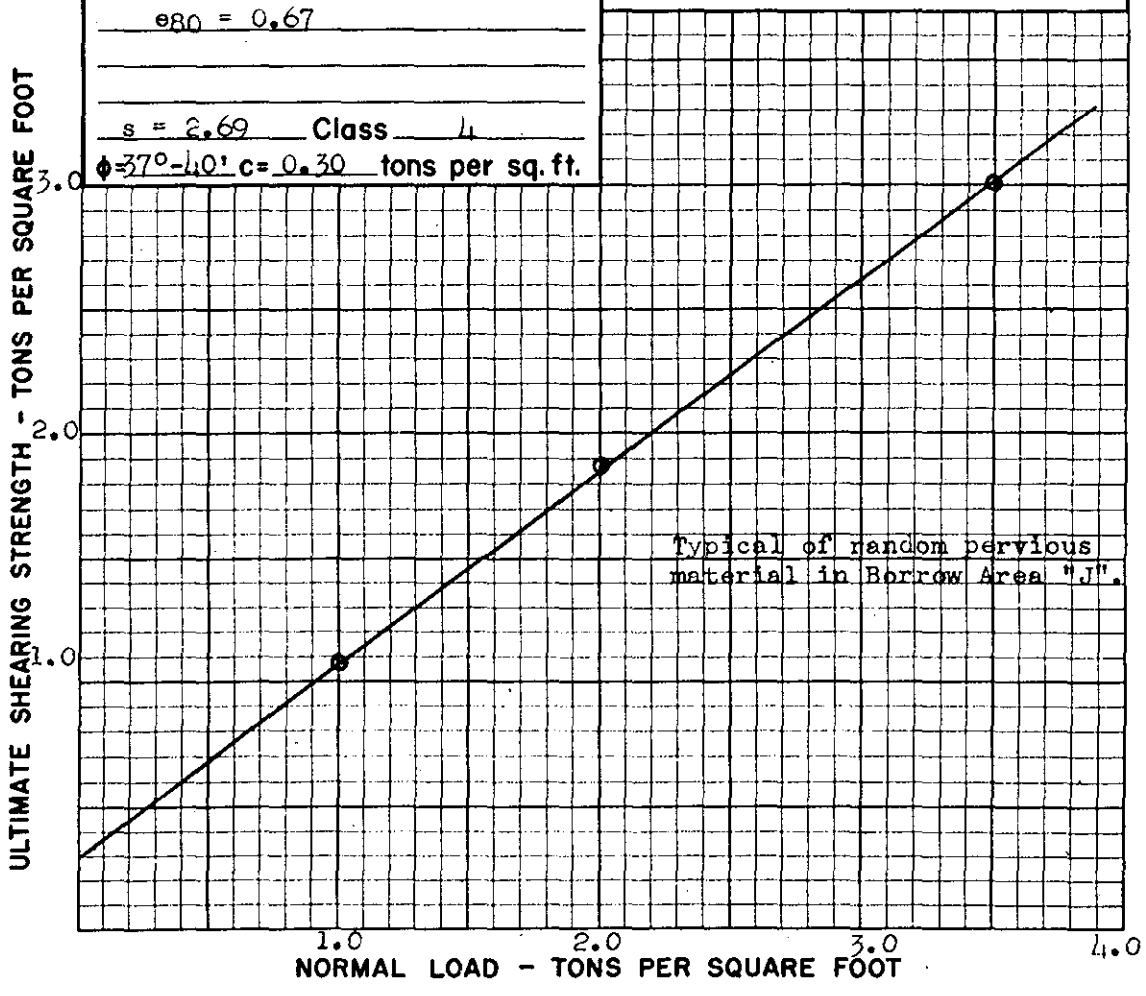
SHEAR TEST

SUPPLEMENTARY DATA

Rate of strain 0.06± in. per min.
Consolidation Full
Shear Plane Dry
Remarks e_0 = 0.89 e_{100} = 0.62
e_{80} = 0.67

s = 2.69 Class 4
ϕ = 37°-40' c = 0.30 tons per sq. ft.

SITE CHICOPEE DIKE
HOLE NO. BA-J7
SAMPLE NO. B3
DEPTH 6.5'



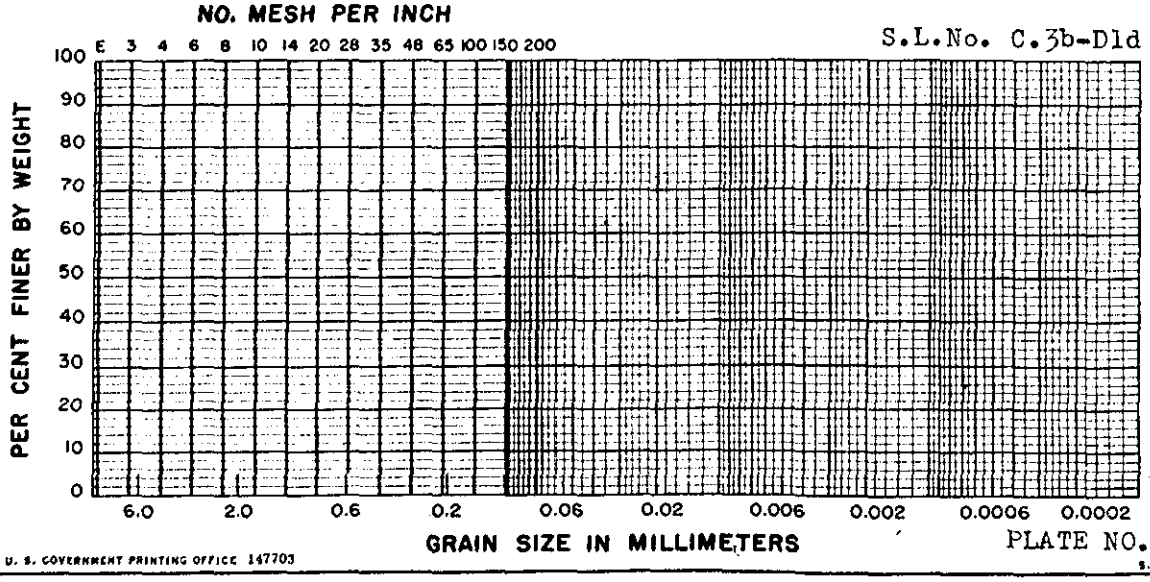


PLATE NO. 17

U. S. GOVERNMENT PRINTING OFFICE 147703
S.L. FORM NO. 66

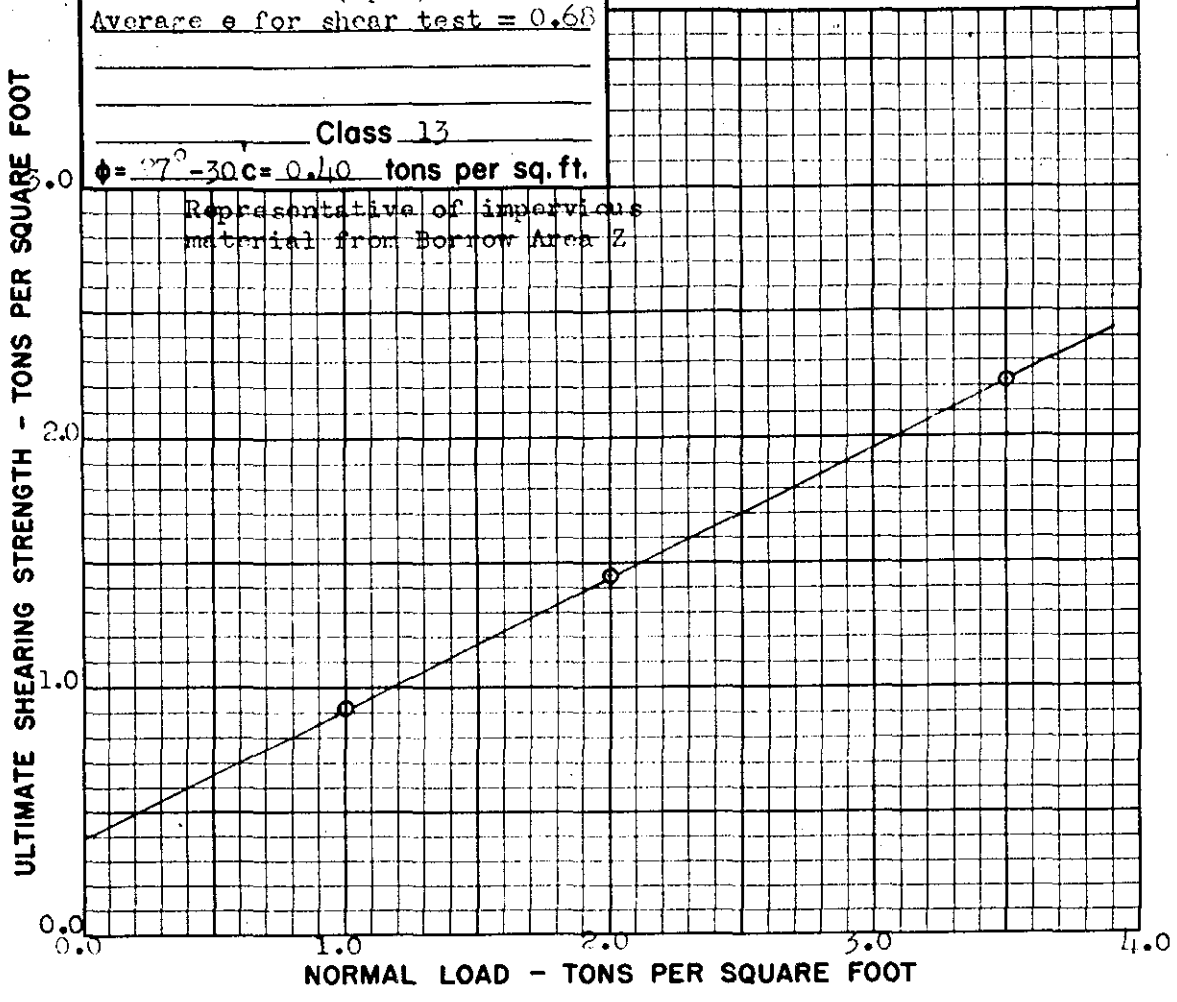
SHEAR TEST

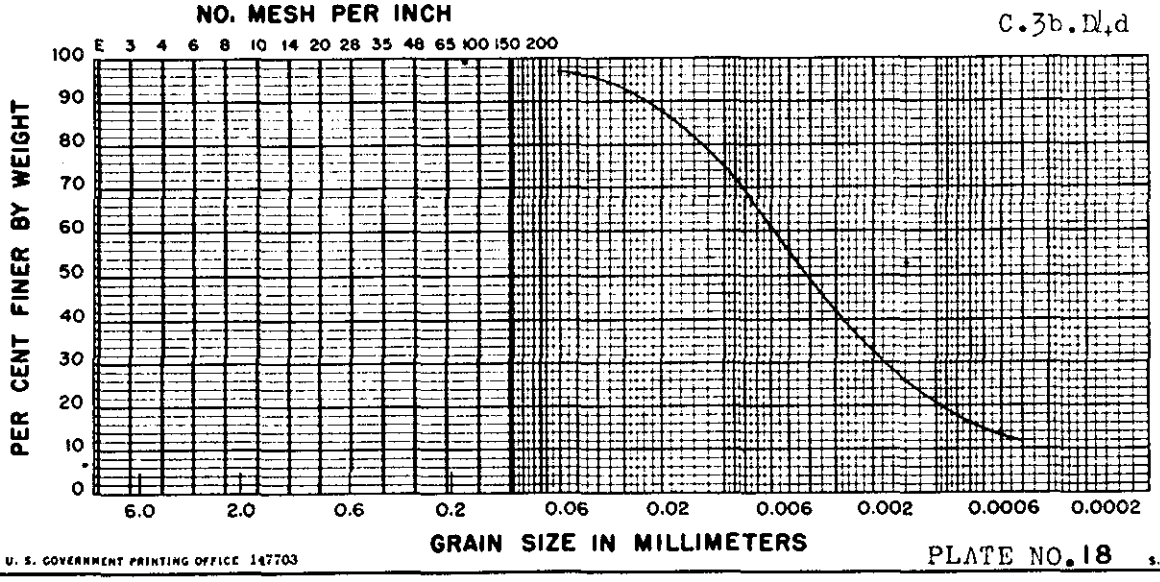
SUPPLEMENTARY DATA

Rate of strain 0.06+ in /min.
Consolidation Full
Shear Plane Dry
Remarks e at w(opt.) = 0.661
Average e for shear test = 0.68

Class 13
ϕ= 27°-30 c= 0.40 tons per sq. ft.

SITE CHICOPEE DIKE
HOLE NO. BA-Z5
SAMPLE NO. B5
DEPTH 11.0





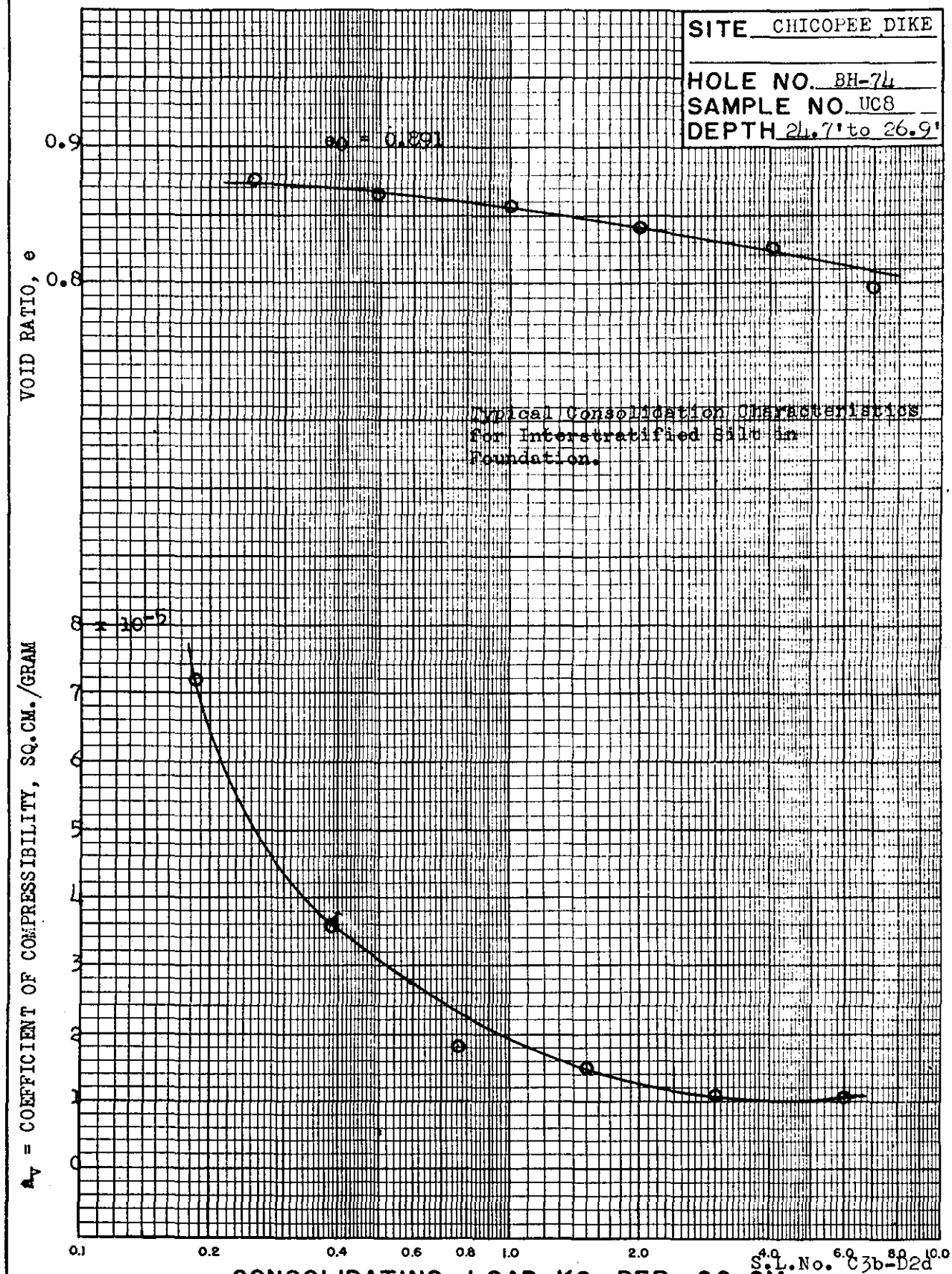
C.3b.D4d

U. S. GOVERNMENT PRINTING OFFICE 147703

PLATE NO. 18

S.L. FORM NO. 66

CONSOLIDATION CHARACTERISTICS

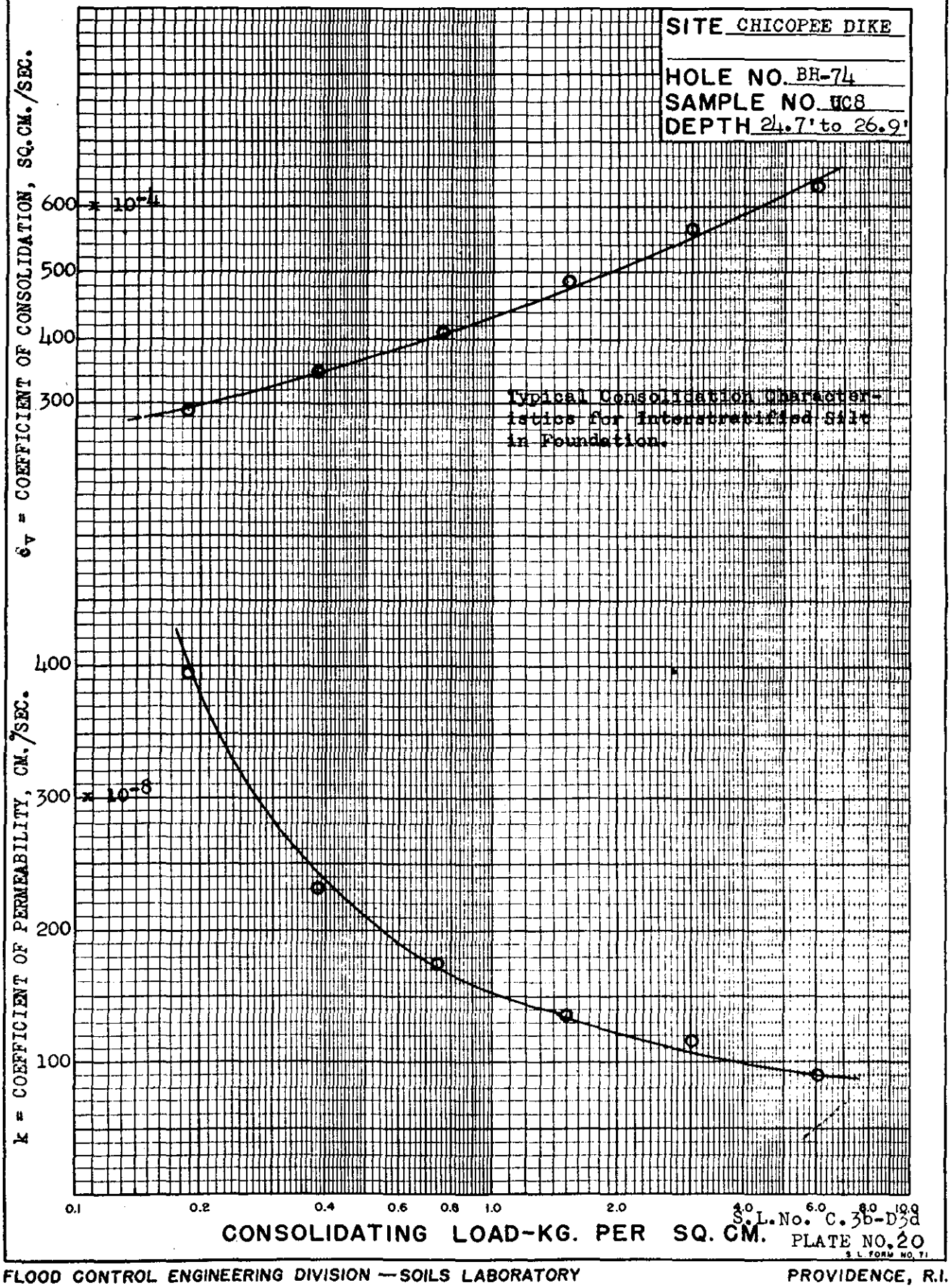


S.L.No. C3b-D2d
PLATE NO. 19

S. L. FORM NO. 71

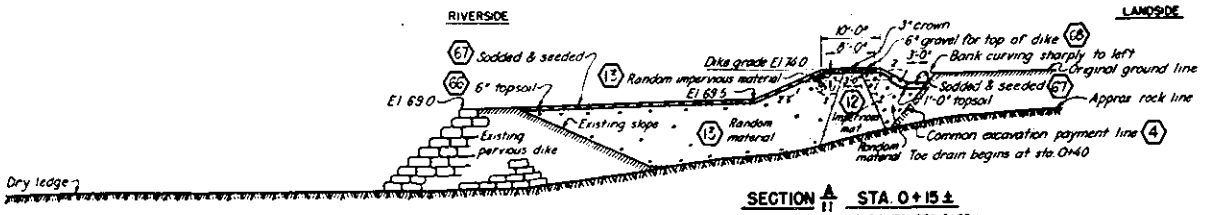
U. S. GOVERNMENT PRINTING OFFICE 175365

CONSOLIDATION CHARACTERISTICS



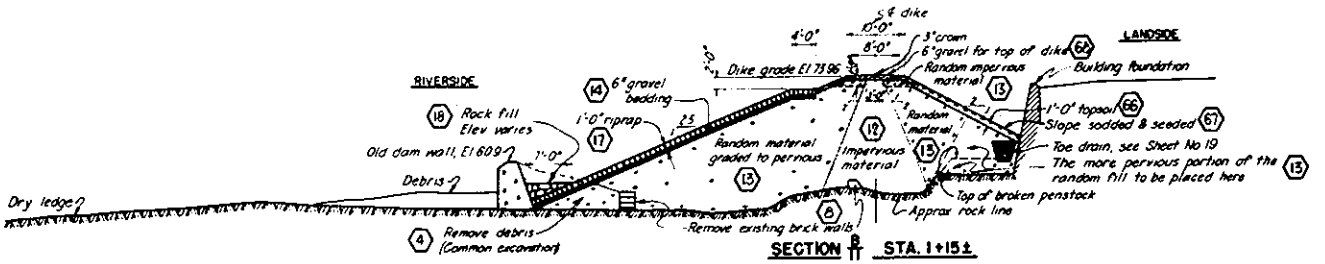
S.L. No. C.3b-D3d
PLATE NO. 20
S. L. FORM NO. 71

U. S. GOVERNMENT PRINTING OFFICE 175365



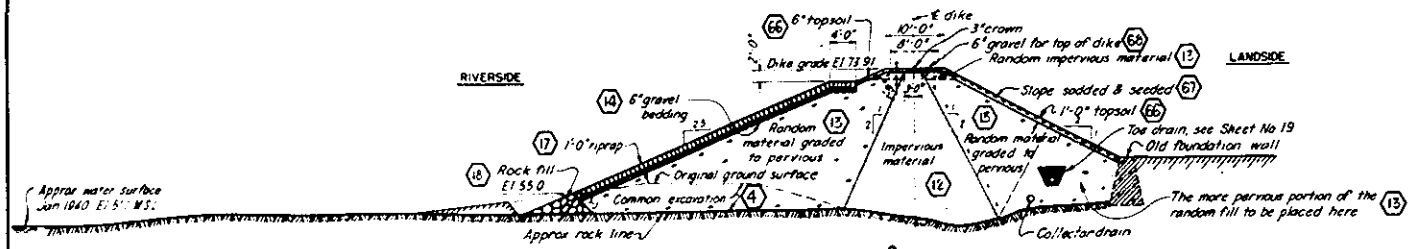
SECTION A/11 STA. 0+15±

TYPICAL FROM STA 0+00 TO STA 0+65±



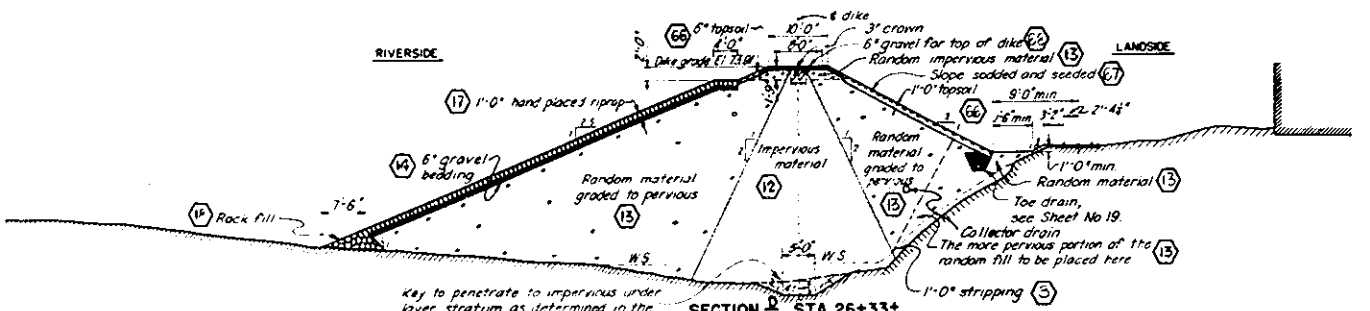
SECTION B/11 STA. 1+15±

TYPICAL FROM STA 0+65± TO STA 2+25±



SECTION C/11 STA. 2+60±

TYPICAL FROM STA 2+25± TO STA 2+77±



SECTION D/13 STA. 26+33±

TYPICAL FROM STA 23+94± TO STA 29+52±

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

NOTES

Elevations refer to Mean Sea Level Datum
Figures in hexagons indicate item numbers under which payment will be made

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

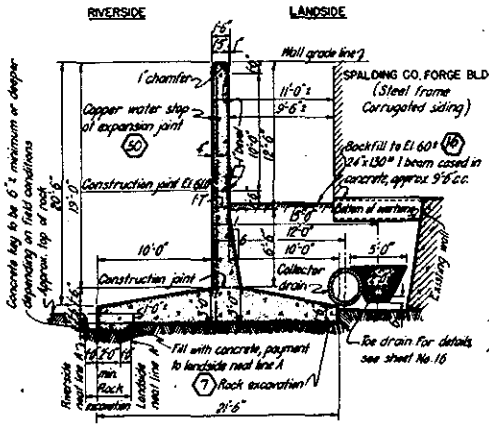
EMBANKMENT DETAILS

CONNECTICUT RIVER — CHICOPEE, MASS.
IN 105 SHEETS — SCALE 1 IN = 10 FT — SHEET NO. 22

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

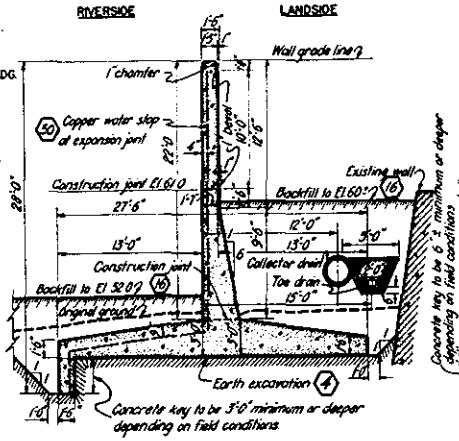
FISCAL YEAR 1940
FILE NO. CT-4-2335

PLATE NO. 21



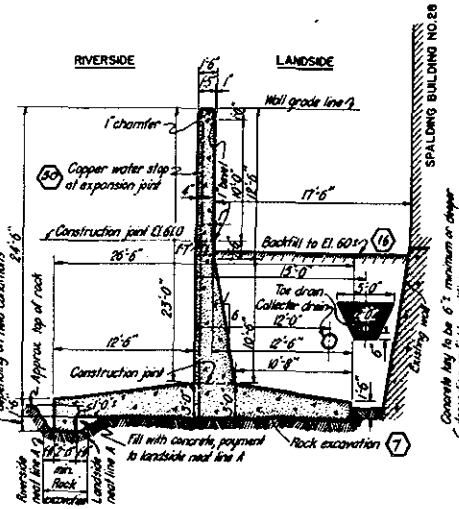
19'-0" WALL SECTION E/11

TYPICAL FROM STA. 8+41.0 TO STA. 8+81.22
AND FROM STA. 8+95.22 TO STA. 9+27.5±
FOR DETAILS FROM STA. 9+27.5± TO STA. 9+30.87,
SEE SHEET NO. 26



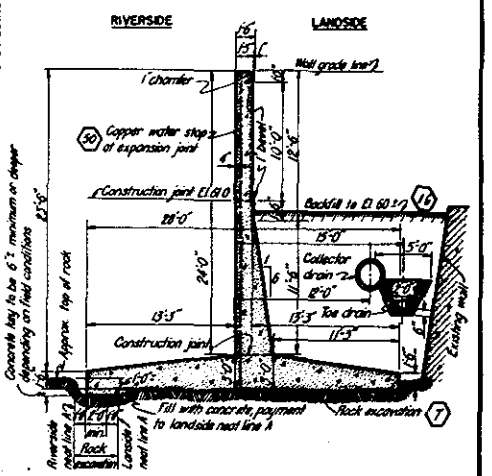
22'-0" WALL SECTION D/11

TYPICAL FROM STA. 5+00 TO STA. 8+41.0



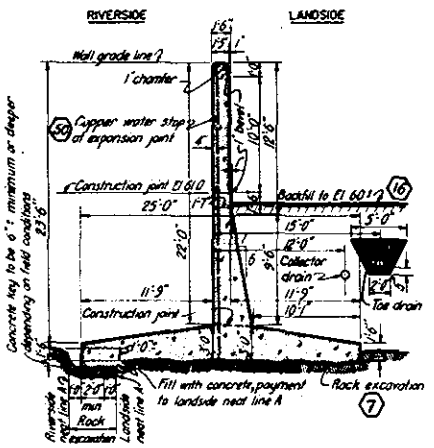
23'-0" WALL SECTION B/11

TYPICAL FROM STA. 3+59.0 TO STA. 4+74.0



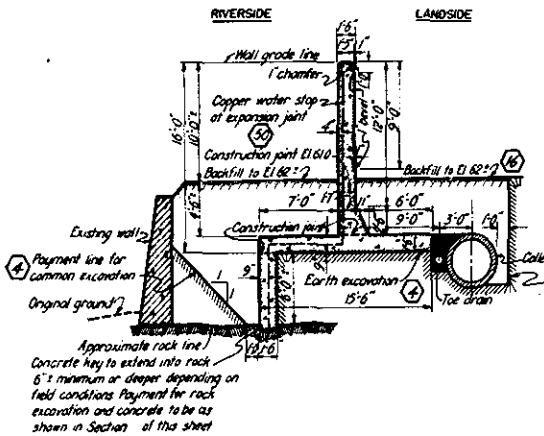
24'-0" WALL SECTION C/11

TYPICAL FROM STA. 4+87.0 TO STA. 5+00



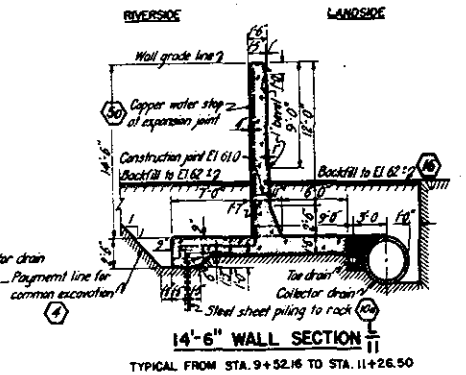
22'-0" WALL SECTION A/11

TYPICAL FROM STA. 2+88.5 TO STA. 3+59.0



14'-6" WALL SECTION F/11

TYPICAL FROM STA. 9+30.87 TO STA. 9+52.16



14'-6" WALL SECTION F/11

TYPICAL FROM STA. 9+52.16 TO STA. 11+26.50

NOTES

Elevations refer to Mean Sea Level Datum.
Wall station line is riverside face of wall.
All exposed edges shall be chamfered as directed by the contracting officer.
Numbers in hexagons indicate item numbers under which payment will be made.
All concrete on this sheet shall be class "A" and will be paid for under item No. 43.

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

WALLS

CONCRETE DETAILS NO. 1

CONNECTICUT RIVER — CHICOPEE, MASS.

IN 105 SHEETS — SCALE: 3/16 IN. = 1 FT. — SHEET NO. 24

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

SUBMITTED: Chief, Design Section — APPROVED RECOMMENDED: Chief, Engineering Div. — APPROVED: Colonel, Corps of Engineers, District Engineer

DESIGNED: H. C. Hanson, Jr., Asst. Engineer — DRAWN: A.G.T. & A.E.B. — TRACED: A.E.B. — CHECKED: C.C.P.

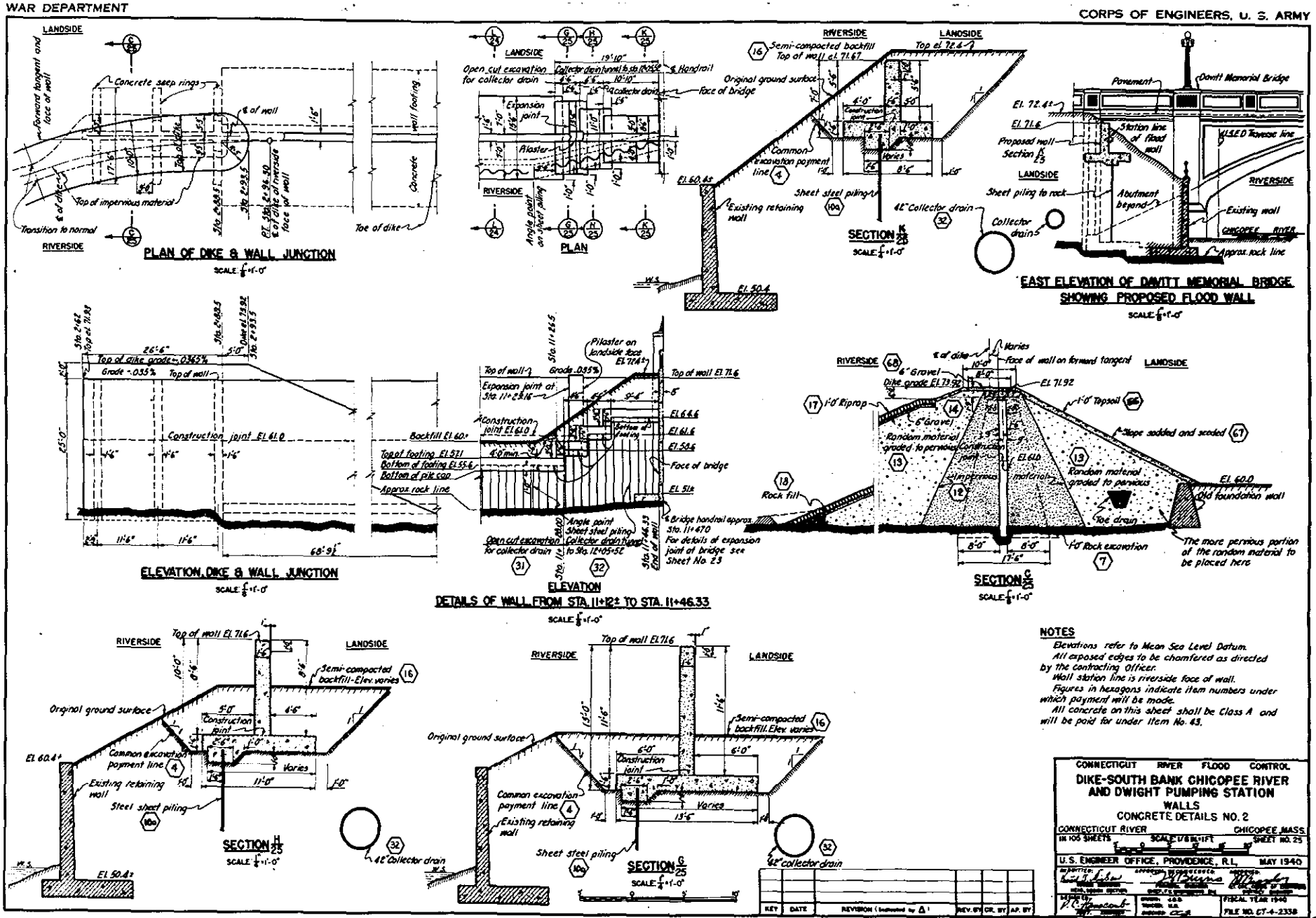
FISCAL YEAR 1940 — FILE NO. CT-4-2337

PLATE NO. 22

C3b

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



NOTES

Elevations refer to Mean Sea Level Datum.

All exposed edges to be chamfered as directed by the contracting Officer.

Wall station line is riverside face of wall.

Figures in hexagons indicate item numbers under which payment will be made.

All concrete on this sheet shall be Class A and will be paid for under Item No. 43.

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

WALLS

CONCRETE DETAILS NO. 2

CONNECTICUT RIVER — CHICOPEE, MASS.

IN 100 SHEETS — SCALE: 1" = 1 FT. — SHEET NO. 25

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

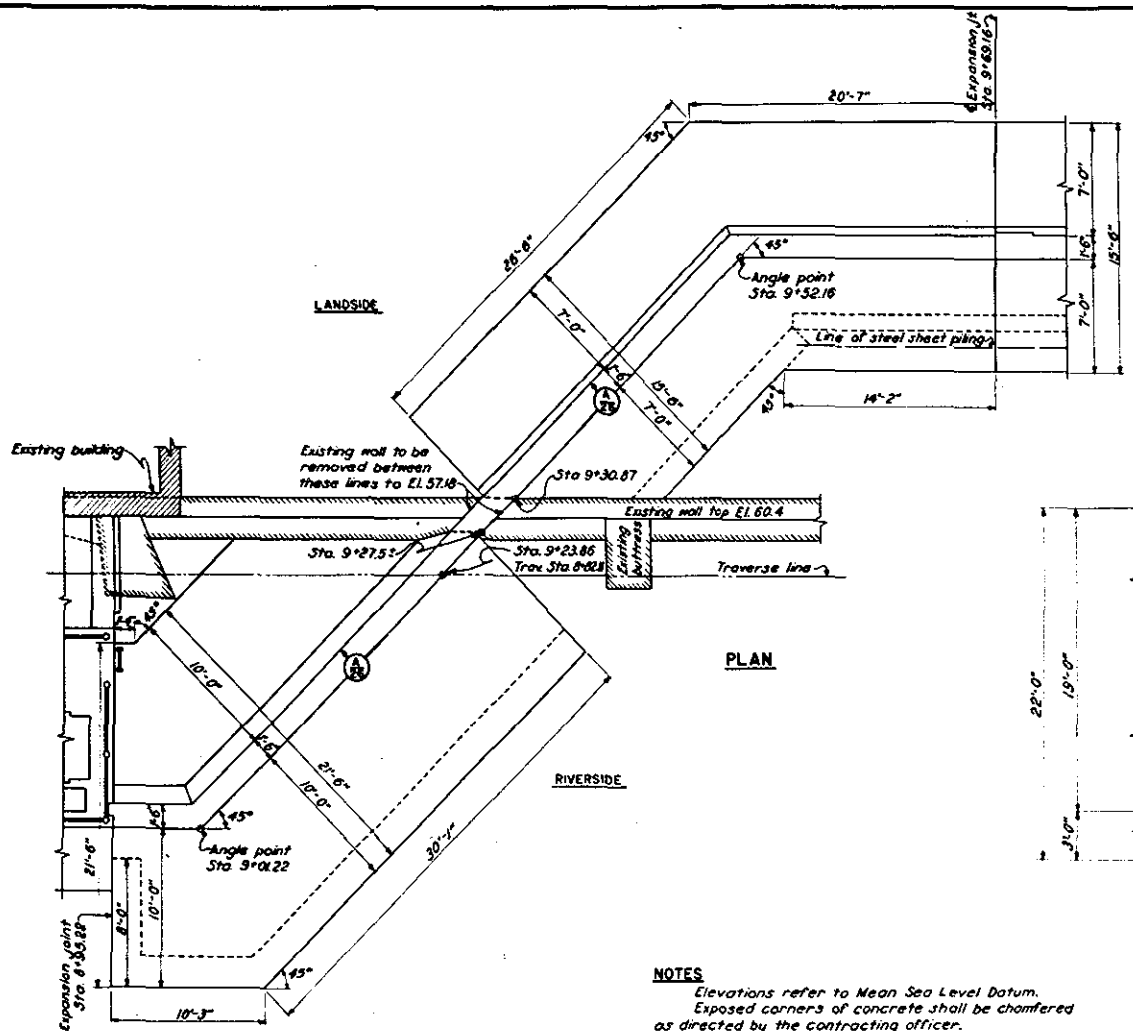
FISCAL YEAR 1940

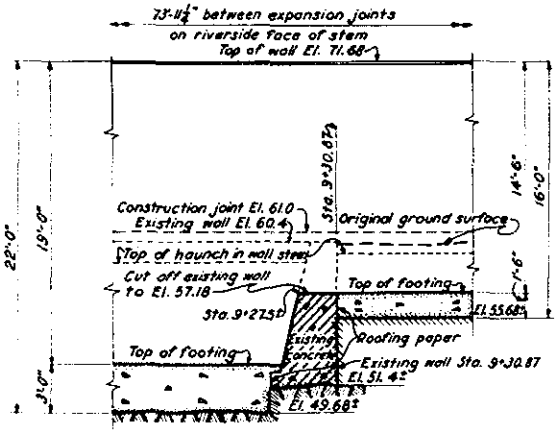
FILE NO. CT-4-2338

PLATE NO. 23

C.3b

25





SECTION A/26

NOTES

Elevations refer to Mean Sea Level Datum.

Exposed corners of concrete shall be chamfered as directed by the contracting officer.

All concrete on this sheet shall be class A and will be paid for under item No. 43

Wall station line is riverside face of wall.

For general location see Sheet No. 11.

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

WALLS

CONCRETE DETAILS NO. 3

CONNECTICUT RIVER — CHICOPEE, MASS.

IN 105 SHEETS — SCALE 1/4 IN. = 1 FT. — SHEET NO. 26

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

SUBMITTED: Resident Engineer, Head, Design Section — RECOMMENDED: Principal Engineer, Chief, Civil Engineering Div. — APPROVED: Colonel, Corps of Engineers, District Engineer

REVIEWED: Chief Engineer

DESIGN: L.T.S.&.E.S.O. — TRACED: F.K.W. — CHECKED: C.O.P.

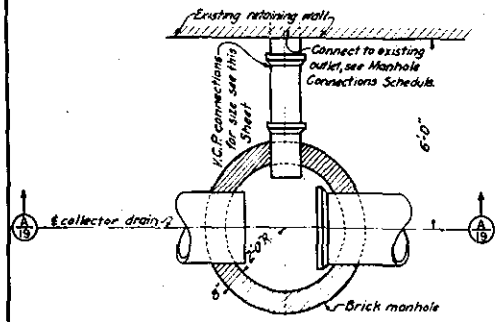
FISCAL YEAR 1940

FILE NO. CT-4-2339

C.3b

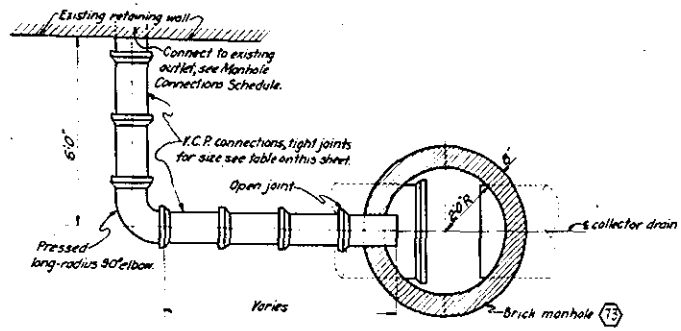
WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



TYPE "A" MANHOLE CONNECTION

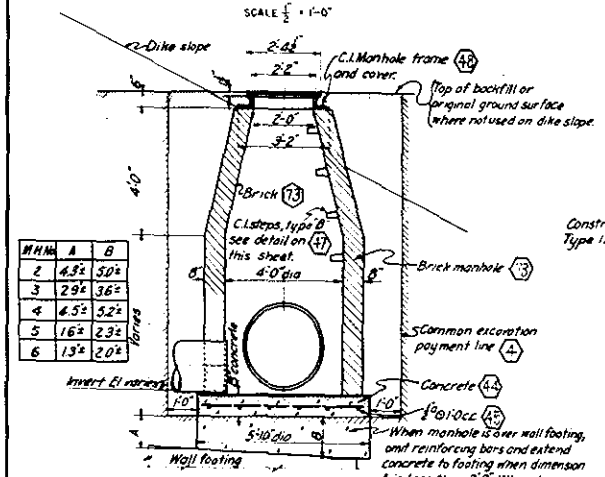
SCALE 1/2" = 1'-0"



TYPE "B" MANHOLE CONNECTION

SCALE 1/2" = 1'-0"

MANHOLE CONNECTIONS						
OUTLET NO	TYPE CONN	SIZE & KIND	LENGTH OF CONNECTION	MANHOLE NO.	REMARKS	PAY ITEM
2	A	12" V.C.	4'-0"	3		26
3	A	10" V.C.	4'-0"	4		24
8	A	18" V.C.	4'-0"	5		28
9	B	4" V.C.	18'-0"	6	1 long radius elbow	20
11	A	8" V.C.	4'-0"	6		22
12	B	4" V.C.	34'-0"	Gate #2	1 long radius elbow	20
14	Special	3" V.C.	33'-0"	7	To be aligned in field	19
15	A	12" V.C.	4'-0"	8		26
17	A	6" V.C.	4'-0"	9		21
18	Special	10" V.C.	26'-0"	9		24
24	Special	4" V.C.	10'-0"	10	Connects to outlet #25	20
25	Special	6" V.C.	25'-0"	10	Carries outlet #24	21
26	A	30" C.I.		10		
28	Special	6" V.C.	80'-0"	10		21
29	A	12" C.I.		11	See Sheet No. 20	
30	Special	4" V.C.	12'-0"	11	See Sheet No. 20	20
31	Special	4" V.C.	36'-0"	11	See Sheet No. 20	20
33	A	6" C.I.		14		
35	A	8" V.C.	10'-0"	15		22
36	A	9" C.I.		16		
37	A	10" C.I.		17		
38	Special	8" C.I.	48'-0"	21	See Sheet No. 20	22
39	Special			18	See Sheet No. 20	
41	Special	10" V.C.	150'-0"	19		24



WHM No	A	B
2	4.3±	5.0±
3	2.9±	3.6±
4	4.5±	5.2±
5	1.6±	2.3±
6	1.3±	2.0±

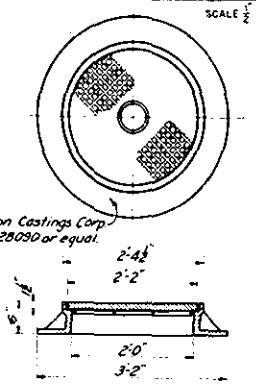
Varies

SECTION A/19

TYPICAL BRICK MANHOLE

TYPICAL FOR MANHOLES NO. 1 TO 10 INCL. & 12 TO 19 INCL.

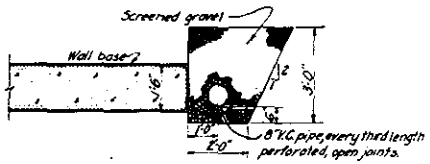
SCALE 1/2" = 1'-0"



DETAIL OF MANHOLE FRAME & COVER

REQUIRED TOTAL WEIGHT = LBS.

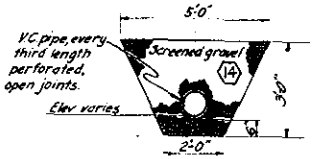
SCALE 1" = 1'-0"



TYPICAL TOE DRAIN SECTIONS AT WALL

FROM STA. 9+30 TO STA. 11+12
FROM MANHOLE NO. 10 AT STA. 21+36 TO STA. 21+80
FROM STA. 22+00 TO STA. 23+60
FROM STA. 23+75 TO MANHOLE NO. 12 AT STA. 24+55
FROM STA. 40+17 TO STA. 42+22±

SCALE 1/2" = 1'-0"



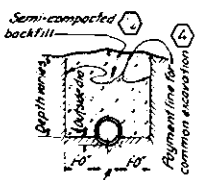
TYPICAL TOE DRAIN SECTION

FROM STA. 0+30 TO STA. 9+30±
FROM MANHOLE NO. 13 AT STA. 24+62 TO STA. 27+85
FROM STA. 28+05 TO STA. 28+35
FROM STA. 28+45 TO STA. 28+80

SCALE 1/2" = 1'-0"

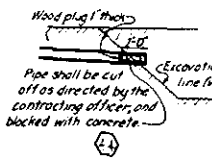
NOTES

Elevations refer to Mean Sea Level Datum.
Figures in hexagons indicate item numbers under which payment will be made.
For toe drain alignment see Sheet Nos. 11, 12, 13 & 14.
For drainage system profile see Sheet: Nos. 17, 18 & 19.



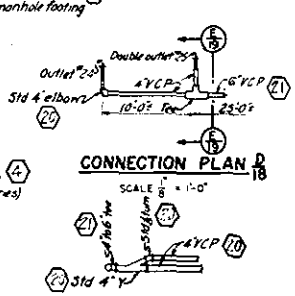
DETAIL OF PIPE TRENCH

SCALE 1/2" = 1'-0"



METHOD OF BLOCKING DRAINS NOT IN USE

SCALE 3/8" = 1'-0"

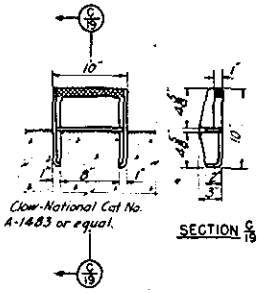


CONNECTION PLAN D/18

SCALE 1/8" = 1'-0"

SECTION E/19

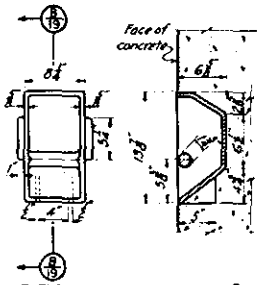
SCALE 1/8" = 1'-0"



C.I. MANHOLE STEP-TYPE "B"

REQUIRED TOTAL WEIGHT = LBS

SCALE 1½" = 1'-0"



STANDARD C.I. BOX STEP-TYPE "A"

REQUIRED TOTAL WEIGHT = LBS

SCALE 1½" = 1'-0"

CONNECTICUT RIVER FLOOD CONTROL
DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION
DRAINAGE DETAILS NO. 1

CONNECTICUT RIVER — CHICOPEE, MASS.
IN 105 SHEETS — SCALE 1/2" = 1 FT — SHEET NO. 19

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

SUBMITTED: Chief, Design Section — APPROVED & RECOMMENDED: Chief, Engineering Div. — APPROVED: Colonel, Corps of Engineers, District Engineer

DESIGNED: Civil Engineer — DRAWN: J.D.S. & E.C. — TRACED: H.S. — CHECKED: C.S.F.

FISCAL YEAR 1940
FILE NO. CT-4-2332

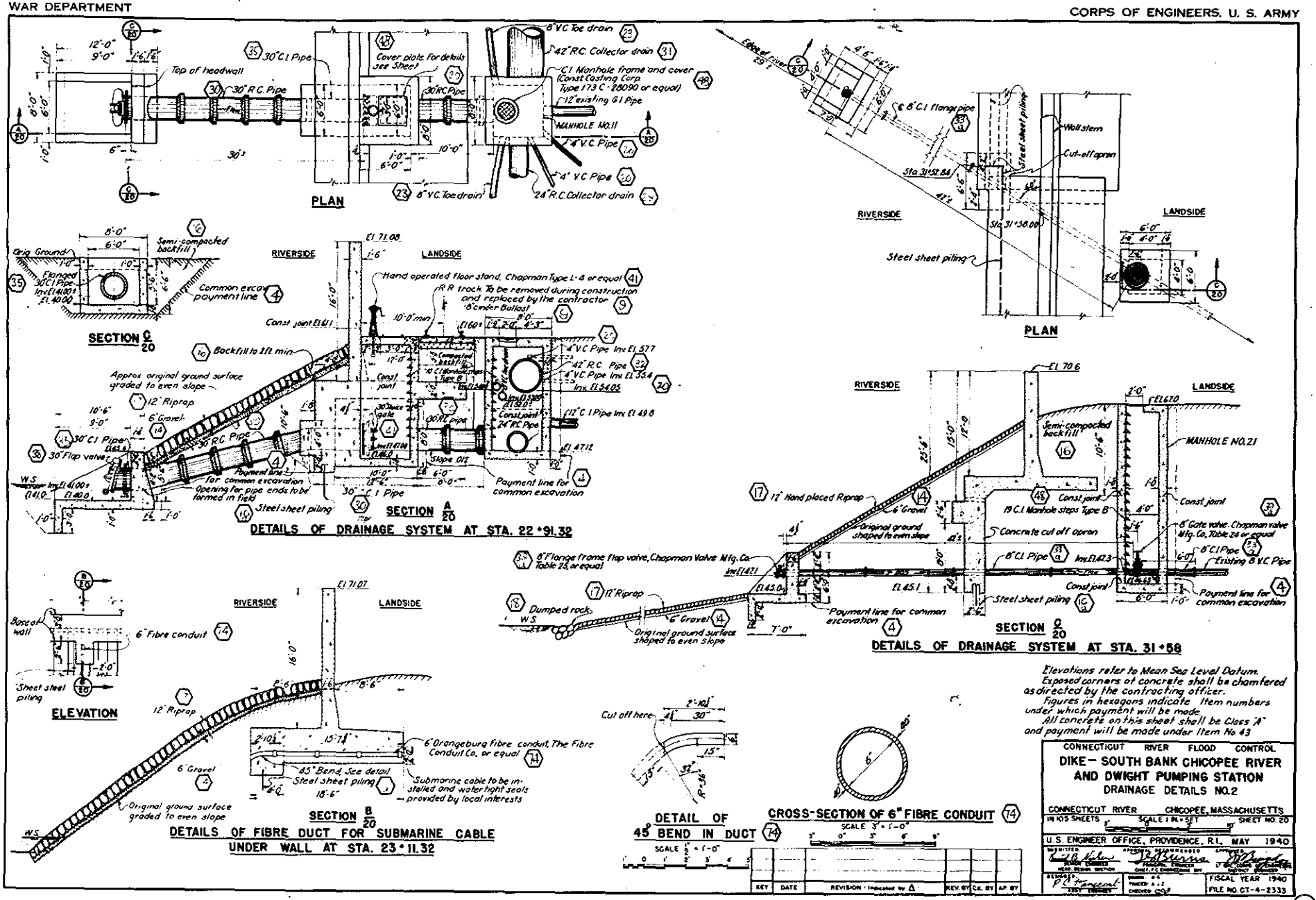
KEY	DATE	REVISION indicated by Δ	REV BY	CK BY	AP BY

PLATE NO. 25

C.3b

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



Elevations refer to Mean Sea Level Datum.
Exposed corners of concrete shall be chamfered as directed by the contracting officer.
Figures in hexagons indicate item numbers under which payment will be made.
All concrete on this sheet shall be Class "A" and payment will be made under Item No. 43

CONNECTICUT RIVER FLOOD CONTROL

DIKE — SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

DRAINAGE DETAILS NO. 2

CONNECTICUT RIVER — CHICOPEE, MASSACHUSETTS

IN 105 SHEETS — SCALE 1 IN. = 5 FT. — SHEET NO. 20

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

FISCAL YEAR 1940

FILE NO. CT-4-2333

KEY	DATE	REVISION (Indicated by Δ)	REV. BY	C.K. BY	A.P. BY

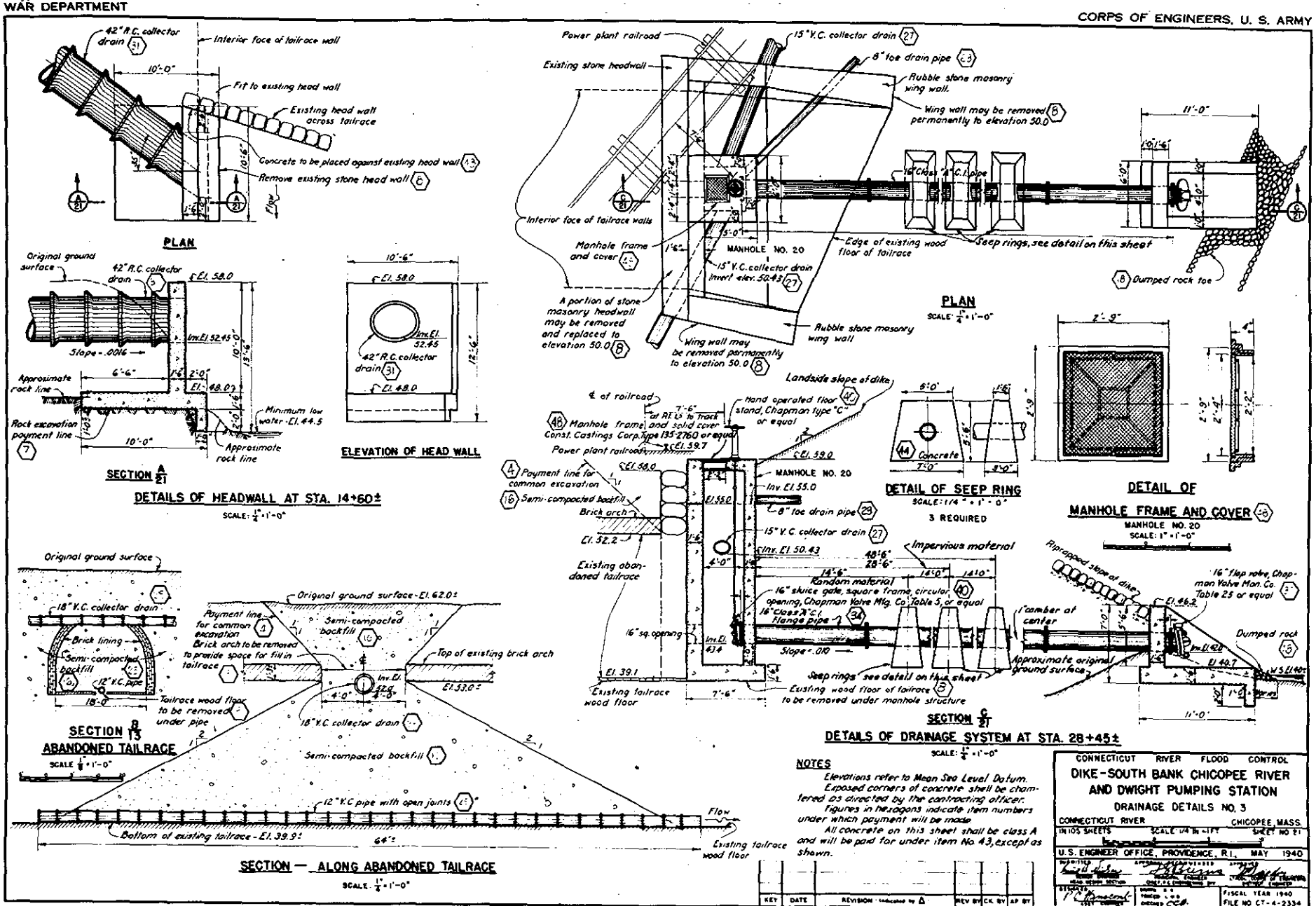
PLATE NO. 26

C3b

20

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



NOTES

Elevations refer to Mean Sea Level Datum.

Exposed corners of concrete shall be chamfered as directed by the contracting officer.

Figures in hexagons indicate item numbers under which payment will be made.

All concrete on this sheet shall be class A and will be paid for under item No. 43, except as shown.

KEY	DATE	REVISION indicated by Δ	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

DRAINAGE DETAILS NO. 3

CONNECTICUT RIVER — CHICOPEE, MASS.

IN 105 SHEETS — SCALE 1/4 IN = 1 FT — SHEET NO. 21

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

FISCAL YEAR 1940

FILE NO. CT-4-2334

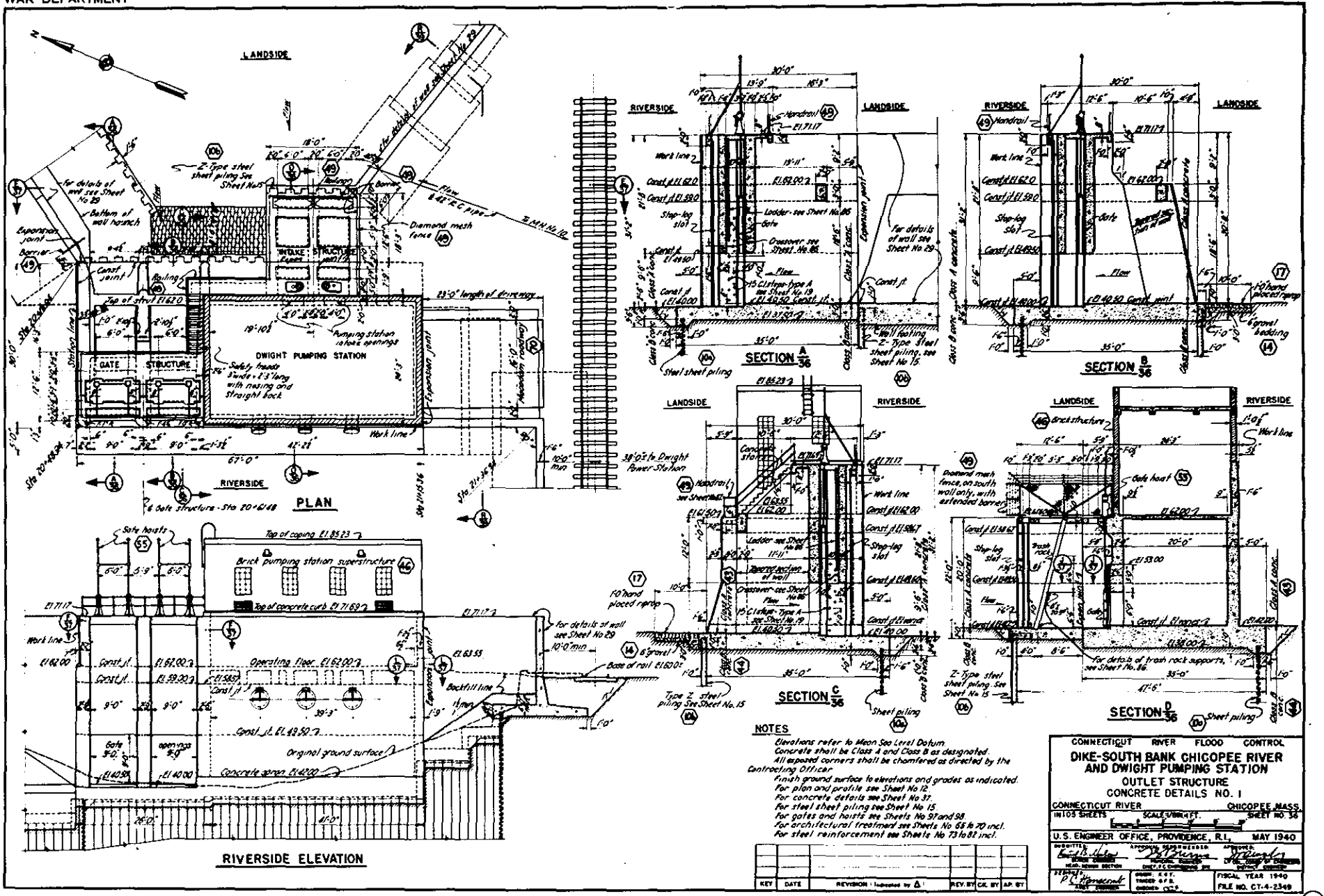
C.3b

(21)

PLATE NO. 27

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



NOTES

Elevations refer to Mean Sea Level Datum.
Concrete shall be Class A and Class B as designated.
All exposed corners shall be chamfered as directed by the Contracting Officer.
Finish ground surface to elevations and grades as indicated.
For plan and profile see Sheet No 12.
For concrete details see Sheet No 37.
For steel sheet piling see Sheet No 15.
For gates and hoists see Sheets No 97 and 98.
For architectural treatment see Sheets No 65 to 70 incl.
For steel reinforcement see Sheets No 73 to 82 incl.

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

OUTLET STRUCTURE

CONCRETE DETAILS NO. 1

CONNECTICUT RIVER CHICOPEE, MASS.

IN 105 SHEETS SCALE 1/8 IN = 1 FT. SHEET NO. 36

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

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

DESIGNED: ASST. ENGINEER — DRAWN: K.G.T. TRACED: G.F.B. CHECKED: C.C.S.

FISCAL YEAR 1940

FILE NO. CT-4-2349

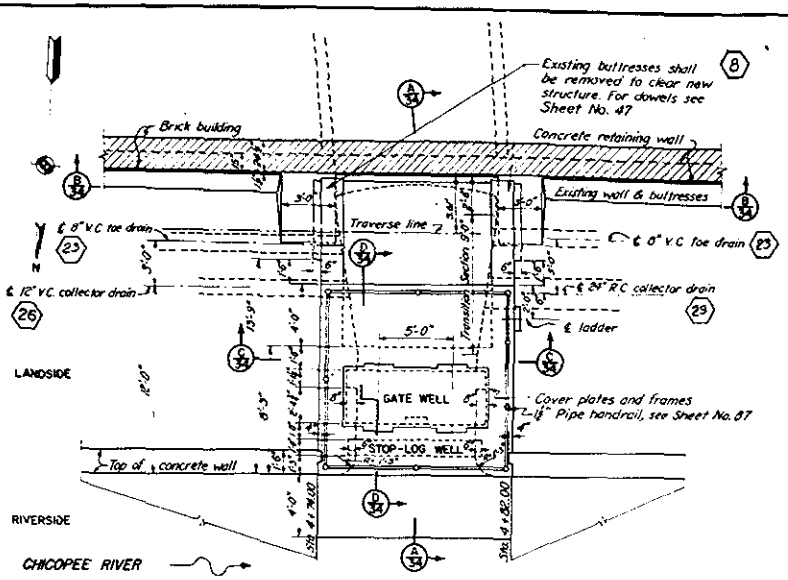
PLATE NO. 28

C.3b

36

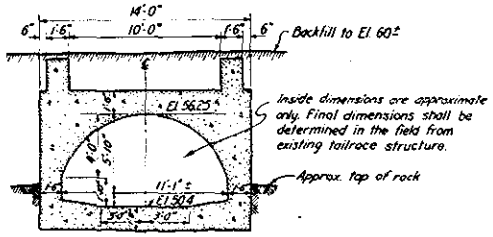
WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



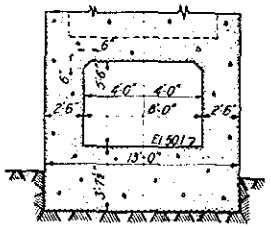
PLAN

SCALE ¼" = 1'-0"



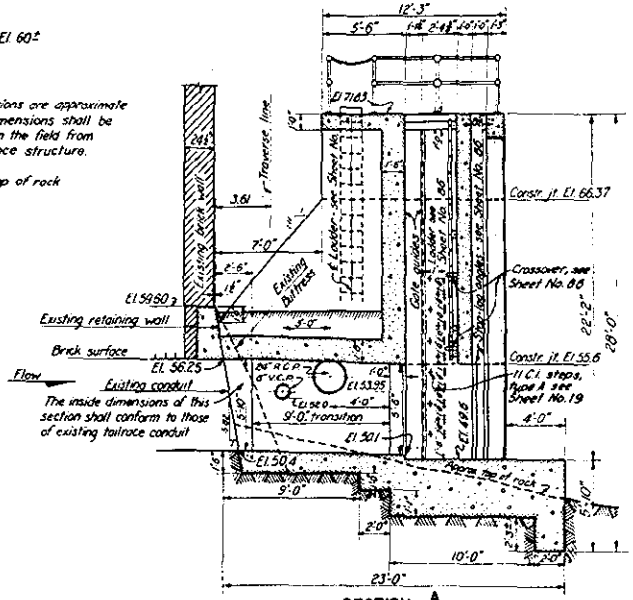
SECTION B/34

SCALE ¼" = 1'-0"



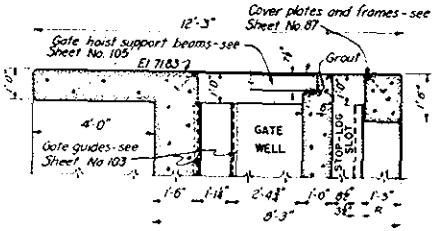
SECTION C/34

SCALE ¼" = 1'-0"



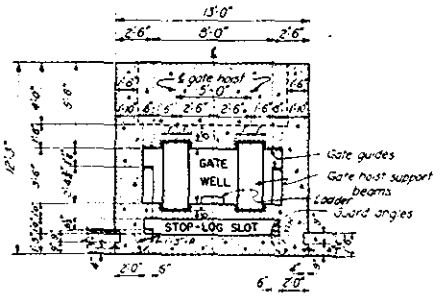
SECTION A/34

SCALE ¼" = 1'-0"



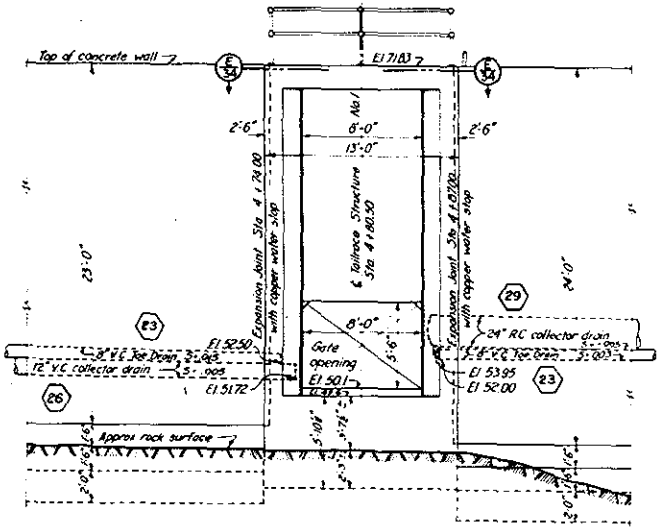
SECTION D/34

SCALE ½" = 1'-0"



SECTION E/34

SCALE ¼" = 1'-0"



ELEVATION

SCALE ¼" = 1'-0"

NOTES

Elevations refer to Mean Sea Level Datum.

Exposed corners of concrete shall be chamfered as directed by the contracting officer.

All concrete on this sheet shall be paid class "A" and will be paid for under Item No. 43.

Numbers in hexagons indicate items under which payment will be made.

KEY	DATE	REVISION indicated by Δ	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

TAILRACE NO. 1

GATE STRUCTURE DETAILS

CONNECTICUT RIVER — CHICOPEE, MASS.

IN SHEETS — SCALE 1/4 IN = 1 FT — SHEET NO. 34

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

SUBMITTED — APPROVAL RECOMMENDED — APPROVED

DESIGNED — DRAWN — TRACED — CHECKED

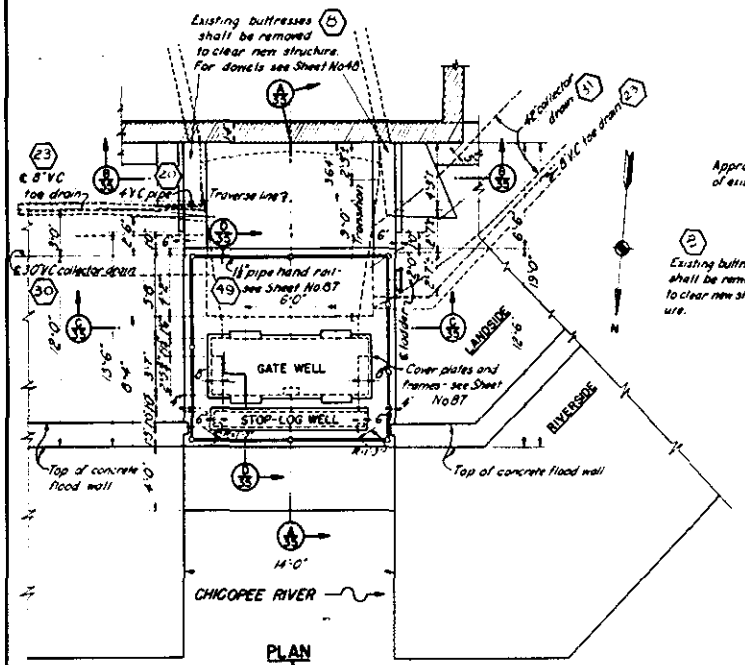
FISCAL YEAR 1940

FILE NO. CT-4-2347

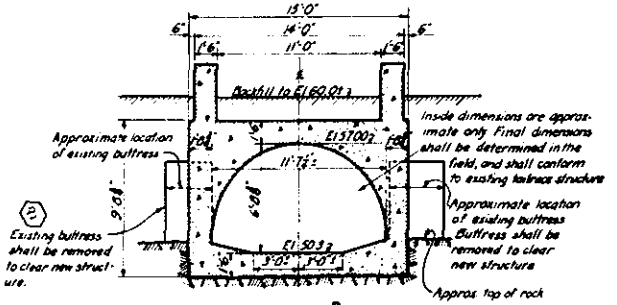
PLATE NO. 29

C. 3b

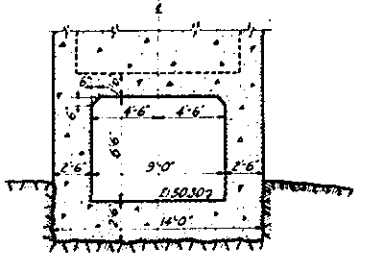
34



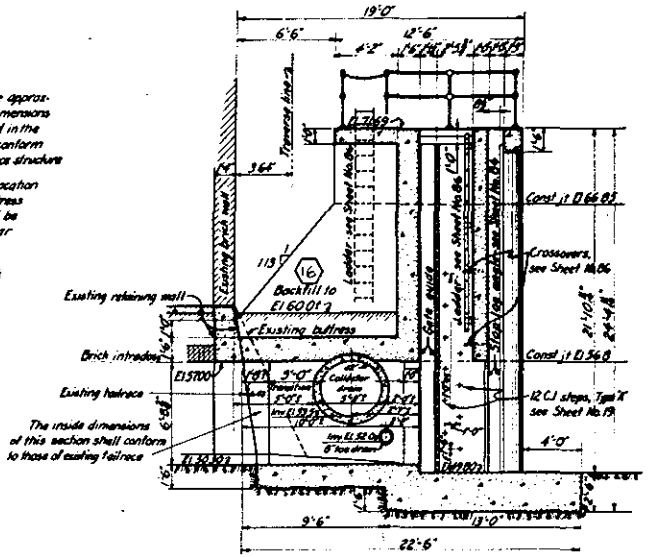
PLAN
SCALE 1/4" = 1'-0"



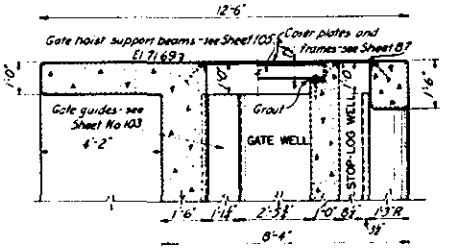
SECTION B/35
SCALE 1/4" = 1'-0"



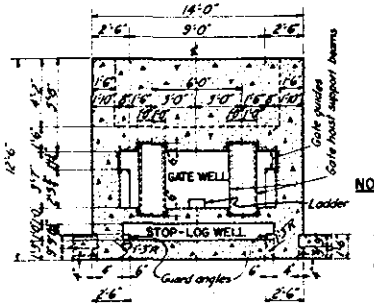
SECTION C/35
SCALE 1/4" = 1'-0"



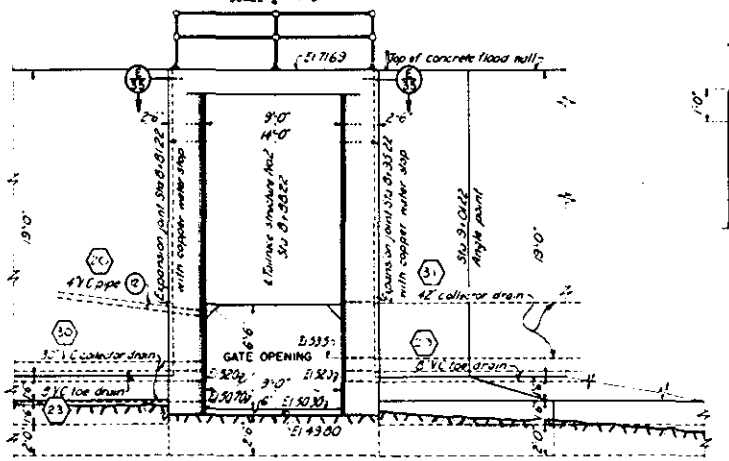
SECTION A/35
SCALE 1/4" = 1'-0"



SECTION D/35
SCALE 1/4" = 1'-0"



SECTION E/35
SCALE 1/4" = 1'-0"



RIVERSIDE ELEVATION
SCALE 1/4" = 1'-0"

NOTES

Elevations refer to Mean Sea Level Datum
Concrete shall be Class "A", and will be paid for under Item No 43
All exposed corners shall be chamfered as directed by the Contracting Officer
For plan and profile of dike see Sheet No. 11
For drainage profile see Sheet No 16
For miscellaneous steel details see Sheet Nos 86 & 87
For gate and hoist see Sheet No. 100.
For steel reinforcement see Sheet No. 48
Numbers in hexagon indicate items under which payment will be made

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

TAILRACE NO. 2

GATE STRUCTURE DETAILS

CONNECTICUT RIVER — CHICOPEE MASS.

IN SHEETS — SCALE 1/4" = 1 FT. — SHEET NO. 35

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

SUBMITTED: Chief, Design Section — RECOMMENDED: Chief, Design Branch — APPROVED: Chief, Engineering Div.

DESIGNED: Asst. Engineer — DRAWN: R.G.T. — TRACED: H.E.L. — CHECKED: C.S.P.

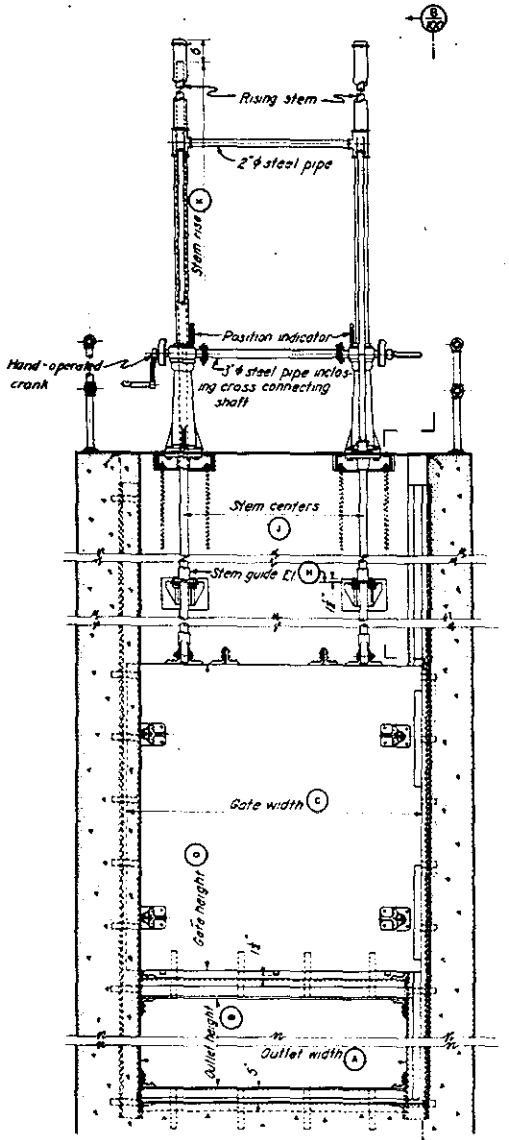
FISCAL YEAR 1940 — FILE NO. CT-4-2348

PLATE NO. 30

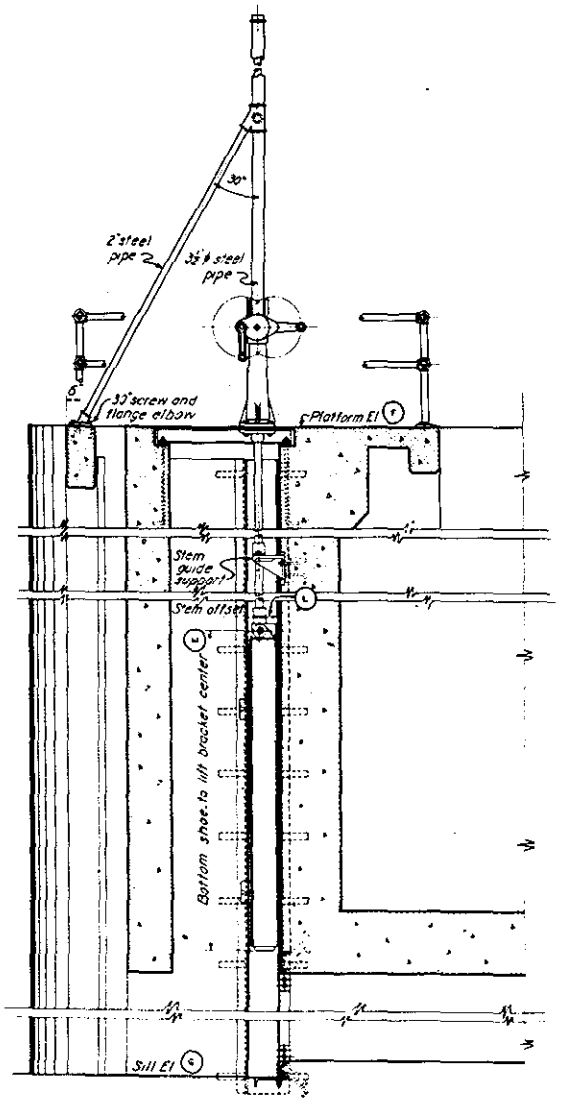
WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

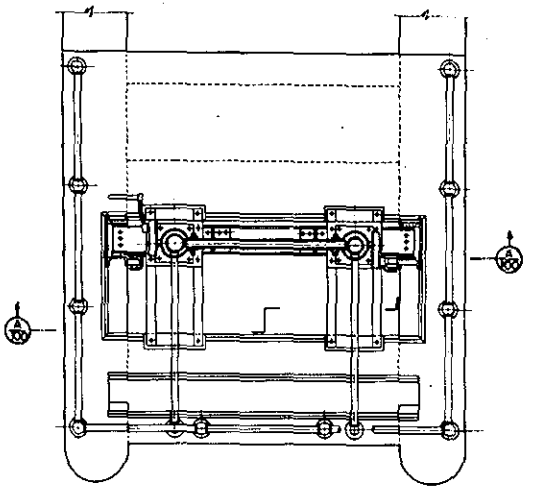
GATE DIMENSIONS, TAILRACES NO 1 & NO 2													
OUTLET			GATE				ELEVATION			STEM			
TAILRACE	WIDTH	HEIGHT	REQD	WIDTH	HEIGHT	GROSS	TOP	SILL	GUIDE	CTRS.	RISE	OFFSET	
	A	B		C	D	E	F	G	H	J	K	L	
NO. 1	8'-0"	5'-6"	1	9'-0"	6'-3"	6'-7½"	71.83	50.7	64.61	5'-0"	6'-0"	7¼"	
NO. 2	9'-0"	6'-6"	1	10'-0"	7'-3"	7'-7½"	71.69	49.8	65.75	6'-0"	7'-0"	7½"	



SECTION A/100



SECTION B/100



PLAN

FLOOR PLATES REMOVED

NOTES

Furnishing and installing flood gates and gate guides will be paid for under Item No. 52

Furnishing and installing gate hoist complete with stem, stem guide, stem housing bracing and hoist supports will be paid for under Item No. 53

KEY	DATE	REVISION - Indicated by Δ	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

GENERAL ARRANGEMENT OF GATE HOISTS

CONNECTICUT RIVER — CHICOPEE MASS

IN 105 SHEETS — SCALE: 1/2 IN = 1 FT — SHEET NO. 100

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

SUBMITTED — APPROVAL RECOMMENDED — APPROVED

DESIGNED — DRAWN — TRACED — CHECKED

FISCAL YEAR 1940

FILE NO. CT-4-2413

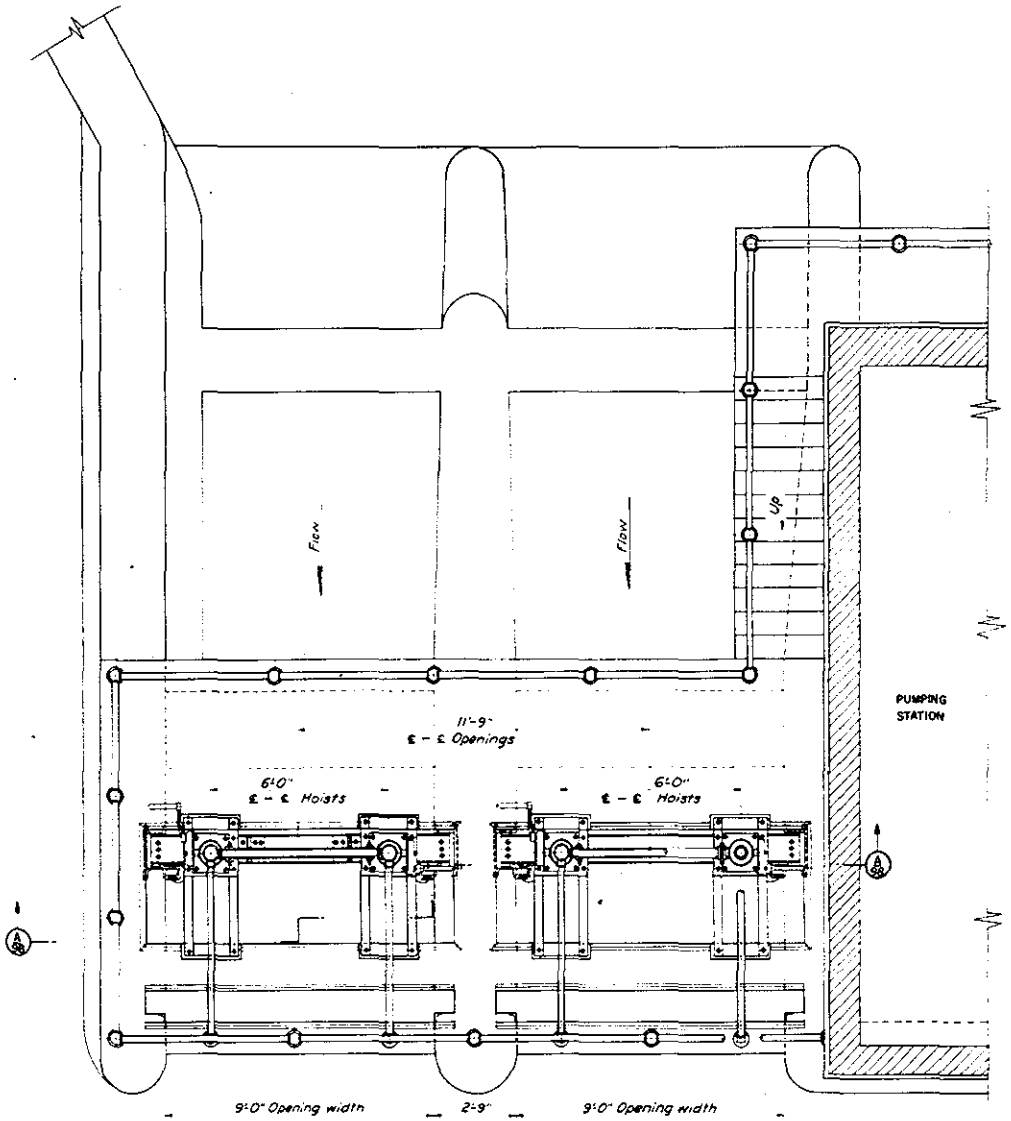
C.3b

100

PLATE NO. 31

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



PLAN

FLOOR PLATES REMOVED

NOTES

Furnishing and installing flood gates and gate guides will be paid for under Item No. 52

Furnishing and installing gate hoist complete with stem, stem guide, stem housing bracing and hoist supports will be paid for under Item No. 53

KEY	DATE	REVISION: Indicated by Δ	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

GATE HOISTS AT TAILRACE STRUCTURE

ARRANGEMENT NO 1

CONNECTICUT RIVER CHICOPEE, MASS.

IN 105 SHEETS SCALE 1/2 IN = 1 FT SHEET NO 97

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., MAY 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: [signature] — DRAWN NO.: TRACED R.L.S. CHECKED: [signature] — FISCAL YEAR 1940 FILE NO. CT-4-2410

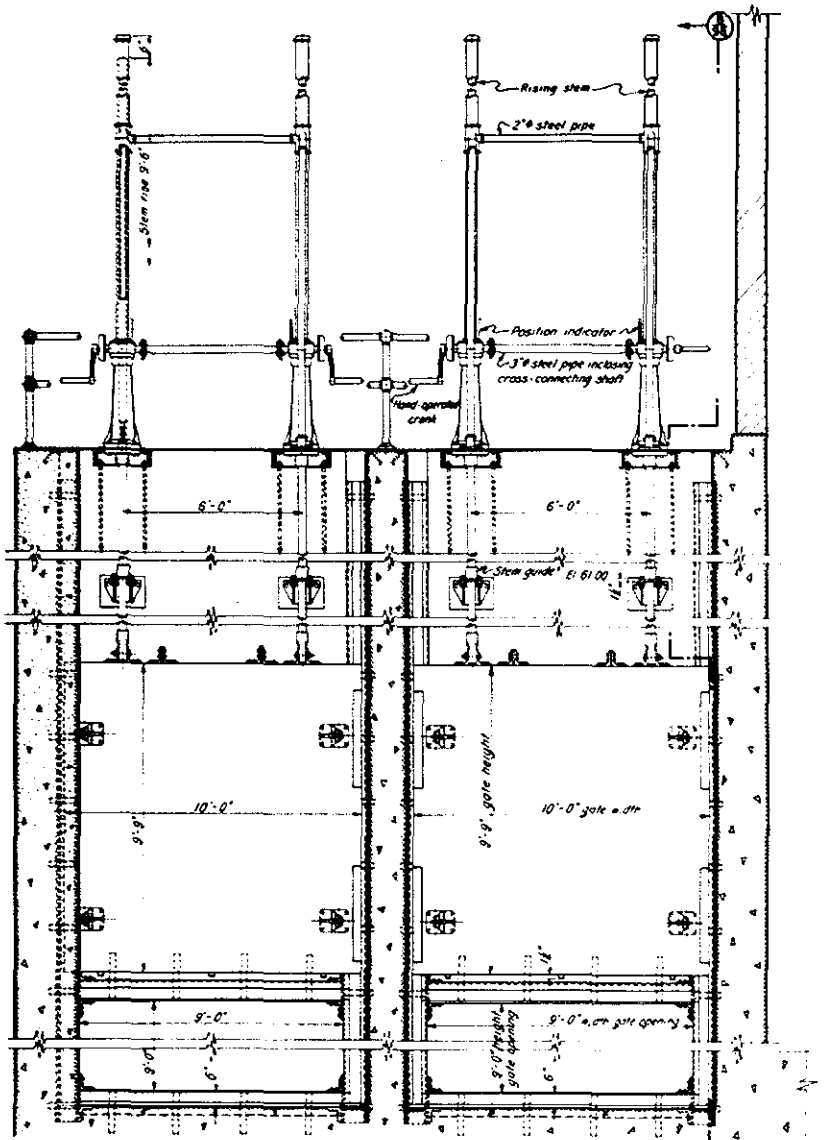
C.3b

97

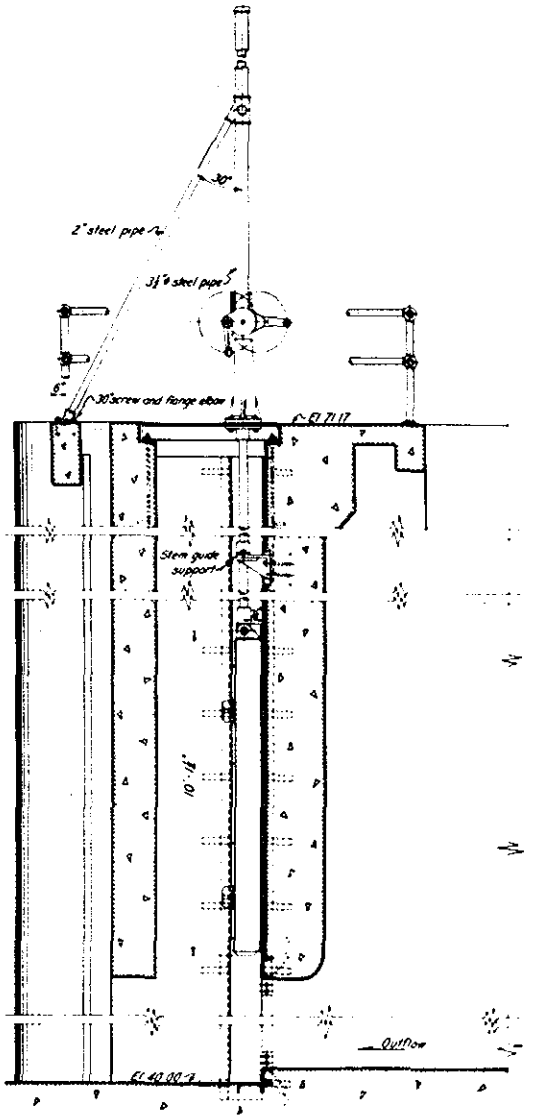
PLATE NO. 32

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



SECTION A/97
TWO GATES REQUIRED



SECTION B/98

NOTES

Furnishing and installing flood gates and gate guides will be paid for under Item No 52.

Furnishing and installing gate hoist complete with stem stem guide, stem housing, bracing and hoist supports will be paid for under Item No 51.

KEY	DATE	REVISION - Indicated by Δ	REV BY	CK. BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

GATE HOISTS AT TAILRACE STRUCTURE
ARRANGEMENT NO. 2

CONNECTICUT RIVER — CHICOPEE, MASS

IN 105 SHEETS — SCALE 1/2 IN = 1 FT — SHEET NO 98

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

SUBMITTED — APPROVAL RECOMMENDED — APPROVED

FISCAL YEAR 1940

FILE NO CT-4-2411

C 3b

98

PLATE NO. 33

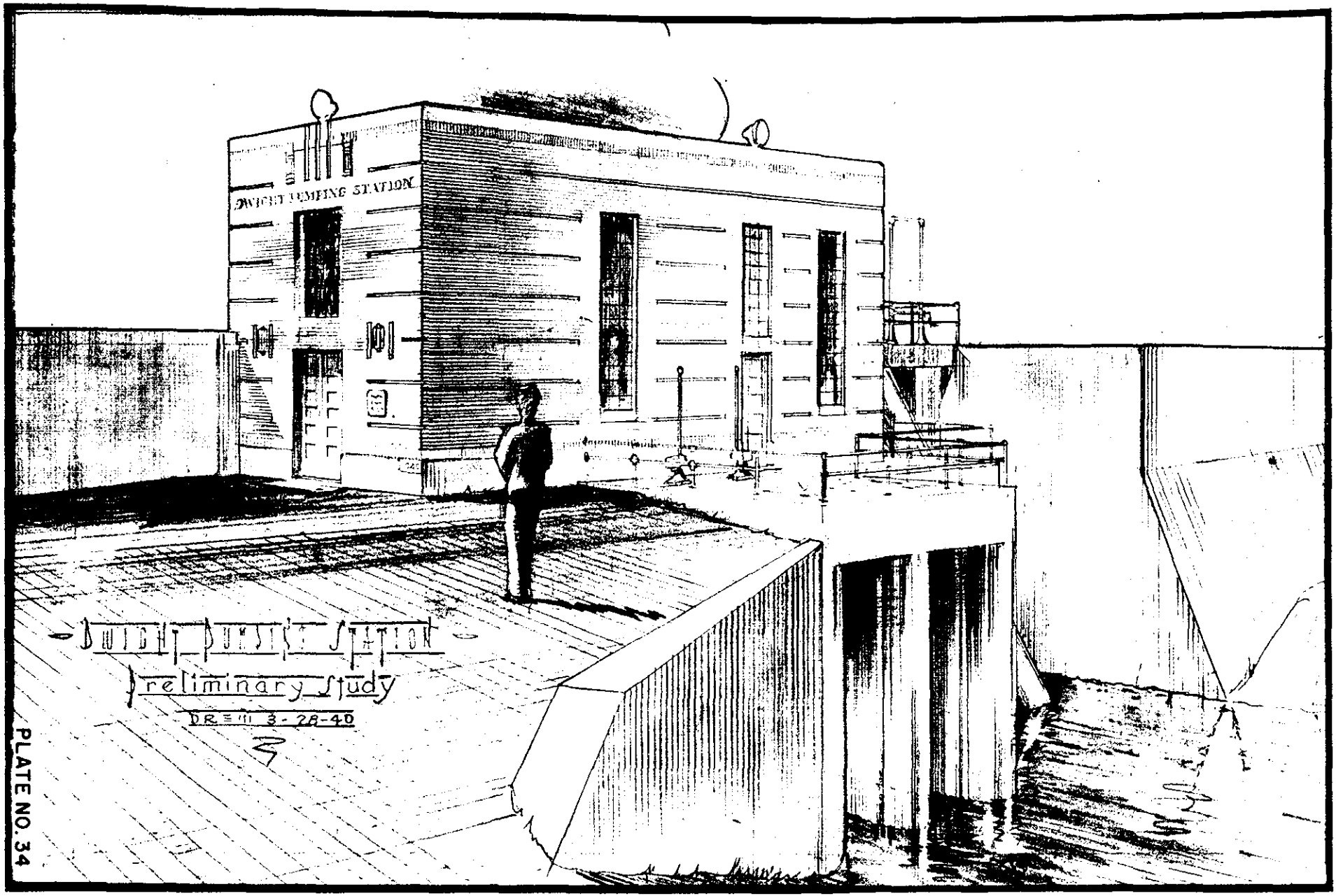
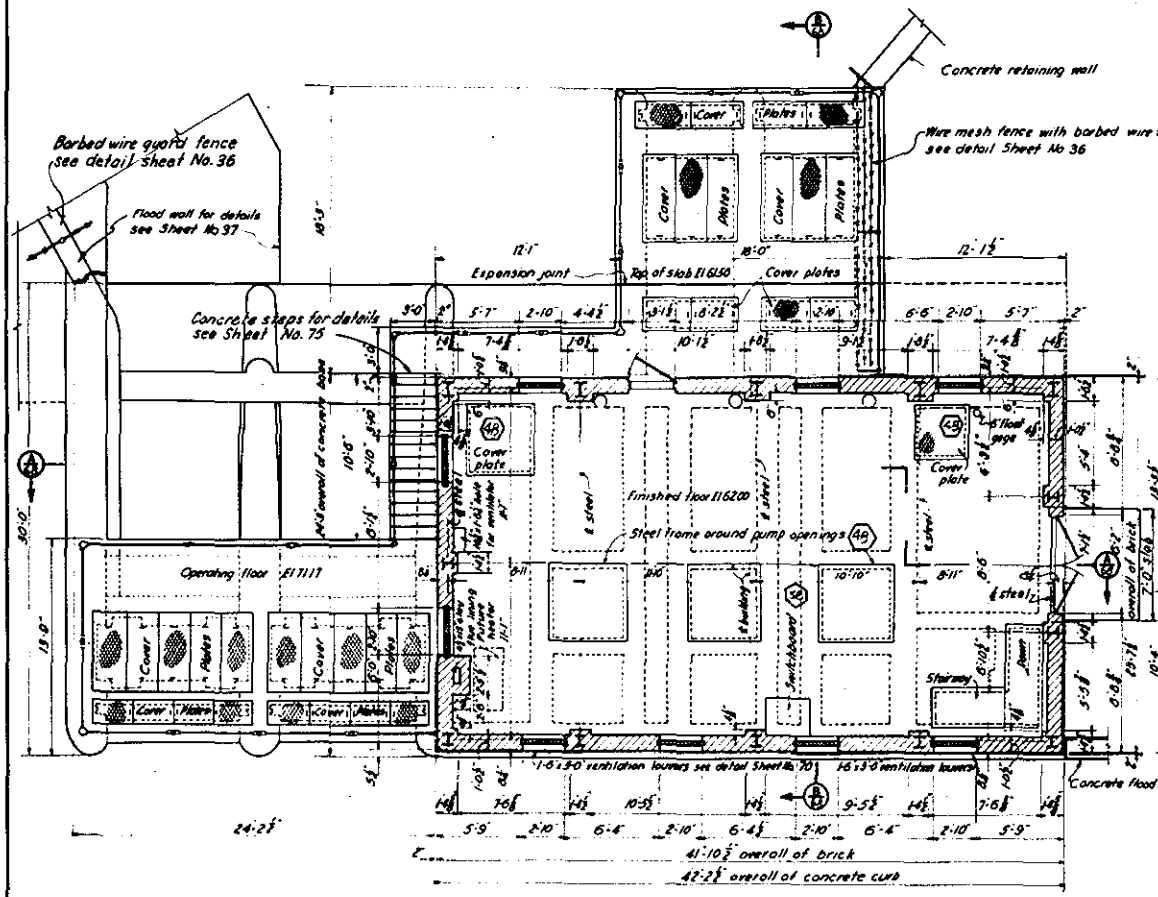
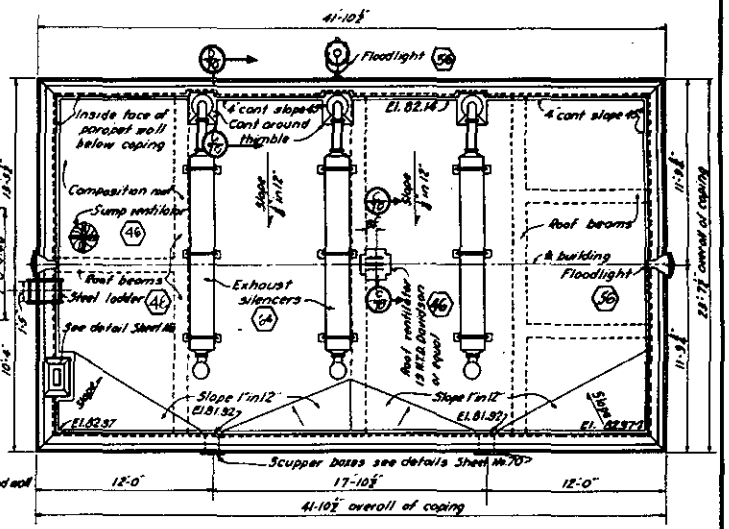

DWIGHT PUMPING STATION
DWIGHT PUMPING STATION
Preliminary Study
DR. 3-28-40

PLATE NO. 34



ENGINEER ROOM FLOOR PLAN

SCALE 1/4" = 1'-0"



ROOF PLAN

SCALE 1/4" = 1'-0"

NOTES:

North and west walls are sectioned above top elevation of flood wall.
South and east walls are sectioned below top elevation of flood wall.

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

CONNECTICUT RIVER FLOOD CONTROL

DIKE - SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

PLANS

ARCHITECTURAL

CONNECTICUT RIVER — CHICOPEE, MASS.

IN 105 SHEETS — SCALE 1/4 IN = 1 FT — SHEET NO. 65

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

SUBMITTED: Robert B. Miller, Senior Engineer, Head, Design Section — APPROVAL RECOMMENDED: Chief, Design Section — APPROVED: Chief, Dist. F.S. Engineering Div. — Chief, Dist. Engineer

DESIGNED: — DRAWN: M.A.R. — TRACED: R.A.N. — CHECKED: H.C.P.

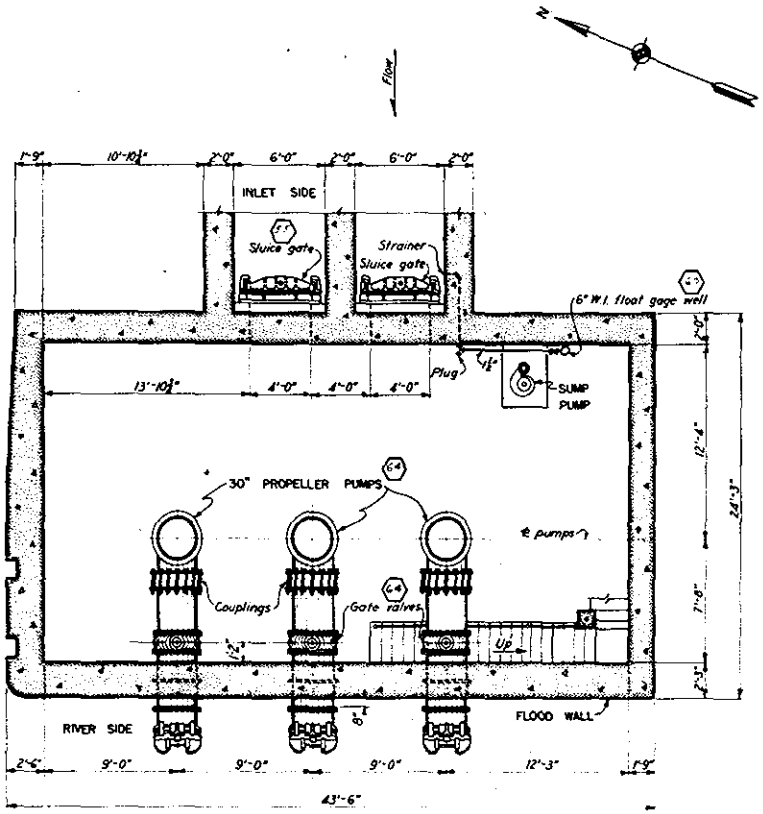
FISCAL YEAR 1940

FILE NO. CT-6-2378

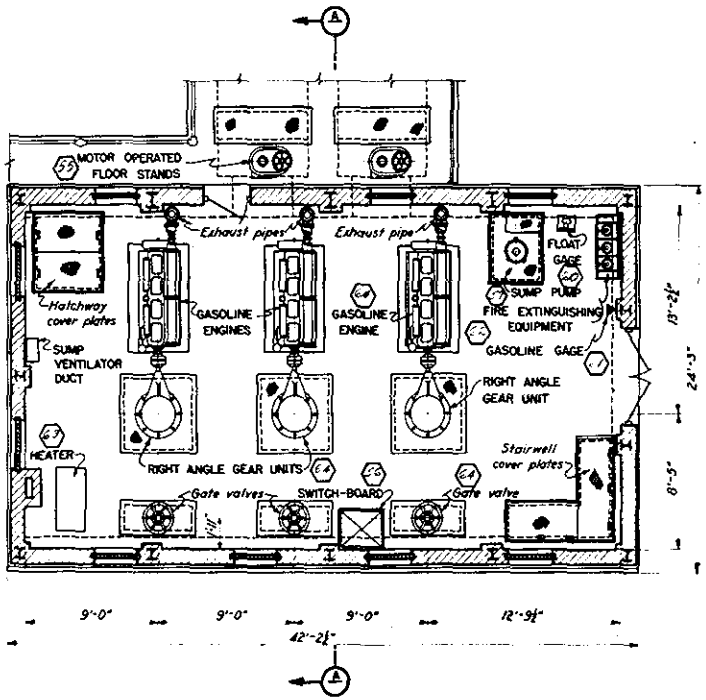
C.3b

65

PLATE NO. 35



PUMP ROOM PLAN



ENGINE ROOM PLAN

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

GENERAL ARRANGEMENT OF EQUIPMENT NO. 1

CONNECTICUT RIVER — CHICOPEE MASS

IN 105 SHEETS — SCALE 1/4 IN = 1 FT — SHEET NO 88

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

FISCAL YEAR 1940

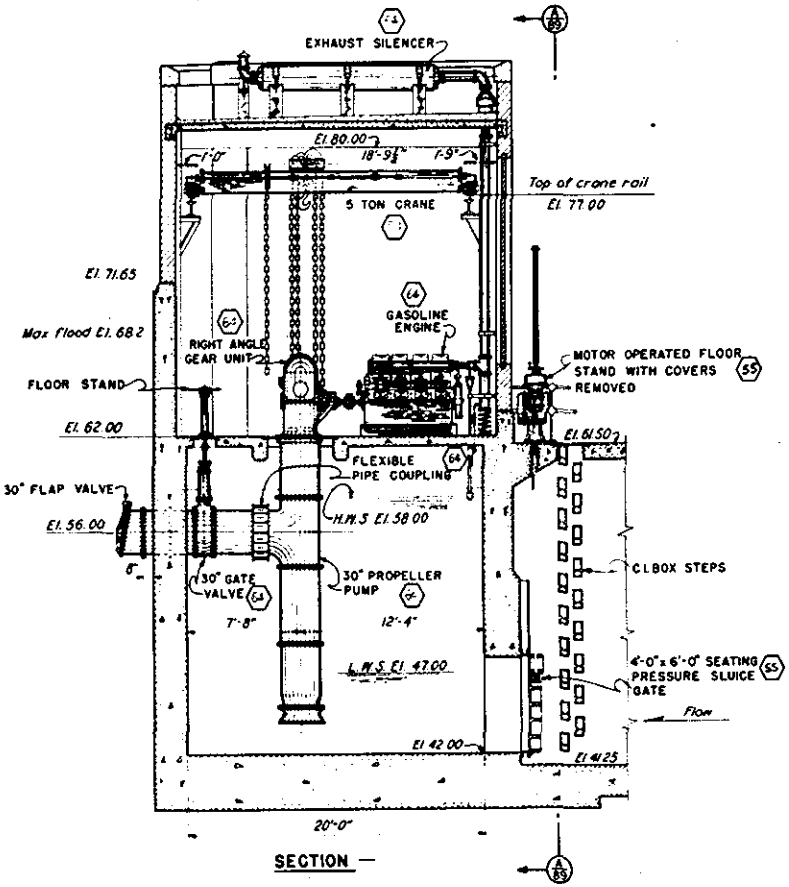
FILE NO. CT-4-2401

KEY	DATE	REVISION Indicated by △	REV BY	CK BY	AP BY

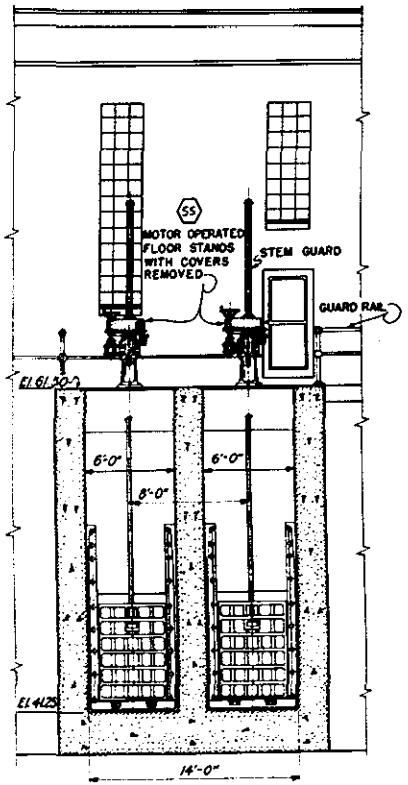
C.3b

88

PLATE NO. 36



SECTION —



SECTION A/55

CONNECTICUT RIVER FLOOD CONTROL

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

GENERAL ARRANGEMENT OF EQUIPMENT NO. 2

CONNECTICUT RIVER — CHICOPEE, MASS.

IN 105 SHEETS — SCALE: 1/4 IN = 1 FT — SHEET NO. 89

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

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

FISCAL YEAR 1940

FILE NO. CT-4-2402

C.3b

89

PLATE NO. 37

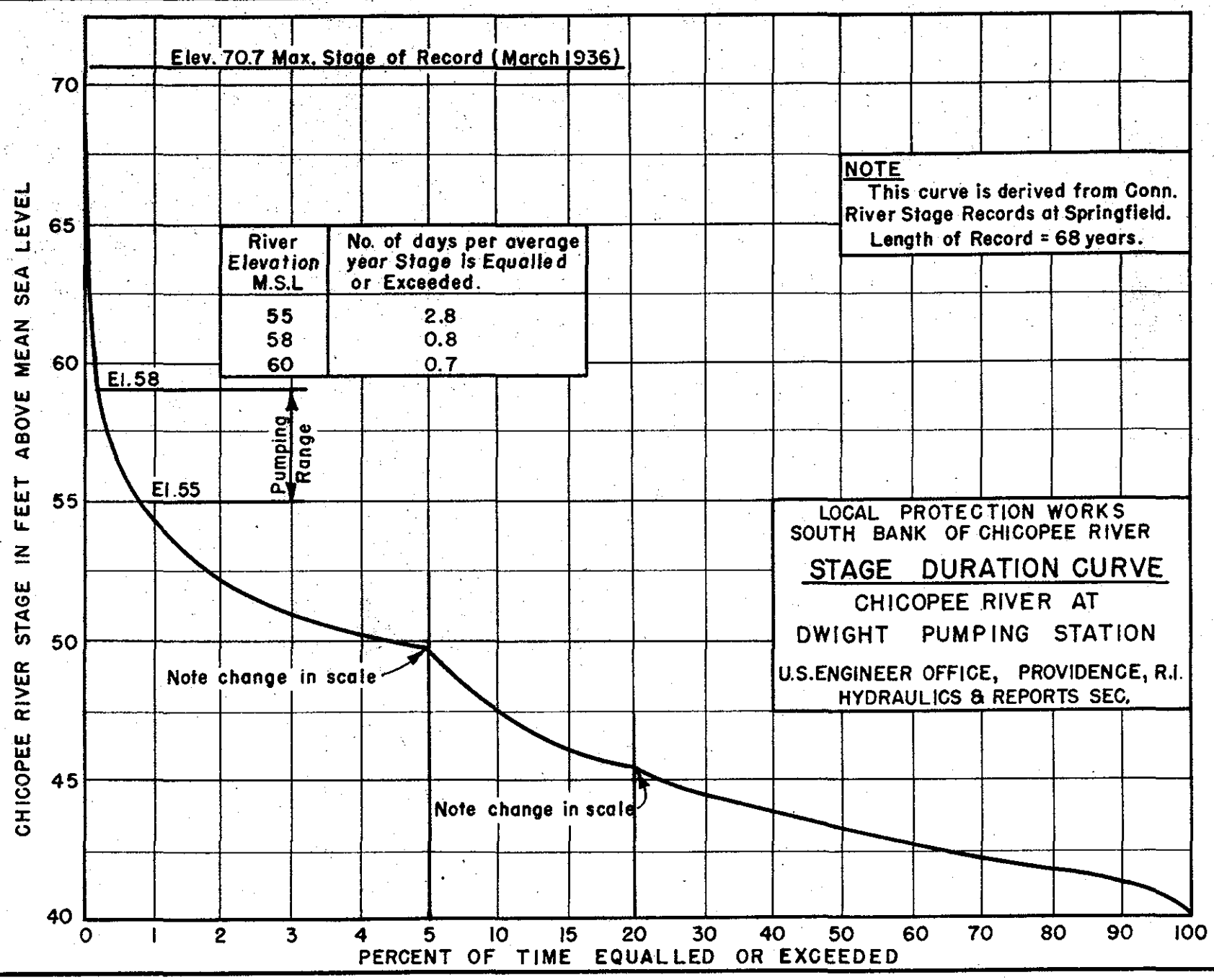
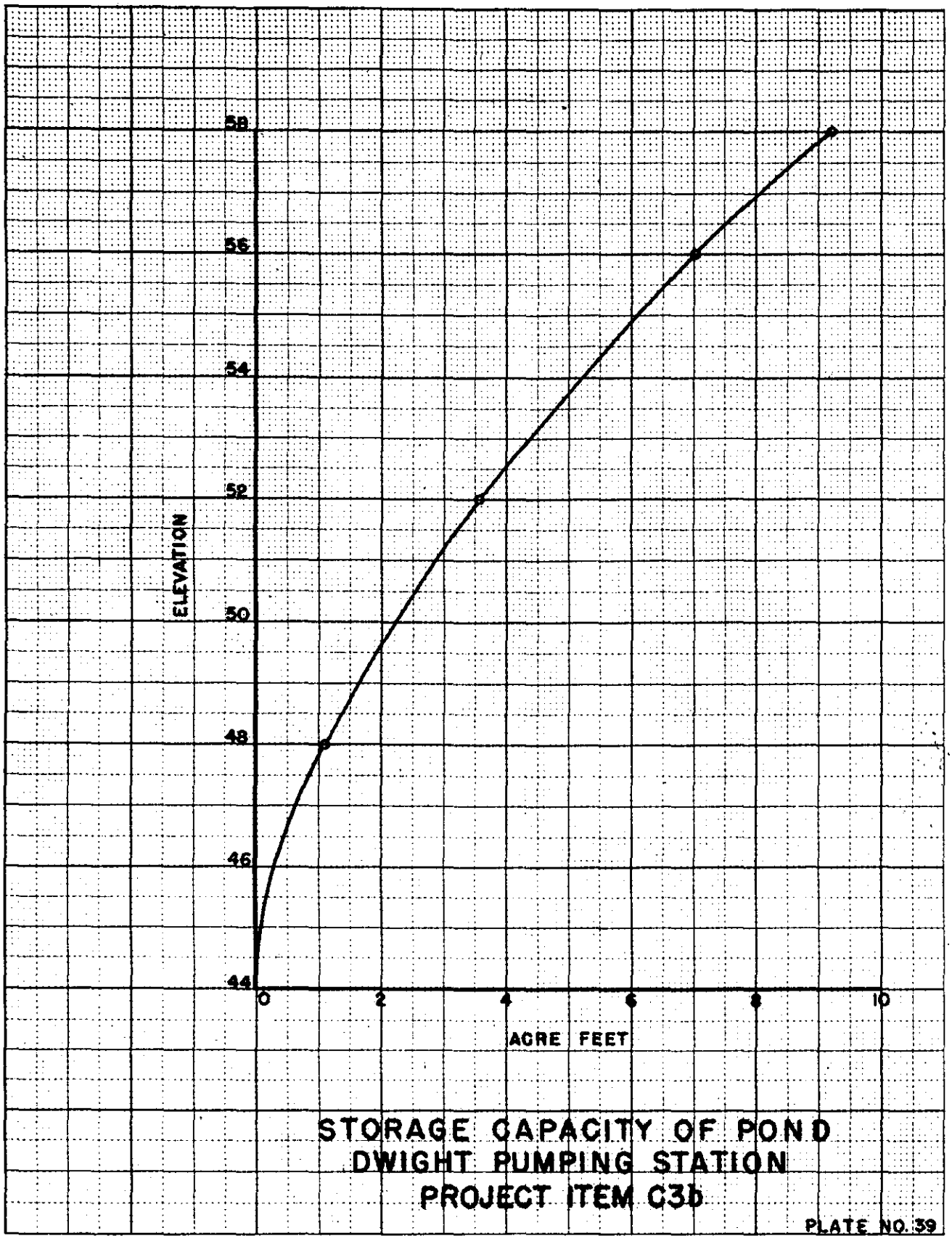

Elev. 70.7 Max. Stage of Record (March 1936)
NOTE
This curve is derived from Conn. River Stage Records at Springfield.
Length of Record = 68 years.
River Elevation M.S.L
No. of days per average year Stage is Equalled or Exceeded.
55 2.8
58 0.8
60 0.7
El. 58
El. 55
Pumping Range
Note change in scale
Note change in scale
LOCAL PROTECTION WORKS
SOUTH BANK OF CHICOPEE RIVER
STAGE DURATION CURVE
CHICOPEE RIVER AT
DWIGHT PUMPING STATION
U.S. ENGINEER OFFICE, PROVIDENCE, R.I.
HYDRAULICS & REPORTS SEC.
CHICOPEE RIVER STAGE IN FEET ABOVE MEAN SEA LEVEL
70
65
60
55
50
45
40
0 1 2 3 4 5 10 15 20 30 40 50 60 70 80 90 100
PERCENT OF TIME EQUALLED OR EXCEEDED

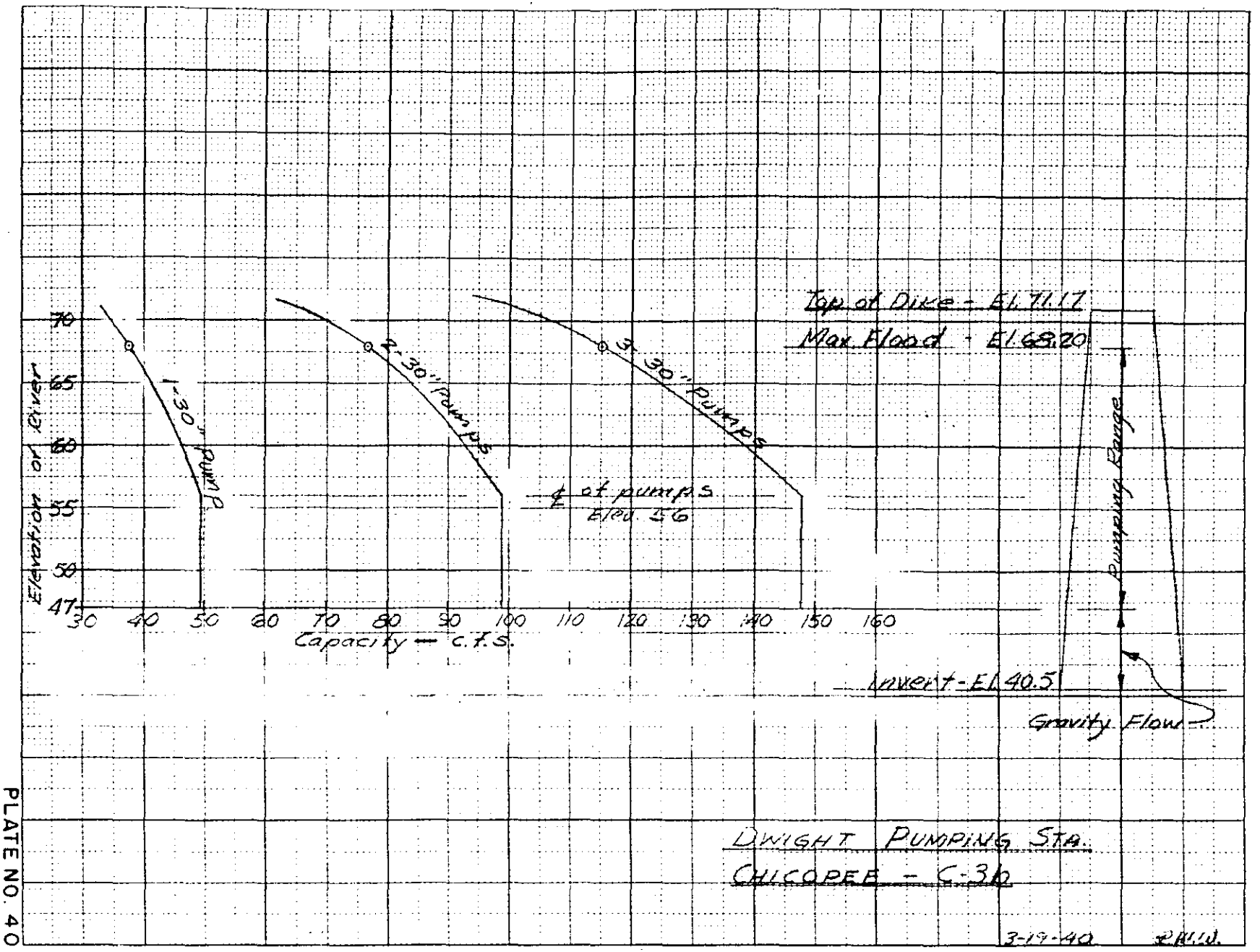
PLATE NO. 38



STORAGE CAPACITY OF POND
DWIGHT PUMPING STATION
PROJECT ITEM C3b

PLATE NO. 39

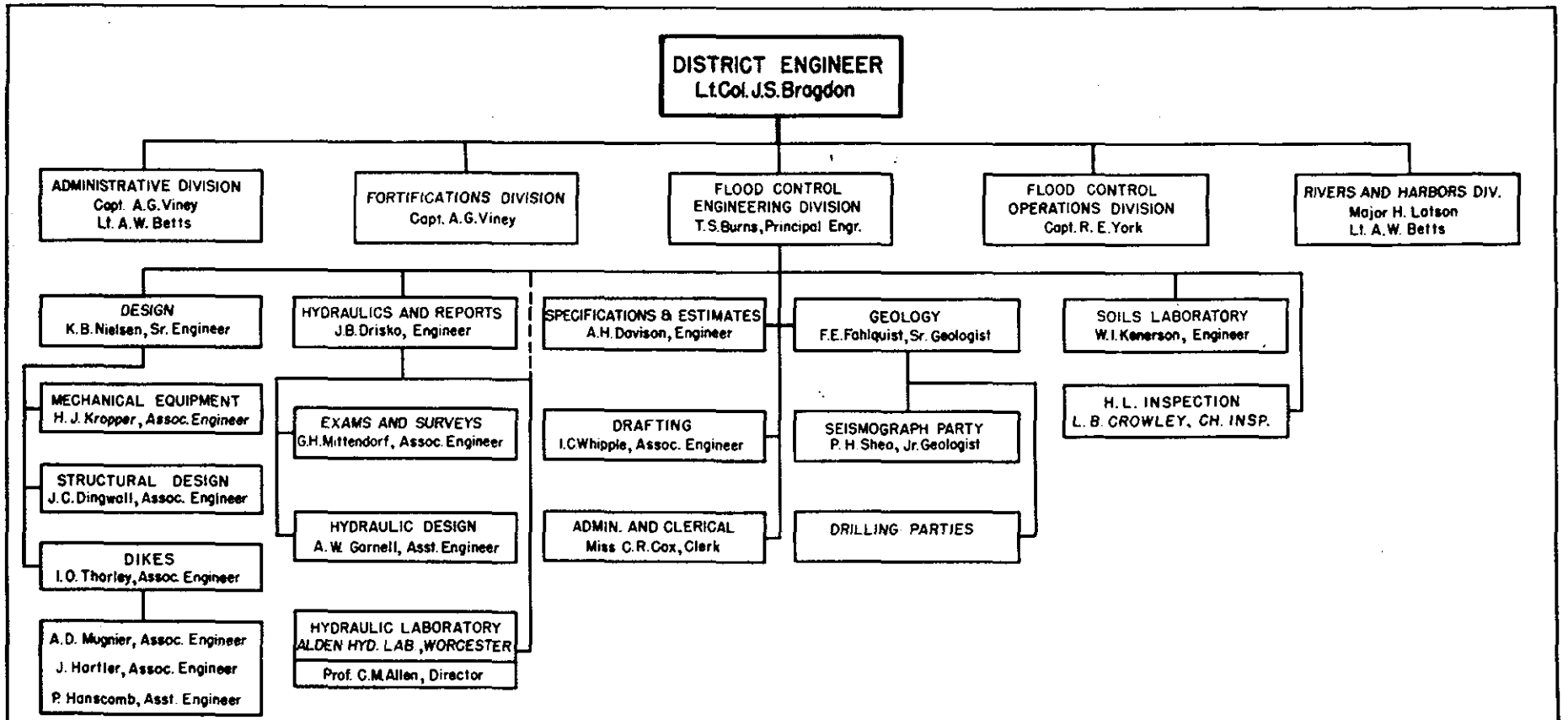
PRINTED IN U.S.A.
EUGENE DIETZGEN CO. NO. 346 B



DWIGHT PUMPING STA.
CHICOPEE - C-310

3-19-40 R.H.J.

PLATE NO. 40



ORGANIZATION CHART

FLOOD CONTROL

ENGINEERING DIVISION

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

MAY 1940

PLATE NO. 41

CONNECTICUT RIVER FLOOD CONTROL PROJECT

CHICOPEE, MASS.

CONNECTICUT RIVER, MASSACHUSETTS

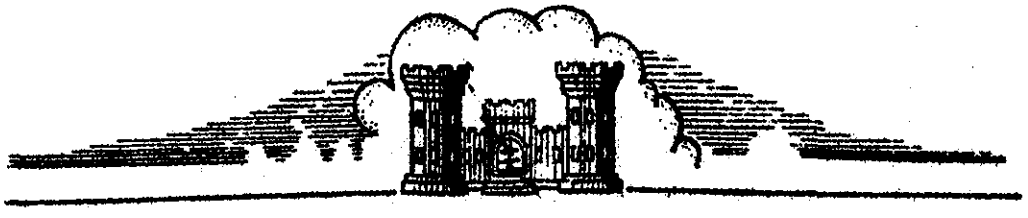
ANALYSIS OF DESIGN

FOR

DIKE-SOUTH BANK CHICOPEE RIVER AND DWIGHT PUMPING STATION

ITEM C.3b - CONTRACT

APPENDIX A



MAY, 1940

CORPS OF ENGINEERS, U.S. ARMY

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

CHICOPEE - ITEM C3b

APPENDIX "A"

STRUCTURAL DESIGN

APPENDIX "A" STRUCTURAL DESIGN

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APPENDIX "A" STRUCTURAL DESIGN

A. GENERAL INFORMATION

1. Location, head and loading. - The reinforced concrete flood walls will extend between the following stations: - Sta. 2+62 to the East side Memorial Highway bridge approach (Sta. 11+46 ±); the west side of the Memorial Highway bridge approach (Sta. 12+05 ±) to outlet structure (Sta. 20+19 ±); south side of the Dwight pumping station (Sta. 21+15 ±) to the dike (Sta. 24+27 ±); from the dike (Sta. 29+18 ±) to the Boston and Maine Railroad embankment (Sta. 31+79 ±) and from Station 40+00 ± to Sta. 42+51 ± near Depot Street and the power intake canal.

Tailrace No. 1 gate structure is at Sta. 4+80 ±; tailrace No. 2 gate structure is at Sta. 8+88 ±; the outlet structure is between stations 20+19 ± and 20+49 ±; the Dwight pumping station is between stations 20+49 ± and 21+15 ±, and the Depot Street stop-log structure is between stations 41+91 ± and 42+27 ±.

The structures are designed to resist a principal load coming from the assumed head of water taken to the top of the walls which is greater than the design flood stage, which is 3 feet below the top of the walls. This design head is in accordance with instructions from the Office of the Chief of Engineers. The walls vary in height from 6'-0" to 30'-8".

2. Type of wall. - The "T" type cantilever wall was selected as being the most economical for the height of wall needed under the

existing conditions. Concrete facing walls were used at locations of existing ramps.

3. Tailrace gate structures. - The concrete tailrace structures were designed to resist a load coming from a head of water, equivalent to that used in the design of the walls. The structures were investigated for stability for two conditions of loading; one with the river at flood stage and one with the river down. The conduit portions of the structures were designed as rigid boxes loaded with maximum pressures obtainable.

4. Pumping station. - In the following design analysis, the outlet structure is considered an integral part of the Dwight pumping station.

The pumping station will be a flat-roofed, brick and glass block structure 24 feet by 42 feet overall. The 12.5-inch brick walls, capped with a cast stone coping, extend above the roof slab to form a parapet wall around the entire roof. The roof system consists of steel beams encased in concrete and supported by steel columns. The roof slab will be 5.5 inches thick, covered with a cinder concrete fill. There are no outside pilasters. Inside the building there are pilasters at the chimney and at each structural steel column, the pilasters forming fire-proof column encasements. The engine room floor will be a 7-1/2 inch structural concrete slab, with a monolithic finish. A hand-operated traveling crane of 5 tons lifting capacity will operate for the full length of the building. The structural steel framing and the roof slab for the Dwight pumping station were determined by comparison with similar layouts for the Northampton and Paderewski Pumping Stations. No computations will appear in this analysis for the same.

B. GENERAL DESIGN DATA

1. General. - The structural design of the structures has been executed in accordance with standard practice. The specifications which follow cover the conditions affecting the design of the reinforced concrete and structural steel.

2. Unit weights. - The following unit weights for material were assumed in the design of the structure:

Water	62.5# per cubic foot
Dry earth	100 # " " "
Saturated earth	125 # " " "
Concrete	150 # " " "

3. Earth pressures. - In computing active earth pressures, equivalent fluid pressures computed by the use of Rankine's formula were used. They are as follows:-

Equivalent liquid pressure of dry earth = 35 pounds per cubic foot.

Equivalent liquid pressure for saturated earth = 80 pounds per cubic foot.

In computing passive resistances, Rankine's formula was used with the coefficient of internal friction = 35 degrees.

4. Hydrostatic uplift. -

a. Riverside of sheet piling

Full head due to headwater.

b. Landside of sheet piling

(1) At landward toe, full head due to tailwater.

(2) At sheet piling, full head due to tailwater plus one-half the difference between headwater and tailwater.

(3) At intermediate points, the uplift was assumed to vary uniformly with the distance from the toe.

(4) Walls on rock, the hydrostatic uplift shall vary from 50 percent headwater at the riverside toe of the base to 50 percent tailwater at the landside toe of the base.

5. Overturning. - The resultant of all external loads, including hydrostatic uplift and excluding base pressure, does not fall within the middle third under every condition but under no condition is the allowable bearing value of the soil exceeded.

6. Sliding. - In general, the total horizontal forces due to external loads shall not exceed the resistance available from friction and passive resistance. The coefficient of friction used is 0.50. At the pumping station and wing walls, steel Z piling was driven behind the base to supplement the frictional resistance of the soil.

7. Bearing. - The total bearing pressure, equal to the sum of hydrostatic pressure plus the remaining effective base pressure, shall in no case exceed the maximum allowable soil pressure.

8. Frost cover. - All footing bases shall lie at least 4 feet beneath the ground surface to avoid heaving by frost action.

9. Path of percolation. - Except where the steel sheet piling is either driven to rock or extended a minimum distance of 3 feet into an underlying stratum of impervious clay, the minimum path of percolation shall be four times the head of water.

10. Structural steel. - The design of structural steel was carried out in accordance with the Standard Specifications for Steel Construction for Buildings of the American Institute of Steel Construction.

11. Reinforced concrete. - In general, all reinforced concrete was designed in accordance with the "Joint Committee on Standard Specifications for Concrete and Reinforced Concrete" issued in January 1937, and with the "Joint Code of the American Concrete Institute and the Reinforcing Steel Institute for the Design of Concrete and Reinforced Concrete" issued in 1928.

a. Allowable working stress. - The allowable working stress in concrete used in the design is based on a compressive strength of 3,000 pounds per square inch in 28 days.

	Lbs. per sq. in.
b. Flexure (f_c). -	
Extreme fibre stress in compression	800
c. Shear (v). -	
Beams with no web reinforcement and without special anchorage	60
Beams with no web reinforcement but with special anchorage of longitudinal steel	90
Beams with properly designed web reinforcement but without special anchorage of longitudinal steel	180
Beams with properly designed web reinforcement and with special anchorage of longitudinal steel	270
d. Bond (u). -	
In beams, slabs, and one way footings	150
Where special anchorage is provided	300
The above stresses are for deformed bars.	
e. Bearing (f_c). -	
Where a concrete member has an area at least twice the area in bearing	500

f. Axial compression (f_c). - Lbs. per sq. in.

Columns with lateral ties 450

g. Steel stresses. -

Tension 18000

Web reinforcement 16000

h. Protective concrete covering. -

Type of members	Minimum cover in inches
Interior slabs	1-1/2
Interior beams	2
Members poured directly against the ground	4
Members exposed to earth or water but poured against forms	3

For secondary steel, such as temperature and spacer steel, the above minimum cover may be decreased by the diameter of the temperature or spacer steel rods.

C. BASIC ASSUMPTIONS FOR DESIGN. -

1. Pumping station and tailrace gate structures. -

a. Stability. - The stability of the pumping station and gate structures as a unit was investigated for the worse condition of loading, namely, with the river at flood stage and also with the river at low stage. In all conditions of loading, the base pressures were held below the allowable.

b. Roof slab of pumping station. - The roof slab is of reinforced concrete. It is designed to carry the full dead load plus a live load of 40# per square foot of roof surface.

c. Roof beams. - The roof beams are of structural steel encased in concrete fireproofing. They are designed to carry the full

dead load, plus the full live load of 40# per square foot of roof surface. In addition to taking up the roof load, these beams, together with the columns to which they are connected, form portal frames which take up wind load and crane thrusts on the building. The end connections are designed to take up all such horizontal loads.

d. Columns. - Structural steel columns in the side walls and end walls of the superstructure take up the direct roof loads as well as all wind loads on the sides of the superstructure. In addition, the columns in the side walls carry crane brackets which support the crane runway. These columns are designed to carry full live and dead load from the roof; dead load, live load and impact effect from the traveling crane; bending due to eccentrically applied loads, and bending due to wind load on the building. No point of inflection was considered in the column design, a pin-ended condition at the base being assumed.

e. Engine room floor of pumping station. - The engine room floor is designed to carry all engines, motors, etc., actually to be placed on that floor, as well as a uniform load.

The following assumptions were made for design purposes:

(1) For the floor slab, the design loads are the estimated dead loads plus a uniform live load of 300# per square foot.

(2) For the removable steel floor plates, the design loads are the estimated dead load plus a uniform load of 300# per square foot.

(3) For the floor beams, the design loads are the estimated dead loads, the actual machinery loads, a concrete base slab load under the gasoline engine and right angle gear units, and a uniform

load of 250# per square foot on the unoccupied portion of the floor slabs which contribute loads to the beams under consideration. For the machinery loads, an impact factor of 100 percent has been added.

f. Pump room side walls. -

(1) The station is so located that the building and its adjoining flood walls form a part of the flood protection dikes. The riverside wall was therefore designed of reinforced concrete to Elevation 71.17 and made a continuation of the concrete flood walls. Above Elevation 71.17 the riverside wall is of brick. The other three walls are of reinforced concrete to Elevation 63.55 and of brick and steel construction from thereon up.

(2) In designing the pump room side walls, careful account was taken of the effect of the thrust of the water against the building with the river at flood stage. This thrust against the riverside wall was assumed to be carried by the floor beams to the rear wall. The rear wall is stiffened by the intake buttresses and is properly reinforced to carry the thrust load down into the base. The large holes for the discharge pipes in the river wall tend to localize the stresses to the section of unbroken concrete between the pipe openings, so the reinforcement was designed to meet with this condition. To assure a fair degree of certainty as to the action of the structure it was decided to design it as a transverse rigid frame.

(3) The portion of the riverside wall extending from the engine room floor to high water at Elevation 71.17 was designed as a cantilever wall.

(4) The assumption was made that the side walls are simply supported at the engine room floor and fixed at the base.

(5) The loading consisted of the vertical loads due to the weight of the structure; the vertical live and impact loads from the engine room floor; the roof live load; and the thrusts against the walls from high water on the riverside and saturated earth pressures on the landside.

From the loadings noted, bending moments were computed in the walls, pump room floor slab and engine room floor beams.

g. Pump room end walls. - The pump room end walls were designed to resist earth pressure at the south end and hydrostatic pressure at the gate structure.

h. Intake structure. - The intake structure is constructed adjacent to but independent of the pumping station to eliminate the effect of hydrostatic loading from the pumping station. The intake structure is designed, as a double box section, for earth loading on one side and for its own dead weight.

i. Trash racks. - There are two trash racks located in the intake structure passages. Each rack consists of two sections supported on a structural steel frame anchored into the side walls of the intake passages. The trash racks are made of structural channel frame which support 4 x 3/8 inch round edge grating bars. These bars are spaced 3 inches in the clear and welded to the channel frame. The trash racks are designed on the assumption of stoppage of 50 percent of flow with the water level above the top of the racks.

j. Stairways and ladders. - A concrete stairway leads from the engine room floor to the wet sump room. A hatchway is provided in the engine room floor for removing machinery from the wet sump. A steel ladder is provided on the outside of the building for access to

the roof of the pumping station. Another concrete stairway on the outside of the building leads to the top of the outlet structure.

k. Conduits. - The conduit portions of the tailrace structures were designed as rigid frames to carry the maximum possible loads from earth cover, horizontal earth thrust and maximum base pressure.

l. Walls. -

(1) The rear wall of the gate structures was designed to resist an earth load from the fill on the landside and a water load from the riverside.

(2) The front curtain wall of the gate structures was designed to resist an ice pressure of 1,000 pounds per square foot assumed to act over two feet giving a loading of 500 pounds per foot.

m. Buttresses. - The buttresses of the outlet structure and gate structures were designed as cantilever beams carrying a load of one-half the span of the conduit. The outer buttress wall on the outlet structure was designed to resist hydrostatic loading to the top of the wall.

2. Flood walls. - The reinforced concrete flood walls were assumed to act as cantilever walls. The restraint of the sheet piling was neglected.

a. Wall stem. - The stem was designed as a cantilever beam fixed at the top of the base support to carry the differential load due to water pressure and earth pressure. The landside face of the stem was designed to carry the load from the backfill for those sections of the wall where these loads exist.

b. Base slab. - Both riverside and landside footings were designed as cantilever beams fixed at the face of the stem.

c. Dike abutments. - The dike abutments were designed as counterforted sections.

d. Depot Street stop-log structure. - The structure has a 36-foot opening spanned by two sections of wooden stop-logs. These logs are held in place by abutments at the ends and by a removable steel H-beam in the middle of the street. The base is designed to take up stresses transmitted to it by the supports which act as counterfort sections.

WAR DEPARTMENT

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

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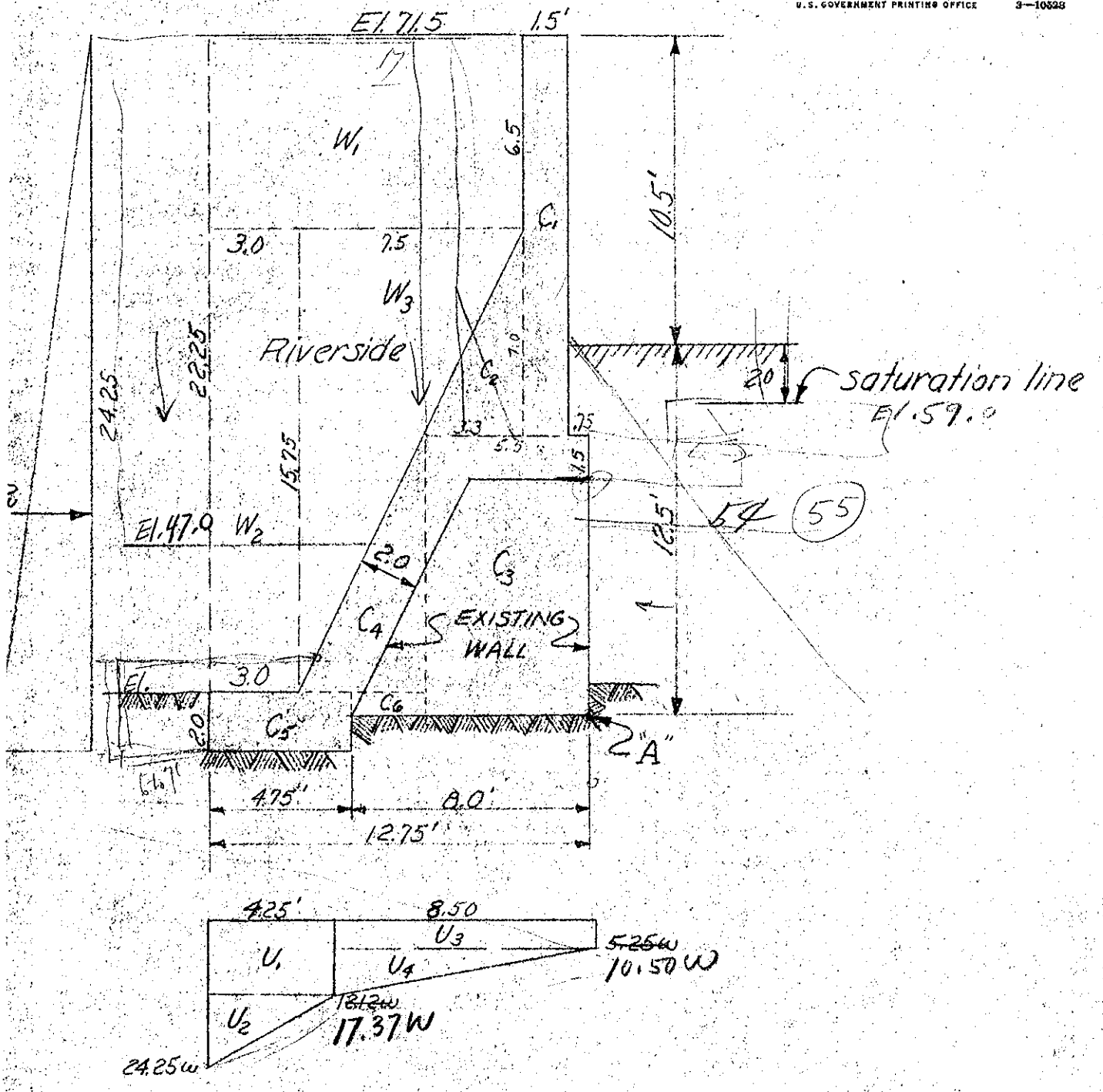
Project: Chicopee C-3b

Computation: Special wall facing — Sta. 12+05± to Sta. 13+20±

Computed by: J.H.L. Checked by: K.W. Date: 3/22/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

Project: Chicopee C-3b

Computation: Stability - Special wall facing

Computed by: J.H.L. Checked by: R.W. Date: 3-22-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

	Force	↓	↑	→	←	Arm	↶	↷
1	13.5×1.5×150	3040				1.5	4550	
2	½×7×3.3×150	1730				3.4	5880	
3	5.5×9.5×150	7830				2.75	21,500	
4	½×8.75×4.25×150	2790				6.9	19,300	
5	4.75×2×150	1430				10.4	14,900	
6	2.5×.75×150	280				6.75	1,900	
W_1	6.5×10.5×62.5	4270				7.5	32,000	
W_2	3×15.75×62.5	2950				11.25	33,200	
W_3	½×7.5×15.75×62.5	3690				7.25	26,900	
U_1	12.1×62.5×4.25		3210			10.6		34,000
U_2	½×12.1×62.5×4.25		1600			11.3		18,100
U_3	5.25×62.5×8.5		2780			4.25		11,800
U_4	½×6.87×62.5×8.5		1820			5.67		10,300
P_w	½×24.25²×62.5			18,400		7.6		140,000
		ΣV = 18,600					160,130	214,200

Position of resultant, neglecting active and passive resistance of earth!

ΣM = 54,070

$$\frac{54,070}{18,600} = 2.9 \text{ feet outside the base}$$

To balance the overturning moment above, the passive resistance of the earth will develope 54,070 ft# ↶ to prevent overturning. The result will be at "A"

ΣV = 18,600 ΣM = 0

$$P = \frac{1}{2} w h^2 \left(\frac{1+\sin\phi}{1-\sin\phi} \right) \qquad w = 125 \quad \phi = 26°34' \quad h = 12.5 \quad \sin\phi = .447$$

$$P = \frac{125}{2}(12.5)^2(2.61) = 25,500\#$$

Moment $P \times \frac{h}{3} = 25,500 \times \frac{12.5}{3} = 106,500$ ft# ↶

∴ Maximum moment of passive resistance which could be developed is entirely adequate to prevent overturning.

WAR DEPARTMENT

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

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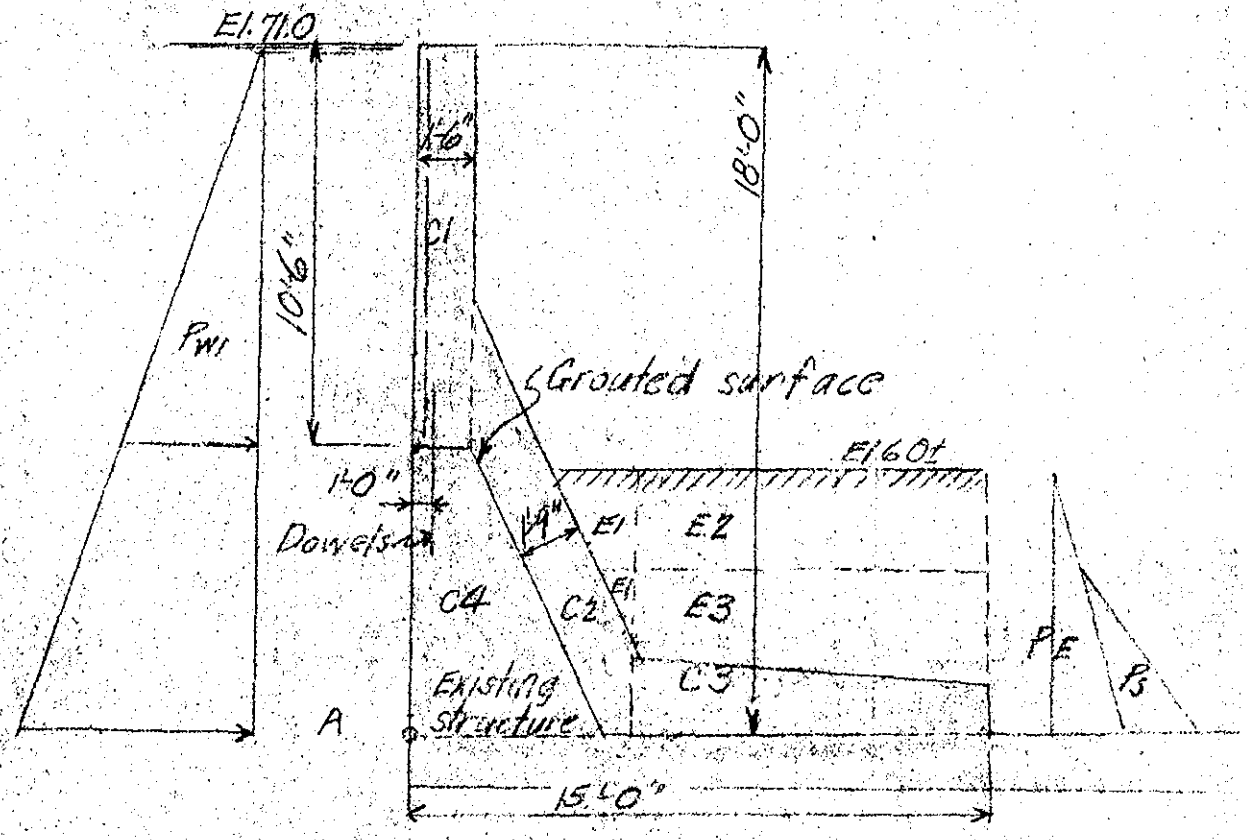
Project CHICOPEE C36

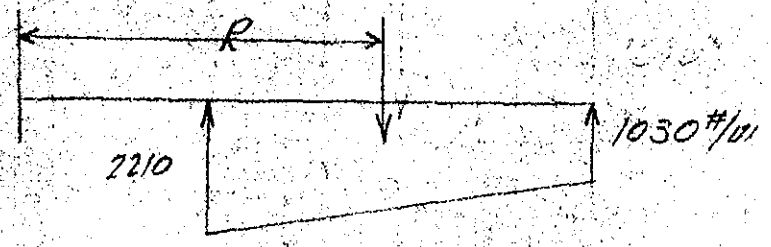
Computation Special Wall Facing

Computed by RSM Checked by RW Date 3-21-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Assume effective bond between existing structure and new concrete eliminating uplift on new section.
Provide dowels to supplement bonding & to add wt. of present structure to new structure to the extent as shown.



Bearing diagram

WAR DEPARTMENT

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

Ject CHICOPEE C36

nputation SPECIAL WALL FACING

nputed by RSM Checked by RW Date 3-22-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY

			Force ↓↑	Force ⇄	Arm	Moments about A ↷	Moments about A ↶
C1	150×1.5×10.5	↓	2360		.8	1.9	
C2	150×1.75×9.0	↓	2360		3.8	9.0	
C3	150×1.75×9.0	↓	2360		10.5	24.9	
E1	100×2×4.7/2	↓	470		4.9	2.3	
E2	100×9×2.5	↓	2250		10.5	23.6	
E3	125×9×2.5	↓	2810		10.5	29.6	
Pw1	62.5×18.0²/2	→		10100	6.0	60.6	
PE	35×7.0²/2	←		860	2.3		2.0
Ps	45×4.5²/2	←		460	1.5		.7
C4	150×1.5×7.5	↓	1690		.8	1.4	
	150×3.5×7.5/2	↓	1970		2.7	5.3	
			16270	8780	Σ	155.9	

Position of resultant: 155900/16270 = 9.6 ; third pt. @ 11.7'

Bearing: $e = 0.4'$ $\frac{16270}{10}\left(1 \pm \frac{6 \times 0.4}{10}\right) = 2015^{\#}/\square'$ to $1240^{\#}/\square'$

WAR DEPARTMENT

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

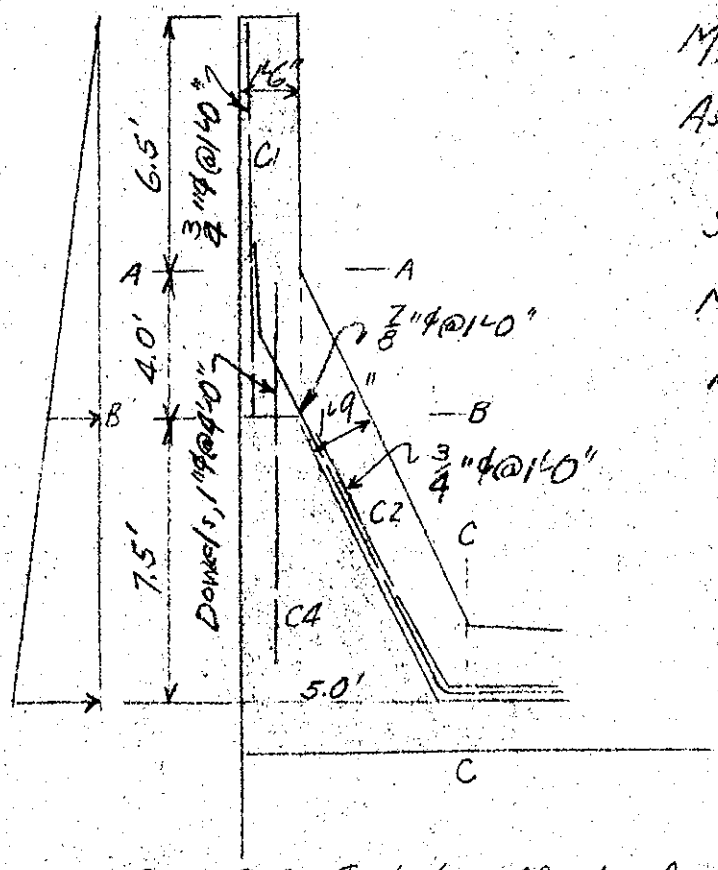
Project: CHICOPEE C36

Computation: Special wall facing

Computed by: RSM Checked by: R.W. Date: 3-22-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEM



Sec. A-A

$M = wh^3/6 = 62.5 \times 6.5^3/6 = 2860'\#$

$A_s = \frac{2860 \times 12}{18000 \times .884 \times 14.5} = .15\square''$ Use 3/4"φ@1'-0"

Sec. B-B

$M = 62.5 \times 10.5^3/6 = 12050'\#$

$A_s = \frac{12050 \times 12}{18000 \times .884 \times 17.5} = .53\square''$ Use 7/8"φ@1'-0"

$V = \frac{wh^2}{2} = \frac{62.5 \times 10.5^2}{2} = 3450\#$

$v = \frac{3450}{12 \times .884 \times 17.5} = 19\#/\square''$

Sec. C-C. Include effect of wt. of structure

$M_W \rightarrow \frac{62.5 \times 18.0^2}{2} \times 4 = 40{,}500'\#$

C1 ← 2360 × 5.0		11800
C2 ← 2360 × 2.3		5450
C4 ← 1690 × 5.0		8450
1970 × 3.0		5910
		31,610
Net	8,890'#	

$A_s = \frac{8890 \times 12}{18000 \times .884 \times 17.5} = .39\square''$ Use 7/8"φ@1'-0" & 3/4"φ@1'-0", for additional strength at this point

$V = wh^2/2 = 62.5 \times 18^2/2 = 8000\#$

$v = 8000/12 \times .884 \times 17.5 = 44\#/\square''$ OK

WAR DEPARTMENT

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

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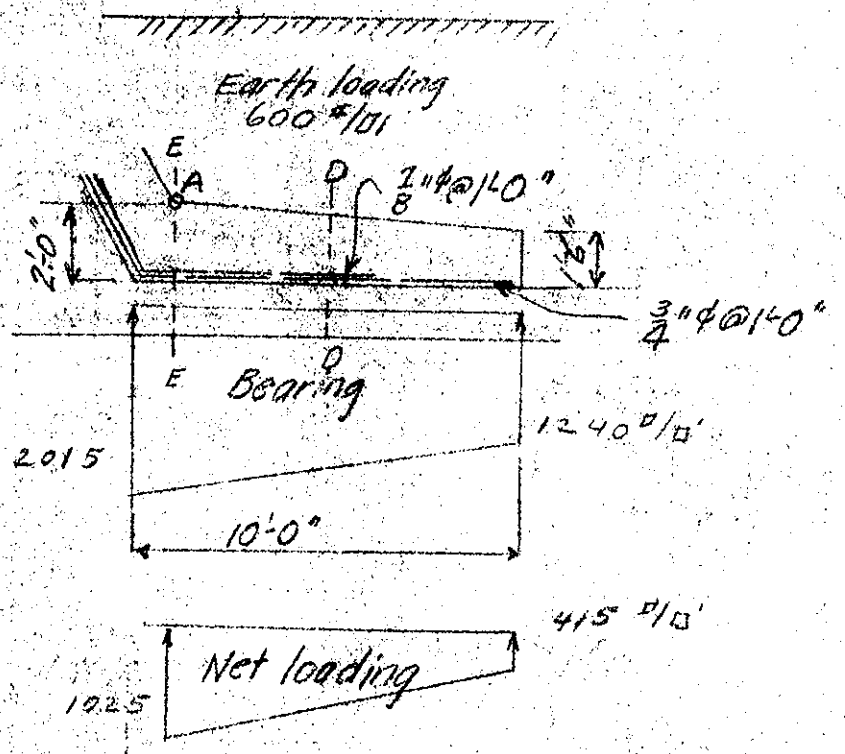
Project: CHICOPEE C36

Computation: Special Wall Facing

Computed by: RSM Checked by: R.W. Date: 3-22-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF BASE



At Sec. D-D

M $415 \times 5^2/2 =$ 5180 '#

$\frac{340 \times 5}{2} \times \frac{5}{3} =$ 1410

6590 '#

$A_s = 6590 \times 12/18000 \times .884 \times 17.5 = .284 \square''$

At Sec. E-E

M $415 \times 9^2/2 =$ 16,840 '#

$\frac{610 \times 9}{2} \times \frac{9}{3} =$ 9,170

26,010 '#

$d = \sqrt{\frac{26010}{123}} = 14.5''$ reqd., $20.5''$ supplied

$A_s = 26010 \times 12/18000 \times .884 \times 20.5 = .96 \square''$

$V = 415 \times 9 =$ 3740

$610 \times 9/2$ 2750

6490

$v = 6260/12 \times .884 \times 20.5 = 29\#/\square''$

WAR DEPARTMENT

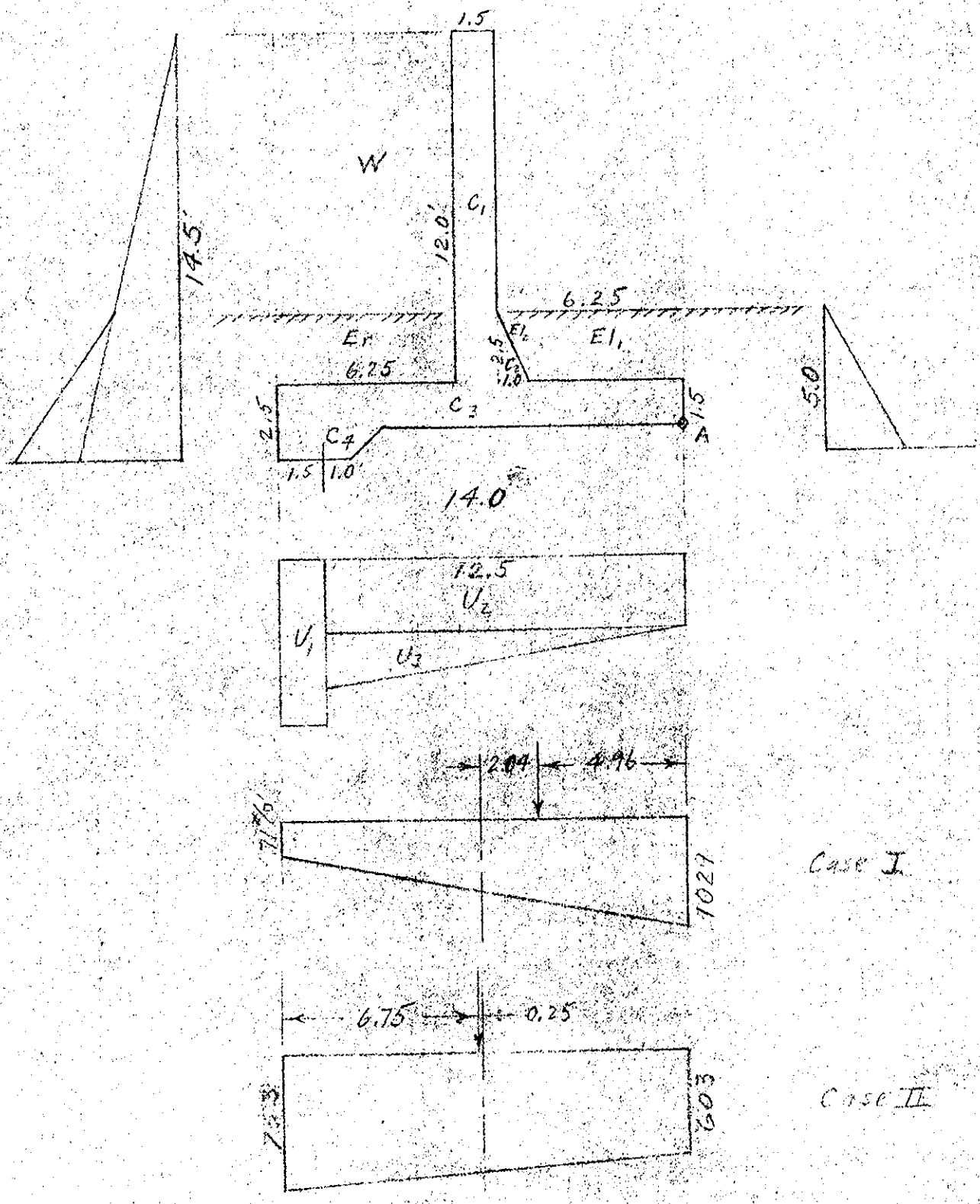
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Project: Chicopee Item C3b

Computation: Standard Wall 12' Stem 14' Base

Computed by: W. H. F. Checked by: Date: 3/28/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

Project: Chicopee C3b

Computation: Standard Wall 12' Tem 14' Base

Computed by: W.H.F. Checked by: Date: 3/28/40

U. S. GOVERNMENT PRINTING OFFICE 8—10538

Case I River Up Stability

Forces Acting		↓	↑	→	←	Arm	Moments About A ↺	Moments About A ↻
C_1	1.5 × 12 × 150	2700				7.0	18900	
C_2	½ × 1 × 2.5 × 150	190				5.92	1120	
C_3	1.5 × 14 × 150	3150				7.0	22050	
C_4	1 × 3 × 150	450				12.5	5630	
W	9.5 × 6.25 × 62.5	3710				10.88	40360	
E_r	2.5 × 6.25 × 125	1950				10.88	21220	
E_{h1}	2.5 × 5.25 × 125	1640				2.62	4300	
E_{h2}	2.5 × 1 × ½ × 125	160				5.58	890	
U_1	14.5 × 1.5 × 62.5		1360			13.25		18030
U_2	4 × 12.5 × 62.5		3130			6.25		19550
U_3	½ × 4.75 × 12.5 × 62.5		1860			8.33		15500
P_w	½ × 14.5² × 62.5			6570		3.83		25180
P_{er}	½ × 5² × 17.5			220		0.67		140
P_{el}	½ × 3² × 80				1000	0.67	670	670
F_r	0.45 × 7600				3420			
PE					2330	0.67	1590	
		13950	6350	6790	6750		116730	79070
		ΣV = 7600 ↓		ΣH = 0			ΣM = 37660 ↺	

Position of Resultant: $\frac{\Sigma M}{\Sigma V} = \frac{37660}{7600} = 4.96$ ⅓ base = 4.67'

resultant 0.29' inside middle

Bearing: $\frac{7600}{14}\left(1 \pm \frac{6 \times 2.04}{14}\right)$ $e = \frac{14}{2} - 4.96 = 2.04$

$= 550 \times \begin{cases} 1.87 = 1029 \\ .13 = 71 \end{cases}$

WAR DEPARTMENT

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

Project: Chicopee C3b

Computation: Standard Wall 12' Stem 14' Base

Computed by: W H F Checked by: Date: 3/30/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II River Down Stability

			→	←		↶	↷
C_1		2700			7.0	18 900	
C_2		190			5.92	1 120	
C_3		3150			7.0	22 050	
C_4		450			12.5	5 630	
El_1	2.5 × 5.25 × 100	1310			2.62	3 430	
El_2	½ × 2.5 × 1 × 100	130			5.58	730	
Er	2.5 × 6.25 × 100	1560			10.88	16 970	
Pel	½ × 5² × 35			440	0.67		290
Pel	½ × 5² × 35		440		0.67	270	
		9490					
		ΣV = 9490				ΣM = 68830 ↶	

Position of Resultant: $\frac{68830}{9490} = 7.25$ ½ Base = 4.67 o.K.

$e = 7.25 - 7.0 = 0.25$

Bearing: $\frac{9490}{14}\left(1 \pm \frac{6 \times .25}{14}\right) = 678 \begin{cases} 1.11 = 753 \\ .89 = 603 \end{cases}$

WAR DEPARTMENT

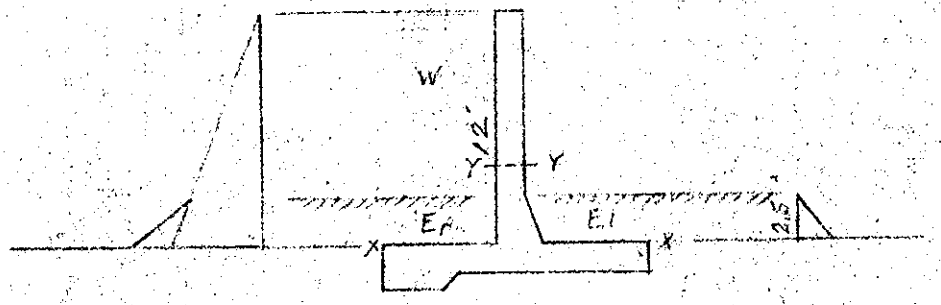
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Project: Chicopee C 3b

Computation: Standard Wall 12' stem 14' base

Computed by: W H F Checked by: Date: 3/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Moments about X-X

Forces Acting		→	←	Arm	↻	↺
P_W	$12^2 \times \frac{1}{2} \times 62.5$	4500		4.0	18000	
Fer	$2.5^2 \times \frac{1}{2} \times 17.5$	50		.83	40	
Fel	$2.5^2 \times \frac{1}{2} \times 50$		250	.83		210
		4550	250		18040	210
		ΣV = 4300			ΣM = 17830	

$d = 2.5' = 30''$

$d' = \sqrt{\frac{4300}{123}} = \cancel{5.73}\ 12.05 < \cancel{30-3.5}\ 20-3.5 = 16.5$

$A_s = \frac{17830}{1325 \times 26.5} = \cancel{0.51}\ 0.82\ \square''$ Use $\cancel{\frac{1}{2}}\ \frac{3}{4}''\phi$ @ $\cancel{1'-0''}\ 6''$ c.c.

Riverside Face

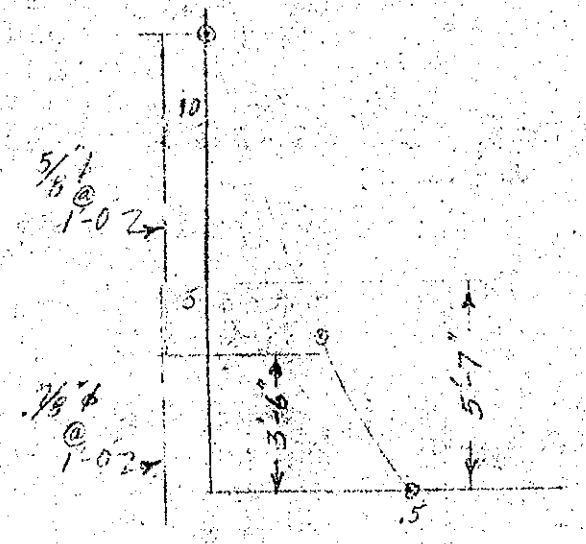
About Y-Y:

$V = 8^2 \times \frac{1}{2} \times 62.5 = 2000$

$M = 2000 \times 2.67 = 5340$

$A_s = \frac{5340}{1325 \times 14.5} = 0.28\ \square''$

Use $\frac{5}{8}''\phi$ @ 1'-0" c.c.



WAR DEPARTMENT

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

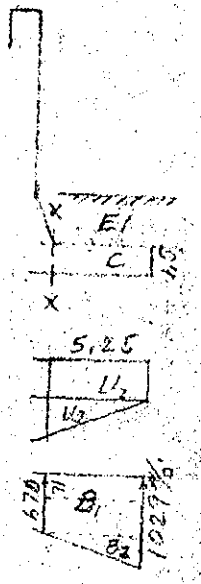
Subject: Chicopee C3b — Page 22

Computation: Standard Wall 12' Stem 14 Base

Computed by: W. H. T. — Checked by: — Date: 3/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I River Up Landside Base



U_3 $9.5 \times \frac{1}{2} \times 62.5 = 297$ $Y_1 = \frac{5.25}{12.5} \times 297 = 125$

$B_1 = \left(\frac{8.75}{14} \times 958\right) + 71 = 670$

$B_2 = 1027 - 670 = 359$

Moments about X-X

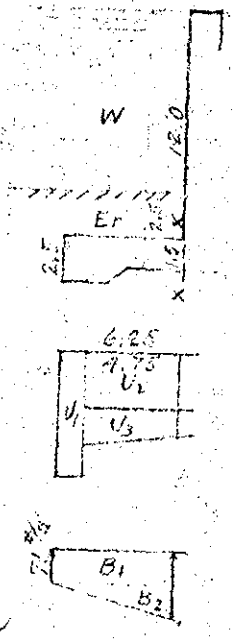
Forces Acting				Arm		
E1	2.5 × 5.25 × 125	1640		2.13	4310	
C	1.5 × 5.25 × 150	1180		2.63	3110	
U_2	4 × 5.25 × 62.5		1310	2.63		3440
U_3	½ × 5.25 × 125		330	1.75		580
B_1	5.25 × 670		3520	2.63		9260
B_2	½ × 5.25 × 359		940	3.5		3300
		2820	6100		7420	16580
		ΣV = 3280	↑		ΣM = 9160	↻

$d = 1.5 = 18''$

$d = \sqrt{\frac{9160}{125}} = 8.6'' < 18 - 3.5$ $A_s = \frac{9160}{1325 \times 13.5} = 0.52\ \square''$

Use ¾" ϕ alt. ⅞" ϕ @ 1-0" c.c. Bottom Steel

Riverside Base



U_3 $Y_1 = \frac{4.75}{12.5} \times 297 = 183$ $Y_2 = 297 - 183 = 114$ $B_2 = \frac{6.25}{14} \times 958 = 428$

W	9.5 × 6.25 × 62.5	3710		3.13	11620	
Er	2.5 × 6.25 × 125	1950		3.13	6100	
C_3	1.5 × 6.25 × 150	1410		3.13	4410	
C_4	1 × 3 × 150	450		4.75	2140	
U_1	1.5 × 14.5 × 62.5		1360	5.5		7480
U_2	4 × 4.75 × 62.5		1190	2.38		2830
U_3	4.75 × 183		870	2.38		2070
U_3	½ × 4.75 × 114		270	3.17		860
B_1	6.25 × 71		440	3.13		1390
B_2	½ × 6.25 × 428		1340	2.08		2760
		7520	5470		24270	17390
		ΣV = 2050	↓		ΣM = 6880	↻

$A_s = \frac{6880}{1325 \times 14.5} = .36$

Use ⅝" ϕ alt ¾" ϕ @ 1'-0" c.c. Top steel

Project: Chicopee C3b
Computation: Standard Wall 12' Stem 14' Base
Computed by: L.W.H.F. Checked by: Date: 3/30/40

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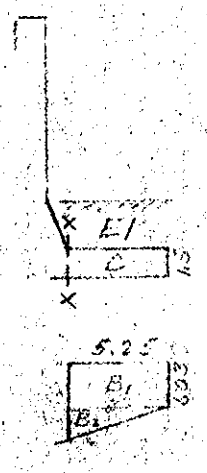
Case II River Down Landside Base.



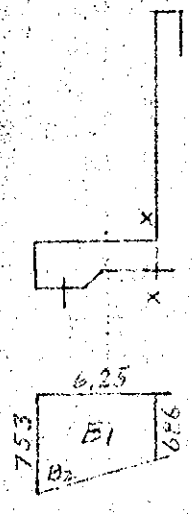
$B_2 = \frac{5.25}{14} \times 150 = 57$

B1	2.5 × 5.25 × 100	1310		2.63	3450	
C		1180		2.63	3110	
B1	5.25 × 603		3160	2.63		8320
B2	½ × 5.25 × 57		150	3.5		525
		2490	3310		6560	8850
		ΣV = 820 ↑			ΣM = 2290 ↺	

$A_s = \frac{2290}{13.25 \times 13.5} = .13''$ Use 5/8" ϕ @ 1'-0" c.c.

Top Steel

Riverside Base.



$B_1 \left(\frac{7.75}{14} \times 150\right) + 603 = 686$ B_2 753 − 686 = 67

Ec	2.5 × 6.25 × 100	1560		3.13	4880	
C3		1410		3.13	4410	
C4		450		4.75	2140	
B1	6.25 × 686		4290	3.13		13490
B2	½ × 6.25 × 67		210	4.17		880
		3420	4500		11430	14320
		ΣV = 1120 ↑			ΣM = 2890 ↻	

$A_s = \frac{2890}{12.25 \times 13.5} = .16''$ Use 5/8" ϕ @ 1'-0" c.c.

Bottom Steel

WAR DEPARTMENT

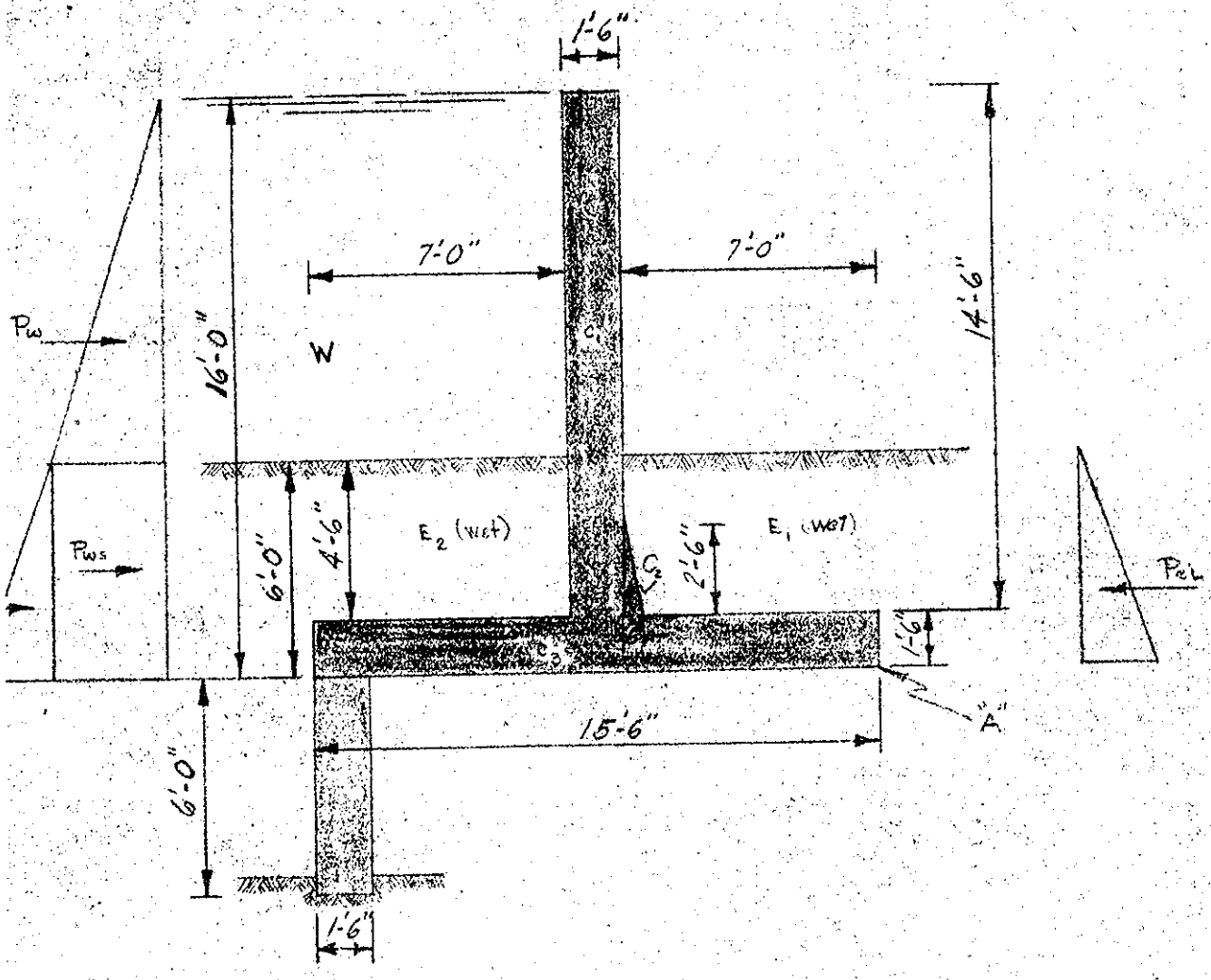
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

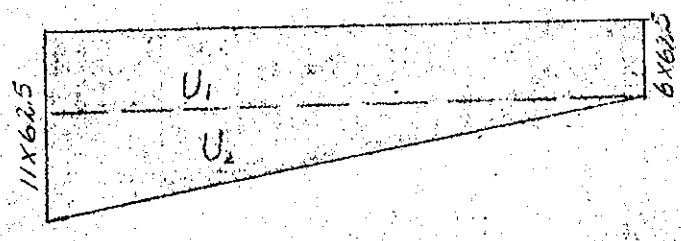
Project: CHICOPEE DIKE C3b

Computation: 14'-6" WALL

Computed by: T.A.C. Checked by: R.H.M. Date: 1/12/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528





Note: Assuming that headwall does not aid toward stability of wall.

WAR DEPARTMENT

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

Project: Chicopee Dike C3b

Computation: 14'-6" Wall

Computed by: J.A.C. Checked by: R.H.M. Date: 1/12/40

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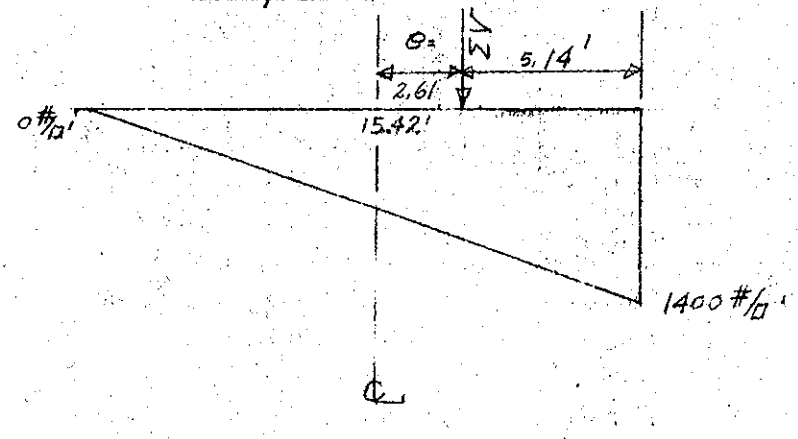
Forces Acting		↓	↑	→	←	Arm	Moments about "A" ↻	Moments about "A" ↺
W	10 × 7.0 × 62.5	4,375				12.0		52,500
E_1	4.5 × 7.0 × 125	3940				3.5		13,790
E_2	4.5 × 7.0 × 125	3,940				12.0		47,300
C_1	14.5 × 1.5 × 150	3,265				7.75		25,300
C_2	2.5 × 1.0 × ½ × 25	30				6.67		200
C_3	1.5 × 15.5 × 150	3,490				7.75		27,000
P_{eR}	$\overline{6.0}^2$ × ½ × 80			1,440		2.0	2,880	
P_{eL}	$\overline{6.0}^2$ × ½ × 80				1,440	2.0		2880
P_w	$\overline{10.0}^2$ × ½ × 62.5			3,125		9.33	29,200	
P_{ws}	10 × 62.5 × 6			3,750		3.0	11,250	
U_1	6 × 62.5 × 15.5		5810			7.75	45030	
U_2	5 × 62.5 × ½ × 15.5		2420			10.33	25000	
		19040	8230	8315	1440		113360	168970
		ΣV = 10810 #↓		ΣH = 6875 #→			ΣM = 55610 #↻	

Position of Resultant $\frac{\Sigma M}{\Sigma V} = \frac{55610}{10810} = 5.14'$ (.03' outside 3rd point)

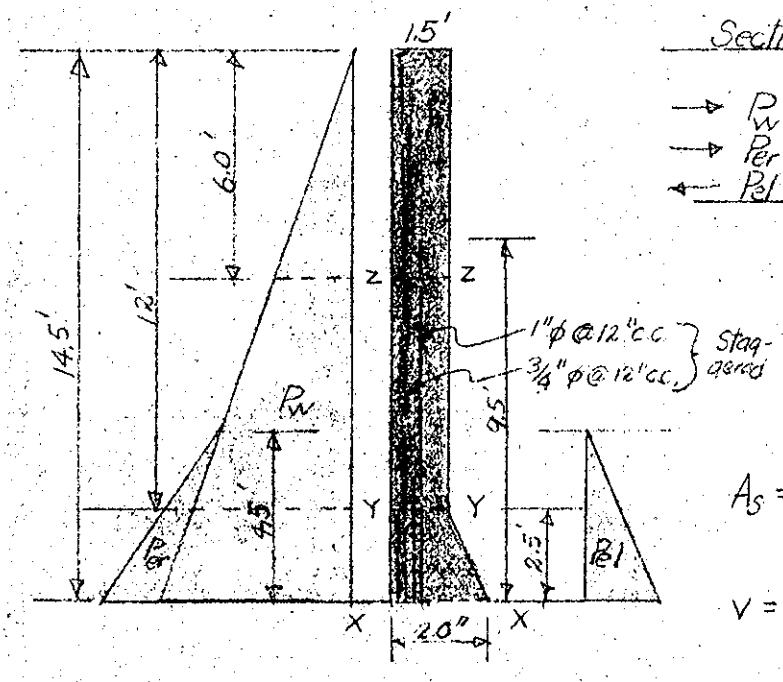
Bearing $= \frac{10810}{3 \times 5.14} \begin{cases} 2 \\ 0 \end{cases} = 700 \begin{cases} 2 = 1400\ \#/\square' & \text{Landside} \\ 0 = 0\ \#/\square' & \text{Riverside} \end{cases}$

Bearing Diagram



Project: Chicopee Dike (C-3b)
Computation: 14'-6" Wall — Design of Stem Steel
Computed by: R.H.M. Checked by: R.W. Date: 1/18/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Section X---X

→ P_w: $14.5^2 \times \frac{1}{2} \times 62.5 = 6580' \times 4.83 = 31780'$
→ P_{er}: $4.5^2 \times \frac{1}{2} \times 17.5 = 180' \times 1.50 = 270'$
← P_{el}: $4.5^2 \times \frac{1}{2} \times 35 = 350' \times 1.50 = 530'$
$\Sigma H = 6410 \quad \Sigma M = 31520 \cdot '\#/'$

$$d = \sqrt{\frac{31520}{123}} = \sqrt{256} = 16'' \text{ OK}$$

$24 - 3.5 = 20.5''$ provided

$$A_s = \frac{12 \times 31520}{18000 \times .884 \times 20.5} = 1.16 \square''$$

Use 1"φ @ 12" c.c.
3/4"φ @ 12" c.c. staggered

$$v = \frac{6410}{12 \times .884 \times 20.5} = 30 \ \#/\square''$$

$$\Sigma_o = \frac{6410}{150 \times .884 \times 20.5} = 2.36''$$

O.K. 5.50" provided

Section Y---Y

→ P_w: $12^2 \times \frac{1}{2} \times 62.5 = 4500 \times 4 = 18000 \cdot '\#/'$

$$d = \sqrt{\frac{18000}{123}} = \sqrt{146} = 12''+ \qquad 18 - 3.5 = 14.5''$$

$$A_s = \frac{12 \times 18000}{18000 \times .884 \times 14.5} = .94 \square''$$

$$v = \frac{4500}{12 \times .884 \times 14.5} = 29 \ \#/\square''$$

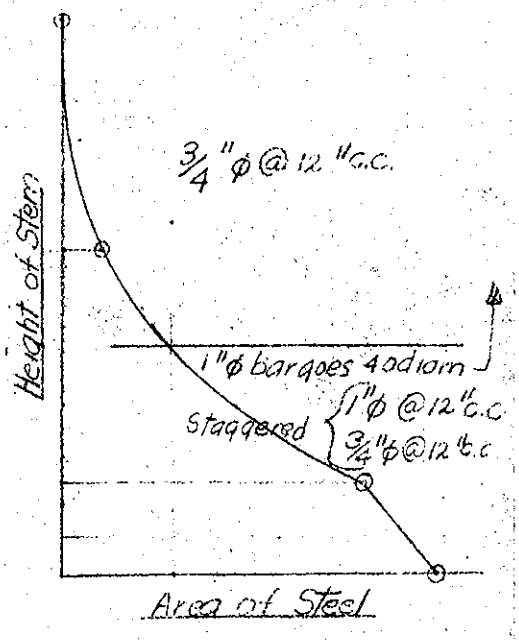
$$\Sigma_o = \frac{4500}{150 \times .884 \times 14.5} = 2.34''$$

O.K. 5.50" provided

Section Z---Z

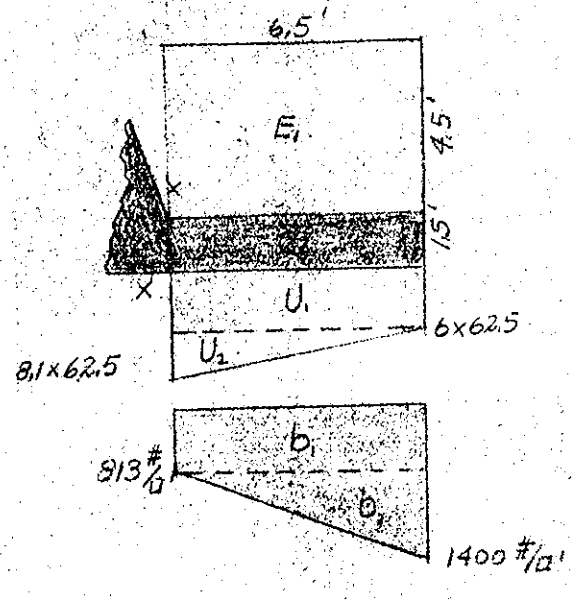
→ P_w: $6^2 \times \frac{1}{2} \times 62.5 = 1130 \times 2.00 = 2260 \cdot '\#/'$

$$A_s = \frac{12 \times 2260}{18000 \times .884 \times 14.5} = .12 \square''$$



Project Chicopee Dike (C-3b)
Computation 14'-6" Wall - Design of Landside Base Slab
Computed by R.H.M. Checked by R.W. Date 1/18/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523



At Section x----x

↓ E_1	4.5 x 6.5 x 125	=	3660	x 3.25	=	11900	'# ↓
↓ C_3	1.5 x 6.5 x 150	=	1460	x 3.25	=	4750	"
↑ U_1	6 x 62.5 x 6.5	=	2440	x 3.25	=	7930	'# ↓
↑ U_2	2.1 x 62.5 x ½ x 6.5	=	430	x 2.17	=	930	"
↑ b_1	813 x 6.5	=	5280	x 3.25	=	17160	"
↑ b_2	587 x ½ x 6.5	=	1910	x 4.33	=	8270	"
	ΣV	=	4940 # ↑	ΣM	=	17640	'# ↓

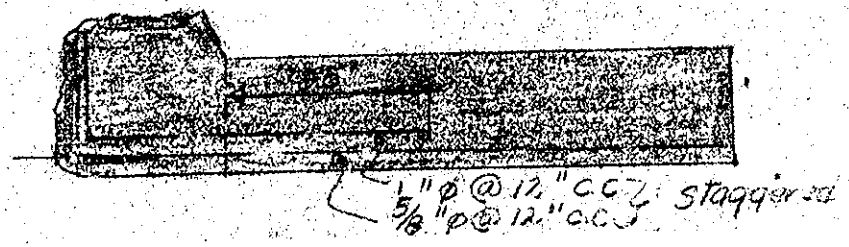
$$d\,(\text{required}) = \sqrt{\frac{17640}{123}} = \sqrt{143.4} = 12\text{"} \qquad 18 - 4.5 = 13.5\text{"} \text{ provide}$$

$$A_s = \frac{12 \times 17640}{18000 \times .884 \times 13.5} = .98\ \square\text{"}$$

Use 1"φ @ 12" c.c. } Staggered
5/8"φ @ 12" c.c. }

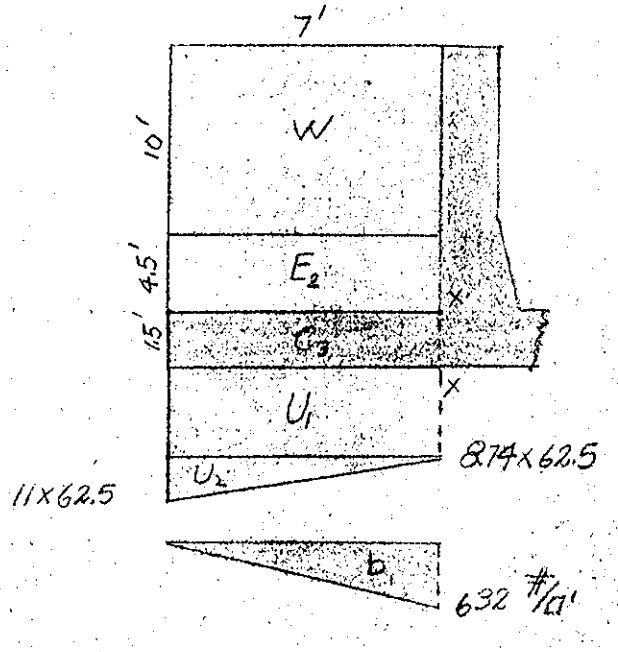
$$v = \frac{4940}{12 \times .884 \times 13.5} = 35\ \#/\square\text{"}$$

$$\Sigma_o = \frac{4940}{150 \times .884 \times 13.5} = 2.76\text{"} \qquad \text{O.K. } 5.10\text{" provided}$$



Project: Chicopee Dike
Computation: 14'-6" Wall – Design of Riverside Base Slab
Computed by: R.H.M. Checked by: [illegible] Date: 1/13/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523



At Section x---x

↓ Headwall: 1.5×6×150	= 1350	× 6.25	= 8440	'#↶
↓ W: 10 × 7 × 62.5	= 4380	× 3.5	= 15330	"
↓ E_2: 4.5 × 7 × 125	= 3940	× 3.5	= 13790	"
↓ C_3: 1.5 × 7 × 150	= 1580	× 3.5	= 5530	"
↑ U_1: 8.74×62.5×7	= 3820	× 3.5	= 13370	'#↷
↑ U_2: 2.26×62.5×½×7	= 490	× 4.66	= 2280	"
↑ b: 632×½×7	= 2210	× 2.33	= 5150	"
$\Sigma V =$	4730 #↓	$\Sigma M =$	22,290 '#↶	

$$d = \sqrt{\frac{22290}{123}} = \sqrt{181} = 13.5'' \text{ required} \qquad 18 - 3.5 = 14.5'' \text{ provided}$$

$$A_s = \frac{12 \times 22290}{18000 \times .884 \times 14.5} = 1.16 \ \square''$$

Use $\left\{ \begin{array}{l} 1''\square \text{ @ } 12'' \text{ c.c.} \\ \frac{5}{8}''\phi \text{ @ } 12'' \text{ o.c.} \end{array} \right\}$ Staggered

$$v = \frac{4730}{12 \times .884 \times 14.5} = 31 \ \#/\square''$$

cut off $\frac{5}{8}''\phi$ bar 2.7' out from stem.

$$\Sigma_o = \frac{4730}{150 \times .884 \times 14.5} = 2.46''$$

O.K. 5.96" provided

WAR DEPARTMENT

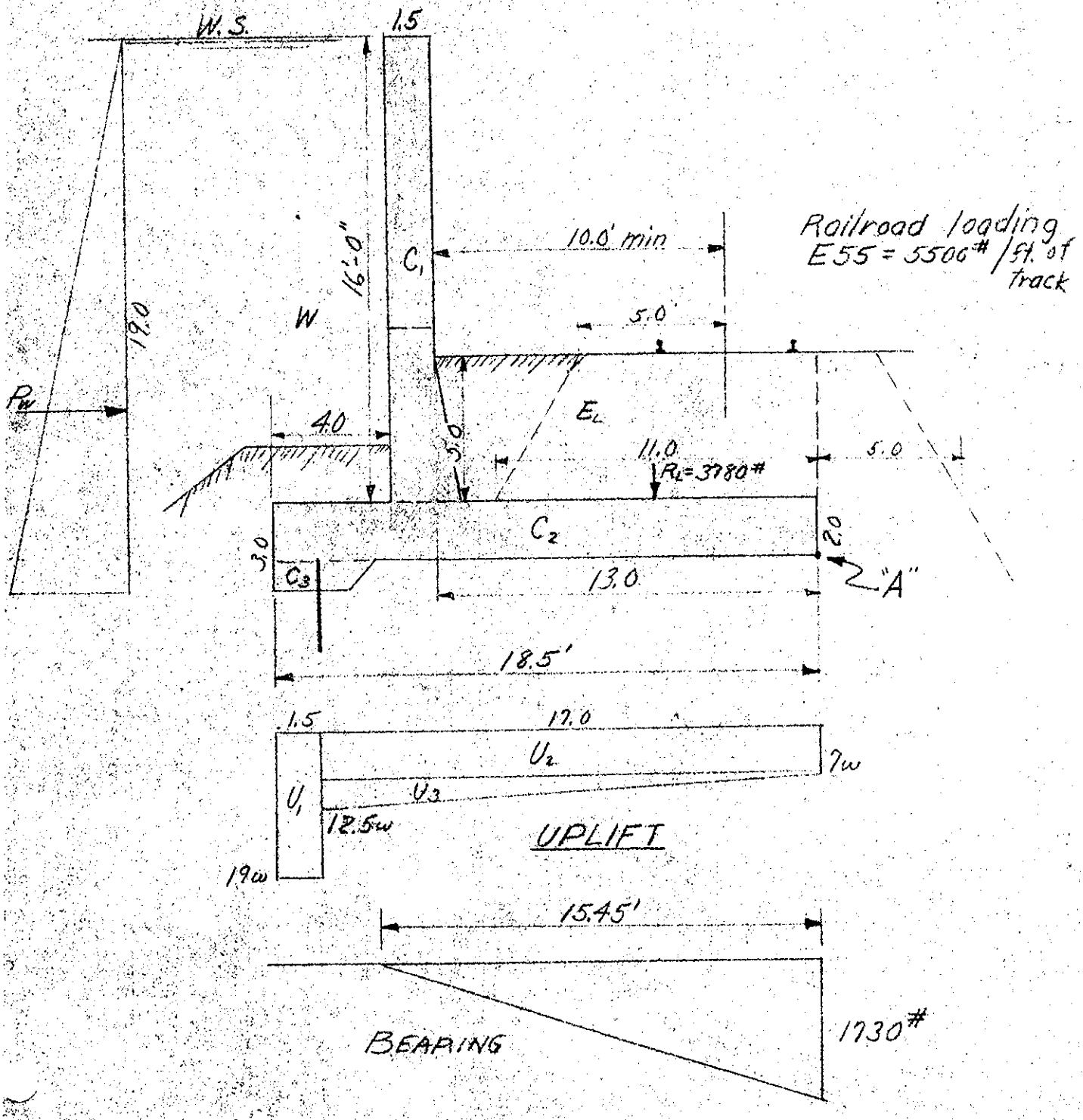
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Project Chicopee C-3b

Computation 16'-0" Floodwall

Computed by J.H.L. Checked by RSM Date 3/25/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538



Subject Chicopee C-3b

Computation Stability

Computed by J.H.L. Checked by RSM Date 3/25/40

Case I - River up, saturated earth, E55 loading on tracks

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1	16×1.5×150	3600				13.75		49,500
C_2	18.5×2×150	5550				9.25		51,300
C_3	3×1×150	450				12.0		7,600
W	16×4×62.5	4000				16.5		66,000
E_L	5×13×125	8130				6.5		52,800
R_L	16×5500	3780				5.5		20,800
U_1	19×62.5×1.5		1780			17.75	31,600	
U_2	7×62.5×17		7430			8.5	63,200	
U_3	½×5.5×62.5×17		2920			11.3	33,000	
P_W	½×19²×62.5			11,300		5.33	60,200	
P_{EL}	½×8²×80				2560	1.67		4,300
F_r	.45×13,380				6020			
P_r	Passive resist.				2720	1.67		4500
		ΣV = 13,380		ΣH = 0			ΣM = 68,800	

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = 5.15'$

Middle third $\frac{18.5}{3} = 6.16'$ is 1.0' outside middle third

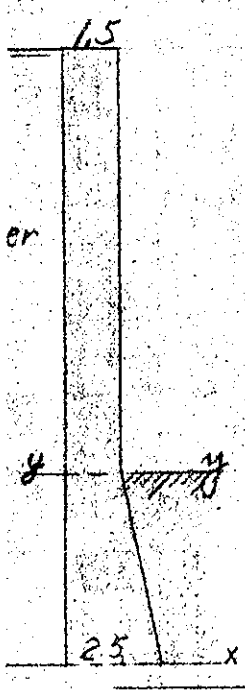
Bearing $= \frac{13,380 \times 2}{3 \times 5.15} = 1,730^{\#}$

Project: Chicopee C-3b
Computation: Stem Steel and Base Steel — 16' wall
Computed by: J.H.L. Checked by: W.H.F. Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stem steel

EM @ x-x



$P_W = \frac{1}{2} \times 16^2 \times 62.5 = 8000\# \times \frac{16}{3} = 42{,}700$

$P_{EL} \quad \frac{1}{2} \times 5^2 \times 80 = 1{,}000 \times \frac{5}{3} = 1{,}700$

$\Sigma H = 7{,}000 \rightarrow \qquad 41{,}000\ '\#$

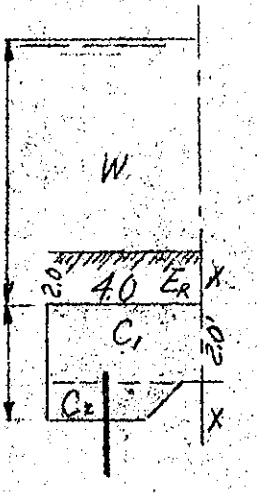
Steel $A_{x-x} = \dfrac{41{,}000 \times 12}{18000 \times .884 \times 26.5} = 1.17\ \square''$ in river face

use $\frac{7}{8}''\phi$ @ 6" c.c. = 1.20 □"

Steel $A_{y-y} = .72\ \square''$ from curve

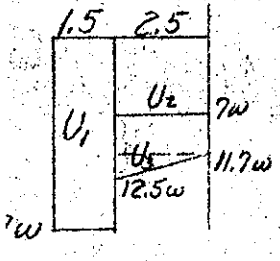
Riverside Base steel

EM @ x-x



W	14×4×62.5 =	3500	×2 =	7000	
E_R	2×4×125 =	1000	×2 =	2000	
C_1	2×4×150 =	1200	×2 =	2400	
C_2	1×3×150 =	450	×2.5 =	1100	
U_1	19×62.5×1.5 =	1780	×3.25 =		5800
U_2	11.7×62.5×2.5 =	1820	×1.25 =		2300
U_3	$\frac{1}{2}$×.8×62.5×2.5 =	60	×1.67 =		100

$\Sigma V = 2490 \downarrow \qquad \Sigma M = 4{,}300$



Steel $A_{x-x} = \dfrac{4300 \times 12}{18000 \times .884 \times 20.5} = .16\ \square''$ in top

use $\frac{5}{8}''\phi$ top and bottom

$\frac{14.5}{17} \times 5.5 = 4.9$

earing is
egligible

Project Chicopee C-3b
Computation Base steel 16'-wall
Computed by J.H.L. Checked by W.H.F. Date

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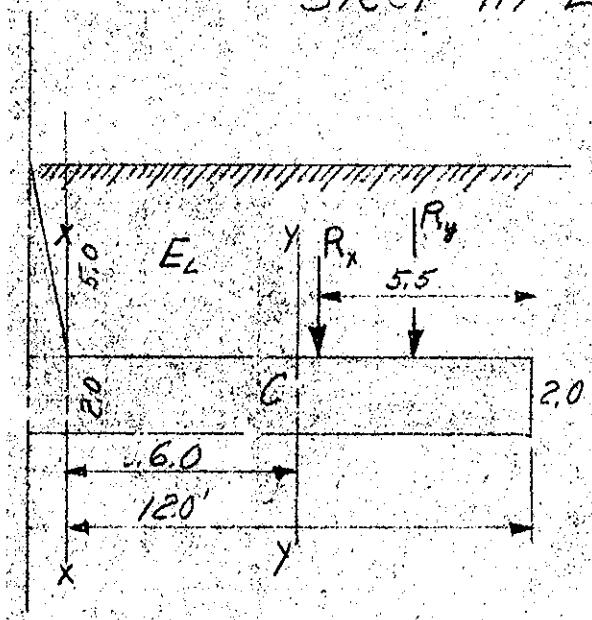
Steel in Landside Base



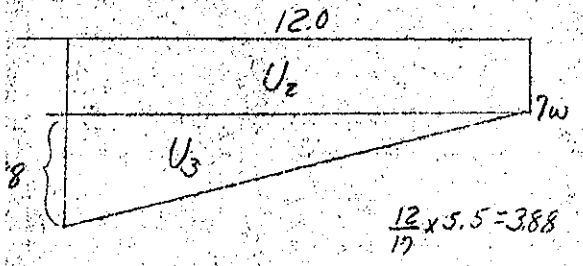
ΣM @ X-X

E_L 5x12x125	= 7500		x 6 = 45,000	
C 2x12x150	= 3600		x 6 = 21,600	
R_x $\frac{11}{16}$ x 5500	= 3780		x6.5 = 24,600	
U_2 7x62.5x12	=	5250	x6 =	31,500
U_3 $\frac{1}{2}$x3.88x62.5x12	=	1450	x4 =	5,800
B_1 390x12	=	4680	x6 =	28,100
B_2 $\frac{1}{2}$x1340x12	=	8050	x8 =	64,400

ΣV = 4550 ↑ ΣM = 38,600 ↗

Unit shear

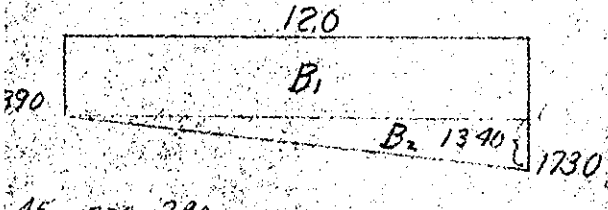
$$\frac{4550}{.884 \times 12 \times 19.5} = 22\# \text{ O.K.}$$



$$\text{Steel } A_{x-x} = \frac{38,600 \times 12}{.884 \times 18000 \times 19.5} = 1.5 \square''$$

in bottom

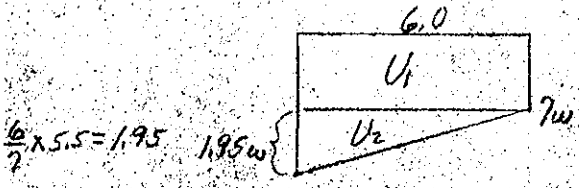
use 1"ø @6"
= 1.58 □"



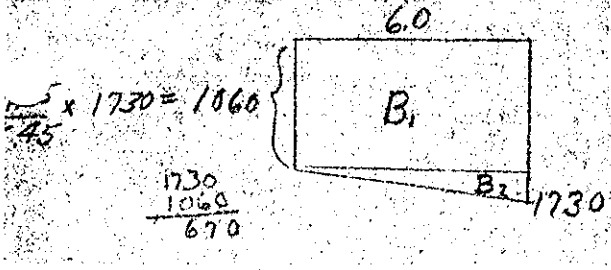
ΣM @ Y-Y

E_L 5x6x125	= 3750		x3 = 11,300	
C 2x6x150	= 1800		x3 = 5,400	
R_y $\frac{6}{16}$x5500	= 2060		x3 = 6,200	
U_1 7x62.5x6	=	2630	x3 =	7900
U_2 $\frac{1}{2}$x1.95x62.5x6	=	360	x2 =	700
B_1 1060x6	=	6350	x3 =	19,100
B_2 $\frac{1}{2}$x670x6	=	2010	x4 =	8,100

ΣV = 3740 ↑ ΣM = 12,900



$$\text{Steel } A_{y-y} = \frac{12900 \times 12}{.884 \times 18000 \times 19.5} = .5 \square''$$



WAR DEPARTMENT

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

Project: Chicopee C-3b

Computation: Cut-off curves 16'-wall

Computed by: J.H.L. Checked by: W.H.E. Date:

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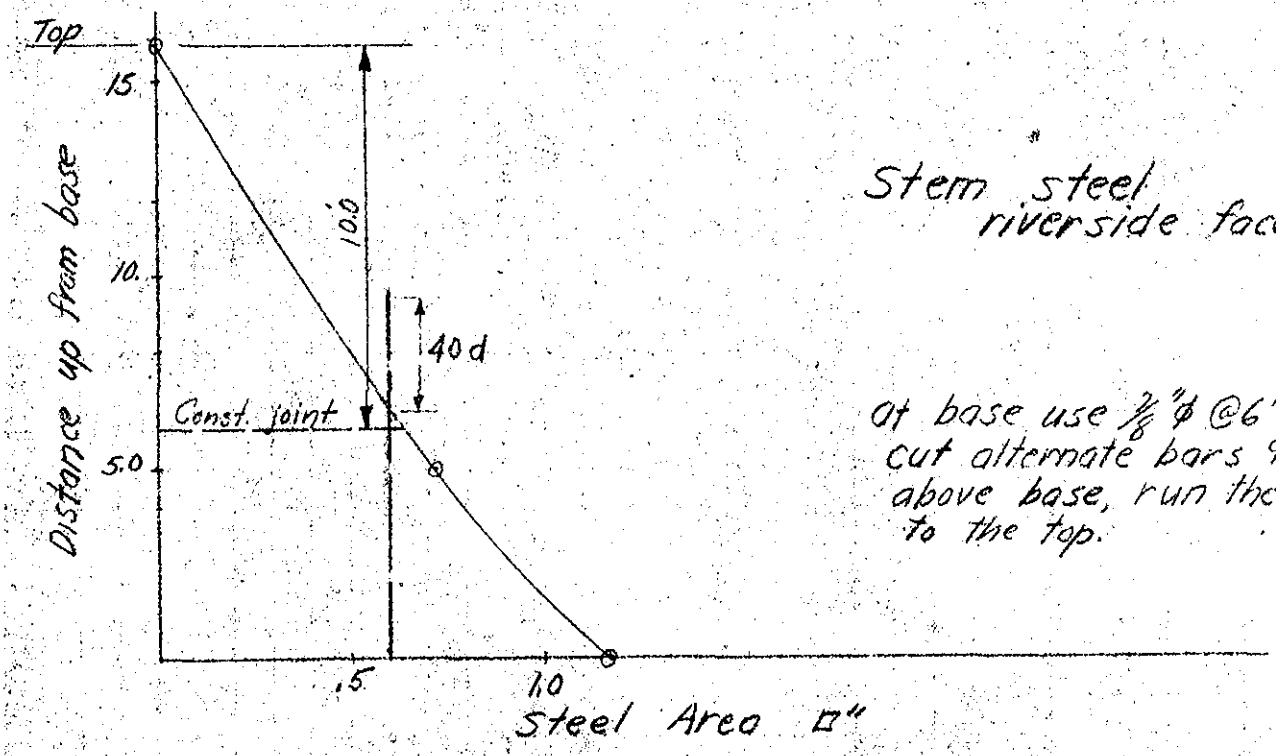
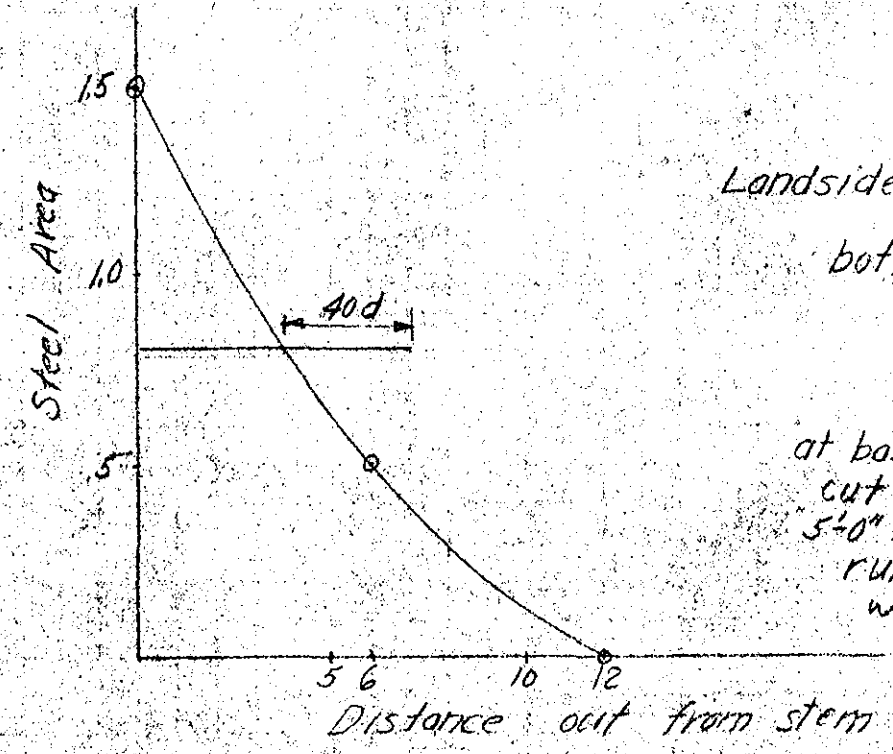


Stem steel
riverside face

at base use 7/8"ϕ @6"
cut alternate bars 9'-6"
above base, run the others
to the top.



Landside base
bottom steel

at base use 1"ϕ @6"
cut alternate bars
5'-0" from end of base
run other bars all the
way

WAR DEPARTMENT

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

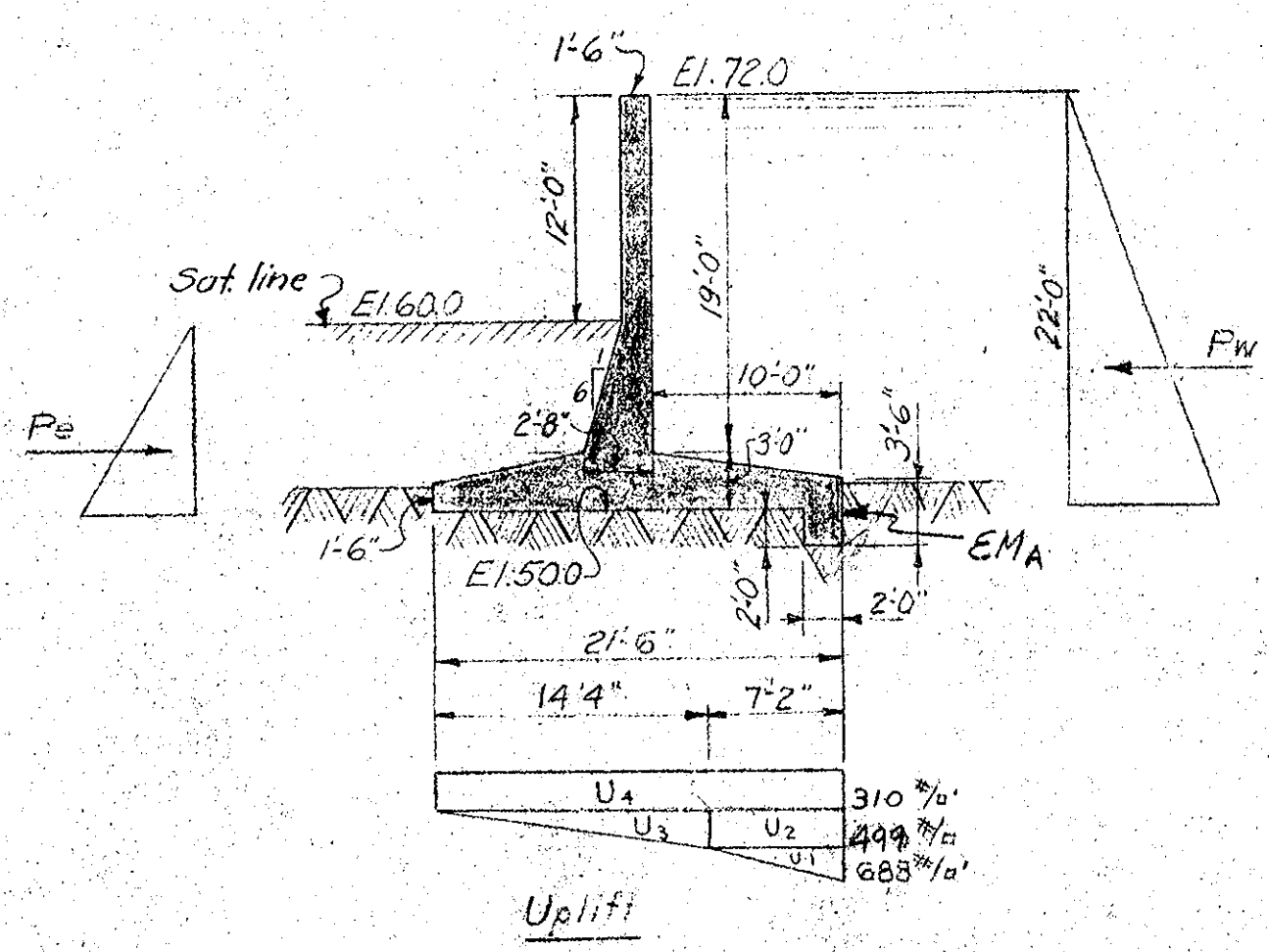
Page 34

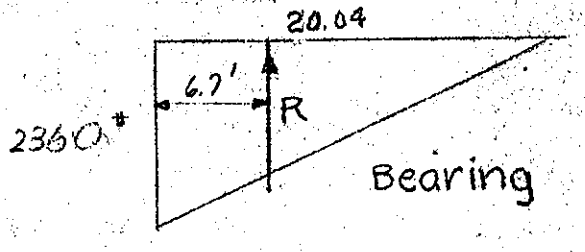
Project Chicopee, Mass. (C3b)

Computation Wall at Spaulding Co. - 19' wall

Computed by N.J. Checked by R.H.M. Date Jan. 12, 1940

U. S. GOVERNMENT PRINTING OFFICE 3—10528





WAR DEPARTMENT

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

Project Chicopee, Mass. (C 3b)

Computation 19'-0" wall

Computed by N.I. & J.H.L. Checked by R.H.M. Date 1/16/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Forces Acting		↓	↑	→	←	Arm	Moments at "A" ↻	Moments at "A" ↺
C_1	150 x 19 x 1.5	4275				10.75		46,000
C_2	150 x 7 x ½ x 1	525				11.87		6,200
C_3	150 x 1.5 x 21.5	4850				10.75		52,100
C_4	150 x .75 x 21.5	2420				10.75		26,000
W	62.5 x 10 x 19.75	12,350				5.0		62,000
E	125 x 9.5 x 7.75	9,200				16.75		154,000
P_W	62.5 x 22 x ½ x 22				15,125	7.33		110,900
U_1	189 x 7.16 x ½		675			2.37	1,600	
U_2	189 x 7.16		1350			3.58	4,830	
U_3	189 x 14.3 x ½		1350			11.93	16,100	
U_4	310 x 21.5		6670			10.75	71,700	
P_E	80 x 10 x ½ x 10			4000		3.33	13,300	
		ΣV = 23,600					ΣM = 349,670	

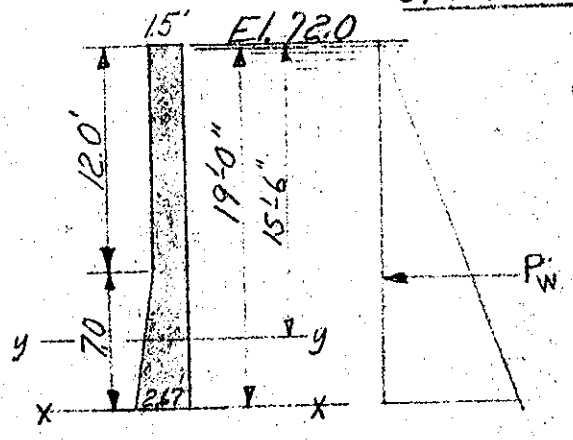
$$\frac{\Sigma M}{\Sigma V} = 14.82 \quad \text{O.K.}$$

$$\text{Bearing} = \frac{2 \times 23{,}600}{3\,(21.5 - 14.82)} = 2{,}360\ \#/\square'$$

Project Chicopee, Mass. (C.S.D.)
Computation Design of stem of 19' wall
Computed by J.H.L. Checked by M.S.J. Date 1/16/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stem – riverside face {no earth, water up}



	Force	Arm	Moment
P_W	$19 \times 62.5 \times \frac{1}{2} \times 19 = 11{,}300$	$\frac{19}{3}$	71,500 '#

$$\Sigma M_{x-x} = 71{,}500 \text{ '#}$$

$$A_{s_{x-x}} = \frac{71{,}500 \times 12}{18000 \times .884 \times 28.5} = 1.89 \text{ □"}$$

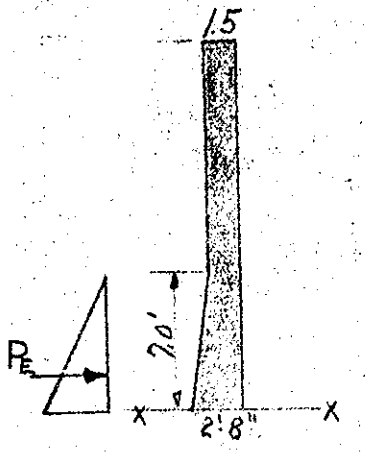
Shear O.K.

$$\Sigma M_{y-y} = 15.5 \times 62.5 \times \tfrac{1}{2} \times 15.5 \times \frac{15.5}{3}$$

$$\Sigma M_{y-y} = 38{,}200 \text{ '#}$$

$$A_{s_{y-y}} = \frac{38{,}200 \times 12}{18000 \times .884 \times 21.5} = 1.34 \text{ □"}$$

Stem - landside face {water down, earth wet



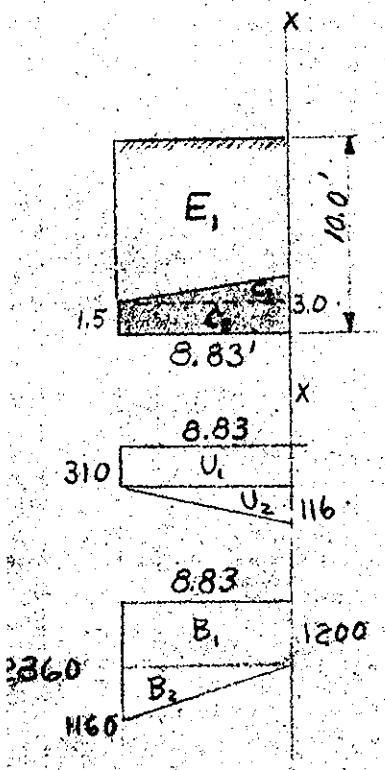
$$\Sigma M_{x-x} = 7 \times 80 \times \tfrac{1}{2} \times 7 \times \frac{7}{3} = 4{,}570 \text{ '#}$$

$$A_{s_{x-x}} = \frac{4570 \times 12}{18000 \times .884 \times 28.5} = .121 \text{ □"}$$

Project Chicopee, Mass. C3b
Computation Design of base 14' wall
Computed by J.H.L. Checked by [illegible] Date 1-17-40

U.S. GOVERNMENT PRINTING OFFICE 3—10828

Steel in landside toe



$\frac{8.83}{14.33} \times 189 = 116$

$\frac{10.21}{20.04} \times 2360 = 1200$

$2360 - 1200 = 1160$

ΣM_{x-x}

	Force	↓	↑	Arm	↲	↱
E_1	8.83×7.75×125	8,550		4.5		38,400
C_1	½×8.83×1.5×150	995		2.94		2,930
C_2	8.83×1.5×150	1985		4.41		8,750
U_1	8.83×310		2740	4.41	12,100	
U_2	½×116×8.83		512	2.94	1,500	
B_1	1200×8.83		10,600	4.41	46,700	
B_2	½×1160×8.83		5,120	5.88	30,100	
		11,530			90,400	50,080

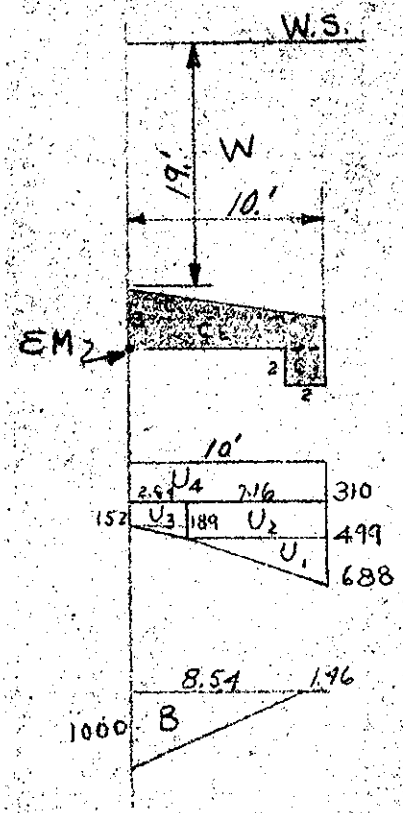
$\Sigma M = 40,320$

$$A_{s_{x-x}} = \frac{40,320 \times 12}{18000 \times .884 \times 31.5} = 1.97 \square''$$ in bottom

Project Chicopee, Mass. C3b
Computation 19' wall
Computed by J.H.L. Checked by RW Date 1-17-40

U. S. GOVERNMENT PRINTING OFFICE 3—10628

Steel in Riverside base



	Force	↓	↑	Arm	↻	↺
W	20.5×10×62.5	12800		5.0	64,000	
C1	½×1.5×10×87.5	656		3.33	2,180	
C2	1.5×10×150	2250		5.0	11,250	
C3	2×2×150	600		9.0	5,400	
U1	189×7.16×½		676	7.61		5,140
U2	189×7.16		1350	6.42		8,680
U3	2.84×152		430	1.42		610
	½×37×2.84		50	1.9		95
U4	310×10		3100	5.0		15,500
B	1000×8.54×½		4270	2.85		12,150
					82,830	42,180

ΣM = 40,650

$$A_s = \frac{40{,}650 \times 12}{18000 \times .884 \times 31.5} = .997 \text{ □}''$$

in top face

$$\frac{8.54}{20.09} \times 2360 = 1000$$

$$\frac{11.5}{14.33} \times 189 = 152$$

WAR DEPARTMENT

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

Project Chicopee, Mass. C3b

Computation Wall at Spaulding Co - 19' wall

Computed by C.H.L. Checked by ..... Date 1-22-40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Case II - Water down, earth saturated, 50% uplift

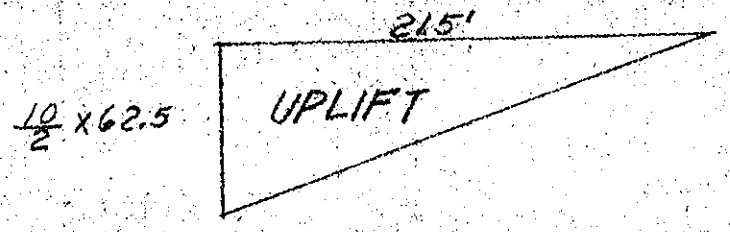
Stability

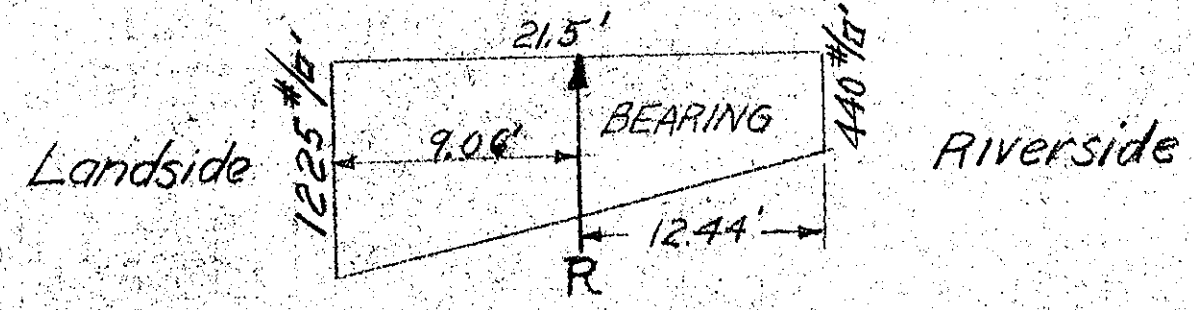
Forces acting		↓	↑	→	←	Arm	↻	↺
C_1		4275						46,000
C_2		525						6,200
C_3		4850						52,100
C_4		2420						26,000
E		9200						154,000
P_E				4000			13,300	
U	5×62.5×½×21.5		3350			14.3	48,000	
		EV 17,920						EM 223,000

$\frac{EM}{EV} = 12.44'$ Eccentricity "e" = 12.44 - 10.75

e = 1.69'

$$\text{Bearing} = \frac{17,920}{21.5}\left(1 \pm \frac{6 \times 1.69}{21.5}\right) = 833\left(\begin{matrix}1 + .472\\ 1 - .472\end{matrix}\right) = \begin{matrix}1225\\ 440\end{matrix}$$



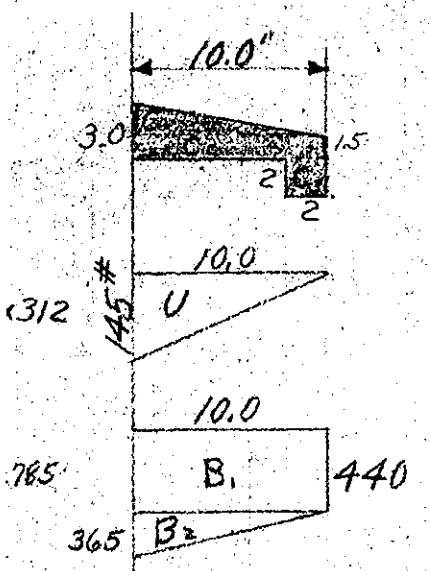


Project Chicopee Dike C3b
Computation Wall at Spaulding Co. - 19' wall
Computed by J.H.L. Checked by Date 1-22-40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Case II

Design of riverside base



Force	↓	↑	Arm	↻	↺
$C_1 = \frac{1}{2} \times 1.5 \times 10 \times 150$	1120		3.33	3730	
$C_2 = 1.5 \times 10 \times 150$	2250		5.0	11,250	
$C_3 = 2 \times 2 \times 150$	600		9.0	5400	
$U = \frac{1}{2} \times 10 \times 145$		725	3.33		2410
$B_1 = 10 \times 440$		4400	5.0		22,000
$B_2 = \frac{1}{2} \times 365 \times 10$		1830	3.33		6,100
				$\Sigma M =$	10,130 ↻

$$A_s = \frac{10{,}130 \times 12}{18000 \times .884 \times 31.5} = .243 \square''$$

in bottom

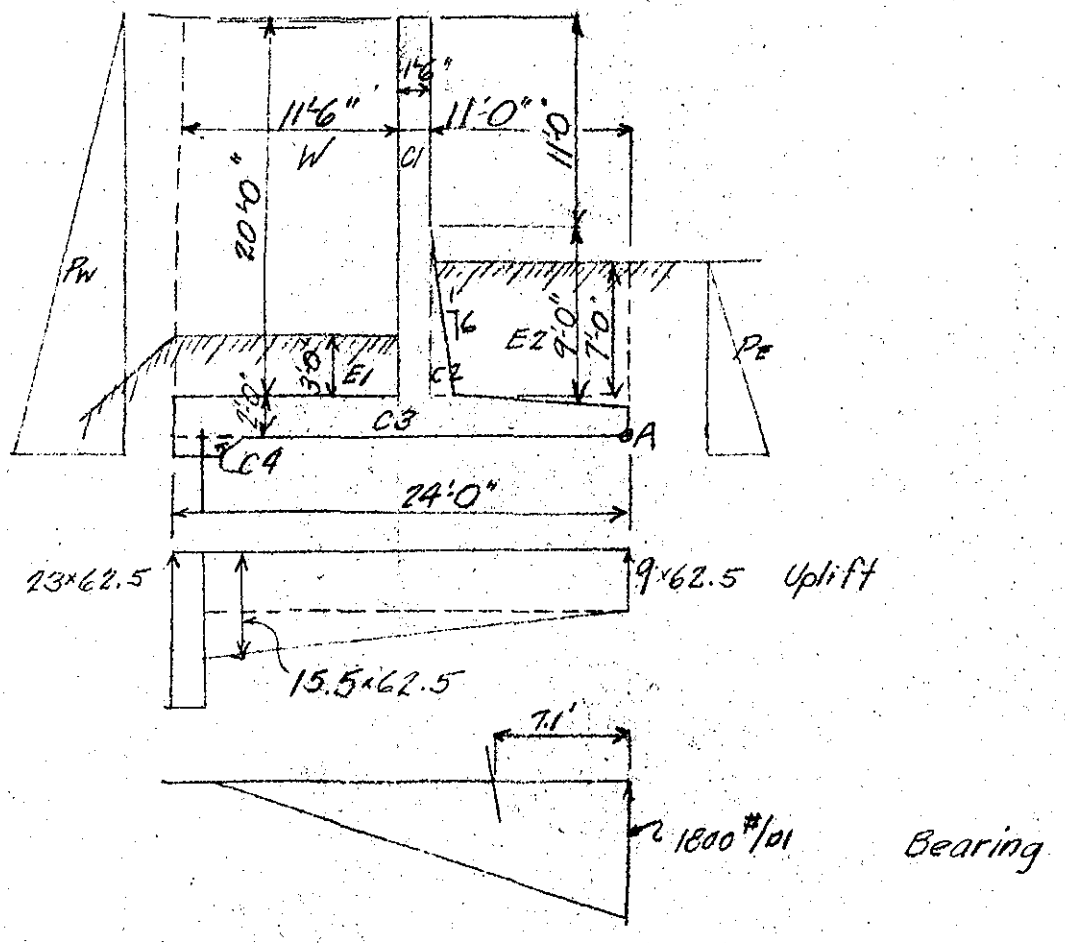
Temperature steel is sufficient

Design of landside base

By inspection Case I is the worse case.

Subject: CHICOPEE C3b
Computation: 20' Wall
Computed by: RSM Checked by: WHF Date: 3-26-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Subject CHICOPEE C3b

Computation 20' Wall

Computed by RSM Checked by W H F Date 3-26-40.

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
W	62.5×11.5×17	12200				18.3		223,300
E1	12.5×11.5×3	4310				18.3		79,000
C1	150×1.5×20	4500				11.7		52,700
C2	150×9×1.5/2	1010				10.5		10,600
C3	150×2×24	7200				12.0		86,400
E2	125×7.3×10.2	9320				5.1		47,500
U1	62.5×23×1.5		2160			23.2	50,100	
U2	62.5×9×22.5		12650			11.3	142,800	
U3	62.5×6.5×22.5/2		4570			15.0	68,600	
PW	62.5×73²/2			16530		6.7	110,700	
PE	80×10²/2				4000	2.3		9,200
		38540	19380				372,200	508,700
		ΣV = 19160		ΣH =			ΣM =	136,500

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = 136{,}500/19160 = 7.1'$

$b = \frac{19160}{21.3} \times 2 = 1800$ #/□' to 0

Project: CHICOPEE C3b
Computation: 20' Wall
Computed by: RSM Checked by: W M F Date: 3-26-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

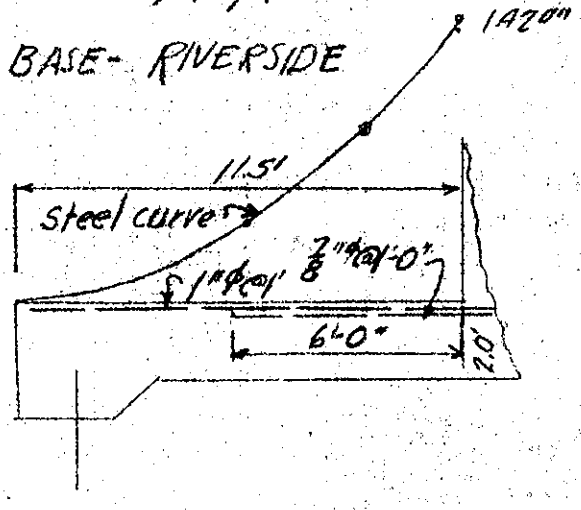
STEM

h	p	M	A_s
8'	$62.5 \times 8^2/2 = 2000^{\#}$	$5330'^{\#}$	$.28^{\square''}$
11'	$62.5 \times 11^2/2 = 3790$	$13900'^{\#}$	$.73^{\square''}$
17'	$(62.5 \times 17^2/2) - (80 \times 4^2/2)$	$50400'^{\#}$	1.44
20'	$(62.5 \times 20^2/2) - (80 \times 7^2/2)$	78900	1.83

Diagram on pg. 4

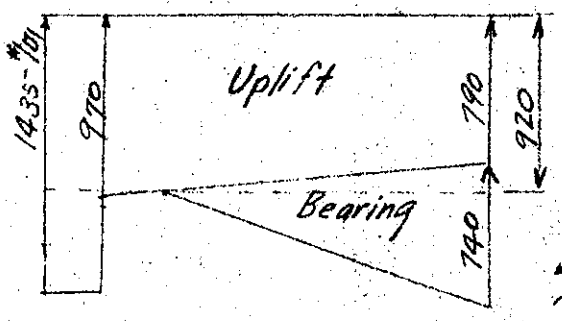
At 20'
$v = 10{,}540 / 12 \times .884 \times 32.5 = 31\ ^{\#}/_{\square''}$ OK

BASE - RIVERSIDE



Loading - Concrete $300^{\#}/_{\square'}$
Water $17 \times 62.5 = 1060$
Earth 3×125 375
$1735^{\#}/_{\square'}$

Loading - V.
$\downarrow (1735 - 920) \times 11.5 =$ 9400#
$\uparrow 610 \times 8.8/2$ 2680
$\uparrow 515 \times 1.5$ 770
Net 5950 #



$v = \dfrac{5950}{12 \times .884 \times 20.5} = 28\ ^{\#}/_{\square''}$

Moment at face of stem

$\curvearrowleft 9400 \times 5.75 =$ $54000'^{\#}$
$\curvearrowright 2680 \times 2.9 =$ 7800
$\curvearrowright 770 \times 10.7 =$ 8200
Net $38000'^{\#}$

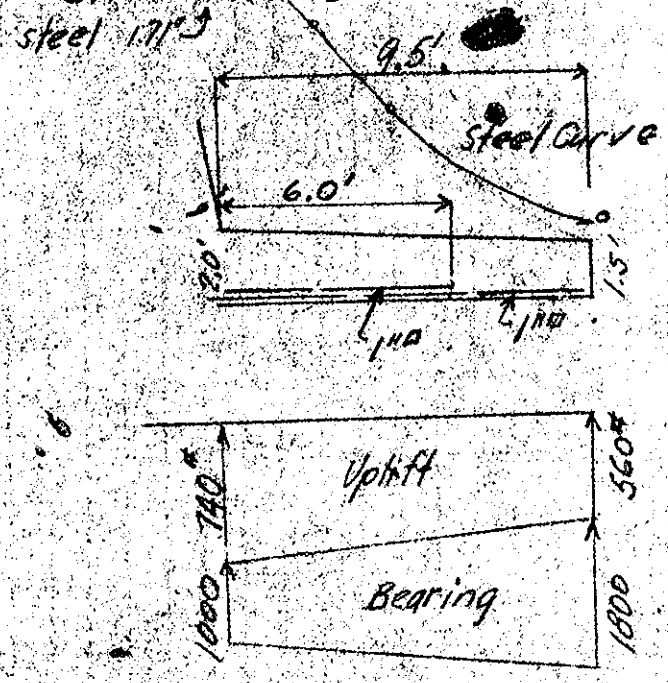
$d = \sqrt{\dfrac{38000}{123}} = 17.6''$ reqd, 20.5" furnished.

$A_s = 38000 \times 12 / 18000 \times .884 \times 20.5 = 1.42^{\square''}$

Subject: CHICOPEE - C36
Computation: 20' Wall
Computed by: RSM Checked by: W H F Date: 3-26-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

BASE-LANDSIDE



Loading ↓

Conc.	300#/□'
Earth	875
	1175#/□'

V

(1740-1175) × 9.5 =	5300 #
620 × 9.5/2	2950
	8250 #
	OK

M

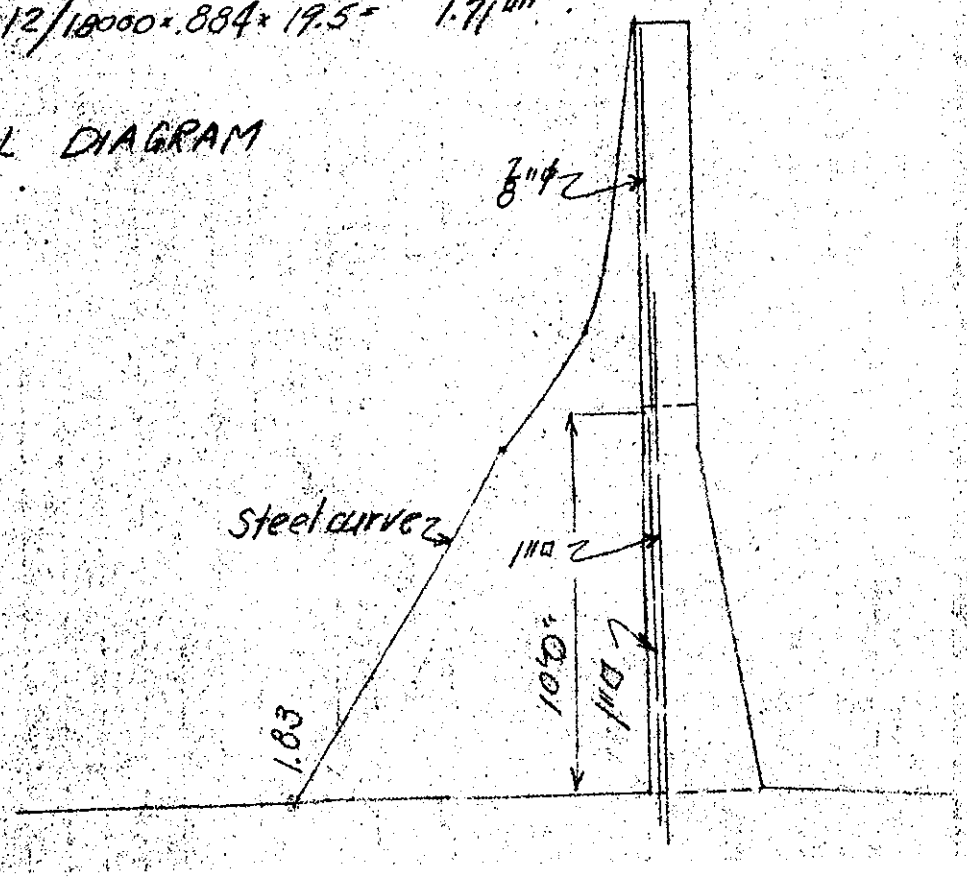
5300 × 4.75 =	25200
2950 × 6.33 =	18650
	43850

$d = \sqrt{\frac{43850}{123}} = 18.8''$ req'd.

19.5" supplied

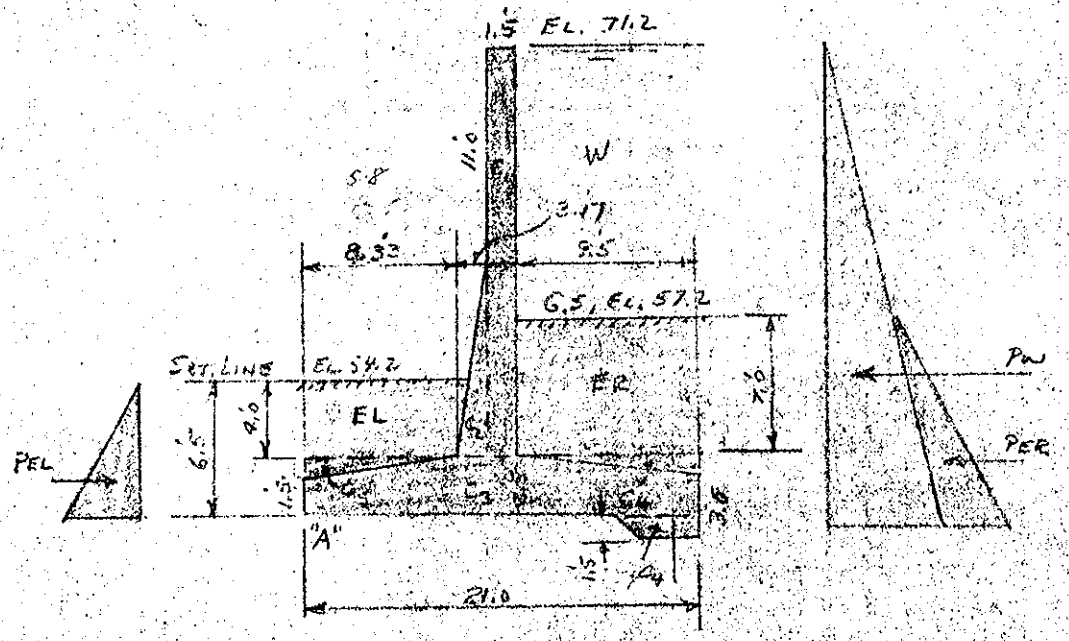
$A_s = 43850 \times 12 / 18000 \times .884 \times 19.5 = 1.71\ \square''$

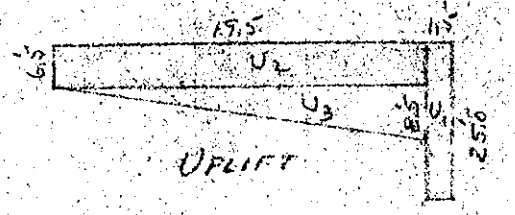
STEM STEEL DIAGRAM



Subject CHICOPEE C-36
Computation CANTILEVER WALL STEM 21.0 STA
Computed by P.L.A. Checked by W.H.F. Date 3/28/40

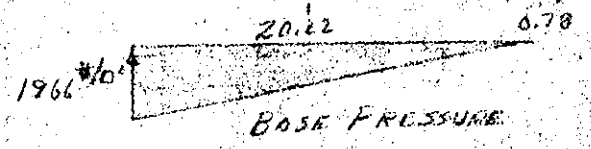
U. S. GOVERNMENT PRINTING OFFICE 3—10528



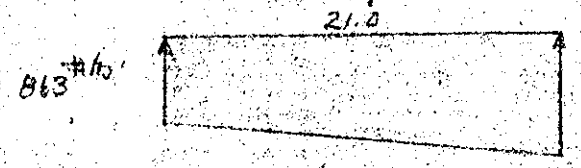


UPLIFT

CASE I



BASE PRESSURE



CASE II
No UPLIFT

BASE PRESSURES

WAR DEPARTMENT

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

Object: CHICOPEE C-36

Computation: CANTILEVER WALL STEM 21' BASE 21' STA 19+63.44 TO 19+89.44

Computed by: P.L.A. Checked by: W.H.F. Date: 3/28/40

U. S. GOVERNMENT PRINTING OFFICE 3—10028

STABILITY CASE I RIVER UP

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT 'A'	
							↻	↺
C_1	21 X1.5 X150	4720				10.75	50800	
C_2	½ X1.67X10 X150	1250				9.44	11 800	
C_3	2.5X21 X150	7870				10.5	82600	
C_4	3.25 X1.5 X 150	732				19.35	14200	
C_5	½ X1 X 8.33 X25		104			2.78		290
C_6	½ X1 X 9.5 X25		119			17.83		2120
EL	4(8.33+9 / 2) X125	4340				4.36	19000	
ER	7X9.5 X125	8300				16.25	135000	
W	14X9.5 X62.5	8300				16.25	135000	
U_1	25X1.5 X62.5		2340			20.25		47500
U_2	6.5X19.5 X62.5		7920			9.75		77300
U_3	½ X8.5X19.5X62.5		5180			13.0		67300
PW	½ X62.5 X $\overline{25}^2$				19500	6.83		133000
PER	½ X17.5 X $\overline{11}^2$				1060	2.17		2300
PEL	½ X80 X $\overline{6.5}^2$			1690		2.17	3660	
FR	0.45X19850			8930				
PR				9940		1.17	11600	
		35512	15663	20560	20560		463660	329810
		ΣV = 19849 ↓		ΣH = 0			ΣM = 133850 ↻	

⅓ BASE = 7.0'

POSITION OF RESULTANT = $\frac{\Sigma M}{\Sigma V} = \frac{133850}{19850} = 6.74$ 0.26 OUTSIDE MIDDLE THIRD

BASE PRESSURE = $\frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{19850}{20.22}\left\{\frac{2.0}{0} = 983\right\}\begin{cases} 2 = 1966 \ \#/\square' \\ 0 = 0 \ \#/\square' \end{cases}$

WAR DEPARTMENT

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

Subject: CHICOPEE C-36

Computation: CANTILEVER WALL STEM 21' BASE 21' STA. 19463.99 TO 19484.99

Computed by: P.L.A. Checked by: W.H.F. Date: 3/28/40

U.S. GOVERNMENT PRINTING OFFICE 8—10528

STABILITY CONT'D. CASE II RIVER DOWN NO UPLIFT

FORCES ACTING		↓	↑	→	←	ARM.	MOMENTS ABOUT 'A' ↷	MOMENTS ABOUT 'A' ↶
C_1		4720					50800	
C_2		1250					11800	
C_3		7870					82600	
C_4		732					14200	
C_5	$\frac{1}{2} \times 1 \times 8.33 \times 50$		208			2.78		578
C_6	$\frac{1}{2} \times 1 \times 9.5 \times 50$		238			17.83		4250
FL	$4\left(\frac{8.33+9}{2}\right) \times 100$	3470				4.36	15200	
EK	$7 \times 9.5 \times 100$	6650				16.25	108000	
PER	$\frac{1}{2} \times 35 \times \overline{11}^2$				2120	2.17		4600
PEL	$\frac{1}{2} \times 35 \times \overline{6.5}^2$			740		2.17	1610	
FR	0.45×24200			10900				
		24692	446	11640	2120		284210	9428
		$\Sigma V = 24246$ ↓		$\Sigma H = 0$			$\Sigma M = 274782$ ↷	

$\frac{1}{3}$ BASE = 7.0

4.36 INSIDE MIDDLE THIRD

$e = 11.36 - 10.5 = 0.86$

$$\text{POSITION OF RESULTANT} = \frac{\Sigma M}{\Sigma V} = \frac{275000}{24200} = 11.36'$$

$$\text{BASE PRESSURES} = \frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{24200}{21}\left(1 \pm \frac{6 \times .86}{21}\right) = 1150 \begin{cases} 1.25 = 1440 \text{ \#/□'} \\ 0.75 = 863 \text{ \#/□'} \end{cases}$$

WAR DEPARTMENT

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

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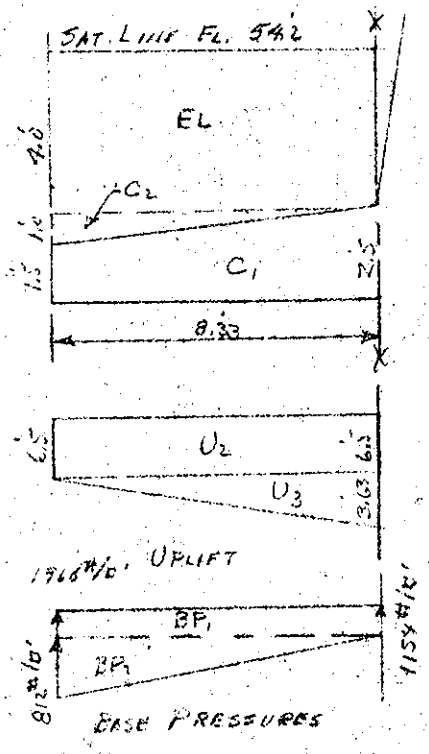
Project: CHICOPEE C-36

Computation: CANTILEVER WALL STEM 21' BASE 21' STA. 19163.99 TO 19184.99

Computed by: P.L.A. Checked by: W.H.E. Date: 3/29/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. LANDSIDE BASE BOTTOM STEEL
CASE I FILL UP



MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS
EL	4 X 8.33 X 125	4160		4.17	17400 ←
C_1	2.5 X 8.33 X 150	3120		4.17	13050 ←
C_2	½ X 1 X 8.33 X 25		104	5.55	575 →
U_2	6.5 X 8.33 X 62.5		3380	4.17	14100 →
U_3	½ X 3.63 X 8.33 X 62.5		943	2.78	2620 →
BP_1	1154 X 8.33		9610	4.17	40000 →
BP_2	½ X 812 X 8.33		3390	5.55	18800 →
		7280	17427		
		ΣV = 10147 #			ΣM = 45648 ←

$$d_{x-x}(\text{REQ'D}) = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{45648 \times 12}{123 \times 12}} = 19.3''$$

ACTUAL $d = 30 - 4.5 = 25.5''$

$$A_{s\,x-x}(\text{REQ'D}) = \frac{M}{f_s j d} = \frac{45648 \times 12}{18000 \times .884 \times 25.5} = 1.36\ \square''$$

$$\text{SHEAR}_{x-x} = \frac{V}{b_j d} = \frac{10147}{12 \times .884 \times 25.5} = 37.4\ \#/\square' < 60\ \#/\square'$$

USE 1"⌀ @ 1'-0" c.c. } ALTERNATE LEAVING
7/8"⌀ @ 1'-0" c.c. } 6" SPACING

$$\text{BOND} = \frac{V}{\Sigma_0 j d} = \frac{10147}{5.9 \times .884 \times 25.5} = 76.5\ \#/\square'' < 150\ \#/\square''$$

WAR DEPARTMENT

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

Project: CHICOPEE C-36

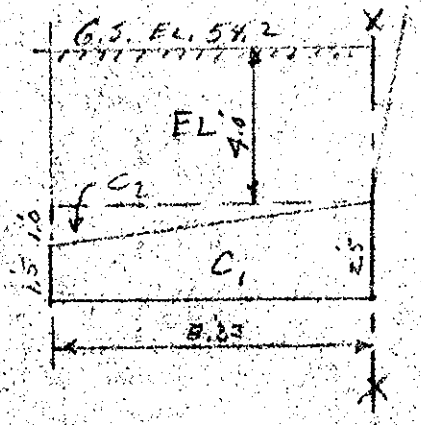
Computation: CANTILEVER WALL STEM 21' BASE 21' STA. 19462.44 TO 19489.44

Computed by: P.L.A. Checked by: W.H.F. Date: 3/29/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

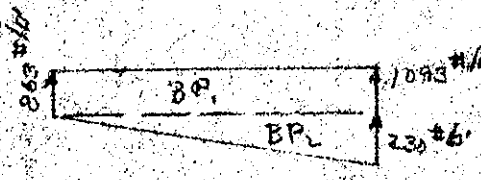
STEEL REINF. CONT'D LANDSIDE BASE TOP STEEL

CASE II RIVER DOWN NO UPLIFT



MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↷	MOMENTS ↶
EL	4 X 8.33 X 100	3330		4.17	13900	
C_1		3120				13050
C_2	½ X 1 X 8.33 X 50		208	5.55	1155	
BP_1	863 X 8.33		7190	4.17	30000	
BP_2	½ X 230 X 8.33		958	2.78	2660	
		6450	8356			
		ΣV = 1906 ↑				ΣM = 6865 ↶

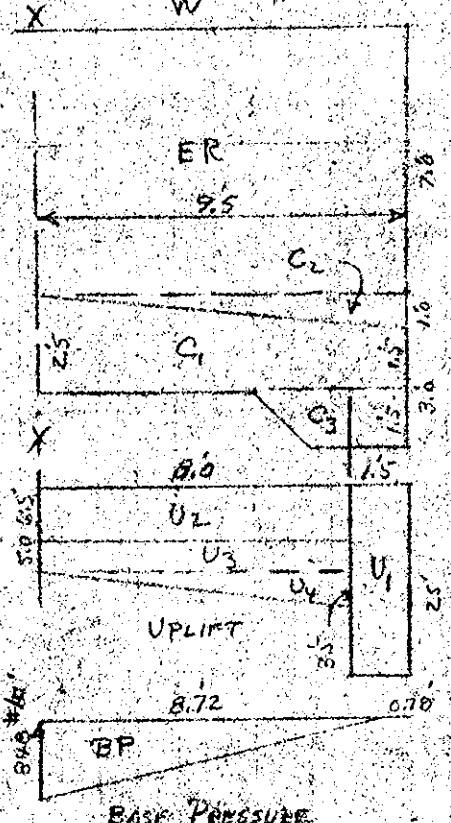


BASE PRESSURES

USE $\frac{5}{8}$" φ @ 1'-0" c.c. IN TOP

RIVERSIDE BASE TOP STEEL CASE I RIVER UP

MOMENTS ABOUT X-X



FORCES ACTING		↓	↑	ARM	MOMENTS ↷	MOMENTS ↶
ER	7 X 9.5 X 125	8320		4.75	39500	
W	14 X 9.5 X 62.5	8320		4.75	39500	
C_1	2.5 X 9.5 X 150	3560		4.75	16900	
C_2	½ X 1 X 9.5 X 2.5		119	6.33		750
C_3	3.25 X 1.5 X 150	732		7.85	5750	
U_1	1.5 X 2.5 X 62.5		2340	8.75	20500	
U_2	6.5 X 8.0 X 62.5		3250	4.0	13000	
U_3	5.0 X 8.0 X 62.5		2500	4.0	10000	
U_4	½ X 2.5 X 8.0 X 62.5		875	5.33	4660	
BP	½ X 898 X 8.72		3700	7.91	10750	
		20932	12784			
		ΣV = 8148 ↓				ΣM = 41990 ↶

$$A_{s_{X-X}}(\text{Reqd}) = \frac{M}{f_s j d} = \frac{41990 \times 12}{18000 \times .884 \times 26.5} = 1.20 \text{ □"}$$

$$\text{SHEAR}_{X-X} = \frac{8148}{12 \times .884 \times 26.5} = 29.0 \text{ #/□" < 60 #/□"}$$

USE $\frac{5}{8}$" φ @ 6" c.c.

$$\text{BOND}_{X-X} = \frac{8150}{5.5 \times .884 \times 26.5} = 63.2 \text{ #/□" < 150 #/□"}$$

WAR DEPARTMENT

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

Project CHICOPEE C-36

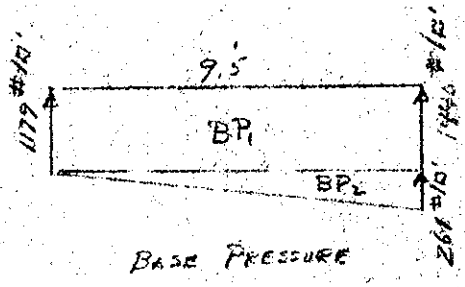
Computation CANTILEVER WALL STEM 21' BASE 21' STA. 19463.44 TO 19489.44

Computed by P.L.A. Checked by W.H.E. Date 3/29/40

U.S. GOVERNMENT PRINTING OFFICE 3—10523

STEEL REINF. CONT'D RIVERSIDE BASE BOTTOM STEEL

CASE II RIVER DOWN NO UPLIFT



BASE PRESSURE

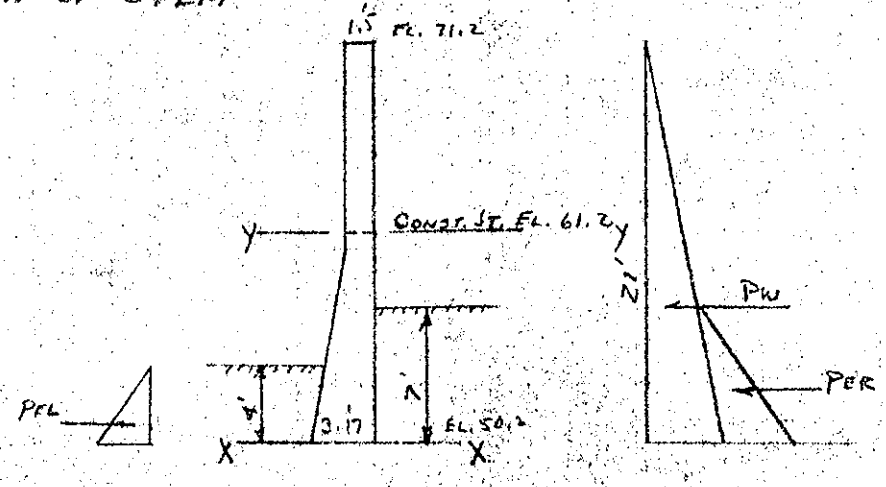
MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↷ ↶
FR	7X9.5 X100	6650		4.75	31600 ↷
C_1		3560			16900 ↷
C_2	½X1X9.5 X50		238	6.33	1510 ↶
C_3		732			5750 ↷
BP_1	1179 X 9.5		11200	4.75	53100 ↶
BP_2	½X261 X9.5		1240	6.33	7850 ↶
		10942	12678		
		ΣV=1736 ↑			ΣM=8210 ↶

$$A_{s_{X-X}}(\text{REQ'D}) = \frac{8210 \times 12}{18000 \times .884 \times 25.5} = 0.24 \text{ □''}$$

USE $\frac{5}{8}$"φ @ 1'-0" c.c. BOTTOM STEEL

DESIGN OF STEM



WAR DEPARTMENT

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

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Project CHICOPEE C-36

Computation CANTILEVER WALL STEM 21' BASE 21' STA. 19463.44 TO 19489.44

Computed by P.L.A Checked by W.H.F Date 3/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. CONT'D

CASE I RIVER UP RIVERSIDE FACE OF STEM

MOMENTS ABOUT X-X

FORCES ACTING		→	←	ARM	MOMENTS ↷	MOMENTS ↶
PW	$\frac{1}{2} \times \bar{21}^2 \times 62.5$		13800	7.0		96500
PER	$\frac{1}{2} \times 17.5 \times \bar{7}^2$		430	2.33		1000
PEL	$\frac{1}{2} \times 80 \times \bar{4}^2$	640		1.33	850	
		640	14230		850	97500
		ΣV = 13590 ←			ΣM = 96650 ↶	

$$d_{x-x}(\text{Req'd}) = \sqrt{\frac{M}{Rb}} = \sqrt{\frac{96650 \times 12}{123 \times 12}} = 28.0''$$

ACTUAL d = 30.0 − 3.5 = 34.5"

$$A_{s_{x-x}}(\text{Req'd}) = \frac{M}{f_s j d} = \frac{96650 \times 12}{18000 \times .884 \times 34.5} = 2.12 \square''$$

$$\text{SHEAR}_{x-x} = \frac{V}{bjd} = \frac{13590}{12 \times .884 \times 34.5} = 37^{\#}/\square'' < 60^{\#}/\square''$$

USE 1" □ @ 1'-0" c.c. / 1 1/8" □ @ 1'-0" c.c. } ALTERNATE LEAVING 6" SPACING.

$$\text{BOND}_{x-x} = \frac{\Sigma V}{\Sigma o j d} = \frac{13590}{8.5 \times .884 \times 34.5} = 52.9^{\#}/\square'' < 150^{\#}/\square''$$

WAR DEPARTMENT

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

ct CHICOPEE C-3b

nputation CANTILEVER WALL STEM 21' BASE 21' 19+63.44 TO 19+89.44

nputed by P.L.A. Checked by W.H.F. Date 3/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. CONT'D

CASE I RIVER UP RIVERSIDE FACE OF STEM

MOMENTS ABOUT Y-Y

FORCES ACTING		←	ARM	MOMENT
PW	$\frac{1}{2} \times 62.5 \times 10^2$	3125	3.33	10400 ↶

d_{y-y} (REQ'D) $= \sqrt{\frac{10400}{123}} = 9.2''$ ACTUAL $d = 14.5''$

$A_{s_{y-y}}$ (REQ'D) $= \frac{10400 \times 12}{18000 \times .884 \times 14.5} = 0.55^{\square''}$

USE $\frac{7}{8}''\phi$ @ 1'-0" c.c.

IN LANDSIDE FACE USE $\frac{5}{8}''\phi$ @ 1'-0" c.c.

WAR DEPARTMENT

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

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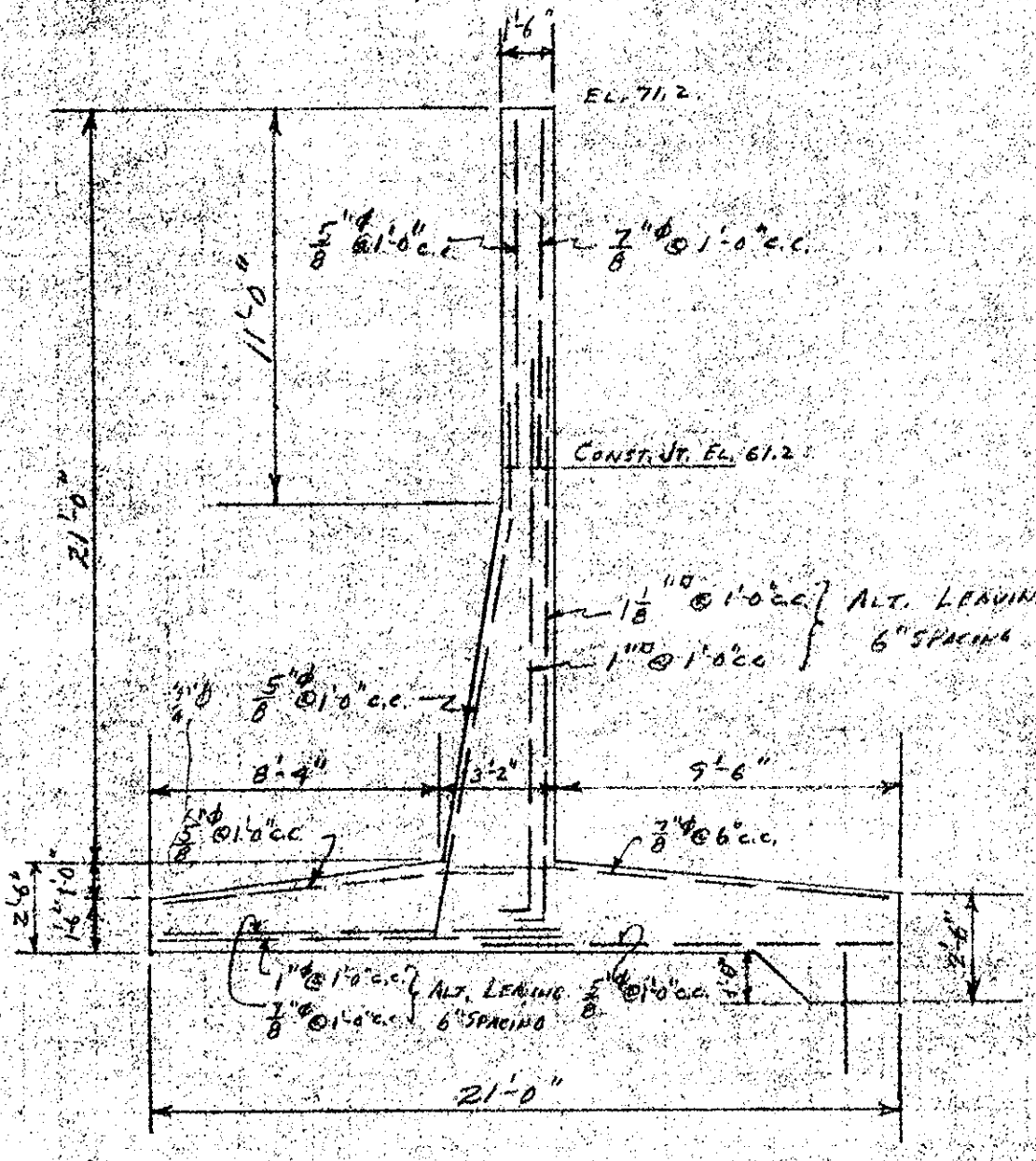
ect CHICOPEE C-3b

mputation CANTILEVER WALL STEM 21' BASE 21' STA. 19+63.44 TO 19+84.44

mputed by P.L.A. Checked by W. H. F. Date 3/29/40

U.S. GOVERNMENT PRINTING OFFICE 3—10628

STEEL AS DESIGNED



ALL LONGITUDINAL TEMPERATURE STEEL 1/2"□ @ 1'-0" c.c.

WAR DEPARTMENT

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

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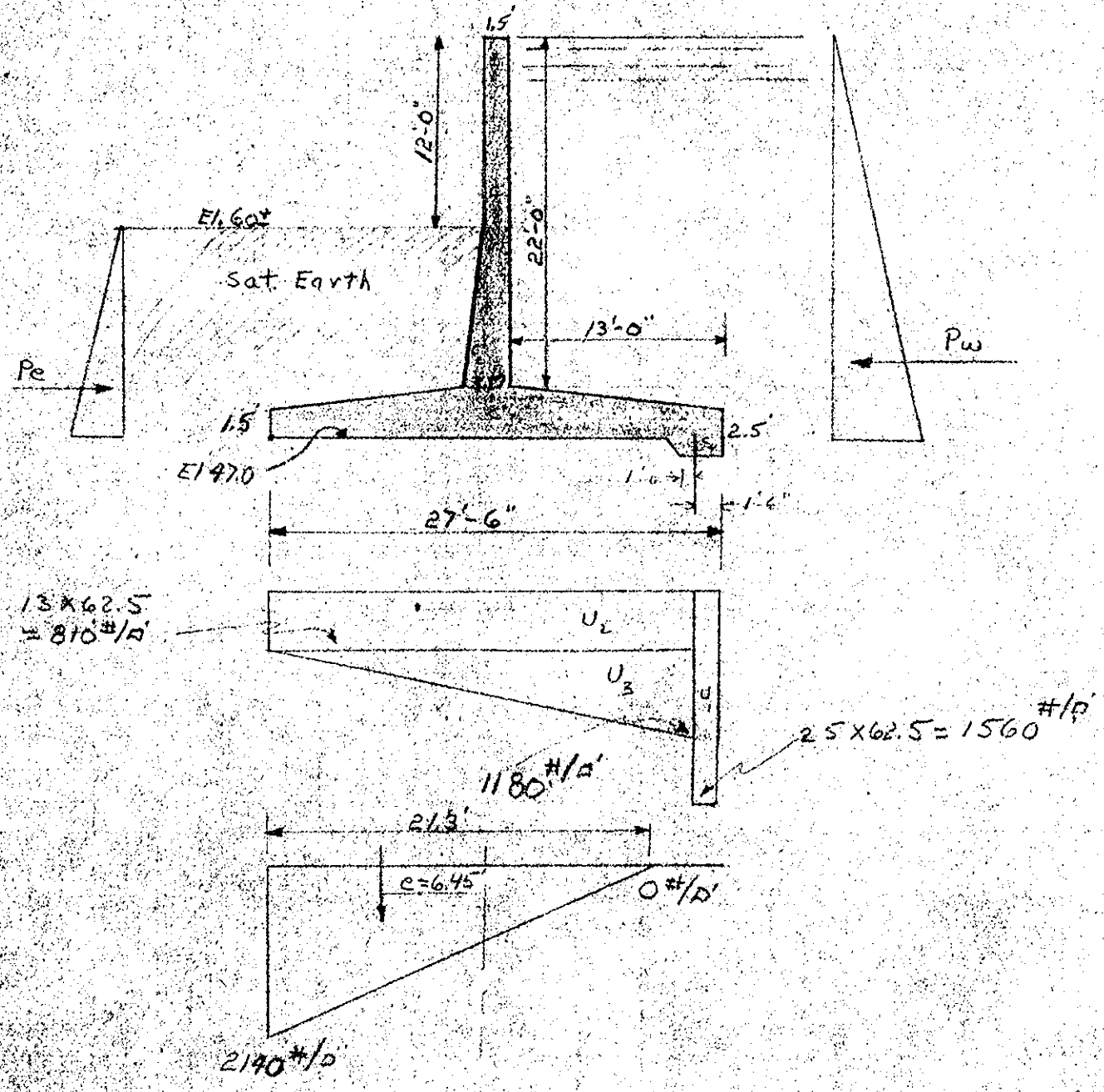
Project Chicopee Mass. C-3b

Computation 22'-0" Wall on Earth

Computed by M. S. Jr. Checked by [illegible] Date 1/16/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

Project Chicopee Mass. C3b

Computation 22'-0" Wall on Earth

Computed by W. S. Jr. Checked by J. H. S. Date 1/17/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

FORCES ACTING	↓	↑	→	←	ARM	MOMENTS AT "A" ↻	MOMENTS AT "A" ↺
C_1 22'×1.5×150'	4950'				13.75'	68,000'	
C_2 10'×1.7'×½×150'	1275'				12.44'	15,850'	
C_3 2.25×27.5×150	9300'				13.75'	128,000'	
C_4 1×3×150'	450'				26.0'	11,700'	
W 22.75'×13'×62.5'	18,500'				21.0'	389,000'	
E_1 12.25'×10.75×125'	16,500'				6.12'	101,000'	
P_W 25²×½×62.5'				19,500'	8.33'		162,500'
P_e 13²×½×80'			6800'		4.34'	29,500'	
U_1 1560'×1.5'		2340'			26.75'		62,500'
U_2 810'×26'		21,000'			13.0'		273,000'
U_3 370'×26'×½'		4810'			17.3'		83,050'
Friction 22,825×.45			10,300				
Passive Pressure			2,400				
	50,975'	28,150'	19,500	19500		743,050'	581,000'
	ΣV = 22,825'		ΣH = 0			ΣM = 162,050'	

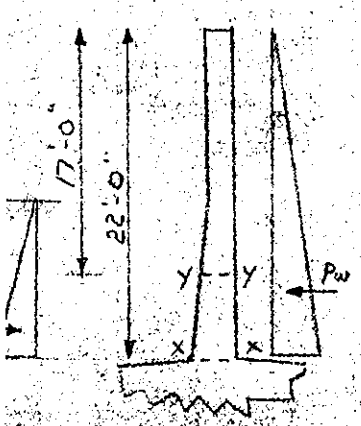
$$\frac{\Sigma M}{\Sigma V} = 7.1' \quad \text{O.K.}$$

$$\text{Bearing} = \frac{22,825}{3 \times 7.1} \times \begin{matrix} 2 \\ 0 \end{matrix} = \begin{matrix} 2140 \\ 0 \end{matrix} \ \#/\square'$$

Resultant falls outside middle third, but bearing pressure is low, and the extreme tailwater condition may never occur.

ct Chicopee Mass C3b
nputation 22'-0" Wall on Earth
nputed by M.S.J. Checked by J.H.T. Date 1/18/40

U. S. GOVERNMENT PRINTING OFFICE 3—10526



te
mit Pe when
esigning river-
de steel.

Design of Stem

Riverside

Moment at X-X

$22^2 \times \frac{1}{2} \times 62.5 = 15{,}100 \times 7.34 = 111{,}000'^{\#}$

$\text{Shear} = \frac{15{,}100}{12 \times 35 \times .884} = 40^{\#/\square''}$ o.k.

$A_s = \frac{111{,}000 \times 12}{18000 \times .884 \times 35} = \frac{1{,}330{,}000}{556{,}000} = 2.39^{\square''}$

Use $1\frac{1}{8}''\square$ @ 6" cc Bond & Shear O.K.

Moment at Y-Y

$17^2 \times \frac{1}{2} \times 62.5 = 9050 \times 5.66 = 51{,}200'^{\#}$

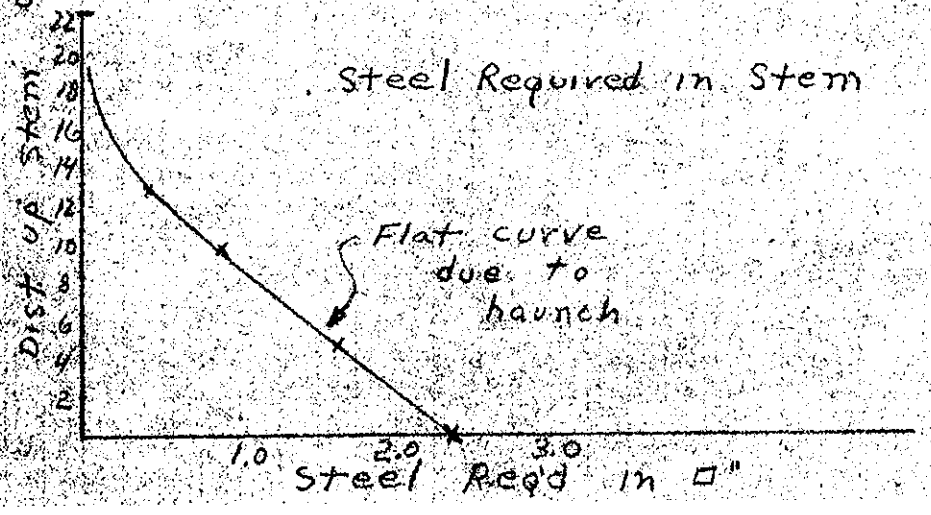
$A_s = \frac{51{,}200 \times 12}{18000 \times .884 \times 25} = 1.55^{\square''}$

Landside

$10^2 \times \frac{1}{2} \times 80 = 4000 \times 3.33 = 13{,}300'^{\#}$

$A_s = \frac{13{,}300 \times 12}{18000 \times .884 \times 35} = .28^{\square''}$

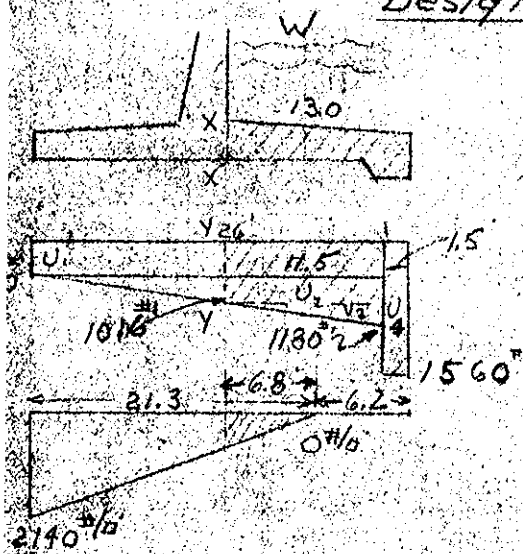
$\frac{5}{8}''\phi$ Temp steel will be o.k. in landside.



ct Chicopee Mass C3b
nputation 22'-0" Wall
nputed by W. S. J. Checked by J. H. J. Date 7/18/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Base



Riverside

$W = 13' \times 22.75' \times 62.5' = 18500 \times 6.5 = 120{,}000'^{\#}$

$C_1 = 13' \times 2.25' \times 150' = 4{,}400' \times 6 = 26{,}400'^{\#}$

$C_2 = 3' \times 1' \times 150 = 450 \times 11.5 = 5{,}200'^{\#}$

$23{,}350^{\#}$ $151{,}600'^{\#}$

$B = 680 \times \frac{1}{2} \times 6.8 = 2300 \times 2.26 = 5{,}200^{\#}$

$U_1 = 810 \times 11.5 = 9310 \times 5.75 = 53{,}500^{\#}$

$U_2 = 206 \times 11.5 = 2370 \times 5.75 = 13{,}600^{\#}$

$U_3 = 164 \times \frac{1}{2} \times 11.5 = 944 \times 7.60 = 7{,}190^{\#}$

$U_4 = 1.5 \times 1560 = 2340 \times 12.25 = 28{,}700^{\#}$

$17{,}260$ $108{,}190$

$\Sigma V = 6{,}090$ $\Sigma M = 43{,}410'^{\#}$

$$\text{Shear} = \frac{6090}{12 \times 31.5 \times .884} = 18^{\#}/\square'' \text{ O.K.}$$

$$A_s = \frac{43{,}410 \times 12}{18000 \times .884 \times 31.5} = 1.04 \ \square''$$

Use 1"□ @ 1'-0" cc.

Bond is O.K.

WAR DEPARTMENT

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

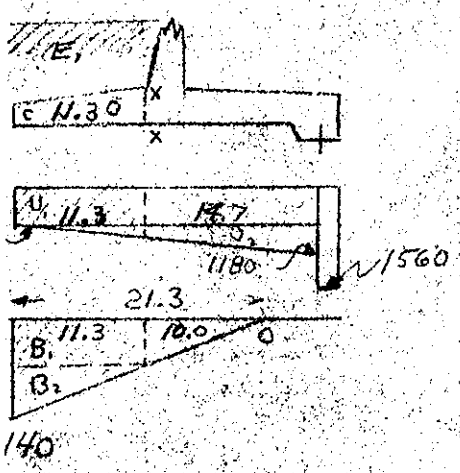
ject Chicopee Mass C3b

nputation 22'-0" Wall

nputed by W.S.J. Checked by J.H.L. Date 1/18/40

U. S. GOVERNMENT PRINTING OFFICE 2—10528

Design of Base



Landside

Moment at x-x

$E_1 = 11.3 \times 10.75 \times 125 = 15{,}200 \times 5.65 = 86{,}000'\#$

$C = 2.25 \times 11.3 \times 150 = 3{,}810 \times 5.5 = 21{,}000'\#$

$19{,}010\# \downarrow \qquad 107{,}000'\#$

$U_1 = 810 \times 11.3 = 9150 \times 5.65 = 51{,}700'\#$

$U_2 = 160 \times 11.3 \times 1/2 = 900 \times 3.8 = 3{,}400'\#$

$B_1 = 7000 \times 11.3 = 11{,}300 \times 5.65 = 63{,}900'\#$

$B_2 = 2140 \times 1/2 \times 11.3 = 12{,}100 \times 7.5 = 90{,}800'\#$

$33{,}450\# \uparrow \qquad 209{,}800'\#$

$\Sigma V = 14{,}400\# \uparrow \qquad \Sigma M = 103{,}000'\#$

$$\text{Shear} = \frac{14{,}400}{12 \times 31.5 \times .884} = 43\#/\square'' \quad \text{O.K}$$

$$A_s = \frac{103{,}000 \times 12}{18000 \times .884 \times 31.5} = 2.47\ \square'' \text{ in bottom}$$

Use $1\frac{1}{8}''\square$ @ 6" cc

Bond is O.K.

WAR DEPARTMENT

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

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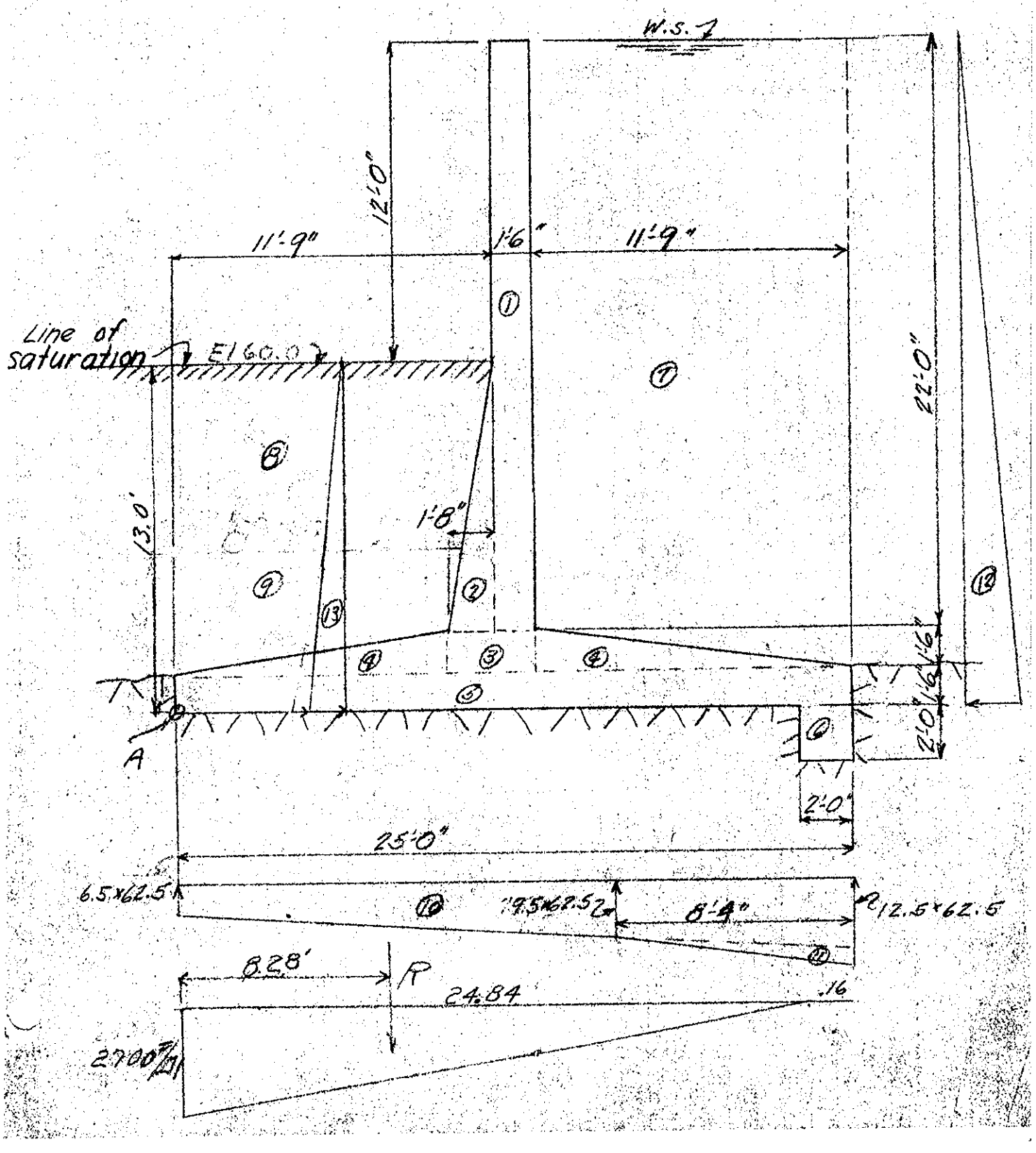
Project: CHICOPEE C3B

Computation: 22' Wall

Computed by: RSM Checked by: J.H.L. Date: 1-10-40

U. S. GOVERNMENT PRINTING OFFICE S—10528



WAR DEPARTMENT

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

Subject: Chicopee C 3b

Computation: 22' Wall

Computed by: K.W. Checked by: J.H.L. Date: 1-17-39

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY

	Force		↓ ↑	← →	Arm	Moment ↻	Moment ↺
C_1	150 × 1.5 × 2.2	↓	4950		12.5	62,000	
C_2	150 × 1.7 × 10 × ½	↓	1280		11.1	14,200	
C_3	150 × 3.2 × 1.5	↓	720		11.7	8,450	
C_4	150 × 1.5 × 21.8 × ½	↓	2450		12.4	30,400	
C_5	150 × 1.5 × 25	↓	5620		12.5	70,400	
C_6	150 × 2 × 2	↓	600		24.0	14,400	
W_7	62.5 × 11.75 × 22.75	↓	16,700		19.2	321,200	
E_8	125 × 10 × 11.4	↓	14,250		5.6	80,000	
E_9	125 × 10.1 × 1.5 × ½	↓	950		3.3	3,140	
U_{10}	65 × 62.5 × 25	↑	10,160		12.5		127,000
	62.5 × 4.5 × 25 × ½	↑	3520		16.7		58,800
U_{11}	62.5 × 8.33 × 1.5 × ½	↑	390		22.1		8,620
P_{W12}	62.5 × 25² × ½	←		19,500	8.3		161,700
P_{E13}	13² × ½ × 80	→		6,750	4.3	29,000	
			↓ 33,450	← 12,750		633,190	356,120
						ΣM = 277,000 ↻	

Position of Resultant $\frac{\Sigma M}{\Sigma V} = \frac{277,000}{33\,450} = 8.28$ Third Point at 8.33

Bearing $e = 12.5 - 8.28 = 4.22$

$b = \frac{33260}{25}\left(1 \pm \frac{6 \times 4.22}{25}\right) = 2700\ \#/\square'$ to zero

WAR DEPARTMENT

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

Project: CHICOPEE C36

Computation: 22' Wall

Computed by: RSM Checked by: J.H.L. Date: 1-10-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEM -

Water up

h	V $wh^2/2$ #	v V/bjd #/□"	M→ ←M $V \times h/3$ '#	As $M/A_s jd$ □"	fc #/□"
8'	2000'	13'	5300'	.28'	
12'	4500'	29'	18000	.94'	
16'	8000'	33'	42600'	350 1.42'	
19'	11300'	36'	71500'	2000 1.83	
22'	15100'	41'	110500'	6000 2.42 -	575

Water down - earth saturated

12'	0'				
16'	640'		860	—	
19'	1960'		4570'	.12'	
22'	4000'		13330'	.29'	

Note: These figures are practically the same as those obtained by assuming full saturation of backfill.

WAR DEPARTMENT

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

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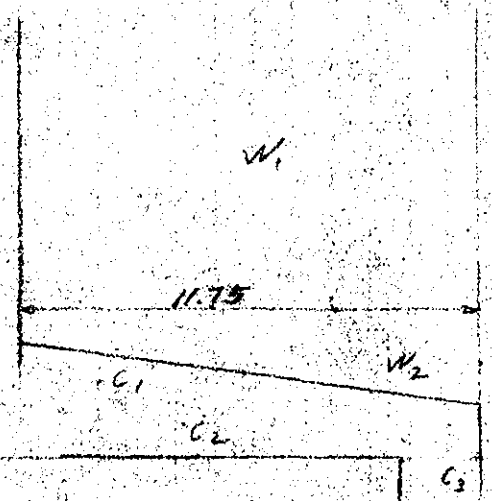
Project: Chicopee Dike C3b

Computation: 22' Wall

Computed by: R.W. Checked by: J.H.L. Date: 1-16-40

U. S. GOVERNMENT PRINTING OFFICE 3—10628

At Face, Design of River Side of Base, Water Up (Revised for raised Saturation Line)



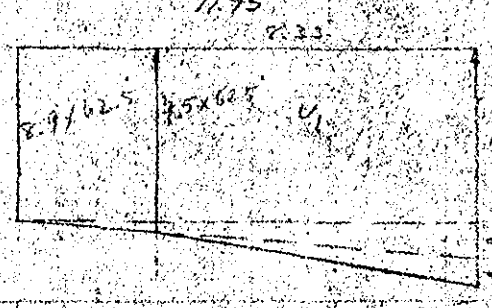
			Arm.	↷	↶
W_1 =	22 x 11.75 x 62.5	16,250	5.9'	96,000'	
W_2 =	1.5 x 11.75 x ½ x 62.5	550'	7.8'	4,240'	
C_1 =	11.75 x 1.5 x ½ x 150	1325'	3.9'	5,170'	
C_2 =	11.75 x 1.5 x 150	2640'	5.9'	15,580'	
C_3 =	2 x 2 x 150	600'	10.8'	6,480'	
U_1 =	62.5 x 11.75 x 8.9	6530	5.9'		38,500'
U_2 =	62.5 x 11.75 x 2.1 x ½	772	7.8'		6020'
U_3 =	8.33 x 1.5 x ½ x 62.5	390	9.0'		3510'
b =	12.70 x 11.75 ½	7470	3.9		29,100'
				127,470	77,130
				ΣM =	50,340'# ↶

$$A_s = \frac{50,340 \times 12}{18,000 \times .884 \times 32.5} = 1.17 \text{ sq. in.}$$

V = O.K.

v = O.K.

1.17 sq. in. - use $1\frac{1}{8}$"□ @ 12" - gives 1.27□" in top

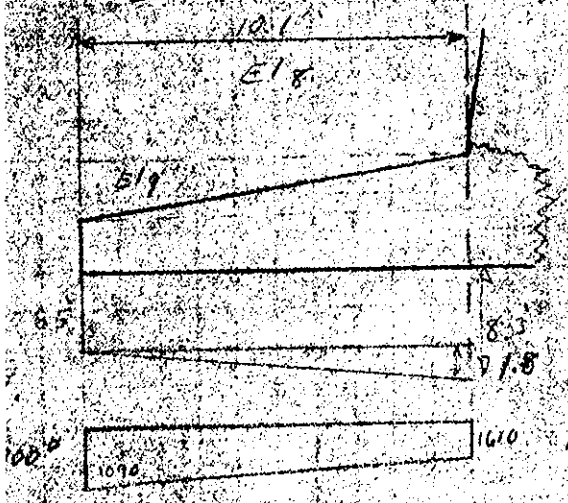


1270

CHICOPEE C36
Computation 22" Wall
Computed by R.W. Checked by J.H.L. Date 1-16-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Land Side of Slab. Water Up



		↓↑	Arm	Moment	
El 8	125 × 10 × 10.1	↓ 12600	5.0'		63,000
El 9	125 × 10.1 × 1.5 × ½	↓ 946	6.7		6340
C4	150 × 1.5 × 10.1 × ½	↓ 1135	3.4		3860
C5	150 × 1.5 × 10.1	↓ 2270	5.0'		11350
U1	6.5 × 10.1 × 62.5	↑ 4110	5.0'	20,550	
U2	1.8 × 10.1 × ½ × 62.5	↑ 570	3.4	1,940	
b1	1610 × 10.1	↑ 16270	5.0'	81,350	
b2	1090 × 10.1 × ½	↑ 5500	6.7	36,900	
				140,740	84,550

ΣM = 56,190 ft#

$A_s = \frac{56,190 \times 12}{18,000 \times .884 \times 31.5} = 1.35$ □"

Use 1" φ @ 6" o.c. (gives 1.58 □") in bottom

v - OK

WAR DEPARTMENT

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

Project: CHICOPEE C-38

Computation: 22'-0 WALL

Computed by: E.H.V. Checked by: J.H.L. Date: 1-20-40

U. S. GOVERNMENT PRINTING OFFICE 3—10536

STABILITY CASE II River down – sat. earth

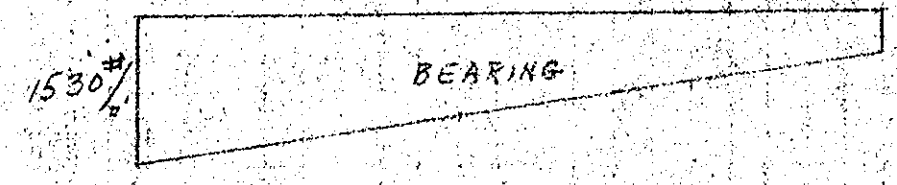
FORCE	↓	↑	→	←	ARM	MOMENTS ↻	MOMENTS ↺
C_1	4950				12.5	62000	
C_2	1280				11.1	14200	
C_3	720				11.7	8450	
C_4	2450				12.4	30400	
C_5	5620				12.5	70400	
C_6	600				24.0	14400	
E_8	14250				5.6	80000	
E_9	950				3.3	3140	
U $6.5 \times 62.5 \times \frac{1}{2} \times .25$		5080			8.33		42300
P_{E13}			6750		4.3	29000	
	$\Sigma V = 25740$ ↓					311,990 #	42,300 #

$\Sigma M = 269,690$ # ↻

$$\frac{\Sigma M}{\Sigma V} = \frac{269,690}{25740} = 10.47'$$

$$e = 12.5' - 10.47' = 2.03''$$

$$\underline{\text{Bearing}} = \frac{25,740}{25}\left(1 \pm \frac{6 \times 2.03}{25}\right) = 1030 \begin{cases} 1.486 \\ .514 \end{cases} =$$



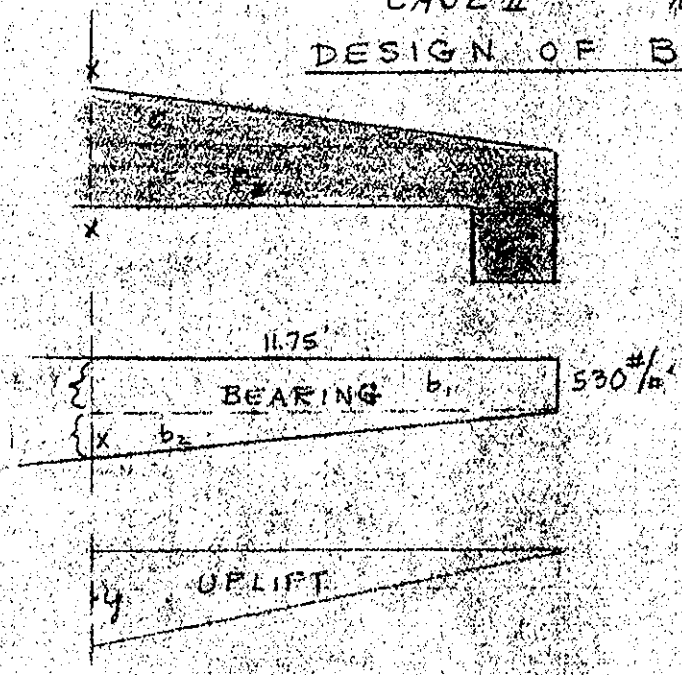
STEM DESIGN: See Case I River up.

Project: CHICOPEE C-3b
Computation: 22'-0" Wall
Computed by: E.H.V. Checked by: J.H.L. Date: 1-20-40

U. S. GOVERNMENT PRINTING OFFICE 8—10228

CASE II River down - sat. earth

DESIGN OF BASE RIVERSIDE



$$\frac{x}{1000} = \frac{11.75}{25}$$

$$x = 470$$

$$\frac{y}{(6.5 \times 62.5)} = \frac{11.75}{25}$$

$$y = 191$$

FORCE	↓	↑	→	←	ARM	MOMENT ↻	MOMENT ↺
C_1	1325				3.9	5,170'	
C_2	2640				5.9	15,580'	
C_3	600				10.8	6480	
$b_1 = 530 \times 11.75$		6230			5.88		36,600'
$b_2 = \frac{1}{2} \times 470 \times 11.75$		2760			3.92		10,820
$U = \frac{1}{2} \times 191 \times 11.75$		1120			3.92		4400'

$\Sigma V = 5545$ ↓ $\Sigma M = 24590'$ ↺

$$A_s = \frac{24590 \times 12}{18{,}000 \times .884 \times 31.5} = .589 \text{ sq in. required}$$

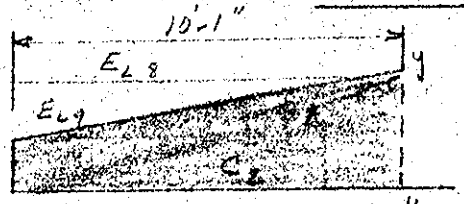
Use $\frac{7}{8}$" ϕ @ 1'-0" c.c. in bottom giving .60 sq.in.

Project CHICOPEE C-36
Computation 22'-0" WALL
Computed by E.H.V. Checked by J.H.L. Date 1-20-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

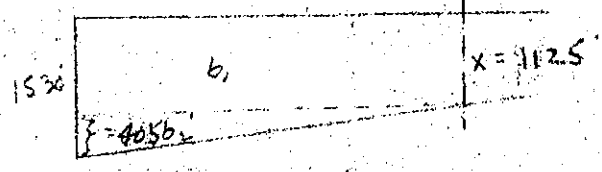
CASE II River down - sat. earth

DESIGN OF BASE LANDSIDE



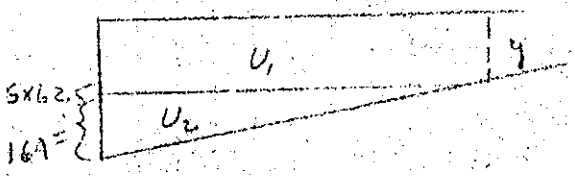
$$\frac{x'}{1080} = \frac{14.9}{25}$$

$x = 595 + 530 = 1125'$



$$\frac{y}{(6.5 \times 62.5)} = \frac{14.9}{25}$$

$y = 242$



FORCE	↓	↑	→	←	ARM	MOMENT ↻	MOMENT ↺
$C_1 = 1.5 \times 10.1 \times \frac{1}{2} \times 150$	1135				3.4	3860	
$C_2 =$	2270				5.0	11350	
E_{L8}	12600				5.0	63000	
E_{L9}	946				6.7	6340	
$b_1 = 1125 \times 10.1$		11380			5.0		56850
$b_2 = \frac{1}{2} \times 405 \times 10.1$		2050			6.7		13730
$U_1 = 242 \times 10.1$		2442			5.0		12220
$U_2 = \frac{1}{2} \times 164 \times 10.1$		828			6.7		5550
	16951	16700				84550	88350

$\Sigma V = 251^{\#}$ $\Sigma M = 3800'^{\#}$ ↺

$$A_{s_{y-y}} = \frac{3800 \times 12}{18{,}000 \times .884 \times 31.5} = .09 \text{ sq. in.}$$

Case I is worse case use $\frac{5}{8}''\phi$ in bottom @ 6'-0" c.c
minimum steel

WAR DEPARTMENT

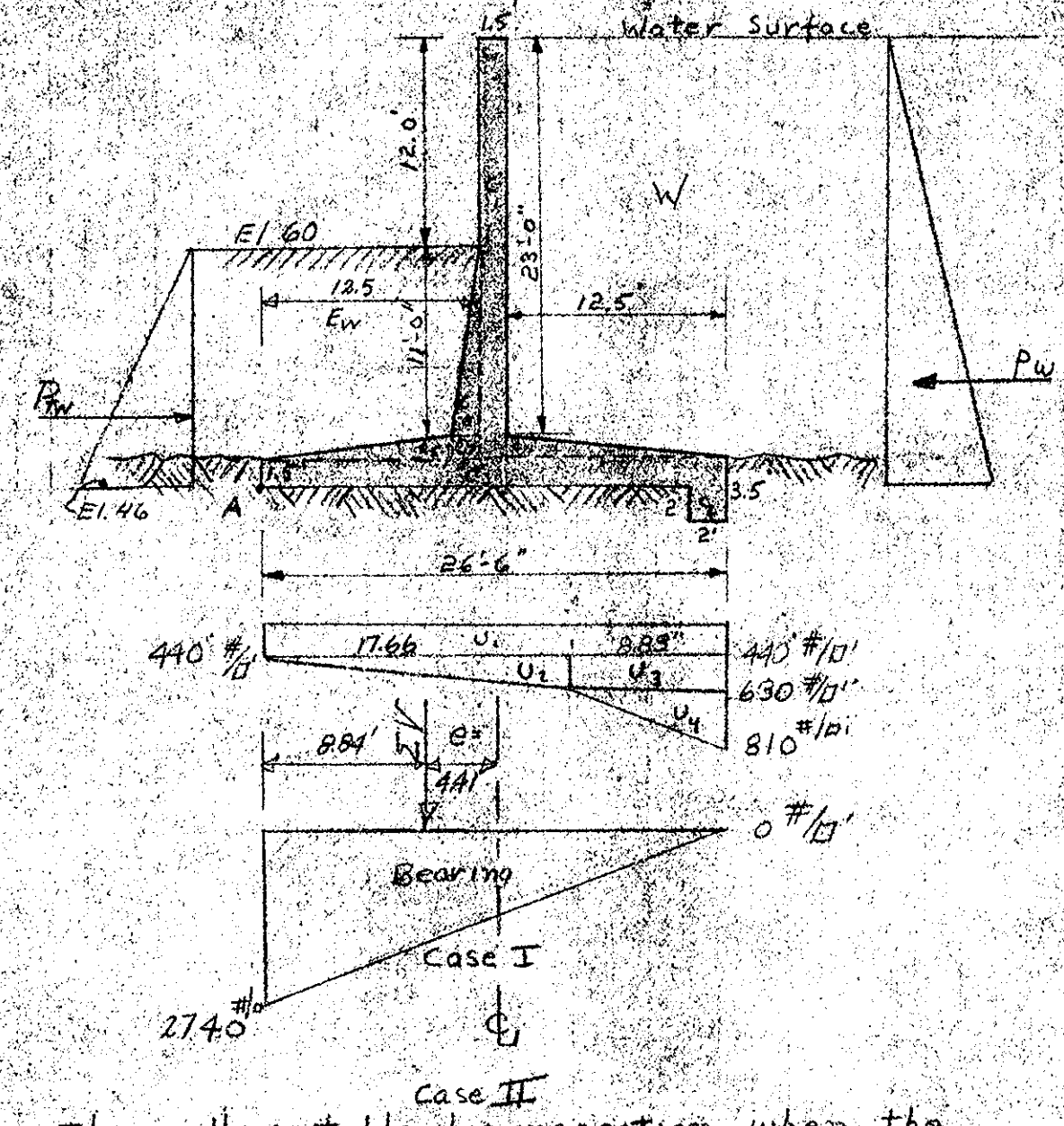
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Project Chicopee Mass C-3 b

Computation 23'-0" Wall on Rock

Computed by M. S. J. Checked by Date 1/11/40

U. S. GOVERNMENT PRINTING OFFICE 2—10628



The wall is stable by inspection, when the river is down.

WAR DEPARTMENT

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

Project: Chicopee Mass. C-3b

Computation: 23'-0" wall on Rock : Stability

Computed by: R.H.M. Checked by: J.H.S. Date:

Earth saturated to El. 60± River up.

U. S. GOVERNMENT PRINTING OFFICE 3—10628

Forces Acting		↓	↑	←	→	Arm	Moments about "A" ↻	Moments about "A" ↺
C_1	1.5'x 24.5'x150	5510'				13.25'	73010'	
C_2	2'x11'x½x 25'	280'				11.83'	3310'	
C_3	1.5'x26.5'x150'	5960'				13.25'	78970'	
C_4	1.5'x 12.5'x½x87.5'	820'				18.17'	14900'	
C_5	1.5'x10.5'x½x25'	200'				7.00'	1400'	
C_6	2'x2'x 150	600'				25.5'	15300'	
C_7	1.5'x2'x 25'	80'				11.5'	920'	
W	12.5'x24.5'x62.5'	19140'				20.25'	387,590'	
E_w	12.5'x12.5'x125'	19530'				6.25'	122,060'	
U_1	440'x 26.5'		11660'			13.25'		154500'
U_2	190'x½x17.66'		1680'			11.77'		19770'
U_3	190'x 8.83'		1680'			22.08'		37090'
U_4	180'x½x8.83'		800'			23.56'		18850'
P_w	26²'x½x62.5'			21130'		8.66'		182990'
P_w	14²'x½x 80'				7840'	4.66'	36530'	
		52120'	15820'	21130'	7840'		733990'	413200'
		$\Sigma V = 36300'$ #↓		$\Sigma H = 13290'$ #←			$\Sigma M = 320,790'$ #↻	

$$\frac{\Sigma M}{\Sigma V} = \frac{320,790}{36300} = 8.84'' \qquad \frac{1}{3}\text{ Base} = 8.83'' \quad \text{OK}$$

$$e = 13.25 - 8.84 = 4.41''$$

$$\text{Bearing} = \frac{36300}{26.5} \begin{cases} 2 \\ 0 \end{cases} = 1370 \begin{cases} 2 = 2740\ \#/\square' \text{ Landside} \\ 0 = 0\ \#/\square' \text{ Riverside} \end{cases}$$

OK by inspection against sliding.

WAR DEPARTMENT

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

Chicopee Mass. C-3b

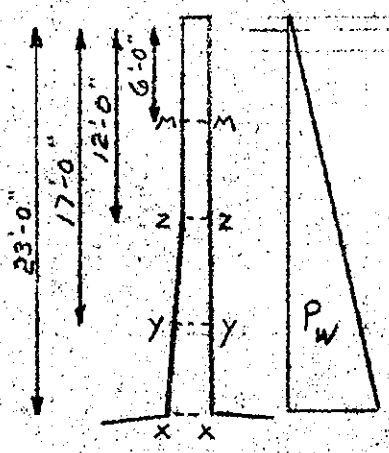
Computation 23'-0" Wall on Rock

Computed by M. S. J. Checked by R.H.M. Date 1/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of stem (Riverside)

(Omit earth on landside)



Moment at x-x

$23^2 \times \frac{1}{2} \times 62.5 = 16{,}500 \quad \times 7.66 = 127{,}000'^{\#}$

$d_{required} = \sqrt{\frac{127{,}000 \times 12}{123 \times 12}} = \underline{32''}$

$d_{provided} = 40'' - 3.5 = \underline{36.5''}$ OK

$\text{Shear} = \frac{16500}{36.5 \times 12} = 37.7^{\#/\square''}$ O.K.

$A_s = \frac{127{,}000 \times 12}{18000 \times .884 \times 36.5} = \frac{1{,}525{,}000''^{\#}}{580{,}000} = 2.63^{\square''}$

Use $1\frac{1}{8}''^{\square}$ @ 6" cc; slightly small but O.K.

Bond O.K.

Moment at y-y

$17^2 \times \frac{1}{2} \times 62.5 = 9{,}020 \quad \times 5.66 = 51{,}000'^{\#}$

$d_{provided} = 28'' - 3.5'' = \underline{24.5''}$ O.K.

Shear O.K.

$A_s = \frac{51{,}000 \times 12}{18000 \times .884 \times 24.5} = \frac{612{,}000''^{\#}}{390{,}000} = \underline{1.57^{\square''}}$

Bond & shear O.K.

Moment at z-z

$12^2 \times \frac{1}{2} \times 62.5 = 4500 \quad \times 4 = 18{,}000'^{\#}$

$d_{provided} = 18'' - 3.5 = 14.5''$

$A_s = \frac{18{,}000 \times 12}{18000 \times .884 \times 14.5} = .94^{\square''}$

Bond & shear O.K.

Project: Chicopee Mass C3b
Computation: 23'-0" Wall
Computed by: W. S. J. Checked by: R.H.M. Date: 1/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10818

Design of stem (cont'd.)

Moment at M-M

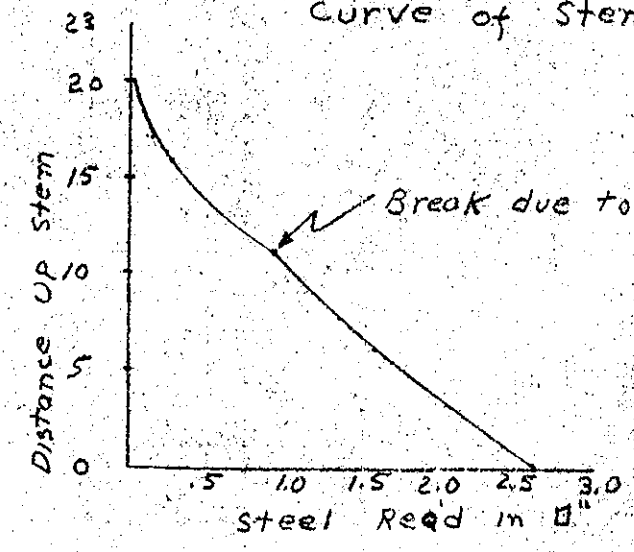
$6^2 \times \frac{1}{2} \times 62.5 = 1125 \times 2 = 2250$ #

$d_{provided} = 14.5''$

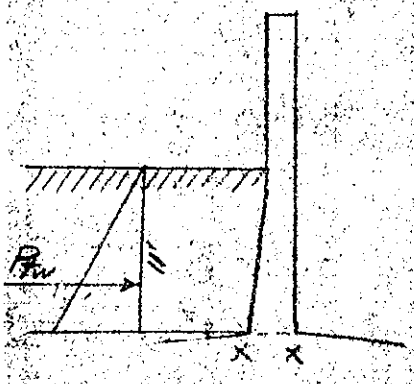
$A_s = \frac{2250 \times 12}{18000 \times .884 \times 14.5} = .118 \square''$

Shear & Bond O.K.

Curve of Stem Steel



Design of stem (Landside)



$P_{tw} = 11^2 \times \frac{1}{2} \times 80 = 4840 \times 3.67 = 17760$ #

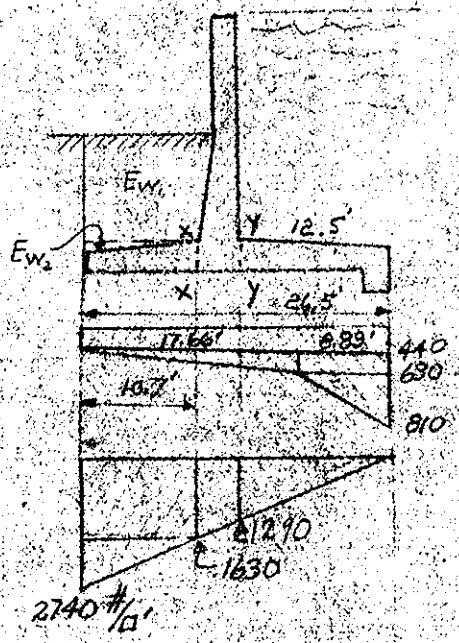
$A_s = \frac{17760 \times 12}{18000 \times .884 \times 36.5} = .38 \square''$

Use $\frac{3}{4}''\phi$ @ 12" c.c.

Project: Chicopee, Mass. C-3b
Computation: 23'-0" Wall.
Computed by: W. S. J. Checked by: Date: 1/12/40

U. S. GOVERNMENT PRINTING OFFICE 2—10538

Design of Base



Landside Base

Moment at X-X

$E_{W_1} = 14.0 \times 10.7 \times 125 = 14710 \times 5.35 = 78700$ '#
$E_{W_2} = 1.5 \times 10.7 \times \frac{1}{2} \times 125 = 1000 \times 7.12 = 7120$ '#
$C_1 = 1.5 \times 10.7 \times 150 = 2400 \times 5.35 = 12,850$ '#
$C_2 = 1.5 \times 10.7 \times \frac{1}{2} \times 150 = 1200 \times 3.56 = 4270$ '#

$V = 19310\#$ $M = 102,940$ '#

$U_1 = 440 \times 10.7 = 4710 \times 5.35 = 25200$ '#
$U_2 = 115 \times \frac{1}{2} \times 10.7 = 620 \times 3.57 = 2210$ '#
$B_1 = 1630 \times 10.7 = 17440 \times 5.35 = 93300$ '#
$B_2 = 1110 \times \frac{1}{2} \times 10.7 = 5940 \times 7.12 = 42290$ '#

$V = 29710\#$ $M = 163,000$ '#

$\Sigma V = 9400\#$ $\Sigma M = 60,060$ '#

$$\text{Shear} = \frac{9400}{12 \times .884 \times 31.5} = 28\ \#/\square'' \quad \text{O.K.}$$

$$A_s = \frac{60,060 \times 12}{18000 \times .884 \times 31.5} = 1.44\ \square''$$

Use "1" ϕ @ 6" o.c.

$$\text{Bond} = \frac{9400}{6.28 \times .884 \times 31.5} = 54\ \#/\square'' \quad \text{O.K.}$$

Riverside Base

Moment at Y-Y

$W = 12.5 \times 23.75 \times 62.5 = 18,500 \times 6.25 = 116,000$ '#
$C = 12.5 \times 2.25 \times 150 = 4220 \times 5.56 = 23,460$ '#

$V = 22,720\#$ $M = 139,500$ '#

$U_1 = 12.5 \times 440 = 5500 \times 6.25 = 34400$ '#
$U_3 = 190 \times 8.83 = 1590 \times 8.08 = 12800$ '#
$U_4 = 180 \times 8.83 \times \frac{1}{2} = 790 \times 9.56 = 7600$ '#
$B = 1290 \times 12.5 \times \frac{1}{2} = 8060 \times 4.17 = 33600$ '#

$V = 15,940\#$ $M = 88,400$ '#

$\Sigma V = 6780\#$ $\Sigma M = 51,100$ '#

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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Project Chicopee Mass. C-3b
Computation 23'-0" Wall
Computed by W. S. Jr. Checked by Date 1/13/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Riverside Base

$$\text{Shear} = \frac{6780}{12 \times .884 \times 32.5} \; 20^{\#/\square''} \quad \text{O.K.}$$

$$A_s = \frac{51{,}100 \times 12}{18000 \times .884 \times 32.5} = \frac{613{,}200}{517{,}000} = 1.19 \; \square''$$

use $\frac{7}{8}''\phi$ @ 6" c.c.

$$\text{Bond} = \frac{6780}{5.5 \times .884 \times 32.5} = 43 \; \#/\square''$$

$\frac{5}{8}\phi$ Temp steel will be O.K. for the top of the landside base, the bottom of the riverside base, and the landside of the stem.

WAR DEPARTMENT

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

Project: Chicopee Dike

Computation: 23'-0" wall - Stability

Computed by: J.H.L. Checked by: W. S. A. Date: 1/20/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

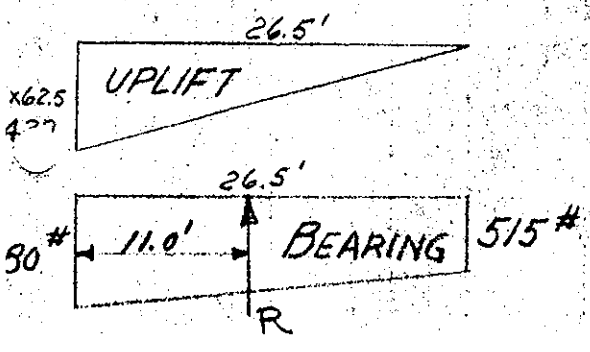
Case II - Saturated earth, river down, 50% uplift

Forces acting		↓	↑	←	→	Arm	Moments at "A" ↻	Moments at "A" ↺
C_1		5510					73,010	
C_2		280					3310	
C_3		5960					78,970	
C_4	$1.5 \times 12.5 \times \frac{1}{2} \times 150$	1410				18.17	25,500	
C_5		200					1400	
C_6		600					15,300	
C_7		80					920	
E_w		19,530					122,060	
P_{tw}					7,840		36530	
U	$\frac{1}{2} \times 7 \times 62.5 \times 26.5$		5790			8.8		50,900
		$\Sigma V = 27,780$					$\Sigma M = 306,100$	

Position of resultant $\frac{306,100}{27,780} = 11.0$ ft. from A

Eccentricity "e" = 13.25 - 11.0 = 2.25'

$$\text{Bearing} = \frac{27,780}{26.5}\left[1 \pm \frac{6 \times 2.25}{26.5}\right] = 1,050\left[1 \pm .51\right] = \begin{matrix} 1580\ \# \\ 515\ \# \end{matrix}$$



WAR DEPARTMENT

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

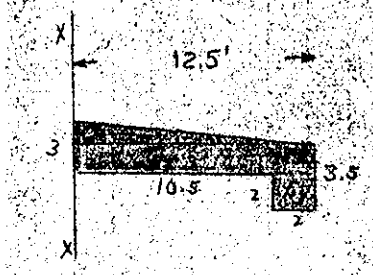
Project: Chicopee Dike c36

Computation: Design of base steel 23" wall

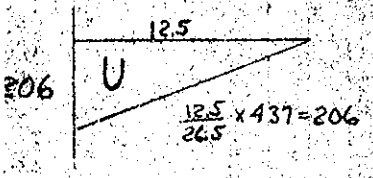
Computed by: J.H.L. Checked by: M.S.A. Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II Design of Riverside base



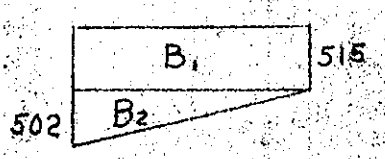
	Force	↓	↑	Arm	↻	↺
C_1	$\frac{1}{2} \times 1.5 \times 12.5 \times 150$	1,410		4.17	5,880	
C_2	$1.5 \times 12.5 \times 150$	2,820		6.25	17,600	
C_3	$2 \times 2 \times 150$	600		11.5	6,900	
U	$\frac{1}{2} \times 206 \times 12.5$		1,290	4.17		5,380
B_1	515×12.5		6,430	6.25		40,200
B_2	$\frac{1}{2} \times 502 \times 12.5$		3,130	4.17		13,000
					30380	58580



$\Sigma M = 28{,}200$

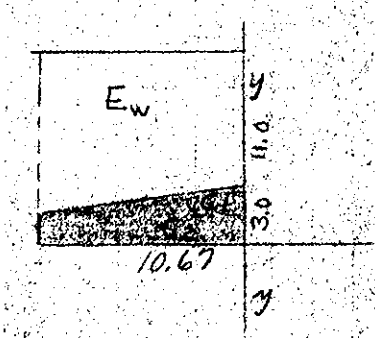
$$A_{s_{x-x}} = \frac{28{,}200 \times 12}{18{,}000 \times .884 \times 31.5} = .675 \square''$$

in bottom

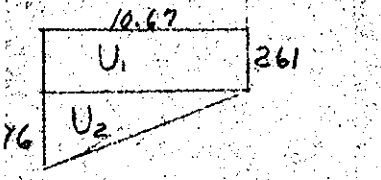


$A_{s_{x-x}} = .675 \square''$ $1''\phi$ @ $12'' = .79$

Case II Design of Landside base

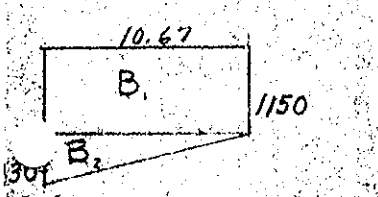


	Force	↓	↑	Arm	↖	↙
C_1	$\frac{1}{2} \times 10.67 \times 1.5 \times 25$	200		3.56	710	
C_2	$1.5 \times 10.67 \times 150$	2400		5.33	12,800	
E_w	$9.5 \times 10.67 \times 125$	12,650		5.33	67,500	
U_1	261×10.67		2780	5.33		14,800
U_2	$\frac{1}{2} \times 176 \times 10.67$		940	7.12		6,700
B_1	1150×10.67		12,300	5.33		65,500
B_2	$\frac{1}{2} \times 430 \times 10.67$		2,290	7.12		16,300



$\Sigma M = 22{,}300$

$$A_{s_{y-y}} = \frac{22300 \times 12}{18000 \times .884 \times 31.5}$$



$A_{s_{y-y}} = .54 \square''$ in bottom

less than for case I

WAR DEPARTMENT

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

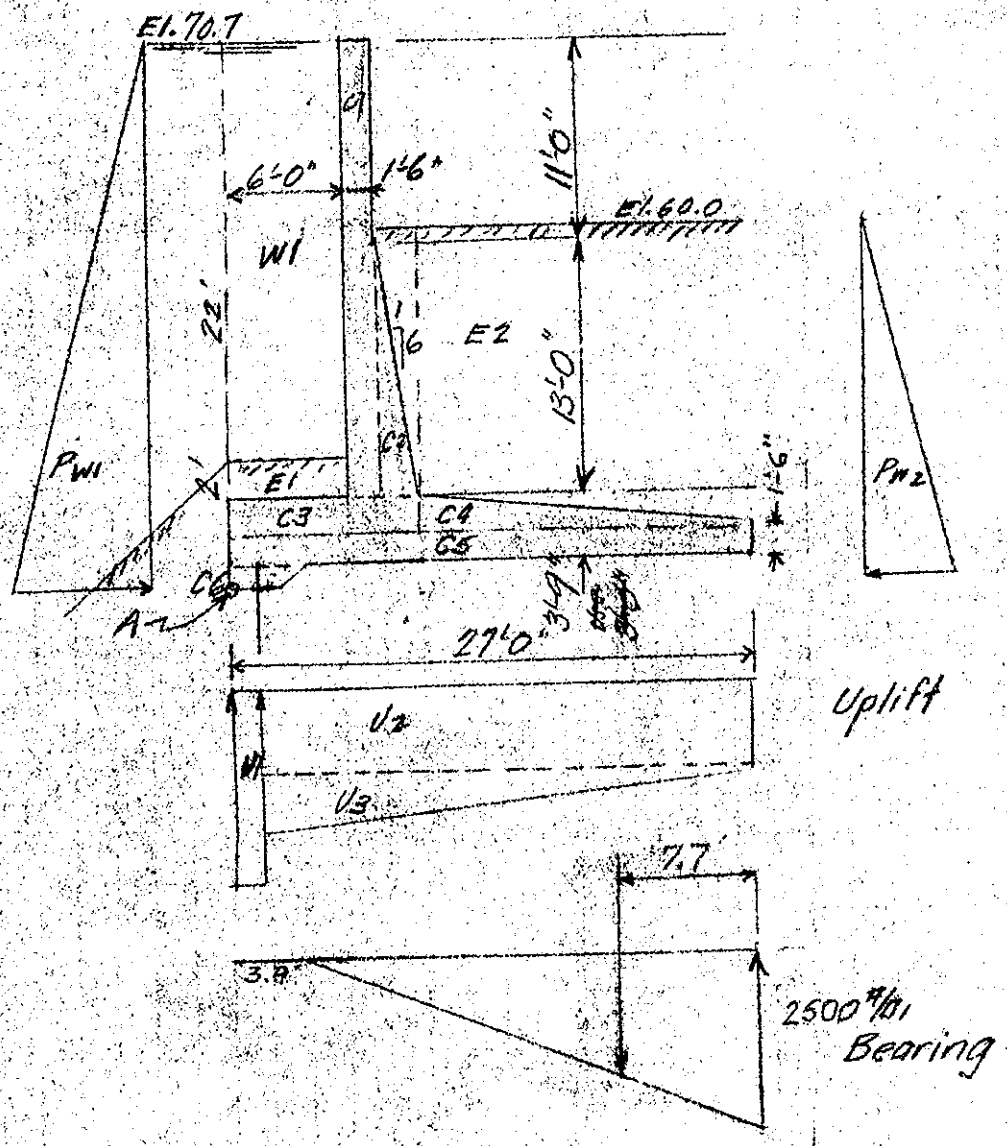
Subject: CHICOPEE C36

Computation: 24' wall

Computed by: RSM Checked by: W H F Date: 3/20/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

24' SECTION



WAR DEPARTMENT

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

Project: CHICOPEE C36

Computation: 24' Wall

Computed by: PSM Checked by: W. H. F. Date: 3/20/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY

		Force ↓↑	Force ⇄	Arm	Moments abt. A ↻	Moments abt. A ↺
C1	150 × 1.5 × 24	5400		6.8	36.7	
C2	150 × 2.2 × 13/2	2140		8.2	17.6	
C3	150 × 9.7 × 2.25	3,280		4.8	15.7	
C4	150 × 17.3 × 2.25/2	2,920		15.5	45.3	
C5	150 × 27 × 1.5	6,080		13.5	82.1	
C6	150 × 1.0 × 3.0	450		1.5	.7	
W1	62.5 × 6 × 22	8,260		3.0	24.8	
E1	125 × 6 × 2	1,500		3.0	4.5	
E2	125 × 13.3 × 17.3	28,800		18.3	527.0	
	125 × 2.2 × 13.3/2	1,830		9.0	16.4	
	125 × 17.3 × 2.25/2 ↓	2,430		21.2	51.5	
U1	62.5 × 1.5 × 28.75 ↑	2,700		.8		2.1
U2	62.5 × 25.5 × 17.0	27,090		14.3		387.4
U3	62.5 × 25.5 × 5.5/2	4,390		10.0		43.9
P_{W1}	62.5 × 28.75²/2		25,800	9.6	247.7	
P_{W2}	80 × 18.0²/2		12,950	6.0		77.7
		28,910	12,850		558.9	

Position of resultant: 558,900/28,910 = 19.3

e = 5.8

Bearing pressure $\frac{2890}{23.1} \times 2 = 2500$ #/□'

WAR DEPARTMENT

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

Project: CHICOPEE C3b

Computation: 24' WALL

Computed by: JAC Checked by: RSM Date: 4/22/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

STABILITY – RIVER DOWN – DRY BACKFILL – NO UPLIFT

	Forces ↓	Forces ↑	Forces ⇄	Arm	Moments ABT "A" ↻	Moments ABT "A" ↺
C_1	5,400				36,700	
C_2	2,140				17,600	
C_3	3,280				15,700	
C_4	2,920				45,300	
C_5	6,080				82,100	
C_6	950				700	
E_1 100 × 6 × 2	1,200			3.0	3,600	
E_2 100 × 13.3 × 17.3	23,000			18.3	421,000	
100 × 2.2 × 13.3/2	1,460			9.0	13,140	
100 × 17.3 × 2.25/2	1,950			21.2	41,400	
P_N 35 × 18²/2			5,670	6.0		34,020
	47,880		5670		677,240	34,020
					ΣM = 643,220 ↻	

Position of Resultant } $\frac{643,220}{47880}$ = 13.4' from A

e = .1 (other side of ℄) Neglect

WAR DEPARTMENT

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

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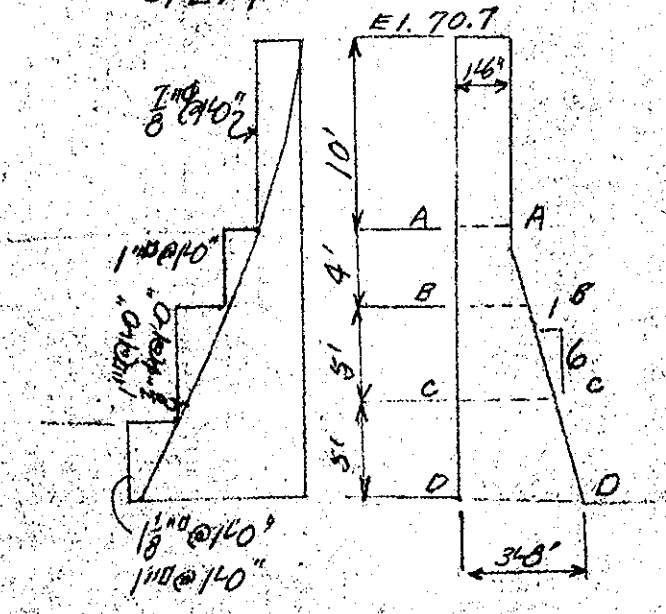
Project: CHICOPEE C3b

Computation: 24' wall

Computed by: RSM Checked by: W.M.F. Date: 3/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEM



River up

Sec. A-A

$M = wh^3/6 = 10^3 \times 62.5/6 = 10{,}400'\#$

$A_s = \dfrac{10{,}400 \times 12}{18000 \times .884 \times 14.5} = .55 \square''$

$v = \dfrac{62.5 \times 10^2}{2 \times 12 \times .884 \times 14.5} = 21\ \#/\square''$

Sec. B-B

$M = 62.5 \times 14^3/6 = 28600'\#$

$-80 \times 3.3^3/6 = -480$

$28120'\#$

$A_s = \dfrac{28120 \times 12}{18000 \times .884 \times 22.5} = .95 \square''$

Sec. C-C

$M = 62.5 \times 19^3/6 = 71500'\#$

$-80 \times 8.3^3/6 = 7700$

$63800'\#$

$A_s = \dfrac{63{,}800 \times 12}{18000 \times 32.5 \times .884} = 1.49 \square''$

Sec. D-D

$M = 62.5 \times 24^3/6 = 143{,}900'\#$

$-80 \times 13.3^3/6 = 31{,}400$

$112{,}500'\#$

$A_s = \dfrac{112{,}000 \times 12}{18000 \times 40.5 \times .884} = 2.10 \square''$

$v = (62.5 \times 24^2 - 80 \times 13.3^2)/2 \times 12 \times .884 \times 40.5 = 25.6\ \#/\square''$

River down

$M = 80 \times 13.3^3/6 = 13800'\#$

$A_s = 13{,}800 \times 12 / 18000 \times .884 \times 40.5 = .26 \square''$. Use $\frac{1}{2}$"⊡@1'-0"

WAR DEPARTMENT

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

ect CHICOPEE C36

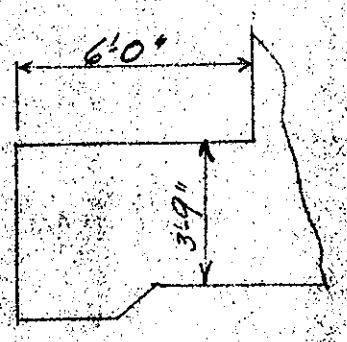
mputation 24' wall

mputed by RSM Checked by Date 3/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10828

BASE- RIVERSIDE

Water	22×62.5 =	1375
Earth	2×125 =	250
Conc.	4.25±×150 =	635
Net	↓	2260#/□'

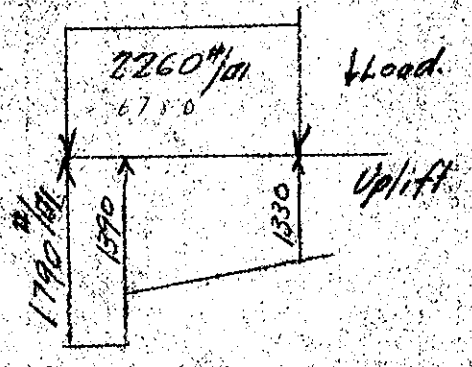


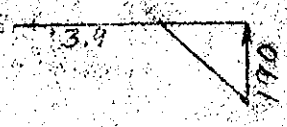
$M = 700 \times \bar{6}^2/2 = 12600$ '#

$A_s = 12600 \times 12 / 18000 \times .884 \times 41.5 = .23$ □"

Temp. steel governs

3'-0" Used $A_s = .14$ □" OK





Bearing

Net, approx 500#/□'

WAR DEPARTMENT

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

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Project: Chicopee Mass. C-3b

Computation: 24' wall

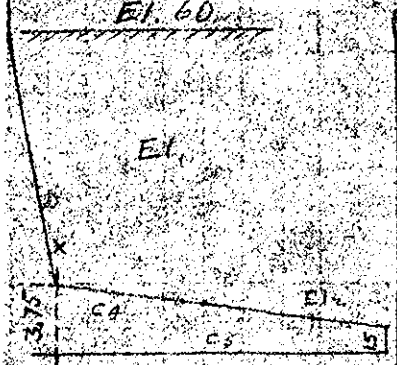
Computed by: W. H. E. Checked by: Date: 3/26/40

U. S. GOVERNMENT PRINTING OFFICE 9—10528

Base — Landside — river up

$V_3 = 10.7 \times \frac{1}{2} \times 62.5 = 334 \qquad Y = \frac{17.3}{22.5} \times 334 = 226$

$B = 2500 - 190 = 2310$

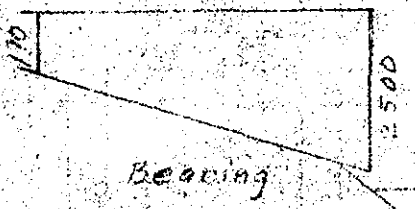


El.	17.3 × 13.3 × 125	28750		8.6	247300	
El_2	½ × 2.25 × 17.3 × 125	2440		11.5	28050	
C4	½ × 2.25 × 17.3 × 150	2920		5.8	16960	
C5	1.5 × 17.3 × 150	3890		8.6	33460	
U_2	17 × 17.3 × 62.5		18380	8.6		158200
U_3	½ × 17.3 × 226		1950	5.8		11320
B_1	17.3 × 190		3270	8.6		28280
B_2	½ × 17.3 × 2310		20000	11.5		230000
		38000	43620		325710	427800
		ΣV = 5620 ↑			ΣM = 102,100 ↷	

$d = 3.75' = 45''$

$d = \sqrt{\frac{102100}{123}} = 28A = 45 = 33.3 < 45$ o.k.

$A_s = \frac{102100}{1325 \times 40.5} = 1.90$ Use 1" ⌀ @ 6" c.c.



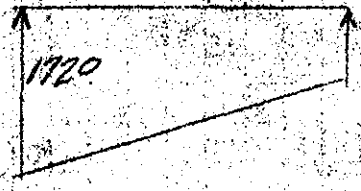
Bearing

Base - Landside - river down

↓ El. 13.5 × 100 = 1350

C4 & 5 2 × 150 = 300

↑ 1650



Net loading = 750#/□' to 0, approx.

$M = \frac{750 \times 17.3}{2} \times 11.5 = 74600'\#$

$A_s = \frac{74600 \times 12}{18000 \times .884 \times 41.5} = 1.37''^{\square}$

WAR DEPARTMENT

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

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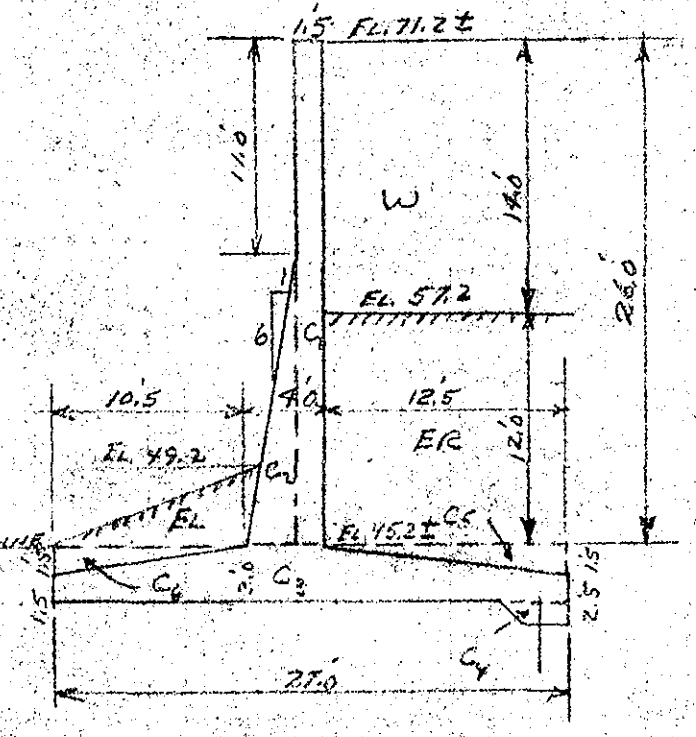
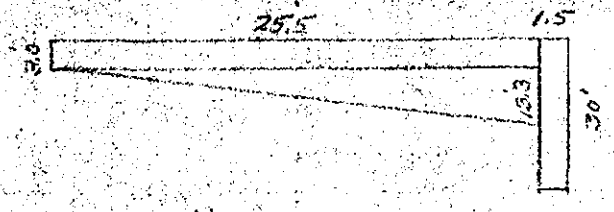
ct CHICOPEE C-36

mputation CANTILEVER FLOOD WALL STEM 26' BASE 27'

mputed by P.L.A. Checked by R.W. Date 4/17/40

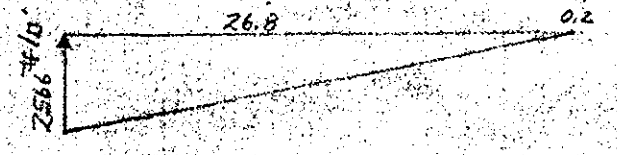
U. S. GOVERNMENT PRINTING OFFICE 3—10328





CASE I

UPLIFT



BEARING

Subject CHICOPEE C-36

Computation CANTILEVER WALL STEM 26' BASE 27'

Computed by P.L.A. Checked by R.W. Date 4/17/40

STABILITY CASE I RIVER UP

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1	26 X1.5 X150	5850				13.75	80500	
C_2	½X2.5 X15 X150	2810				12.17	34200	
C_3	3X27 X150	12150				13.5	164400	
C_4	3 X 1X150	450				25.5	11500	
C_5	½X1.5X12.5 X 25		230			22.83		5250
C_6	½X1.5 X10.5 X25		200			3.5		700
W	14X12.5 X62.5	10900				20.75	226000	
FR	12X12.5X125	18800				20.75	390000	
FL	½X4 X10.5 X100	2100				7.0	14700	
U_1	30X1.5X62.5		2820			26.25		74100
U_2	3X25.5 X62.5		4780			12.75		61000
U_3	½X13.3X25.5X62.5		10600			17.0		180000
PW	½X62.5X 30^2				28100	10.0		281000
PFR	½X17.5X16^2				2240	5.33		11940
FR	.5X34430			17200				
		53060	18630	17200	30340		921300	613990
		ΣV = 34430 ↓		ΣH = 13140 ←			ΣM = 307310 ↻	

Position of Resultant $\Big\} = \frac{\Sigma M}{\Sigma V} = \frac{307310}{34430} = 8.93'$ ⅓ BASE = $\frac{27}{3}$ = 9.0'

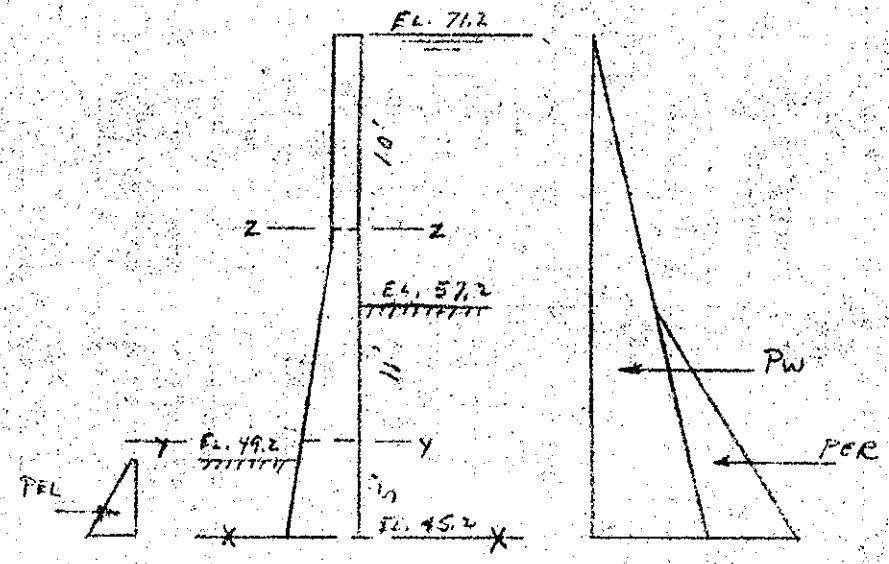
FALLS 0.07' OUTSIDE MIDDLE THIRD

$$p = \frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{34430}{26.79}\left(\frac{2}{0}\right) = 1283 \begin{cases} 2 = 2566\ \#/\square' \\ 0 = 0\ \#/\square' \end{cases}$$

ct CHICOPEE C-36
nputation CANTILEVER WALL ON PILES
nputed by P.L.A. Checked by RW Date 4/1/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. STEEL IN STEM RIVERSIDE FACE
CASE I RIVER UP



MOMENTS ABOUT X-X

FORCES ACTING		→	←	ARM	MOMENT ↷	MOMENT ↶
PEL	$\frac{1}{2} \times 80 \times \overline{4}^2$	640		1.33	850	
PW	$\frac{1}{2} \times 62.5 \times \overline{26}^2$		21100	8.67		183000
PER	$\frac{1}{2} \times 17.5 \times \overline{12}^2$		1260	4.0		5040
		640	22360		850	188040
		ΣV = 21720 ←			ΣM = 187190 ↶	

$$d_{X-X}(\text{REQ'D}) = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{187190 \times 12}{123 \times 12}} = 39.0''$$

ACTUAL $d = 48.0 - 3.5 = 44.5'$

$$A_{s_{X-X}}(\text{REQ'D}) = \frac{M}{f_s j d} = \frac{187190 \times 12}{18000 \times .884 \times 44.5} = 3.18^{\square''}$$ USE $1\frac{1}{4}''\square$ @ 6" o.c.

$f_s = 18360$ #/□"

$$\text{SHEAR}_{X-X} = \frac{V}{bjd} = \frac{21720}{12 \times .884 \times 44.5} = 45.8\ \#/\square'' < 60\ \#/\square''$$

$$\text{BOND}_{X-X} = \frac{V}{\Sigma_0 jd} = \frac{21720}{10 \times .884 \times 44.5} = 55.2\ \#/\square'' < 150\ \#/\square''$$

Project: CHICOPEE C-36
Computation: CANTILEVER WALLS — STEM 26' BASE 24'
Computed by: P.L.A. Checked by: R.W. Date: 4/2/40

U.S. GOVERNMENT PRINTING OFFICE 3—10636

STEEL REINF. CONT'D RIVERSIDE FACE
CASE I RIVER UP

MOMENTS ABOUT Y-Y

FORCES ACTING		←	ARM	MOMENTS ↶
PW	$\frac{1}{2} \times 62.5 \times 31^2$	15800	7.0	96500
PER	$\frac{1}{2} \times 175 \times 7^2$	430	2.33	1000
		14230		97500 ↶

$d_{YY} = 38.0 - 3.5 = 34.5$

$$A_{s_{YY}} = \frac{97500 \times 12}{18000 \times .884 \times 34.5} = 2.14^{\square''}$$

USE 1" @ 1'-0" c.c. } ALTERNATELY PLACED
1 1/8" @ 1'-0" c.c. } LEAVING 6" SPACING

MOMENTS ABOUT Z-Z

PW $\frac{1}{2} \times 62.5 \times 10^2 = 3125$ ← $3125 \times 3.33 = 10400'^{\#}$ ↶

$d = 14.5''$

$$A_{s_{Z-Z}} (\text{Reqd}) = \frac{10400 \times 12}{18000 \times .884 \times 14.5} = 0.55^{\square''}$$

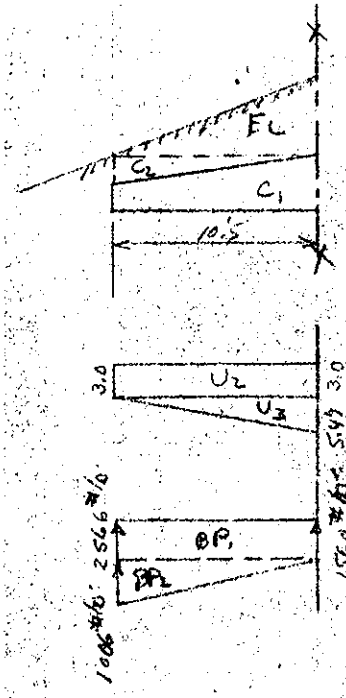
USE 7/8" ϕ @ 1'-0" c.c.

LANDSIDE FACE USE 1/2" ϕ @ 1'-0" c.c.

Project: Chicopee C-36
Computation: Cantilever Wall Stem 26' Base 27'
Computed by: P.L.A. Checked by: R.W. Date: 4/17/40

U.S. GOVERNMENT PRINTING OFFICE 3—10228

Steel Reinf. Cont'd. Landside Base Slab
Case I River Up



Moments About X-X

Forces Acting		↓	↑	Arm	Moments ↻	Moments ↺
C_1	3×10.5×150	4720		5.25		24800
C_2	½×1.5×10.5×25		200	7.0 / 5.21	1400 / 1050	
EL	½×4×10.5×100	2100		3.5		7350
U_2	3×10.5×62.5		1970	5.25	10330	
U_3	½×5.47×10.5×62.5		1800	3.5	6300	
BP_1	1560×10.5		16400	5.25	86000	
BP_2	½×1006×10.5		5280	7.0	37000	
		6820	25650		140680	32150
		18830 ↑			ΣM = 108530 ↻	

$$d_{X-Y}(\text{Req'd}) = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{108530 \times 12}{123 \times 12}} = 29.7''$$

Actual $d = 36.0 - 4.5' = 31.5''$

$$A_{s\,X\to}(\text{Req'd}) = \frac{M}{f_s j d} = \frac{108530 \times 12}{18000 \times .884 \times 31.5} = 2.61 \text{ □}''$$

$$\text{Shear}_{X-Y} = \frac{V}{bjd} = \frac{18830}{12 \times .884 \times 31.5} = 56.1 \text{ \#/□}''$$

Use $1\frac{1}{4}$" □ @ 1'-0" c.c. } Alt. @ 6" c.c. **Bottom Steel**
$1\frac{1}{8}$" □ @ 1'-0" c.c. }

$$\text{Bond}_{X-Y} = \frac{V}{\Sigma_0 j d} = \frac{18830}{9.5 \times .884 \times 31.5} = 71.3 \text{ \#/□}''$$

Top Steel Use ½" □ @ 1'-0" c.c.

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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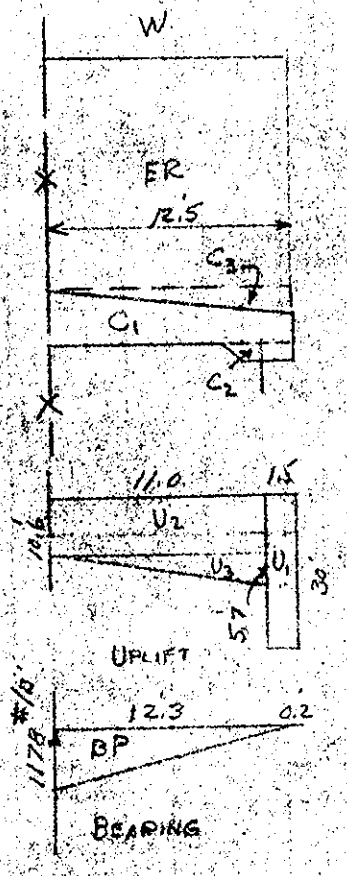
ect CHICOPEE C-36
omputation CANTILEVER WALL STEM 26' BASE 27'
omputed by P.L.A. Checked by RW Date 4/17/40

U.S. GOVERNMENT PRINTING OFFICE 3—10538

STEEL REINF. CONT'D RIVERSIDE BASE SLAB
CASE I RIVER UP



MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS →	MOMENTS ←
W	14X12.5X62.5	10900		6.25	68100	
ER	12X12.5 X125	18800		6.25	117500	
C_1	3X12.5 X150	5630		6.25	35200	
C_2	3X1X150	450		11.0	4950	
C_3	½X1.5X12.5X26		230	8.33		1915
U_1	30X1.5X62.5		2820	11.75		33200
U_2	10.6X11.0X62.5		7300	5.5		40100
U_3	½X5.7X11X62.5		1960	7.33		14370
BP	½X1178X12.3		7250	4.15		29700
		35780	19560		225750	119,285
		ΣV=16220 ↓			ΣM=106,465 →	

106,465

$d = 36.0 - 3.5 = 32.5''$

$A_{s_{X-X}}$ (REQD) $= \dfrac{106,465 \times 12}{18000 \times .884 \times 32.5} = 2.47\ \square''$

$SHEAR_{X-X} = \dfrac{16220}{12 \times .884 \times 32.5} = 46.9\ \#/\square''$

USE ~~1"□ @ 1'0" c.c.~~ $1\frac{1}{8}''\square$ @ 1'6" c.c. } ~~ACT~~ @ 6" c.c. TOP STEEL

$BOND_{X-X} = \dfrac{16220}{9.0 \times .884 \times 32.5} = 62.8\ \#/\square''$

BOTTOM STEEL USE $\frac{1}{2}''\square$ @ 1'0" c.c.

WAR DEPARTMENT

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

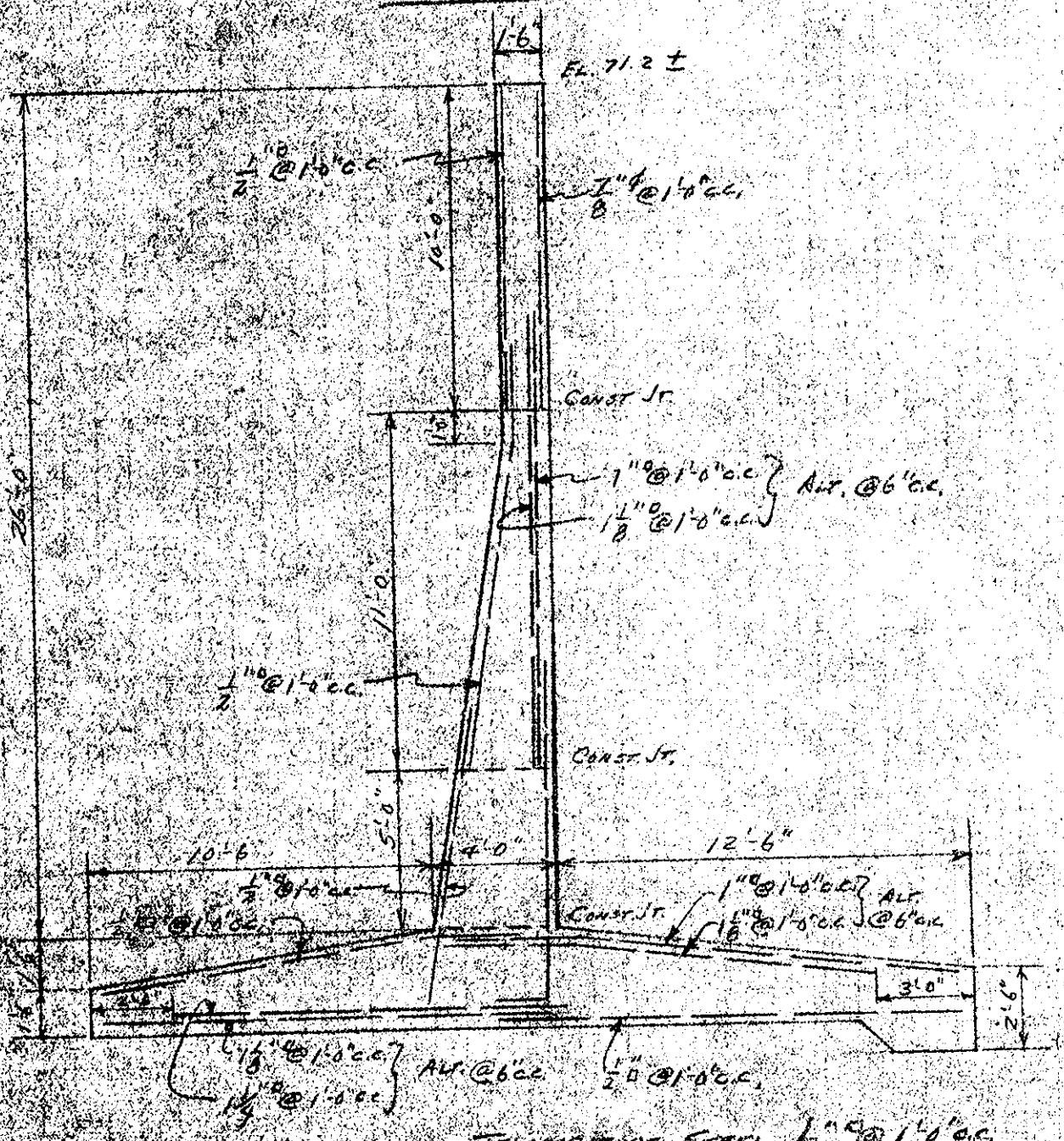
Project: Cascade G-36

Computation: Container Wall Stem 26' Base 27'

Computed by: PLA Checked by: Date: 4/17/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL AS DESIGNED



LONGITUDINAL TEMPERATURE STEEL 1/2" ϕ @ 1'-0" c.c.

WAR DEPARTMENT

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

Project C3b Chicopee

Computation 26' wall - Steel Z pile retaining wall

Computed by RW Checked by ..... Date 4-13-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Assumptions on Passive Resistance

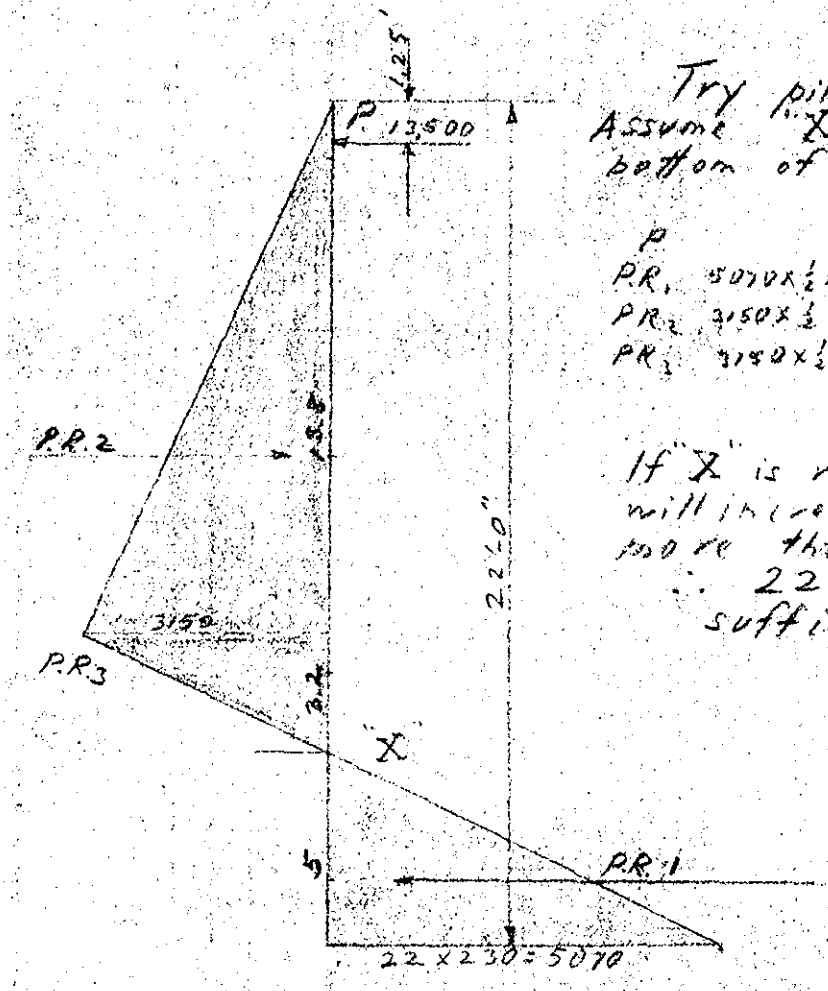
Weight of Submerged Earth = 65 #/cu. ft.

θ = 34° (Based on Studies by Lane Const. Co.)

$P.R. = wh \tan^2(45° + \frac{34°}{2})$

$= 65 \tan^2 62°$

$65 \times (1.881)^2$ $65 \times 3.55 = 230$ #/□' per ft. of depth



Try piling depth of 22'

Assume "X" = point of reversal, 5' above bottom of piling.

			Moments about "P"
P		13500	
PR_1	$5070 \times \frac{1}{2} \times 5$	= 12700 ←	$\times 19.3 =$ 245000 ↻
PR_2	$3150 \times \frac{1}{2} \times 13.8$	= 21740 →	$\times 8.1 =$ 176000
PR_3	$3150 \times \frac{1}{2} \times 3.2$	= 5040 →	$\times 13.8 =$ 69600
	ΣH	580# →	ΣM = 400'# ↻

If "X" is raised to make $\Sigma H = 0$, ΣM ↻ will increase, in other words become more than necessary.

∴ 22' length of piling is sufficient.

Subject: Chicopee C3b
Computation: 26' wall
Computed by: R W Checked by: Date: 4-16-40

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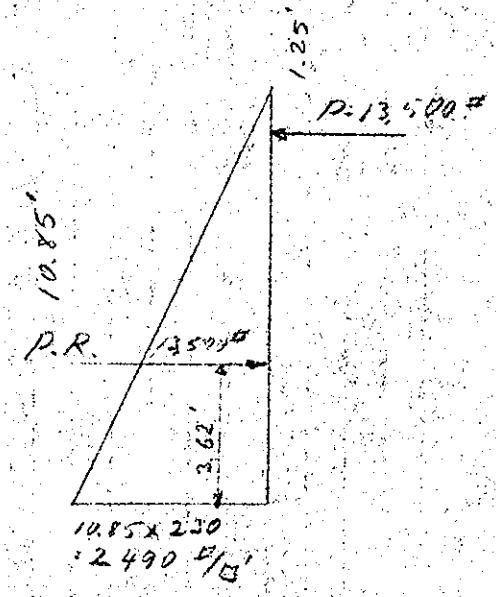


Point of Zero Shear
= Point above which passive Resistance
= 13,500 #
Passive Pressure per foot of depth = 230 #/□'

Total passive pressure = $230 \times h^2 \times \frac{1}{2}$

$$230 \times h^2 \times \tfrac{1}{2} = 13{,}500$$
$$h^2 = \frac{13{,}500 \times 2}{230}$$
$$h = 10.85'$$

Point of Zero Shear = Point of Max. Moment.

Moments about point 10.85' down

		Arm	Moment
P =	13,500 # ←	x 9.6 =	129700 #'
PR =	13,500 # →	x 3.62 =	48800 #'
ΣH = Zero		ΣM =	80,900 #'

Section Modulus Required

$$S = \frac{80{,}900 \times 12}{24{,}000} = 42.2 \text{ (inches)}^3$$

If Section MZ 32 is used,
Unit stress will be $\frac{42.2}{38.3} \times 24{,}000 = 26{,}500$ #/□"

So Use Z-pile
Section MZ 32, 22' long
below top of footing.

(Section Modulus 38.3 (inches)^3

WAR DEPARTMENT

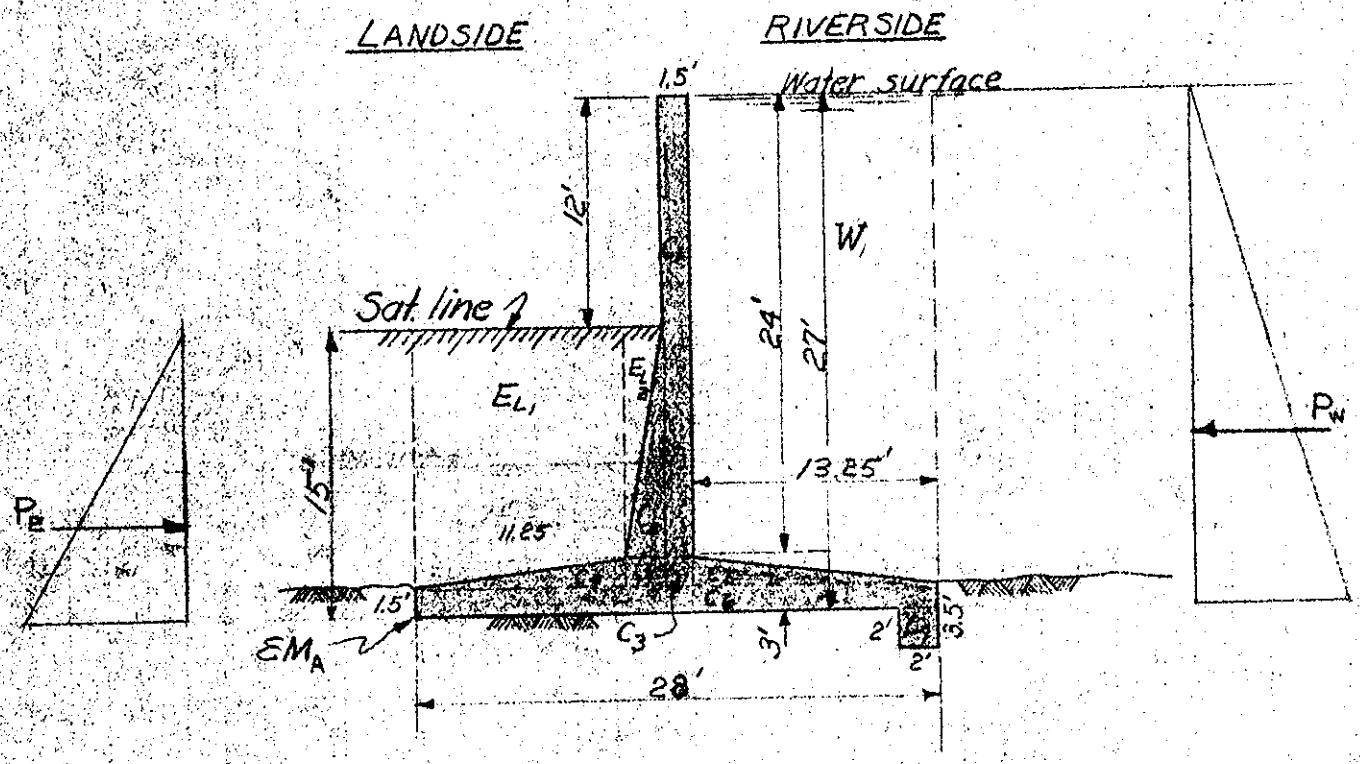
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

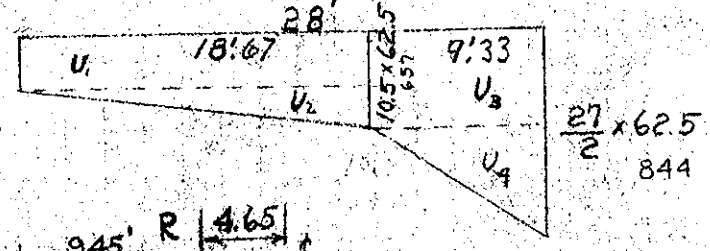
Project: Chicopee Dike C-3b

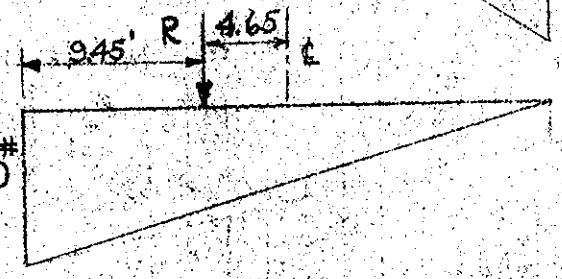
Computation: 27' floodwall - 24' stem

Computed by: W.H.L. & E.H.V. Checked by: R.H.M. Date: 1-11-40

U. S. GOVERNMENT PRINTING OFFICE 3—10538







WAR DEPARTMENT

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

Project: Chicopee Dike C3b

Computation: 27' floodwall - 24' stem

Computed by: J.H.L. Checked by: R.H.M. Date: 1-18-40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Stability

Forces acting		↓	↑	→	←	Arm	Moments at A ↻	Moments at A ↺
C_1	1.5 × 24 × 150	5400				14.0	75,600	
C_2	.5 × 2 × 12 × 150	1800				12.58	22,640	
C_3	3.5 × 1.5 × 150	790				13.0	10,240	
C_4	.5 × 1.5 × 11.25 × 25	210				7.5	1,580	
C_5	.5 × 1.5 × 13.25 × 87.5	870				19.17	16,600	
C_6	1.5 × 28 × 150	6300				14.0	88,250	
C_7	2 × 2 × 150	600				27.0	16,200	
W	25.5 × 13.25 × 62.5	21,100				21.38	451,000	
E_{L_1}	11.25 × 13.5 × 125	19,000				5.63	107,000	
E_{L_2}	.5 × 2 × 12 × 125	1,500				11.92	17,900	
P_E	15 × 80 × ½ × 15			9000		5.0	45,000	
P_W	27 × 62.5 × ½ × 27				22,800	9.0		205,000
U_1	469 × 18.67		8,760			9.33		81,700
U_2	½ × 18.67 × 188		1760			12.45		21,900
U_3	657 × 9.33		6130			23.34		143,000
U_4	½ × 9.33 × 187		870			24.89		21,700
F_R				13,800				
	Totals	57,570	17,520	22800	22,800		852,010	473,300

$\Sigma V = 40{,}050$ $\Sigma M = 378{,}710$

$$\frac{\Sigma M}{\Sigma V} = \frac{378{,}710}{40{,}050} = 9.45 \qquad \text{Middle third} = \frac{28}{3} = 9.33$$

$$\text{Eccentricity "e"} = \frac{28}{2} - 9.45 = 4.55 \text{ ft.}$$

$$\text{Bearing Pressure} = \frac{40{,}050}{28}\left(1 \pm \frac{6 \times 4.55}{28}\right) = 1{,}430\left[\begin{matrix}1 + .975\\ 1 - .975\end{matrix}\right]$$

$= 2860^{\#}$ & $4^{\#}$ - The latter figure is neglected.

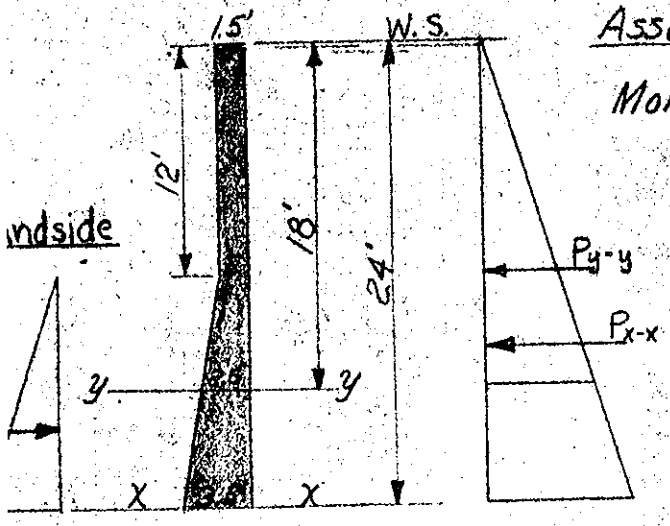
* C_4 unit wt. = 150 - 125 = 25

** C_5 unit wt. = 150 - 62.5 = 87.5

Project: Chicopee Dike C3b
Computation: Design of stem steel 27' wall
Computed by: J.H.L. Checked by: R.H.M. Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Riverside face



Assume water up, no earth on landside

Moment at x-x $= 24 \times 62.5 \times 24 \times \frac{1}{2} \times 8$
$= 144{,}000$ '#

Steel $A_{x-x} = \dfrac{144{,}000 \times 12}{18{,}000 \times .884 \times 38.5} = 2.83$ □"

$A_{s_{x-x}} = 2.83$ □"

$d_{x-x} = \sqrt{\dfrac{144{,}000}{123}} = 34'' + 3.5 < 42''$ O.K.

Moment at y-y $= 18 \times 62.5 \times 18 \times \frac{1}{2} \times 6$
$= 60{,}800$ '#

$d_{y-y} = \sqrt{\dfrac{60{,}800}{123}} = 22'' + 3.5'' < 30''$ O.K.

Steel $A_{y-y} = \dfrac{60{,}800 \times 12}{18{,}000 \times .884 \times 26.5}$

$A_{s_{y-y}} = 1.73$ □"

Steel in Landside face

Assume earth wet, water down

Moment at x-x $= 12 \times 80 \times 12 \times \frac{1}{2} \times 4 = 23{,}000$ '#

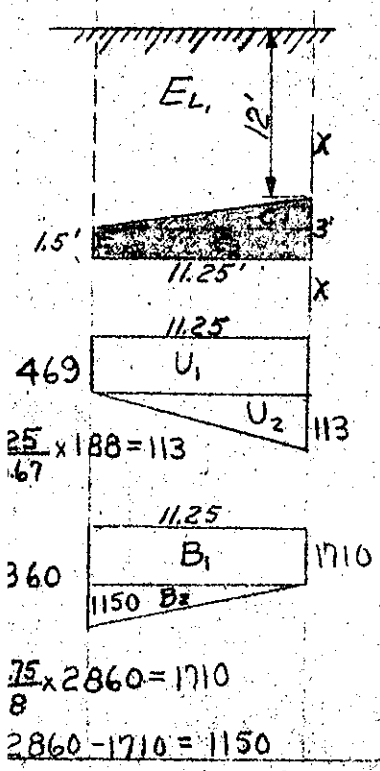
Steel $A_{s_{x-x}} = \dfrac{23{,}000 \times 12}{18{,}000 \times .884 \times 38.5} = .451$ □"

$A_{s_{x-x}} = .451$ □"

Project Chicopee Dike C3b
Computation Design of base steel 27' wall
Computed by J.H.L. Checked by R.H.M. Date

U. S. GOVERNMENT PRINTING OFFICE 8—10628

Steel in Landside base



Force	↓	↑	Arm	↻	↺
E_{L_1} 13.5 x 11.25 x 125	19,000		5.63		107,000
C_1 ½ x 11.25 x 1.5 x 25	210		3.75		790
C_2 1.5 x 11.25 x 150	2530		5.63		14,250
U_1 469 x 11.25		5280	5.63	29,800	
U_2 ½ x 113 x 11.25		640	3.75	2,390	
B_1 1710 x 11.25		19,250	5.63	108,500	
B_2 ½ x 1150 x 11.25		6470	7.5	48,500	

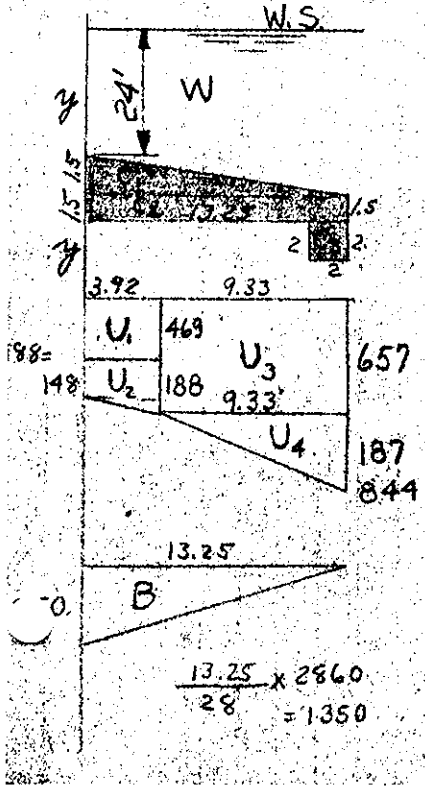
$\Sigma V = 9900$ #↓ $\Sigma M = 67,150$ ↺

$$\text{Steel } A_{s_{x-x}} = \frac{67150 \times 12}{18,000 \times .884 \times 31.5} = 1.61 \square'' \text{ in bottom}$$

$$d_{x-x} = \sqrt{\frac{67150}{123}} = 23 + 4.5 < 36'' \text{ o.k.}$$

$$V = \frac{9900}{12 \times .884 \times 31.5} = 30 \, \#/\square'' \text{ ok}$$

Steel in Riverside base



Force	↓	↑	Arm	↻	↺
W 25.5 x 13.25 x 62.5	21,100		6.63	140,000	
C_1 ½ x 1.5 x 13.25 x 87.5	870		4.42	3,840	
C_2 1.5 x 13.25 x 150	2980		6.63	19,750	
C_3 2 x 2 x 150	600		12.25	7,350	
U_1 469 x 3.92		1840	1.96		3610
U_2 [148 x 3.92		580	1.96		1140
½ x 46 x 3.92		80	2.62		210
U_3 657 x 9.33		6130	8.59		52,600
U_4 ½ x 187 x 9.33		870	10.14		8820
B ½ x 1350 x 13.25		8950	4.42		39,500

$\Sigma V =$ $\Sigma M = 65,060$ ↻

$$\text{Steel } A_{s_{y-y}} = \frac{65060 \times 12}{18,000 \times .884 \times 32.5} = 1.52 \square'' \text{ in top}$$

: Chicopee Dike C3b
nputation 27' floodwall
nputed by J.H.L. Checked by Date 1/22/40

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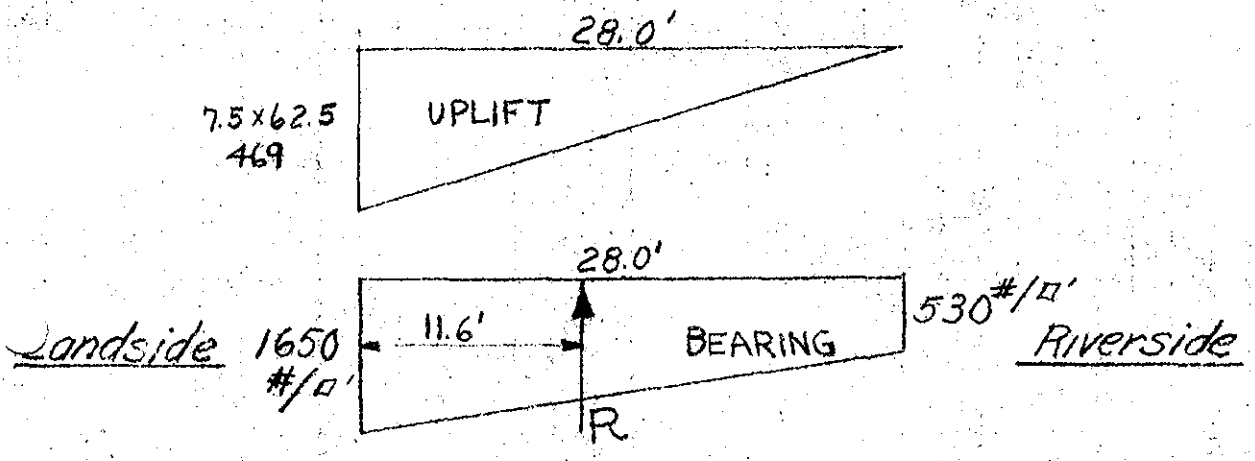
Stability - Case II
Water down, earth saturated, 50% uplift

Forces acting		↓	↑	→	←	Arm	Moments at "A" ↻	↺
C_1		5400					75,600	
C_2		1800					22,640	
C_3		790					10,240	
C_4		210					1580	
C_5	.5×1.5×13.25×150	1490				19.17	28,600	
C_6		6300					88,250	
C_7		600					16,200	
E_{L1}		19,000					107,000	
E_{L2}		1500					17,900	
P_E				9000			45,000	
U	½×469×28		6570			9.33		57,100
		ΣV 30,520					ΣM_A 353,910	

Position of resultant $\frac{\Sigma M}{\Sigma V} = 11.6'$ from "A"

Eccentricity "e" $= \frac{28}{2} - 11.6 = 2.4'$

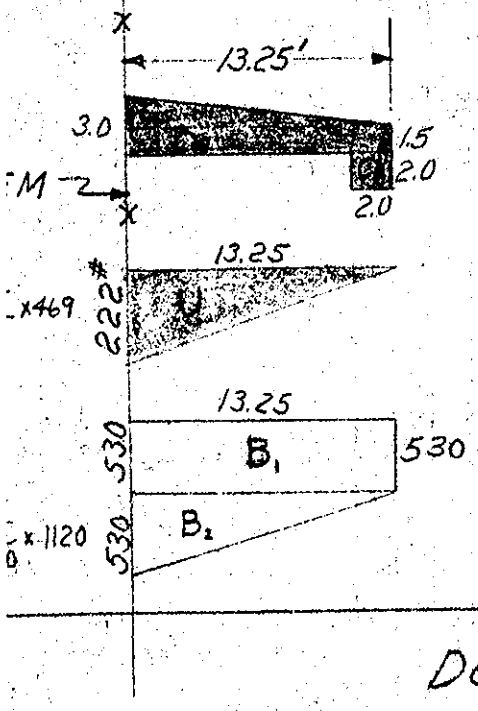
$$\text{Bearing} = \frac{30,520}{28}\left(1 \pm \frac{6 \times 2.4}{28}\right) = 1090\left[\begin{matrix}1 + .514\\ 1 - .514\end{matrix}\right] = \begin{matrix}1650\#\\ 530\#\end{matrix}$$



Project: Chicopee Dike C3b
Computation: 27' floodwall
Computed by: J. H. L. Checked by: Date: 1/22/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II - Design of riverside base



	Force	↓	↑	Arm	↻	↺
C_5		1490		4.42	6600	
C_6	1.5×13.25×150	2980		6.63	19750	
C_7		600		12.25	7350	
U	$\frac{1}{2}$×222×13.25		1470	6.63		9750
B_1	530×13.25		7025	6.63		46,600
B_2	$\frac{1}{2}$×530×13.25		3510	4.42		15,500
		ΣV =	6,935		ΣM =	38,150

$$A_{s_{X-X}} = \frac{38,150 \times 12}{18000 \times .884 \times 31.5} = .914 \text{ □"}$$

in bottom

Design of landside base

By inspection the steel required in the bottom will be less than for Case I

WAR DEPARTMENT

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

Page 96

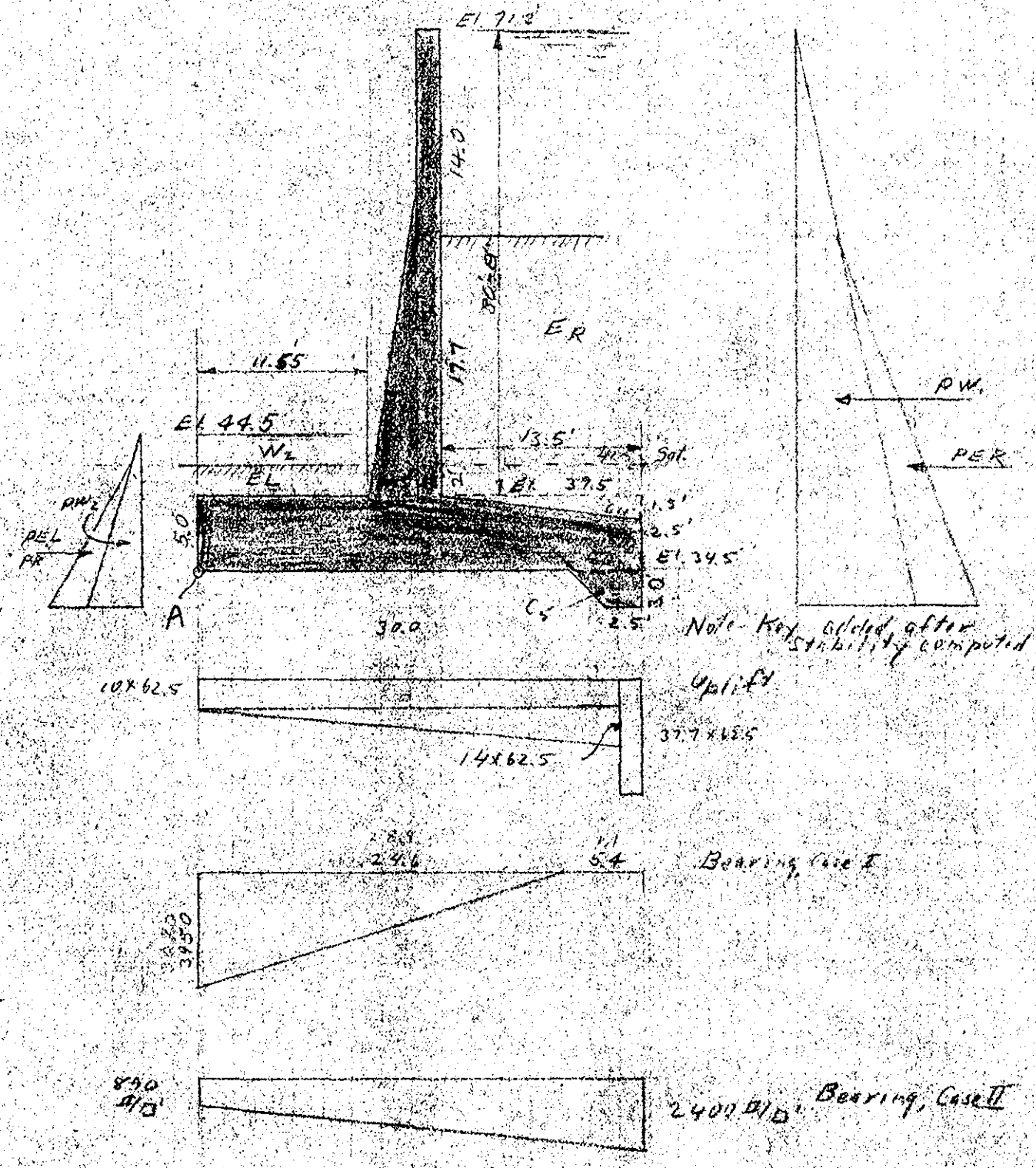
Project: Chicopee C3b

Computation: 30.67' wall 30 Base

Computed by: RW Checked by: Date: 4-1-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability River Down



Subject Chicopee, Mass. C-26

Computation 30.67' Wall 30' Base

Computed by W H F Checked by Date 4/19/40

Stability River Up

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1	30.7 × 1.5 × 150	6720				15.75	109 000	
C_2	½ × 19.7 × 3.3 × 150	4880				13.7	67 900	
C_3	4 × 30 × 150	18 000				15.0	270 000	
C_4	½ × 1.5 × 13.5 × 25		250			25.5		640
C_5	.1 × 3 × 150	450				28.5	12 830	
W_1	14 × 13.5 × 62.5	11 820				23.25	274 500	
E_r	16.7 × 13.5 × 125	28 200				23.25	656 000	
W_2	3 × 12.1 × 62.5	2270				6.0	13 620	
E_l	1 × 11.8 × 125	1470				5.9	8 670	
U_1	35.7 × 1.5 × 62.5		3350			29.25		98 000
U_2	8 × 28.5 × 62.5		14 250			14.25		203 000
U_3	½ × 13.3 × 28.5 × 62.5		11 830			19.0		224 800
P_{w_1}	$\overline{35.7}^2 \times ½ \times 62.5$				39 800	10.7		424 000
P_{e_1}	$\overline{21.5}^2 \times ½ \times 17.5$				4060	6.2		25 200
F_r	.5 × 44330			22165				
		74010	29 690	22 165	43 860		1 412 530	955 640
		ΣV = 44330 ↓		ΣH = 21690 →			ΣM = 426890 ↻	

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = \frac{426\,890}{44\,330} = 9.63$ ½ Base = 10.0 e = 15 − 9.63 = 5.37

Base Pressure $= \frac{44330}{3 \times 9.63} \times \begin{cases} 2 \\ 0 \end{cases} = 1535 \times \begin{cases} 2 = 3070\ \#/\square' \\ 0 = 0 \end{cases}$

Subject: Chicopee, Mass. C-3b

Computation: 30.67' Wall 30' Base

Computed by: W H F Checked by: _____ Date: 4/19/40

Stability River Down

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1		6920				15.75	109 000	
C_2		4880				13.9	67 900	
C_3		18000				15.0	270 000	
C_4			250			25.5		640
C_5		450				28.5	12 830	
Er_1	15.7 × 13.5 × 100	21200				23.25	493 000	
Er_2	1 × 13.5 × 125	1690				23.25	39 300	
El	1 × 11.8 × 125	1470				5.9	8 680	
U	6 × 30 × 62.5		11 250			15.0		168 800
Per_1	$21.7^2 \times \frac{1}{2} \times 35$				8 250	6.23		51 400
Per_2	$6^2 \times \frac{1}{2} \times 45$				810	1.0		810
Pel	$6^2 \times \frac{1}{2} \times 80$			1440		1.0	1440	
Fr	0.5 × 43110			21560				
		54610	11,500	23000	9060		1002,150	221 650.
		$\Sigma V = 43110$ ↓		$\Sigma H = 13940$ →			$\Sigma M = 780500$ ↻	

$$\text{Position of Resultant} = \frac{\Sigma M}{\Sigma V} = \frac{780\,500}{43\,110} = 16.2 \qquad e = 16.2 - 15.0 = 1.2$$

$$\text{Base Pressure} = \frac{43110}{30} \times 1 \pm \frac{6 \times 1.2}{30} = 1437 \times \begin{cases} 1.24 = 1782 \text{ \#/□ River} \\ .76 = 1092 \text{ \#/□ Land} \end{cases}$$

WAR DEPARTMENT

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

...t Chicopee C3b

...nputation 30.67' Wall, 30' Base

...nputed by RW Checked by [illegible] Date 4-3-40

Steel Sketch

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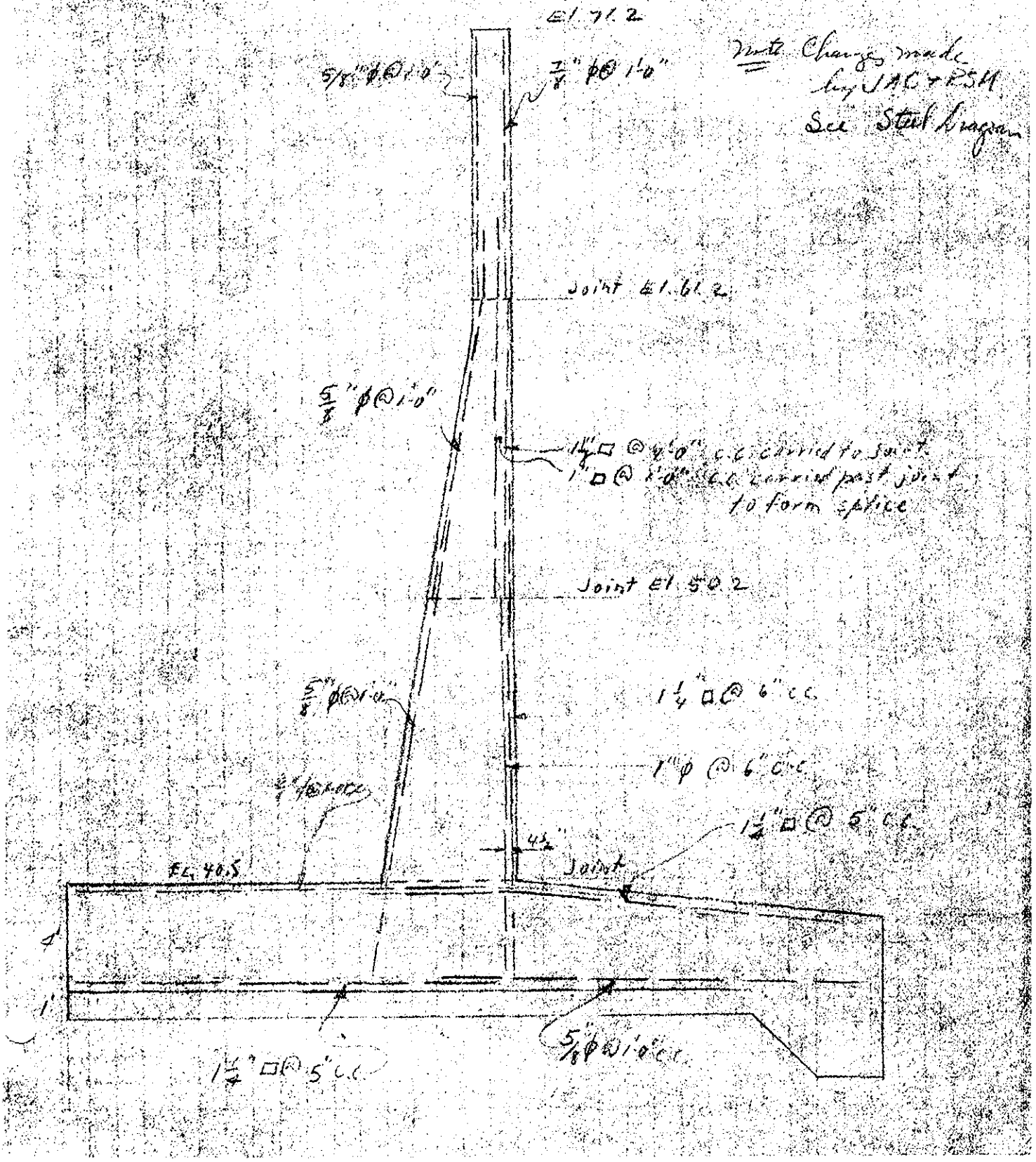
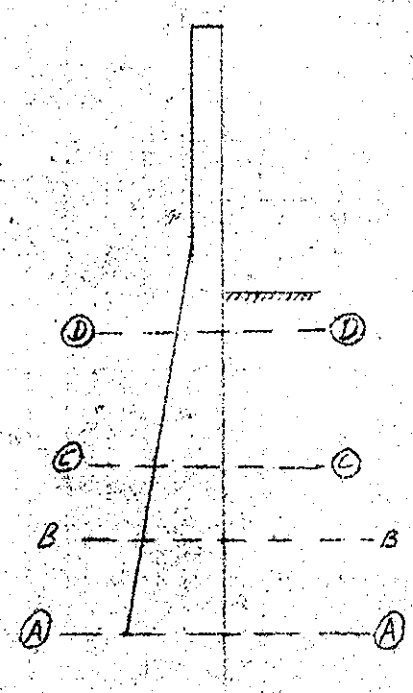


Project Chicopee C3b
Computation 30.67' Wall on Piles
Computed by PW Checked by P.J.A. Date 4-2-49

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Stem Steel



(A)-(A) Top of Base

	Force	Arm	Moment
W_1	$31.7^2 \times \frac{1}{2} \times 62.5 = 31{,}400$	10.6	333,000
ER	$17.7^2 \times \frac{1}{2} \times 17.5 = 2740$	5.9	16180
EL	$2^2 \times 17.5 \times \frac{1}{2} = 35$	0.7	30
W_2	$5^2 \times 62.5 \times \frac{1}{2} = 780$	1.7	1330
	$\Sigma V = 33{,}325$		$\Sigma M = 347{,}820$

d Required $= \sqrt{\frac{347820}{123}} = \cancel{52.3}$ 53.1"

d Provided = 55.59

(B)-(B) 5' Above Top of Base

W_1	$26.7 \times \frac{1}{2} \times 62.5 = 22{,}300$	$\times 8.9 =$ 198500	
ER	$12.7^2 \times \frac{1}{2} \times 17.5 = 1410$	$\times 4.2 =$ 5[illegible]	
	$\Sigma V = 23{,}710$	$\Sigma M = 204{,}4[illegible]$	

C-C 23' Below Top of Wall

W	$23^2 \times \frac{1}{2} \times 62.5 = 16500$	$\times 7.33 =$ 121000	
ER	$8^2 \times \frac{1}{2} \times 17.5 = 710$	$\times 3 =$ 2130	
	$\Sigma V = 17{,}210$	$\Sigma M = 123{,}130$	

D-D 16' Below Top of Wall

W	$16^2 \times \frac{1}{2} \times 62.5 = 8000$	$\times .53 =$ 42400	
E	$2^2 \times \frac{1}{2} \times 17.5 = 35$	$\times 0.67 =$ 30	
	$\Sigma V = 8035$	$\Sigma M = 42{,}430$	

Moments at other depths taken from similar walls.

WAR DEPARTMENT

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

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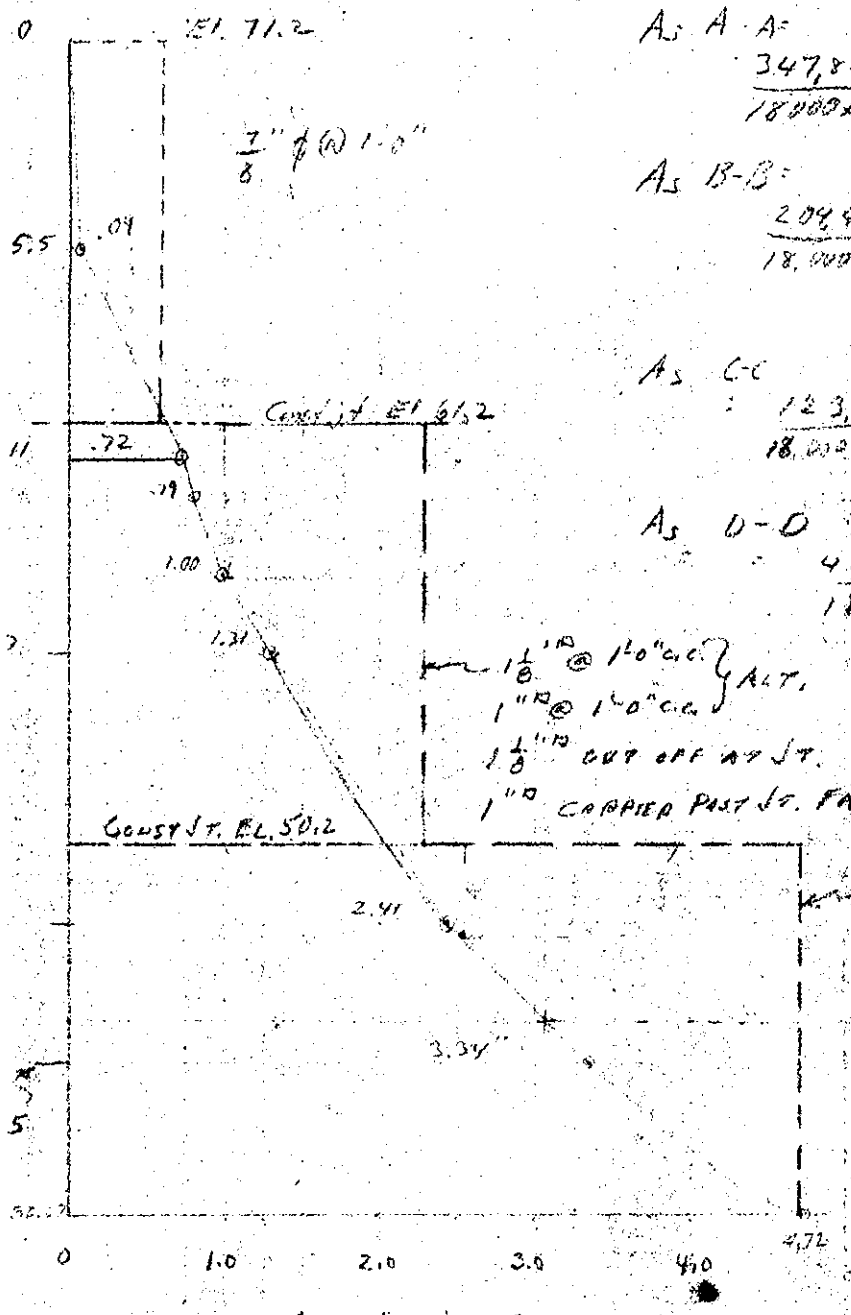
Project: Chicopee C3b

Computation: 30.67 Wall

Computed by: K.W. Checked by: R.E.C. Date: 4-2-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Stem Steel



As A-A:

$$\frac{347{,}824 \times 12}{18000 \times .884 \times 55.5} = 4.72 \square''$$

As B-B:

$$\frac{209{,}420 \times 12}{18{,}000 \times .884 \times 46} = 3.34 \square''$$

As C-C

$$= \frac{123{,}130 \times 12}{18{,}000 \times .884 \times 38.5} = 2.41 \square''$$

As D-D

$$= \frac{42{,}430 \times 12}{18{,}000 \times .884 \times 24.5} = 1.31 \square''$$

$1\frac{1}{8}''\square$ @ 1'-0" c.c. } Alt.
$1''\square$ @ 1'-0" c.c.
$1\frac{1}{8}''\square$ cut off at Jt.
$1''\square$ carried past Jt. for splice

Back Row 1"ϕ bars cut off at Jt. Row of $1\frac{1}{4}''\square$ extend past Jt. for splice

Double rows
$1\frac{1}{4}''\square$ @ 6" c.c. } $4\frac{1}{2}''$ c to c of rows
1"ϕ @ 6" c.c.

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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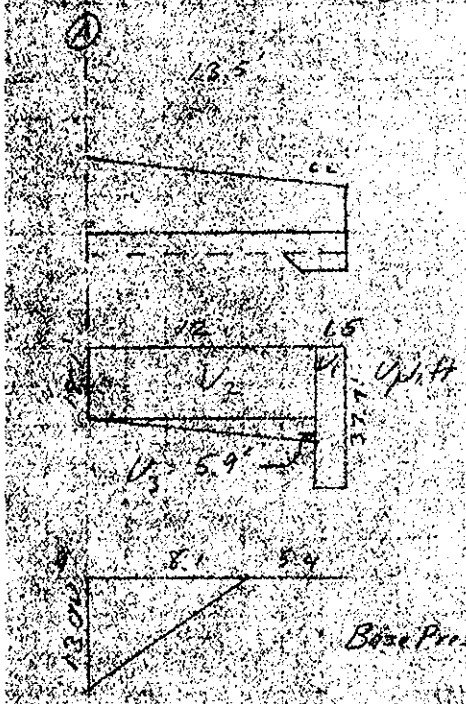
Chicopee C3b
Computation 30 ft Wall 30' Base
Computed by R.W. Checked by P.L.A. Date 4-3-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Base Steel - River Side

River Up

Section A-A



Forces		↓↑	Arm	Moments
W	14 × 13.5 × 62.5	= 11800↓	6.75	= 79 500
ER	17.7 × 13.5 × 125	= 29900↓	6.75	= 202 000
C_1	5 × 13.5 × 150	= 10 120↓	6.75	= 68 500
C_3	3 × 1 × 150	= 450↓	12	= 5 400
C_2	− 13.5 × 1.5 × ½ × 25	= 250↑	9	= 2 250
P	8.1 × ½ × 1300	= 5260↑	2.7	= 14 200
U_1	37.7 × 1.5 × 62.5	= 3530↑	12.75	= 45 000
U_2	12 × 18.1 × 62.5	= 13 600↑	6	= 81 600
U_3	5.9 × 12 × ½ × 62.5	= 2210↑	8	= 17 700

ΣV = ~~47420~~ 27420 #↓ ΣM = ~~196,900~~ 194650 #

$d(\text{Req'd}) = \sqrt{\frac{194650}{123}} = 40''$

Base Pressure $A_s = \frac{194650 \times 12}{18,000 \times .884 \times 44.5} = 3.30$ □"

Use 1¼" □ @ 5" c.c.

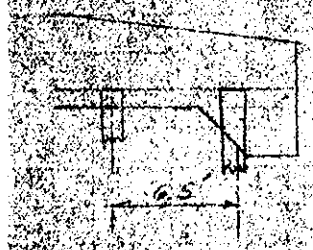
Top Steel

River Down

ER_1	15.7 × 13.5 × 100	21 200↓	× 6.75	= 143,000
ER_2	2 × 13.5 × 125	3370↓	× 6.75	= 22 700
C_1		10120↓	× 6.75	= 68 400
C_3		450↓	× 12	= 5 400
C_2		250↑	× 9	= 2 250
P_1	1720 × 13.5	23200↑	× 6.75	= 156 500
P_2	680 × ½ × 13.5	4580↑	× 9	= 41 300
U	7 × 62.5 × 13.5	5900↑	× 6.75	= 39 800

ΣV = 1210 # ΣM = 350 # ↑

Use ⅝" □ @ 1'0" c.c.



Slab acting as beam between piles

$M = \frac{w l^2}{12}$

$ER_1 = 15.7 \times 100 = 1570$ ↓
$ER_2 = 2 \times 125 = 250$ ↓
$C = 5 \times 150 = 750$ ↓
$U = 7 \times 62.5 = 440$ ↑

Net w = 2130 #/□' ↓

$M = \frac{2130 \times 6.5^2}{12} = 7500$ '#

$A_s = \frac{7500 \times 12}{18000 \times .884 \times 44.5} = 12.7$ □" Temp Steel

WAR DEPARTMENT

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

Project: Chicopee C3b

Computation: 30.67 Wall, 30' Base

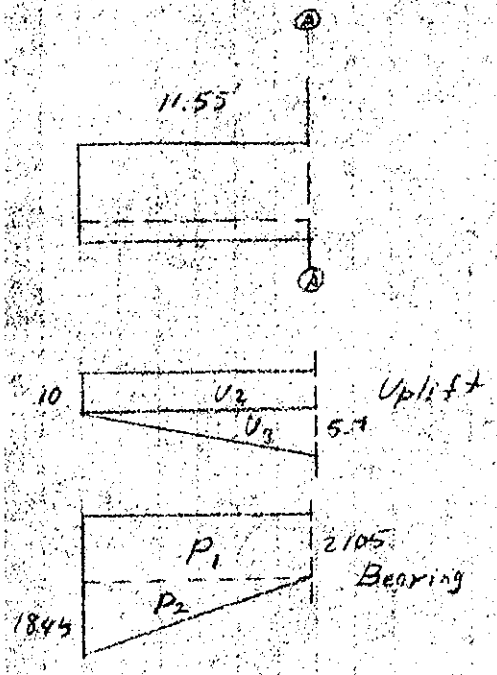
Computed by: RW Checked by: [illegible] Date: 4-3-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Base Steel - Land Side

River Up

Section A-A



W	$3 \times 62.5 \times 11.55$	$= 2170\uparrow \times 5.8$	$= 12\,600$	↓
E	$2 \times 125 \times 11.55$	$= 2890\uparrow \times 5.8$	$= 16\,770$	↓
C	$5 \times 11.55 \times 150$	$= 8660\downarrow \times 5.8$	$= 50\,300$	↓
U_2	$10 \times 62.5 \times 11.55$	$= 7220\uparrow \times 5.8$	$= 41\,900$	↑
U_1	$11.55 \times \frac{1}{2} \times 5.7 \times 62.5$	$= 2060\uparrow \times 3.9$	$= 8\,050$	↑
P_1	2105×11.55	$= 24\,300\uparrow \times 5.8$	$= 141\,000$	↑
P_2	$1845 \times \frac{1}{2} \times 11.55$	$= 10\,650\uparrow \times 7.8$	$= 83\,100$	↑
		$\Sigma V = 39\,510\uparrow$	$\Sigma M = \cancel{197,380}$ 194 380	↑

$$A_s = \frac{197\,380 \times 12}{18\,000 \times .88 \times 44.5} = 3.34 \ \square''$$

$$\text{Shear} = \frac{39\,510}{12 \times .88 \times 44.5} = 64.6 \ \#/\square''$$

Use $1\frac{1}{4}''\square$ @ 5" c.c.

Top - Temp. Steel by inspection

WAR DEPARTMENT

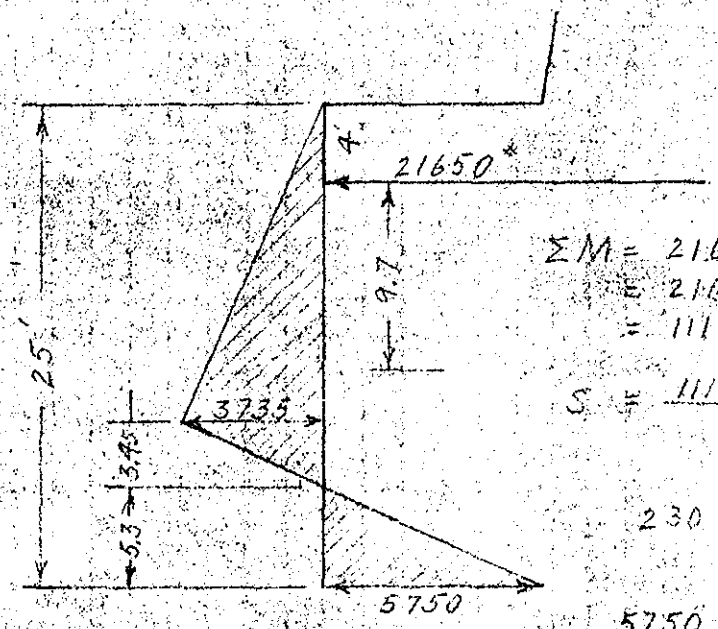
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Project: Chicopee, Mass. C-3b

Computation: 2 Piles at Toe 32.67 Wall 32 Base

Computed by: W. H. F. Checked by: Date: 4/19/40

U. S. GOVERNMENT PRINTING OFFICE 3—10533



Pt. of Zero Shear

$$21650 = \frac{230\,x^2}{2} \qquad x = 13.7$$

$$\Sigma M = 21650 \times 9.7 - (13.7 \times 230 \times 6.85 \times 4.57)$$
$$= 210{,}000 - 98{,}650$$
$$= 111\,350$$

$$S = \frac{111\,350 \times 12}{28000} = \underline{47.7''^3} \qquad MZ\ 38 = \underline{46.8''^3}$$

$$230 \times 25 = 5750$$

$$\frac{5750}{5.3} = \frac{230\left[25 - (5.3 + x)\right] + 57.50}{5.3 + x}$$

$$5750x = 1120\left[25 - (5.3 + x)\right]$$
$$6970x = 24035$$
$$x = 3.45 \qquad 16.25 \times 230 = 3740$$

$$\Sigma H = (3740 \times 19.7 \times \tfrac{1}{2}) - \left[21650 + (5750 \times 5.3 \times \tfrac{1}{2})\right]$$
$$= 36850 - 36900 = 50 \leftarrow$$

$$\Sigma M = \left[(\tfrac{1}{2} \times 3740 \times 16.25 \times 10.83) + (\tfrac{1}{2} \times 3740 \times 3.45 \times 17.4)\right] - \left[(\tfrac{1}{2} \times 5750 \times 5.3 \times 23.23) + (21650 \times 4)\right]$$
$$= \left[1870\,(16.25 \times 10.83) + (3.45 \times 17.4)\right] - \left[(2875 \times 5.3 \times 23.23) + 86600\right]$$
$$= 441\,500 - 440\,500 = 1000\ \text{L}$$

WAR DEPARTMENT

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

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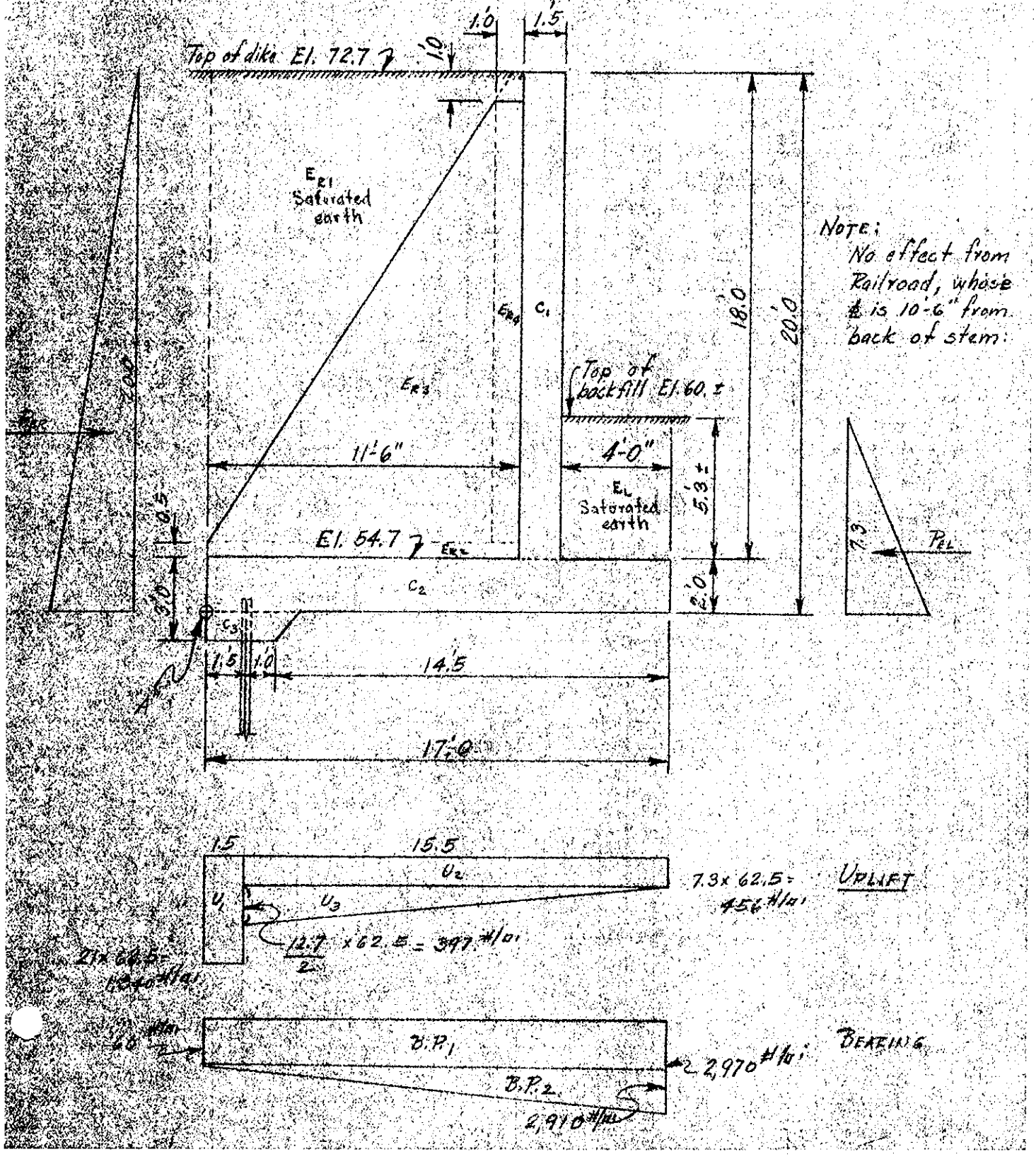
Project: CHICOPEE DIKE C. 36.

Computation: 18'-0" COUNTERFORT WALL - Dike Abutments

Computed by: J.A.C. Checked by: R.W. Date: 3/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523



Project: CHICOPEE DIKE - C.3b
Computation: 18'-0" COUNTERFORT WALL - Dike Abutments
Computed by: J.A.C. Checked by: R.W. Date: 3/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT "A" ↷	MOMENTS ABOUT "A" ↶
E_{R1}	$\frac{1}{2} \times 11 \times 17.5 \times 125$	12,050				3.67		44,200
E_L	$4 \times 5.3 \times 125$	2,650				15.0		39,700
C_1	$18 \times 1.5 \times 150$	4,050				12.25		49,100
C_2	$17 \times 2.0 \times 150$	5,100				8.5		43,400
C_3	$3 \times 1 \times 150$	450				1.5		675
E_{R2}	$11.5 \times 0.5 \times 125$	720				6.75		4,850
E_{R3}	$\frac{1}{2} \times 16.5 \times 10.5 \times 125$	10,800				7.0		75,600
E_{R4}	$16.5 \times 1.0 \times 125$	2,060				11.0		22,700
P_{ER}	$\frac{1}{2} \times \overline{20}^2 \times 80$			16,000		6.67		106,500
P_{EL}	$\frac{1}{2} \times \overline{7.3}^2 \times 80$				2,130	2.43	5,180	
U_1	$21 \times 62.5 \times 1.5$		2,020			0.75	1,510	
U_2	$7.3 \times 62.5 \times 15.5$		7,070			9.25	65,400	
U_3	$\frac{1}{2} \times 6.38 \times 62.5 \times 15.5$		3,080			6.67	20,500	
F_x	$0.45 \times 25,710$				11,570			
P_x	Passive Resistance				2,310	2.43	5,610	
		37,880	12,170	16,000	16,000		98,200	386,725
		$\Sigma V = 25,710$ ↑		$\Sigma H = 0$			$\Sigma M = 288,525$ ↷	

Position of Resultant $\Big\} = \frac{\Sigma M}{\Sigma V} = \frac{288,525}{25,710} = 11.22'$ 0.78' inside middle 3rd

$e = 2.72'$

Bearing $\frac{\Sigma V}{b}\left(1 \pm \frac{6e}{b}\right) = \frac{25,710}{17}\left[1 \pm \frac{6 \times 2.72}{17}\right] = 1,515\left[1 \begin{matrix} + .96 \\ - .96 \end{matrix}\right] = \begin{matrix} 2,970 \text{ \#/□'} \\ 60 \text{ \#/□'} \end{matrix}$

Max. Passive Resistance Available $= wh^2 \times 1.3 = 125 \times \overline{7.3}^2 \times 1.3 = 8,650^{\#}$

WAR DEPARTMENT

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

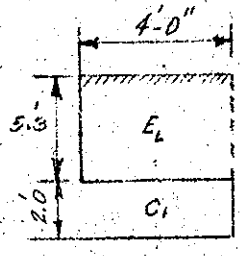
Project: CHICOPEE DIKE – C.3b

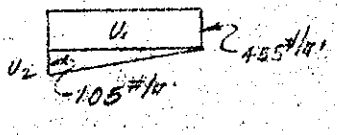
Computation: 18'-0" COUNTERFORT WALL – Dike Abutments

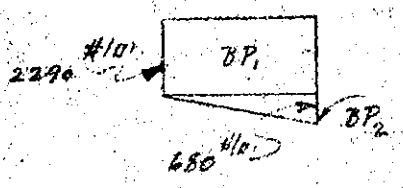
Computed by: T.A.C. Checked by: Date: 3/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10639

DESIGN OF TOE SLAB







Forces Acting		↓	↑	Arm	Moments ↻	Moments ↺
E_L		2,650		2.0	5,300	
C_1	4 x 2 x 150	1,240		2.0	2,480	
U_1	455 x 4		1,820	2.0		3,640
U_2	½ x 105 x 4		210	1.33		280
$B.P._1$	2290 x 4		9,170	2.0		18,340
$B.P._2$	½ x 680 x 4		1,360	2.67		3,630
		3,890	12,560		7,780	25,890
		ΣV = 8,670 #↑			ΣM = 18,110 '#↻	

Uplift and Bearing values scaled from diagrams Figs. 344.

$d = 24 - 3.5 = 20.5''$

$d_{REQ} = \sqrt{\frac{18,110}{123}} = \sqrt{147} = 12''+$

$A_s = \frac{12 \times 18,110}{18,000 \times .884 \times 20.5} = 0.67\ \square''$

$Z_o = \frac{8,670}{150 \times .884 \times 20.5} = 3.18''$ 3.14 Supplied

$v = \frac{8,670}{12 \times .884 \times 20.5} = 40\ \#/\square''$

USE 1" ϕ @ 1'-0" cc.

IN BOTTOM FACE

Project Chicopee C 3b
Computation 18' Counterfort Wall - Dike Abutments
Computed by RW JAC Checked by ..... Date 3-28-40

U. S. GOVERNMENT PRINTING OFFICE 8—10038

Counterfort Steel
Section at top of base

Forces acting	⇄	Arm	Moments
PER $\frac{1}{2} \times 18^2 \times 80 \times 13$	168,500	6.0	1,011,000
PEL $\frac{1}{2} \times 53^2 \times 80 \times 13$	14,600	1.77	26,900
ΣH	153,900		ΣM = 984,100 '#

d Scaled from P.6 = 128"

$d = (Req'd) = \sqrt{\frac{984100}{123}} = 90"$

$A_s = \frac{12 \times 984100}{18000 \times .884 \times 128} = 5.8 \square"$ Use 6 - 1" □

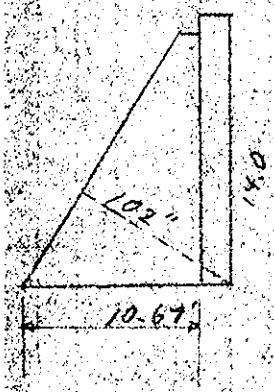
$\Sigma o = \frac{153,900}{150 \times .884 \times 128} = 9.1"$

$Shear = \frac{153,900}{18 \times .884 \times 128} = 75.7 \#/\square"$

Project Chicopee C-36
Computation 18' Counterfort Wall - Dike Abutments
Computed by RW, JAC Checked by Date 3-22-40

U. S. GOVERNMENT PRINTING OFFICE 3—10529

Counterfort on ℄ Dike Section 14' from top



Forces		→	Moments about C
PER	$\frac{1}{2} \times 14^2 \times 80 \times 13 = 102{,}000$	$\times 4.67$	$= 476{,}000$
PEL	$\frac{1}{2} \times 1.2^2 \times 80 \times 13 = 880$	$\times 0.42$	$= 380$
	$\Sigma H = 101{,}120$	ΣM	$475{,}620$ '#

d (Scaled from page 6) = 102"

$$A_s = \frac{12 \times 475{,}620}{18{,}000 \times .884 \times 102} = 3.51 \ \square''$$

$$\Sigma O = \frac{101{,}120}{150 \times .884 \times 102} = 7.5 \ \square''$$

$$v = \frac{101{,}120}{18 \times .884 \times 102} = 62 \ \#/\square''$$

A_s - use 4 - 1" □

WAR DEPARTMENT

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

Project Chicopee C3b

Computation 18' Counterfort Dike Abutments

Computed by JAC - RW Checked by ..... Date 3-28-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Counterfort Steel (Cont'd)

Section at 9' below top of Stem

Forces	$\rightleftarrows$	Arm	Moments
PER $\frac{1}{2} \times 9^2 \times 80 \times 13$	42,100	3	126,300

d scaled from Pl. = 70"

d req'd $= \sqrt{\frac{126,300}{123}} = 32"$

$A_s = \frac{12 \times 126,300}{18,000 \times .884 \times 70} = 1.36 \square"$ Use 2 - 1" ⊡

ΣO and Shear O.K. by inspection

WAR DEPARTMENT

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

Project Chicopee C3b

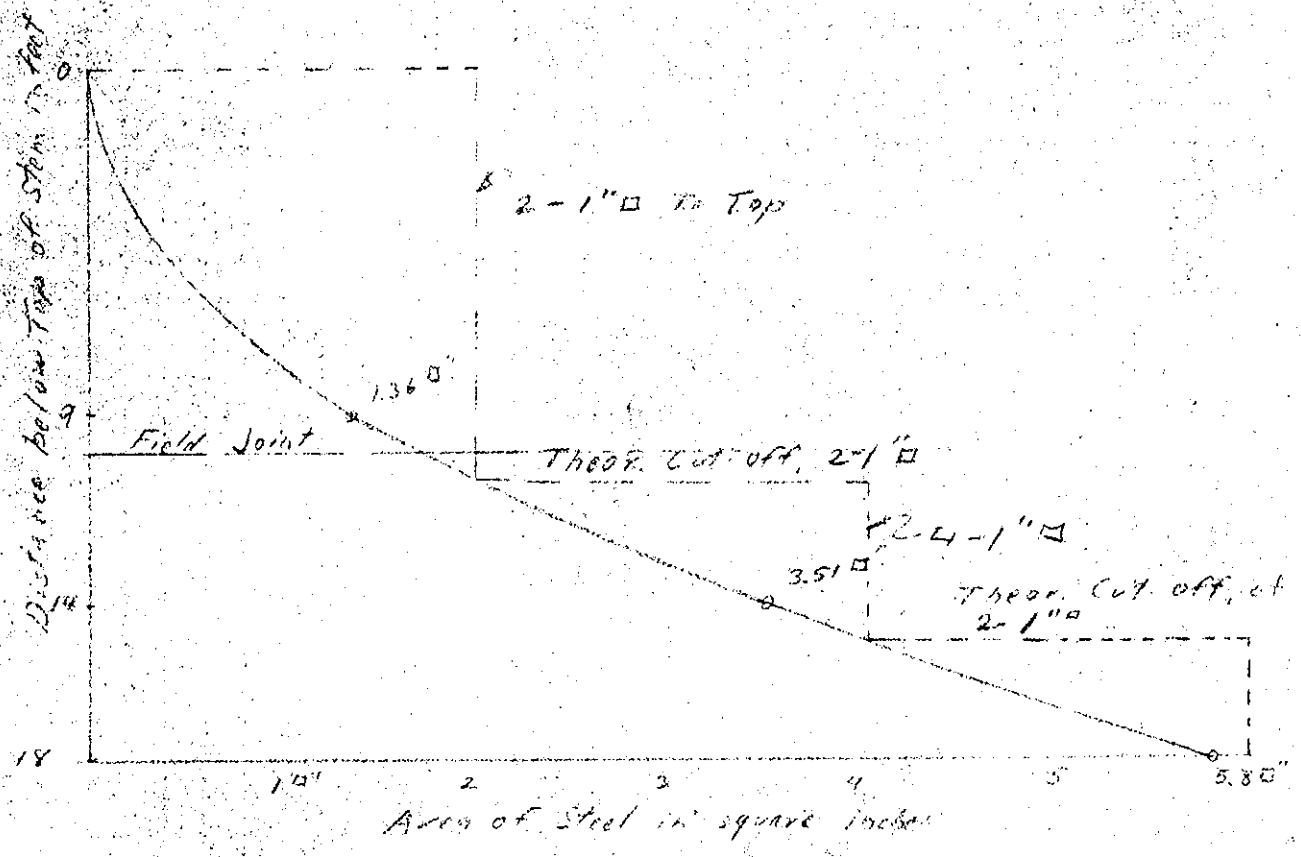
Computation 18' counterfort walls - Dike Abutments

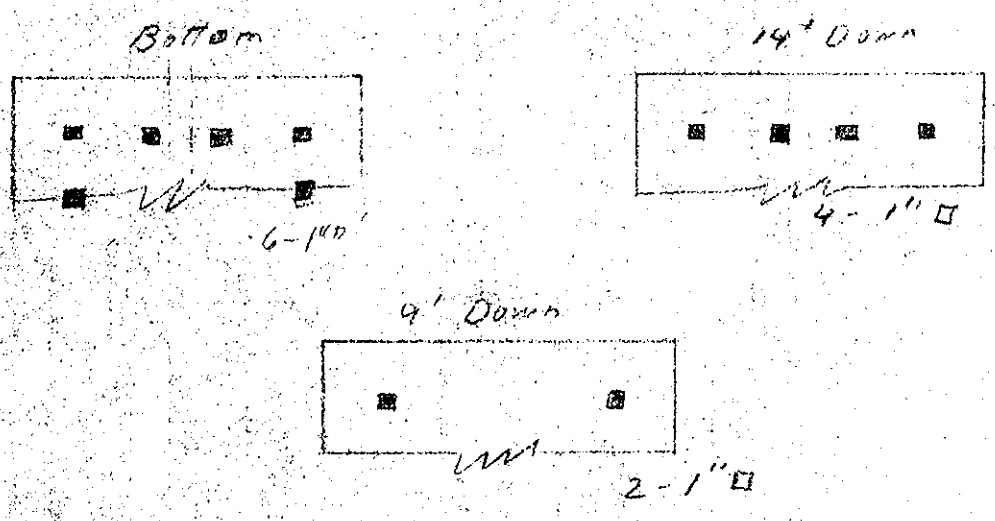
Computed by JAL Checked by ..... Date 3-28-40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Steel Diagram

Hor. 1" = 1 □"
Vert. 1" = 5'



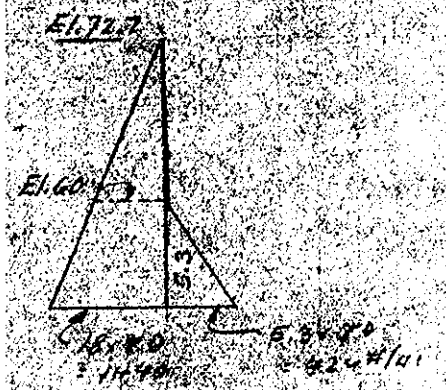


Project: Chicopee Dike - C. 3b
Computation: 18'-0" Counterfort Wall - Dike Abutments
Computed by: J.A.C. Checked by: RW Date: 3/22/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Bonding Bars into Stem

Section at 18'-0" below Top of Stem (i.e. Top of Base)



Consider a 1'-0" Section (Vert.)

Total V on 1 Bar = 101.5 x 13 = 13,200 # (Panel Load)

$A_s = \frac{P}{S} = \frac{13,200}{18,000} = 0.733$ □" ÷ 2 = 3.66

Since bar is cut twice only ½ of this A_s is rqd.

∴ Use ¾" φ @ 1'-0" c.c.

Section at El. 60.0

Unit Press = 12.7 x 80 = 101.6 #/□' x 13 = 13,200 # Panel Load

∴ Use ¾" φ @ 1'-0" c.c.

Change in Size of Bonding Bars to ½"□

Where V = 9,000 $A_s = \frac{9,000}{18,000} = 0.50$ □" or ½"□ @ 1'-0" c.c.

But V = 13 x Unit Pr.

9,000 = 13 U.P.

U.P. = 692 #/□'

692 = 80 x

x = 8'

(Distance below top of stem to point where ½"□ bonding bars begin. - Run ½"□ @ 1'-0" c.c. to top.)

Above El. 64.7 - Use ½"□ @ 1'-0" c.c.
Below El. 64.7 - Use ¾" φ @ 1'-0" c.c.

Subject: Chicopee Pike C3b
Computation: 18' Counterfort - Dike Abutments
Computed by: RW, JAC Checked by: RW Date: 3-28-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEM

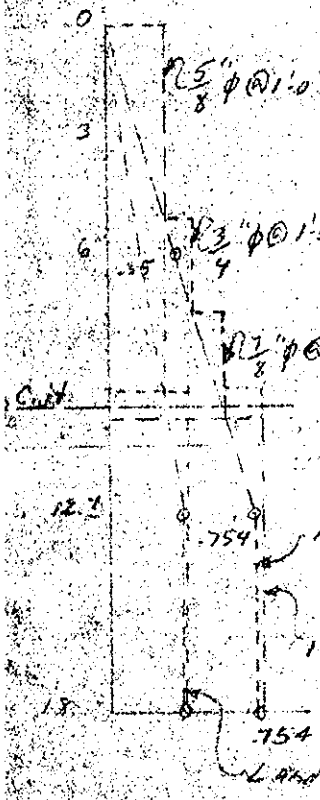
Net Unit Pressure at AA = 1016 #/□' depth 18'

BB = 1016 #/□' depth 12.4'

CC = 480 #/□' depth 6'

DD = 240 #/□' depth 3'

Moments		At Counterfort	Mid Span
M_{AA}	$\frac{1016 \times 13^2}{12} =$	14,300 '#	7,150 '#
M_{BB}	Same	14,300 '#	7,150 '#
M_{CC}	$480 \times \frac{13^2}{12}$	6,750 '#	3375 '#
M_{DD}	$240 \times \frac{13^2}{12}$	3,375 '#	1687 '#



Steel Area

A_s AA, A_s BB $= \frac{14,300 \times 12}{18000 \times .884 \times 14.5} = .745$ □" River Side

$\times \frac{12}{24} = .373$ □" Land Side

A_s CC $= \frac{6750 \times 12}{18000 \times .884 \times 14.5} = .35$ □" River Side

$\times \frac{12}{24} = 0.18$ □" Land Side

A_s D-D $= \frac{3375 \times 12}{18000 \times .884 \times 14.5} = .17$ □" River Side

$\times \frac{12}{24} = .08$ □" Land Side

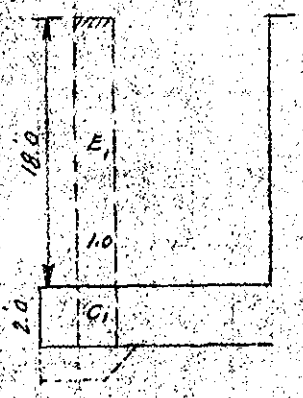
Land Side, Use 3/4" φ @ 1'-0" below El. 63

Use 5/8" φ @ 1'-0" above El. 63

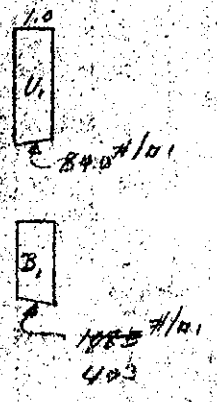
Subject: CHICOPEE DIKE - C.3.b
Computation: 18'-0" COUNTERFORT WALL - DIKE ABUTMENTS
Computed by: T.A.C. Checked by: RW Date: 3/22/40

U.S. GOVERNMENT PRINTING OFFICE 3—10533

DESIGN OF HEEL SLAB



FORCES ACTING		↓	↑
E_1	18×125×1	2,250	
C_1	2×150×1	300	
U_1	840×1×1		840
P_1	403×1×1		403
		2,550	1,243
		ΣV = 1307 #/ft ↓	



$$M = \frac{1307 \times 13^2}{12} \times 12 = 221{,}000 \text{ "\#}$$

$$V = \frac{1307 \times 13}{2} = 8500 \text{ \#}$$

$$d_M = \sqrt{\frac{221{,}000}{12 \times 123}} = \sqrt{150} = 12.5''$$

$$d_V = \frac{8{,}500}{60 \times 12 \times .884} = 13.4''$$

$$A_s = \frac{221{,}000}{18{,}000 \times .884 \times 20.5} = .68 \text{ □"}$$

USE 1" ϕ @ 1'-0" C.C. - TOP FACE

BONDING BARS INTO HEEL SLAB

$$V = 1307 \times 13 = 17{,}000 \text{ \#}$$

$$A_s = \frac{17{,}000}{18{,}000} = 0.94 \text{ □"} \div 2 = 0.47 \text{ □"}$$

USE ½" ϕ @ 1'-0" C.C.

Subject: Chicopee Dike C3b
Computation: 18' counterfort wall - Dike abutments
Computed by: RW Checked by: Date:

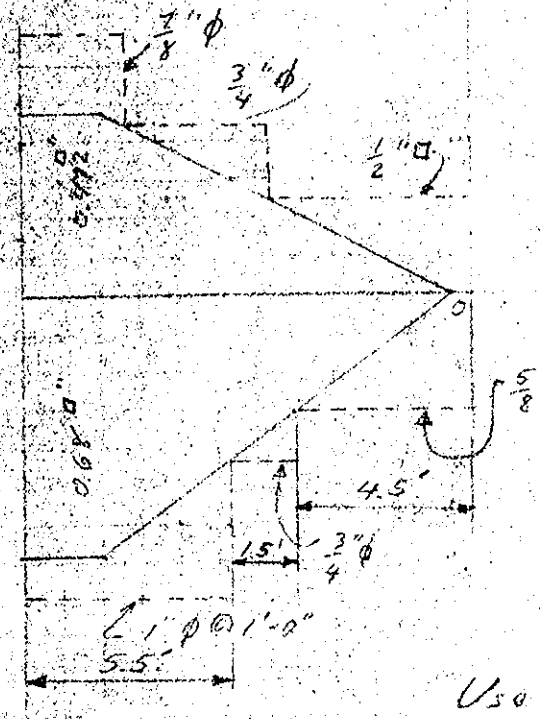
U.S. GOVERNMENT PRINTING OFFICE 3—10528

Base Steel Diagram

A_s

Longitudinal base steel

Bonding Steel



Base bonding steel

Use 3 - 7/8" φ
4 - 3/4" φ
5 - 1/2" □

Longitudinal Base Steel

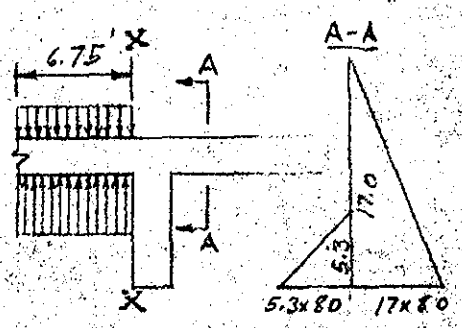
Use 6 - 1" φ @ 1'-0"
2 - 3/4" φ @ 1'-0"
4 - 5/8" φ @ 1'-0" Top of base

Use 4 - 3/4" φ @ 1'-0"
8 - 5/8" φ @ 1'-0" Bottom of base

Subject: Chicopee Dike - C.3b
Computation: 18' counterfort wall - Dike abutments
Computed by: T.A.C. Checked by: R.W. Date: 3/23/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEM AS CANTILEVERED FROM 13'-0" COUNTERFORT



SECTION AT TOP OF BASE

$17 \times 80 \times 6.75 = 9,200 \times 3.38 = 31,100$ '#

$5.3 \times 80 \times 6.75 = 2,870 \times 3.38 = 9,700$

$\Sigma M_{x-x} = 21,400$ '#

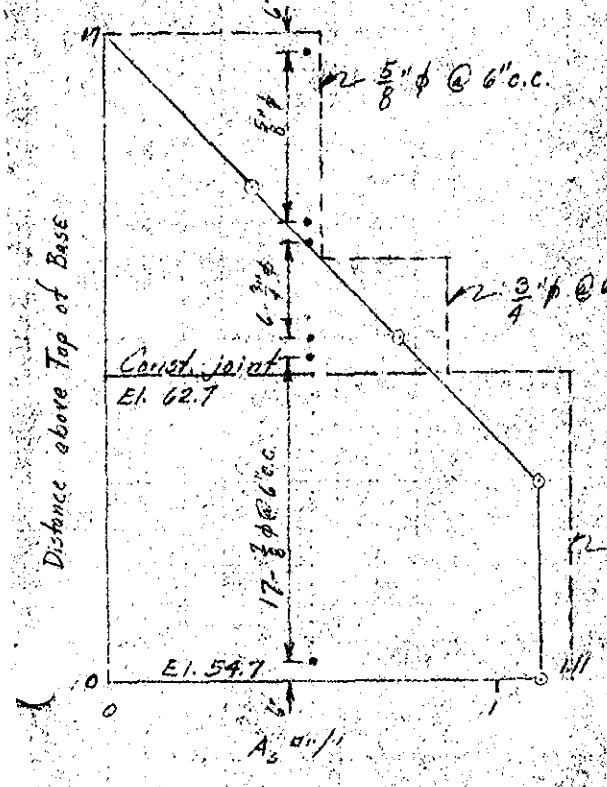
$$A_s = \frac{12 \times 21,400}{18,000 \times .884 \times 14.5} = 1.11 \text{ □''}$$

SECTION 5.3' ABOVE TOP OF BASE

$11.7 \times 80 \times 6.75 = 6,310 \times 3.38 = 21,400$

Same A_s as above 1.11 □''

RIVERSIDE FACE
STEEL



SECTION 9.0' ABOVE TOP OF BASE

$8.0 \times 80 \times 6.75 = 4,320 \times 3.38 = 14,600$ '#

$$A_s = \frac{12 \times 14,600}{18,000 \times .884 \times 14.5} = 0.76 \text{ □''}$$

SECTION 13.0' ABOVE TOP OF BASE

$4.0 \times 80 \times 6.75 = 2,160 \times 3.38 = 7,300$ '#

$$A_s = \frac{12 \times 7,300}{18,000 \times .884 \times 14.5} = 0.38 \text{ □''}$$

LANDSIDE FACE

USE $\frac{5}{8}$"φ @ 1'-0" c.c.

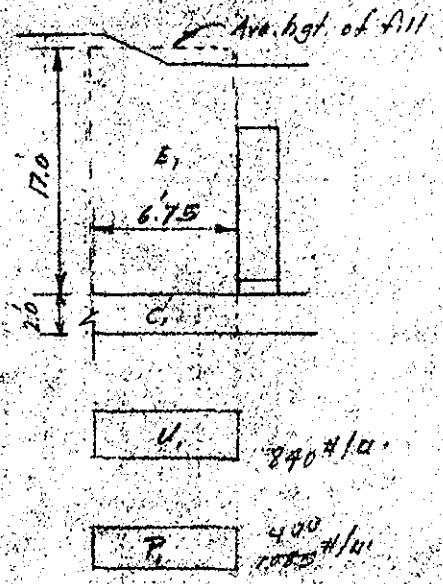
ALL THE WAY

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
Page 117

Subject: Chicopee Dike – C. 3b.
Computation: 18' counterfort wall – Dike Abutments
Computed by: J.A.C. Checked by: RW Date: 3/23/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF BASE AS CANTILEVERED FROM 13'-0" COUNTERFORT



1'-0" SECTION 10.0' FROM DIKESIDE FACE OF STEM

E_1 17 × 6.75 × 125 = 14,350 × 3.38 = 48,500 '#
C_1 2 × 6.75 × 150 = 2,030 × 3.38 = 6,860
U_1 840 × 6.75 = 5,670 × 3.38 = 19,200
P_1 ~~1085~~ 400 × 6.75 = ~~7,310~~ 2,700 × 3.38 = ~~24,800~~ 9,120
27,030
~~11,360~~

$$A_s = \frac{12 \times \cancel{11,360}\ 27,030}{18,000 \times .884 \times 20.5} = \cancel{0.42}\ \square'' \ 1.0$$

7/8" φ and 3/4" φ alt. @ 6" TOP FACE

USE 3/4" φ @ ~~1'-0" c.c. FOR ENTIRE WIDTH OF RIVERSIDE BASE SLAB~~

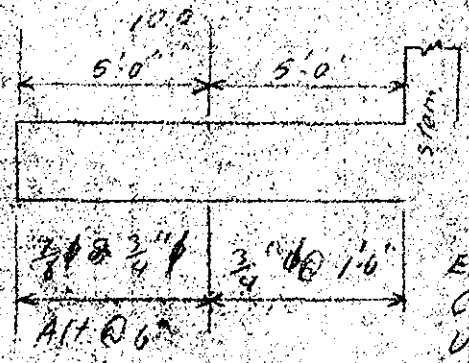
1'-0" SECTION 5.0' FROM DIKESIDE FACE OF STEM

For bearing and uplift pressures see Pages

E_1 48,500 '#
C_1 6,860
U_1 725 × 6.75 = 4,800 × 3.38 = 16,600
P_1 ~~1380~~ 1180 × 6.75 = ~~9,310~~ 7,900 × 3.38 = ~~31,500~~ 26,700
12,060 '#

$$A_s = \frac{12 \times \cancel{7,260}\ 12,060}{18,000 \times .884 \times 20.5} = \cancel{0.27}\ \square''\ 0.444\ \square''$$

Use 3/4" φ



1'-0" SECTION AT DIKESIDE FACE OF STEM

E_1 48,500 '#
C_1 6,860
U_1 660 × 6.75 = 4,050 × 3.38 = 13,700
P_1 1,710 × 6.75 = 11,550 × 3.38 = 39,000
'#

$$A_s = \frac{12 \times 2,660}{18,000 \times .884 \times 20.5} = 0.10\ \square''$$

WAR DEPARTMENT

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

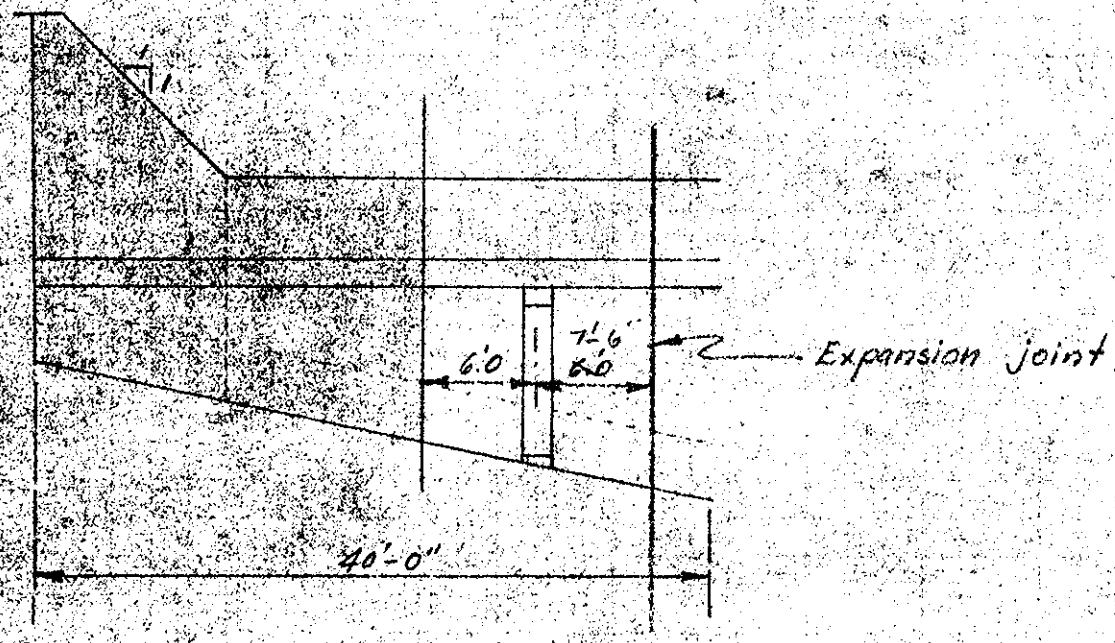
Subject: Chicopee Dike - C. 3b

Computation: 18' counterfort wall - Dike Abutments

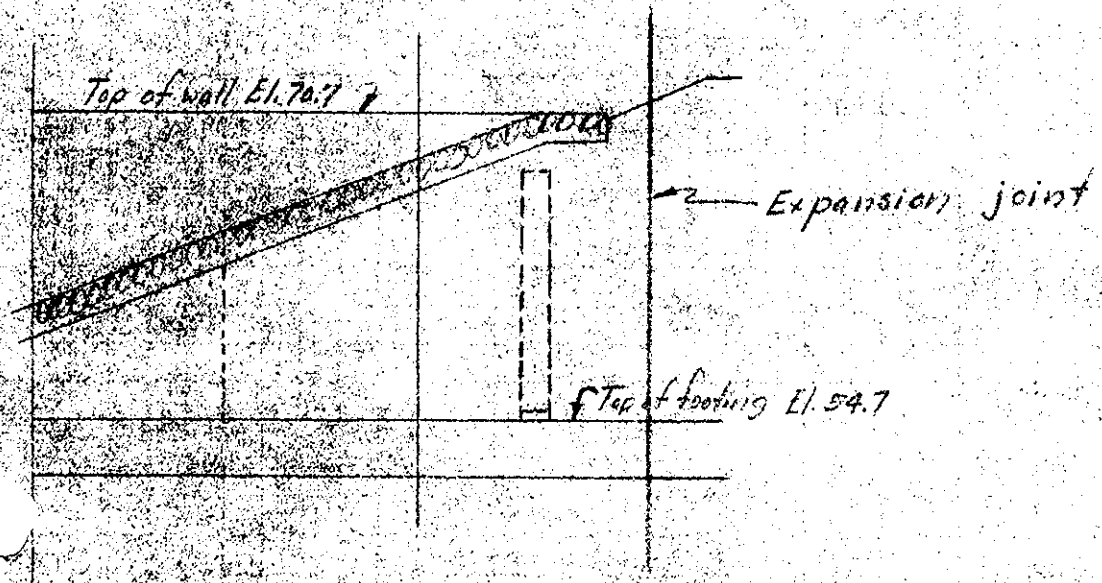
Computed by: T.A.C. Checked by: RW Date: 3/25/40

U. S. GOVERNMENT PRINTING OFFICE 3—10533

DESIGN OF SHADED AREA AS CANTILEVER WALL



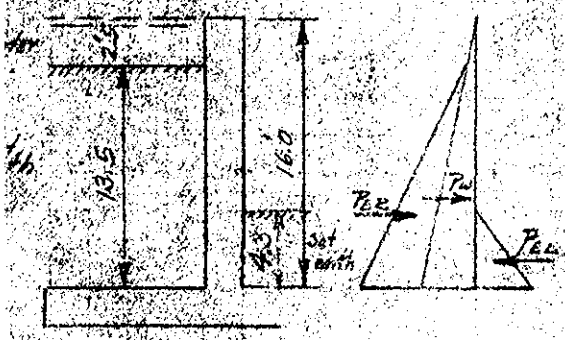
SCALE: 1" = 10'-0"



Subject: Chicopee Dike - C.36
Computation: 16' Cantilevered Section - Dike abutments
Computed by: T.A.C. Checked by: R.W. Date: 3/25/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Design of Stem (Section 6'-0" from ℄ Counterfort)



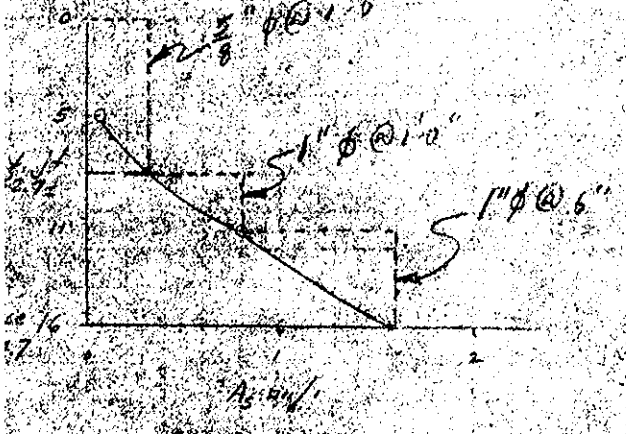
Section at Top of Base
6'-0" from ℄ Counterft.

$\frac{1}{2} \times 16^2 \times 62.5 = 8{,}000 \times 5.33 = 42{,}600'^{\#}$
$\frac{1}{2} \times 13.5^2 \times 17.5 = 1{,}600 \times 4.5 = 7{,}200$
$\frac{1}{2} \times 4.3^2 \times 80 = 740 \times 1.43 = 1{,}060$

$\Sigma M = 48{,}740'^{\#}$

$A_s = \frac{12 \times 48{,}740}{18{,}000 \times .884 \times \cancel{14.5}\ 23.5} = \cancel{2.54}\ 1.57\ \square''$

$d(\text{req'd}) = \sqrt{\frac{\cancel{48{,}740}\ 123}{}} = 19.9''$



Section 5.0' above Base

$\frac{1}{2} \times 11^2 \times 62.5 = 3{,}660 \times 3.67 = 13{,}450'^{\#}$
$\frac{1}{2} \times 8.5^2 \times 17.5 = 630 \times 2.83 = 1{,}790$

$15{,}240'^{\#}$

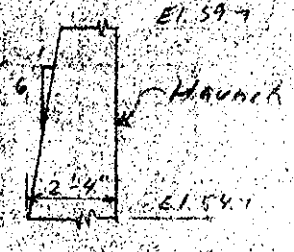
$A_s = \frac{12 \times 15{,}240}{18{,}000 \times .884 \times 14.5} = .80\ \square''$

Section 11.0 above Base

$\frac{1}{2} \times 5^2 \times 62.5 = 780 \times 1.67 = 1{,}300'^{\#}$
$\frac{1}{2} \times 2.5^2 \times 62.5 = 195 \times .83 = 160$

$1{,}140'^{\#}$

$A_s = \frac{12 \times 1{,}140}{18{,}000 \times .884 \times 14.5} = .06\ \square''$



Use haunch starting at 13' Counterfort on land side, Top of haunch at El. 59.7

WAR DEPARTMENT

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

Subject: Chicopee Dike - C.8b

Computation: Dike Abutments

Computed by: T.A.C. Checked by: K.W. Date: 3/26/40

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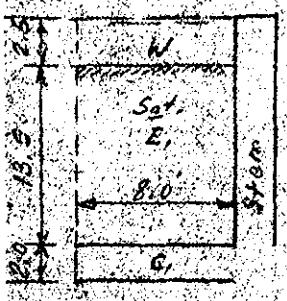
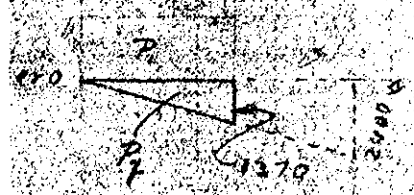




DESIGN OF BASE (SECTION 6'-0" + FROM ℄ CONTRFORT)

	↓	↑	→	←	ARM	MOMENT
$W = 2.5 \times 8.0 \times 62.5$	1,250				4.0	5,000
$E_1 = 13.5 \times 8.0 \times 125$	13,500				4.0	54,000
$C_1 = 2.0 \times 8.0 \times 150$	2,400				4.0	9,600
$U_1 = 600 \times 8.0$		4800			4.0	19,200
$U_2 = \frac{1}{2} \times 200 \times 8.0$		800			5.33	4,270
$P_1 = \cancel{1160 \times 8}\ 1370 \times \frac{1}{2} \times 8$		5500			2.67	14,700
$\cancel{P_2 = \frac{1}{2} \times 530 \times 8}$		$\cancel{9440}$			$\cancel{4.0}$	$\cancel{37,760}$
$U_3 = 19 \times 62.5 \times 1.5$		2120			$\cancel{1.33}$	$\cancel{2,820}$
		1780			7.25	12,900

$\Sigma M = 17,520$ '#

$$A_s = \frac{12 \times 17,520}{18,000 \times .884 \times 20.5} = .165 \text{ in}^2/\text{ft}$$

Use 1"ϕ @ 1'-0" top.

$$d \text{ req'd} = \sqrt{\frac{17,520}{123}} = \text{O.K. for Depth}$$

Subject: Chicopee C3b
Computation: Dike Abutments
Computed by: VAC Checked by: Date: 4/1/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEM OF 16'-0" COUNTERFORT
CANTILEVERED FROM THE COUNTERFORT

SECTION AT TOP OF BASE

$18 \times 80 \times 5.0 = 7{,}200 \times 2.5 = 18{,}000$
$5.3 \times 80 \times 5.0 = 2{,}120 \times 2.5 = -5{,}300$
$12{,}700^{\#}$

$A_s = \frac{12 \times 12{,}700}{18{,}000 \times .884 \times 14.5} = 0.66^{\square''}$

230,500

SECTION AT 4'-0" ABOVE TOP OF BASE

$14 \times 80 \times 5.0 = 5{,}600 \times 2.5 = 14{,}000$
$1.3 \times 80 \times 5.0 = 520 \times 2.5 = 1{,}300$
$12{,}700^{\#}$

$A_s = \frac{12 \times 12{,}700}{230{,}500} = .66^{\square''}$

SECTION AT 8'-0" ABOVE TOP OF BASE

$10 \times 80 \times 5.0 = 4{,}000 \times 2.5 = 10{,}000^{\#}$

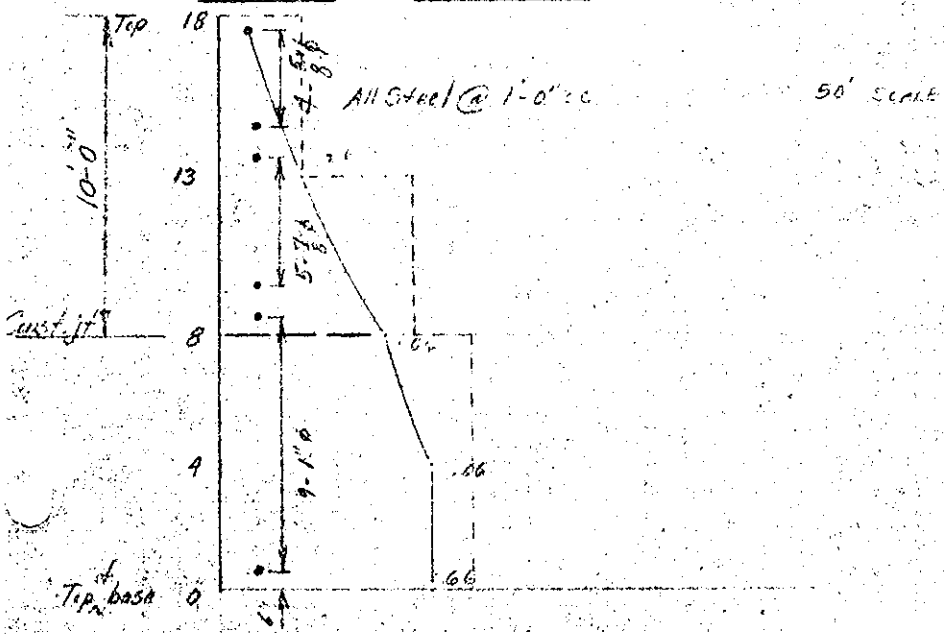
$A_s = \frac{12 \times 10{,}000}{230{,}500} = 0.52^{\square''}$

SECTION AT 13'-0" ABOVE TOP OF BASE

$5 \times 80 \times 5.0 = 2{,}000 \times 2.5 = 5{,}000^{\#}$

$A_s = \frac{12 \times 5{,}000}{230{,}500} = 0.26^{\square''}$

A. DIAGRAM — DIKESIDE FACE



Project: Chicopee C36
Computation: Dike Abutments
Computed by: VAC Checked by: Date: 4/1/40

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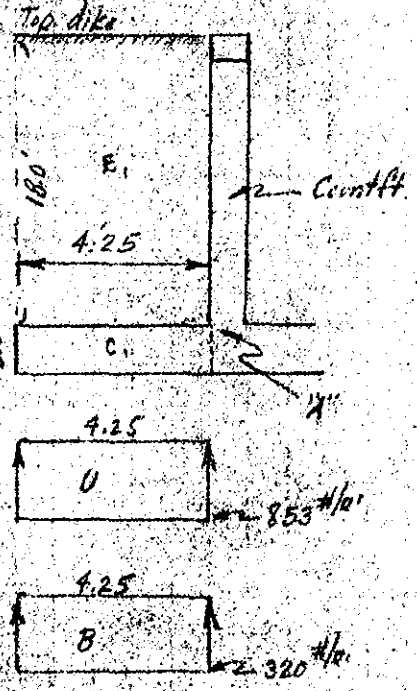
Base of The 16'-0" Counterfort Cantilevered from The Counterfort

Section 1'-6" from Heel



Compare with base steel when computed as a continuous slab between counterforts on 12'-0" c.c.

Section 1'-6" from Heel (Just inside Sheet Pile)

ΣM abt "A"

$18.0 \times 4.25 \times 125 = 9{,}660 \times 2.13 = 20{,}400$
$2.0 \times 4.25 \times 150 = 1{,}275 \times 2.13 = 2{,}700$
$\Sigma V = 10{,}835^{\#}$ $M = 23{,}100'^{\#}$

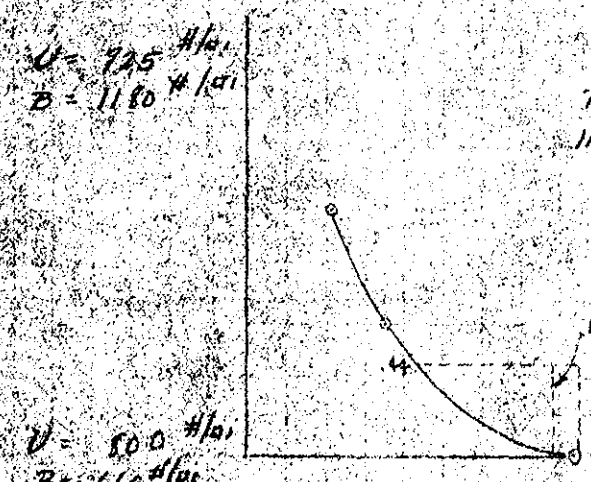
$853 \times 4.25 = 3{,}630 \times 2.13 = 7{,}700$
$320 \times 4.25 = 1{,}360 \times 2.13 = 2{,}900$
$V = 4{,}990^{\#}$ $M = 10{,}600$
$\Sigma V = 5{,}845^{\#}$ $\Sigma M = 12{,}500'^{\#}$

$$A_s = \frac{12 \times 23{,}100}{18{,}000 \times .884 \times 20.5} = 0.85^{\square''}$$

$$z_0 = \frac{5{,}845}{150 \times .884 \times 20.5} = 2.15''$$

$$v = \frac{5{,}845}{12 \times .884 \times 20.5} = 27\ ^{\#}/\square''$$

Section 5'-0" from Dikeside Face of Stem



$725 \times 4.25 = 3{,}080 \times 2.13 = 6{,}560'^{\#}$
$1180 \times 4.25 = 5{,}010 \times 2.13 = 10{,}700$
$17{,}260'^{\#}$

$23{,}100$
$-17{,}260$
$\Sigma M\ 5{,}840'^{\#}$

$$A_s = \frac{12 \times 5{,}840}{18{,}000 \times .884 \times 20.5} = .22^{\square''}$$

Section 8'-0" from Dikeside Face of Stem

$800 \times 4.25 = 3400 \times 2.13 = 7{,}250$
$660 \times 4.25 = 2{,}810 \times 2.13 = 5{,}970$
$13{,}220$

$23{,}100$
$13{,}220$
$\Sigma M = 9{,}880$

$$A_s = \frac{12 \times 9{,}880}{18{,}000 \times .884 \times 20.5} = 0.36^{\square''}$$

Use same steel as when computed as a slab.
i.e. Continue slab steel into cantilever section.

Subject: CHICOPEE C-36
Computation: RETAINING WALL STEM 22' BASE 15'
Computed by: P.L.A. Checked by: W.H.F. Date: 4/3/40

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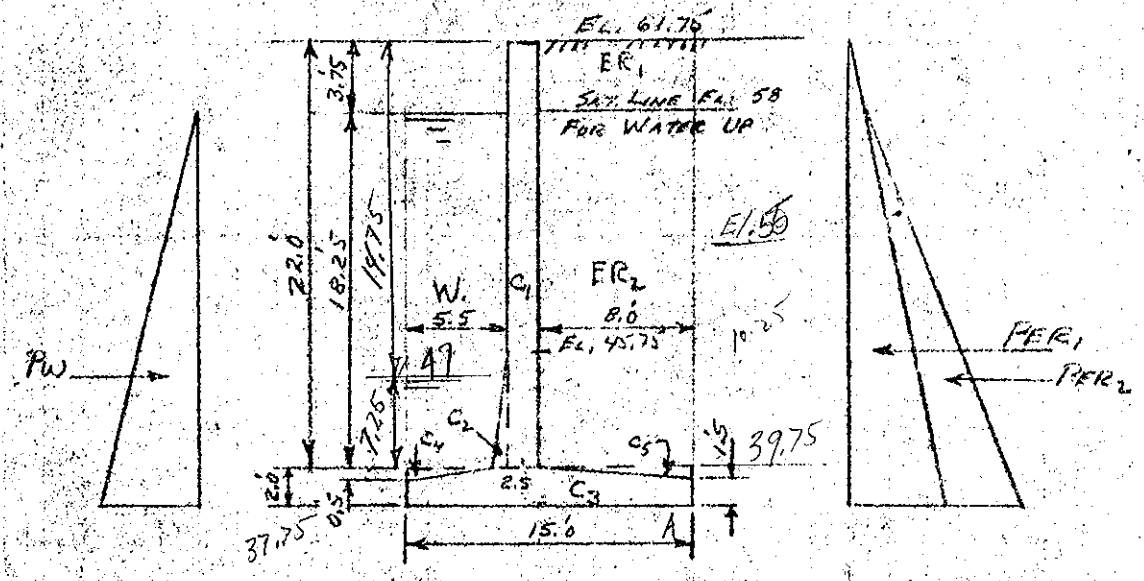
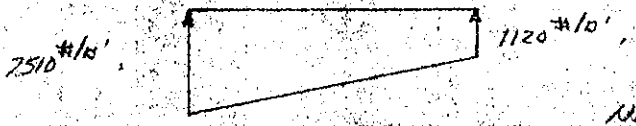
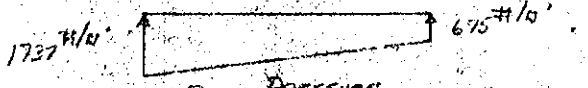


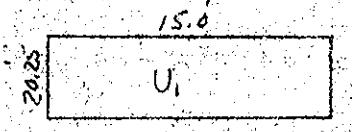


BASE PRESSURE

CASE I.
NO WATER ACTING ON WALL
DRY EARTH FILL



BASE PRESSURE



UPLIFT

CASE II.
WATER ACTING ON WALL
EARTH SAT. TO EL. 58.0.

Subject CHICOPEE C-36

Computation RETAINING WALL STEM 22' BASE 15'

Computed by P.L.A. Checked by W.H.F. Date 4/3/40

STABILITY

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1		4950	·			8.75	·	43300
C_2		450	·			9.83	·	4420
C_3	2.0 X 15 X 150	4500	·			7.5	·	33800
C_4			170	·		13.5	· 2300	
C_5	½ X ½ X 8 X 50		100	·		2.67	· 267	
FR	8 X 22 X 100	17600	·			4.0	·	70400
PER	½ X 35 X 24²				10100	8.0	·	80800
FR	27230 X .45			12250	·			
		27500 ·	270 ·	12250 ·	10100		2567 ·	232720
		ΣV = 27230 ·		ΣH = 0 ·			ΣM = 230153	

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = \frac{230153}{27230} = 8.46'$

⅔ BASE = 10.0'

FALLS 1.54' INSIDE MIDDLE THIRD

$e = 8.46 - 7.5 = 0.96'$

BASE PRESSURE $= \frac{V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{27230}{15}\left(1 \pm \frac{6 \times .96}{15}\right) = 1815 \begin{cases} 2510 \ \#/\square' \\ 1120 \ \#/\square' \end{cases}$

Subject CHICOPEE C-36

Computation RETAINING WALL STEM 22' BASE 15'

Computed by P.L.A. Checked by [illegible] Date 4/3/40

STABILITY CASE II RIVER UP TO EL. 58.0

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1		4950				8.75		43300
C_2		450				9.83		4420
C_3		4500				7.5		33800
C_4	$\frac{1}{2} \times \frac{1}{2} \times 4.5 \times 87.5$		99			13.5	134	
C_5	$\frac{1}{2} \times \frac{1}{2} \times 8.0 \times 25$		50			2.67	134	
FR_1	$3.75 \times 8 \times 100$	3000				4.0		12000
FR_2	$18.25 \times 8 \times 125$	18250				4.0		73000
W_1	$5.5 \times 12.25 \times 62.5$	4210				12.25		51600
W_2	$6(\frac{4.5+5.5}{2}) \times 62.5$	1875				12.5		23400
U_1	$20.25 \times 15 \times 62.5$		19000			7.5	142500	
PER_1	$\frac{1}{2} \times 35 \times \overline{24}^2$				10100	8.00		80800
PER_2	$\frac{1}{2} \times 45 \times \overline{20.25}^2$				9230	6.75		62300
PW	$\frac{1}{2} \times 62.5 \times \overline{20.25}^2$			12800		6.75	86500	
FOR				8140				
		37235	19149	20940	19330		229268	384620
		$\Sigma V = 18086$ ↓		$\Sigma H = 0$			$\Sigma M = 155352$ ↺	

$$\left.\begin{array}{l}\text{Position of}\\ \text{Resultant}\end{array}\right\} = \frac{\Sigma M}{\Sigma V} = \frac{155352}{18086} = 8.6'$$

$\frac{2}{3}$ BASE = 10'

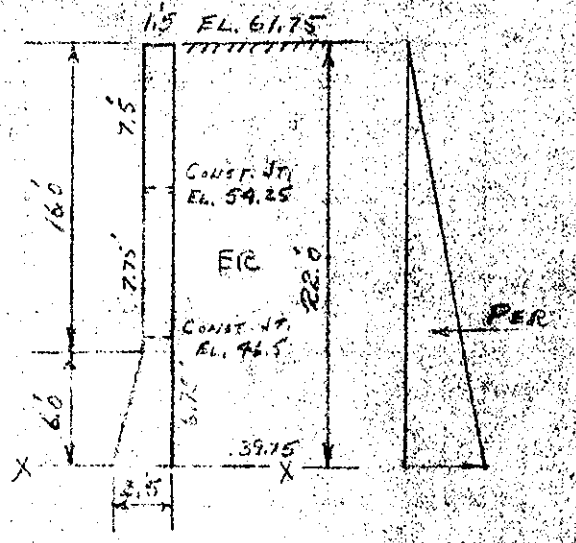
$e = 8.6 - 7.5 = 1.1$

$$\text{BASE PRESSURE} = \frac{V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{18086}{15}\left(1 \pm \frac{6 \times 1.1}{15}\right) = 1206 \begin{cases} 1737\ \#/\square' \\ 675\ \#/\square' \end{cases}$$

Subject CHICOPEE C-36
Computation RETAINING WALL STEM 22'
Computed by P.L.A. Checked by W.H.F. Date 4/3/40

U.S. GOVERNMENT PRINTING OFFICE 3—10529

STEEL REINF. BACK FACE OF STEM FILL TO TOP



MOMENT ABOUT X-X

PER $\frac{1}{2} \times 35 \times 22^2 = 8470 \times 7.33 = 62100$ '#

d_{X-X} (REQD) $= \sqrt{\frac{M}{Kb}} = \sqrt{\frac{62100 \times 12}{123 \times 12}} = 22.4''$

ACTUAL $d = 30.0 - 3.5 = 26.5''$

$A_{s_{X-X}}$ (REQD) $= \frac{M}{f_s j d} = \frac{62100 \times 12}{18000 \times .884 \times 26.5} = 1.77 \square''$

SHEAR$_{X-X}$ $= \frac{V}{b j d} = \frac{8470}{12 \times .884 \times 26.5} = 30$ #/□" < 80 #/□"

USE 1" □ @ 6" C.C.

BOND $= \frac{V}{\Sigma_o j d} = \frac{8470}{8.0 \times .884 \times 26.5} = 45.2$ #/□" < 150 #/□"

Subject: CHICOPEE C-36
Computation: RETAINING WALL STEM 22' BASE 15'
Computed by: P.L.A. Checked by: W.H.F. Date: 4/3/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. CONT'D BACK FACE OF STEM FILL TO TOP

MOMENTS 15.25' FROM TOP

PER $\frac{1}{2} \times 35 \times \overline{15.25}^2 = 4070 \times 5.08 = 20700'\#$

$$d\,(\text{REQ'D}) = \sqrt{\frac{M}{Rb}} = \sqrt{\frac{20700 \times 12}{123 \times 12}} = 13.0''$$

ACTUAL $d = 14.5''$

$$A_s\,(\text{REQ'D}) = \frac{M}{f_s j d} = \frac{20700 \times 12}{18000 \times .884 \times 14.5} = 1.08\,\square''$$

USE $\frac{7}{8}''\phi$ @ 6" c.c.

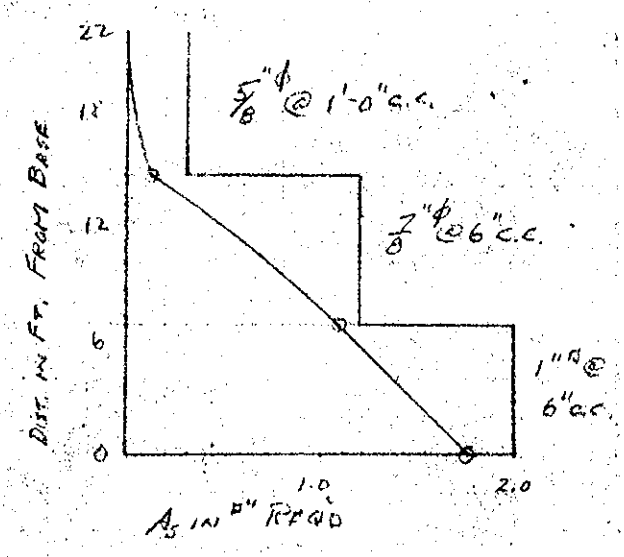
MOMENTS 7.5' FROM TOP

PER $= \frac{1}{2} \times 35 \times \overline{7.5}^2 = 985 \times 2.5 = 2460'\#$

$$A_s\,\text{REQ'D} = \frac{2460 \times 12}{18000 \times .884 \times 14.5} = 0.13\,\square''$$

USE $\frac{5}{8}''\phi$ @ 1'-0" c.c.

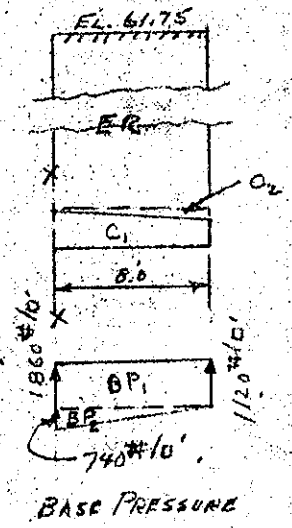
IN FRONT FACE USE
$\frac{5}{8}''\phi$ @ 1'-0" c.c.



bject: Chicopee C-36
putation: Retaining Wall Stem 22' Base 15'
mputed by: P.L.R. Checked by: W.H.F. Date: 4/4/40

U.S. GOVERNMENT PRINTING OFFICE 3—10638

Steel Reinf. Cont'd. Back Side Base Slab Top Steel
Dry Earth Fill To Top Case I
Moments About X-X



Forces Acting		↓	↑	Arm	Moments ↻	Moments ↺
ER	8 X 22 X 100	17600		4.0	70400	
C_1	2 X 8 X 150	2400		4.0	9600	
C_2	½ X ½ X 8 X 50		100	5.33		533
BP_1	1120 X 8		8960	4.0		35840
BP_2	½ X 740 X 8		2960	2.67		7900
		20000	12020		80000	44273
		ΣV = 7980 ↓			ΣM = 35727 ↻	

$$d_{x-x}\ (\text{Req'd}) = \sqrt{\frac{M}{Rb}} = \sqrt{\frac{35727 \times 12}{123 \times 12}} = 17.0''$$

Actual $d = 24.0 - 3.5 = 20.5''$

$$A_{s_{x-x}}\ (\text{Req'd}) = \frac{M}{f_s j d} = \frac{35727 \times 12}{18000 \times .884 \times 20.5} = 1.32''$$

$$\text{Shear}_{x-x} = \frac{V}{bjd} = \frac{7980}{12 \times .884 \times 20.5} = 36.6\ \#/□'' < 60\ \#/□''$$

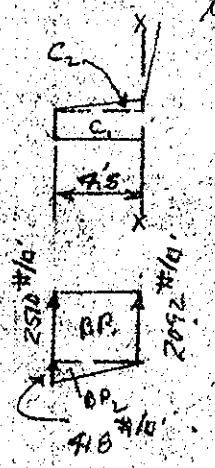
Use 1" ϕ @ 1'-0" c.c. } Alternate leaving 6" spacing.
7/8" ϕ @ 1'-0" c.c. }

$$\text{Bond}_{x-x} = \frac{V}{\Sigma o j d} = \frac{7980}{5.9 \times .884 \times 20.5} = 74.8\ \#/□'' < 150\ \#/□''$$

Subject: CHICOPEE C-36
Computation: RETAINING WALL STEM 22' BASE 15'
Computed by: P.L.R. Checked by: W.H.F. Date: 4/4/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. CONT'D FRONT SIDE BASE SLAB
NO EARTH FILL ON FRONT SIDE CASE I BOTTOM STEEL



BASE PRESSURE

MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↷	MOMENTS ↶
C_1	1.5 X 4.5 X 150	1010		2.25		2280
C_2	½ X ½ X 4.5 X 150	170		1.5		255
BP_1	2092 X 4.5		9400	2.25	21200	
BP_2	½ X 418 X 4.5		940	3.0	2820	
		1180	10340		24020	2535
		ΣV = 9160 ↑			ΣM = 21485 ↷	

$$A_{s_{X-X}}\ (\text{REQ'D}) = \frac{M}{f_s j d} = \frac{21485 \times 12}{18000 \times .884 \times 19.5} = 0.84\ \square''$$

$$\text{SHEAR}_{X-X} = \frac{V}{b j d} = \frac{9160}{12 \times .884 \times 19.5} = 44.2\ \#/\square'' < 60\ \#/\square''$$

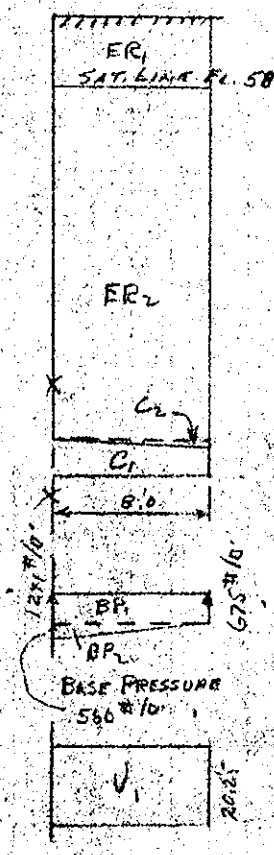
USE $\frac{3}{4}''\phi$ @ 6" c.c.

$$\text{BOND}_{X-X} = \frac{V}{\Sigma_o j d} = \frac{9160}{4.7 \times .884 \times 19.5} = 113\ \#/\square'' < 150\ \#/\square''$$

Project CHICOPEE C-36
Computation RETAINING WALL STEM 22' BASE 15'
Computed by P.L.R. Checked by W.H.F. Date 4/4/40

U. S. GOVERNMENT PRINTING OFFICE 2—10528

STEEL REINF. CONT'D BACK SIDE BASE SLAB TOP STEEL
SAT. EARTH FILL TO EL. 58 CASE II



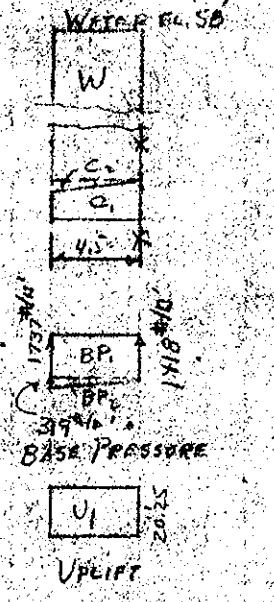
MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↷	MOMENTS ↶
ER_1	3.75 X 8 X 100	3000		4.0	12000	
ER_2	18.25 X 8 X 125	18250		4.0	73000	
C_1	2.0 X 8 X 150	2400		4.0	9600	
C_2	½ X ½ X 8 X 25		50	5.33		267
BP_1	675 X 8		5400	4.0		21600
BP_2	½ X 566 X 8		2260	2.67		6030
U_1	20.25 X 8 X 62.5		10100	4.0		40400
		23650	17810		94600	68297
		ΣV = 5840 ↓			ΣM = 26303 ↷	

CASE I GOVERNS

USE 1" ϕ @ 1'-0" c.c. } ALTERNATE LEAVING
7/8" ϕ @ 1'-0" c.c. } 6" SPACING

FRONT SIDE BASE SLAB WATER TO EL. 58.0 CASE II



FORCES ACTING		↓	↑	ARM	MOMENTS ABOUT X-X ↷	MOMENTS ABOUT X-X ↶
W_1	18.25 X 4.5 X 62.5	5130		2.25		11540
C_1	2.0 X 4.5 X 150	1350		2.25		3040
C_2	½ X ½ X 4.5 X 87.5		99	3.0	297	
BP_1	1418 X 4.5		6380	2.25	14340	
BP_2	½ X 319 X 4.5		718	3.0	2154	
U_1	20.25 X 4.5 X 62.5		5700	2.25	12800	
		6480	12897		29591	14580
		ΣV = 6417 ↑			ΣM = 15011 ↷	

CASE I GOVERNS

USE 3/4" ϕ @ 6" c.c. BOTTOM STEEL

WAR DEPARTMENT

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

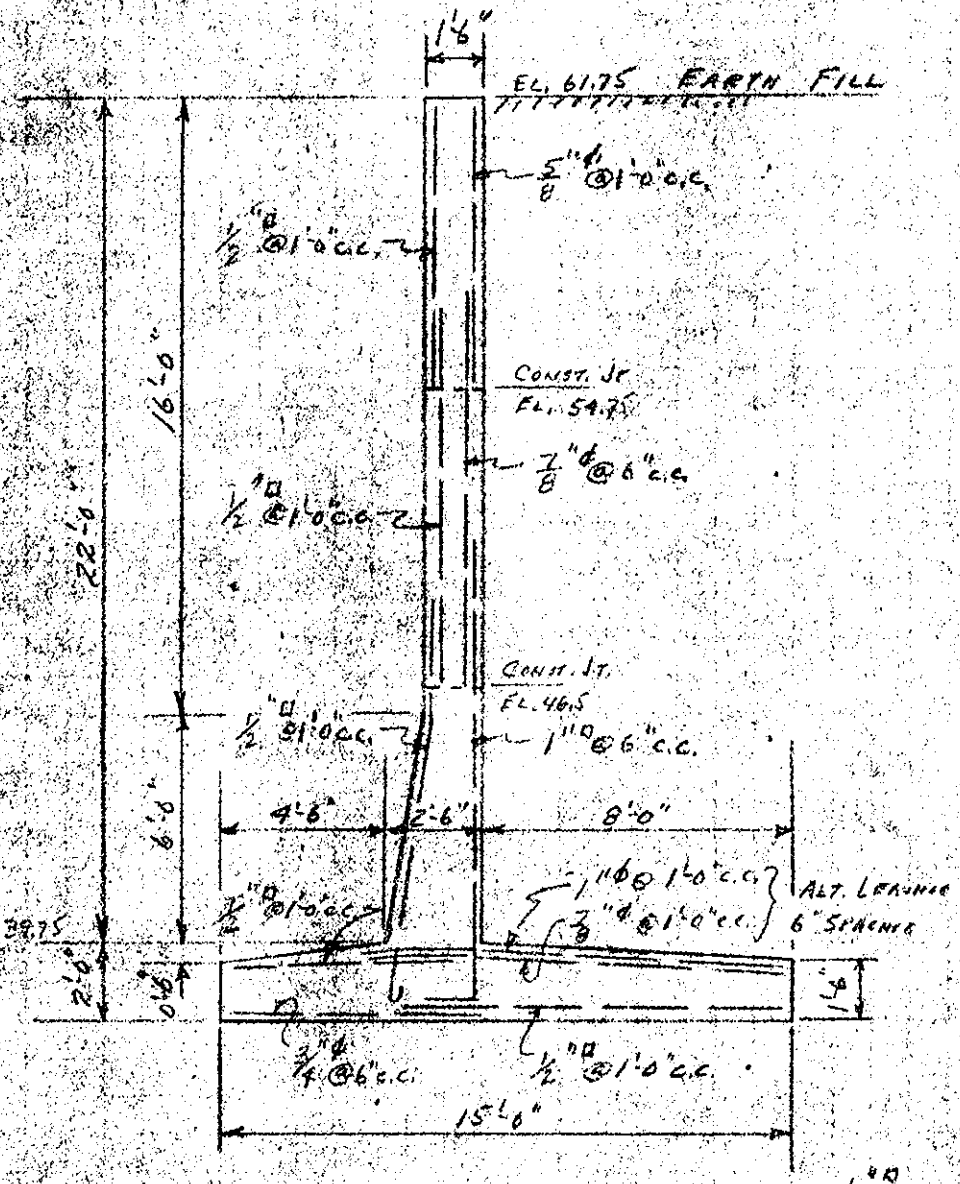
Subject: CHICOPEE C-36

Computation: RETAINING WALL STEM 22' BASE 15'

Computed by: P.L.A. Checked by: W.H.F. Date: 4/4/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

WALL AS DESIGNED



ALL LONGITUDINAL TEMPERATURE STEEL IS 1/2" □ @ 1'-0" c.c.

WAR DEPARTMENT

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

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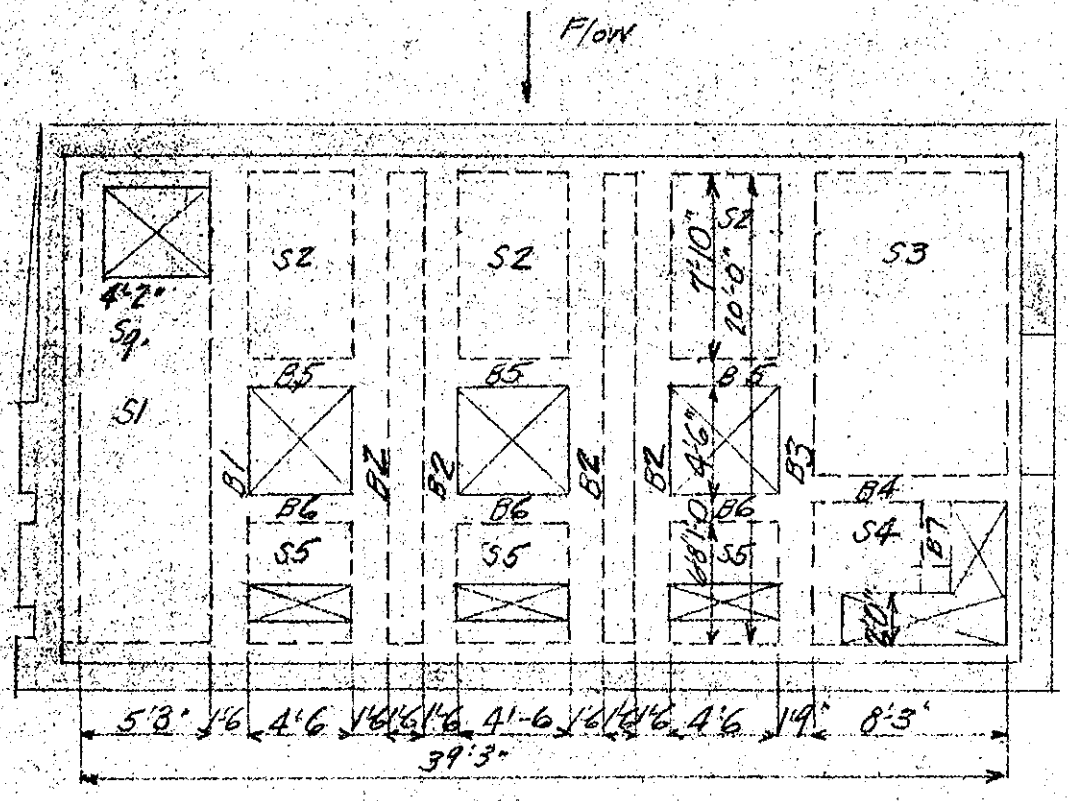
Subject: Chicopee — Dwight Pumping Sta. — C3b

Computation: Operating floor

Computed by: RSM Checked by: W. S. Jr. Date: 3-27-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Weights of equipment

1. Crane	7000#
2. Crane wheel loads, wheels 5'-8" c.-c.	8730#
3. Gasoline engine	4,500
4. " " base, 4'-0×6'-6"×1'-6" (alt.)	6,000
5. Gear reduction unit	3,500
6. Propellor pump	10,000
7. " " - thrust	6,000
8. Gate valve & discharge pipe full of water	7,500
9. Motor for sump pump	500

Subject: Dwight Pumping Sta. – Chicopee C3b
Computation: Operating floor
Computed by: RSM Checked by: M. S. L. Date: 3-27-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Uniform L.L. for slab design

Shortest span 4'-6"
Moment due to engine on slab = 350×2.25 − 350×0.5 = 612 '#
Equivalent uniform load = $\frac{1}{8}$W × 20¼ = 612'#; W = 240 #/□' use 300 #/□'.
Moment due to engine on beam = 2250×11 − 2250×1.5 = 21420 '#
Equivalent uniform load = $\frac{1}{8}$W×484 = 21,420'#; W = 354 #/lin. ft.

Use 300 #/□' uniform loading for beams.

Slab S-1

Loading 300 #/□' L.L.
100 #/□' d.L.
400 #/□'

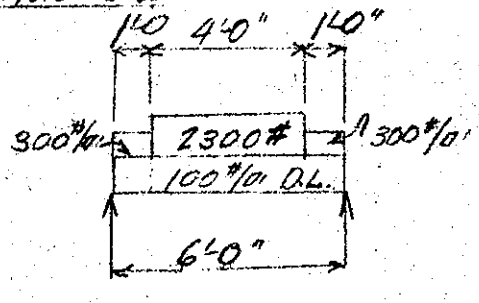
$-M = 400 \times \overline{6.75}^2/8 = 2280$ '#

$+M = 400 \times \overline{6.75}^2 \times .06 = 1140$ '#

$d = \sqrt{\frac{2280}{123}} = 4.3''$ reqd. 5.9" net depth. supplied.

$-A_s = 2280 \times 12/18000 \times .884 \times 5.9 = .29$ □"
Use ½"φ@7" c.-c., top and bottom.

Slab S-2



Engine loading

Engine	4500#
Impact	4500
Base	6000
	15000#

Load per ft. = $\frac{15000}{6.5}$ = 2300 #

$-M = 400 \times \overline{6.0}^2/12 = 1200$ '#
$1100 \times 6 \left(\frac{1+.33-.06}{12}\right) = 700$
1900

$-A_s = 1900 \times 12/18000 \times .884 \times 5.9 = .26$ □" Use ½"φ@6½"
$w = 1750/12 \times .884 \times 7 = 26$ #/□"

Subject: Dwight Pumping Sta. – Chicopee C3b
Computation: Operating floor
Computed by: RSM Checked by: W. S. P. Date: 3-27-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Slab S-3

Span 9'-3"

Loading D.L. 100 #/□'
L.L. 300
400 #/□'

$-M = 400 \times \overline{9.3}^2/8 = 4300$ '# ✓

$d = \sqrt{\frac{4300}{123}} = 5.9"$. Use 5.9" Total depth = 7.5"

$-A_s = 4300 \times 12/18000 \times .884 \times 5.9 = .55$ □". ✓

$v = 2000\pm/12 \times .884 \times 5.9 = 33$ #/□" OK ✓

Slab S-4

Span 5'-6"

Loading 400 #/□'

$-M = 400 \times \overline{6.5}^2/8 = 2210$ '#

$A_s = 2210 \times 12/18000 \times .884 \times 5.9 = .28$ □". Use ½"φ @ 9" ✓ top & bott.

Slab S-5

Span 6'-0"

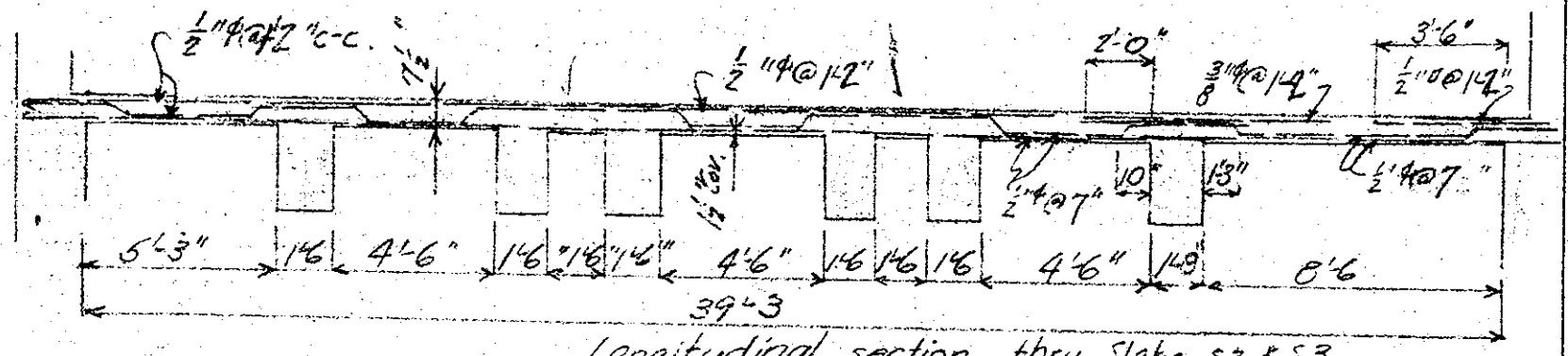
Loading 400 #/□'

$-M = 400 \times \overline{6}^2/12 = 1200$ '# ✓

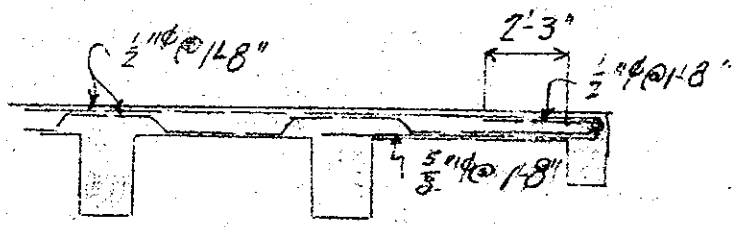
$A_s = 1200 \times 12/18000 \times .884 \times 5.9 = .16$ □". Use ½"φ @ 10" ✓

$v = \frac{400 \times 3}{1.57 \times .884 \times 6.2} = 148$ #/□". OK ✓

bject Dwight Pumping Sta. - Chicopee Cab
Computation Operating Floor
Computed by RSM Checked by Date 3-27-46



Longitudinal section thru Slabs S2 & S3



Section thru slabs S5 & S4

Note: For final steel see construction drawings

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Subject: Dwight Pumping Sta. - Chicopee C3b
Computation: Operating floor
Computed by: RSM Checked by: W. S. P. Date: 3-27-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Beam B-5 & Beam B-6
Span 6'-0"
Loading -
Assume beam 12" wide by 18" deep

D.L.	225 #/lin.ft.
L.L. - from floor, say	475
Machinery, say	2000
	2700 #/lin.ft.

Machinery loading

Gear reduction unit	3500 #
100% impact	3500
Propellor pump	10,000
100% impact	10,000
Discharge pipe - ½ load	3750
Propellor pump thrust	6000
	36750 #
Divided 4 ways	9200 # per beam
9200/4.5 =	2040 #/lin.ft.

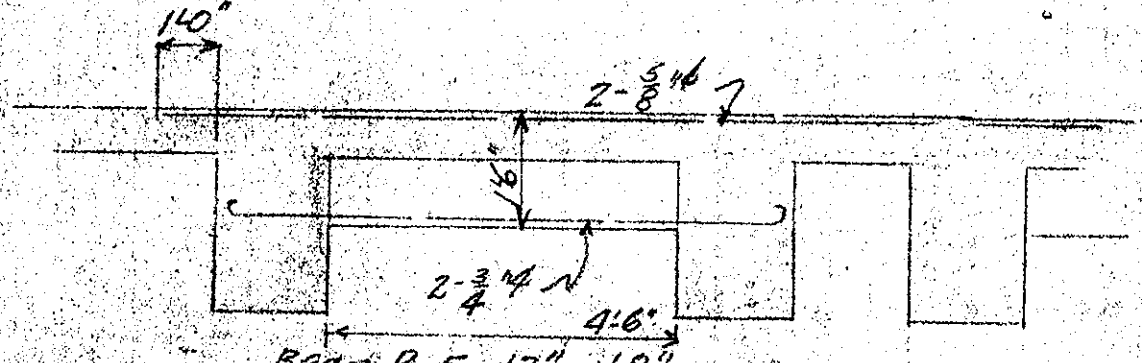
$M = wl^2/8 = 2700 \times 6^2/8 = 12150$ '# ✓

$d = \sqrt{12150/123} = 10"$ reqd.; 15.5" furnished ✓

$A_s = \frac{12150 \times 12}{18000 \times .884 \times 15.5} = .60$ □" Use 2-¾"ϕ bars ✓

$v = 8100/12 \times .884 \times 15.5 = 50$ #/□" OK ✓

$u = 8100/4.71 \times .884 \times 15.5 = 126$ #/□" OK ✓



Beam B-5 12" × 18"
Beam B-6 ✓

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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Object: Dwight Pumping Sta. – Chicopee C3b
Computation: Operating floor
Computed by: RSM Checked by: W. S. Jr. Date: 3-27-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Beam B-7
Span 4'

Loading – Assume beam 12" x 15".

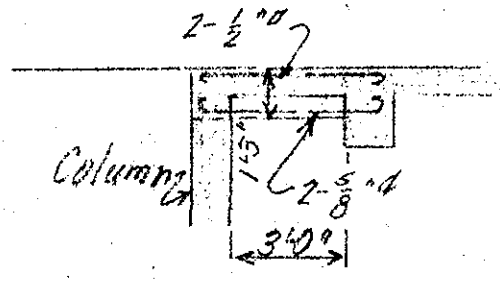
D.L. of beam 190 #/lin. ft.
L.L. 4 x 400 = 1600
1790 #/lin. ft.

$M = 1790 \times 4^2/8 = 3580$ '#

$d = \sqrt{\frac{3580}{123}} = 5.4$" req'd.

$A_s = 1790 \times 12/18000 \times .884 \times 12.5 = .11^{\square''}$ reqd.

Use 2-$\frac{5}{8}$"φ bars

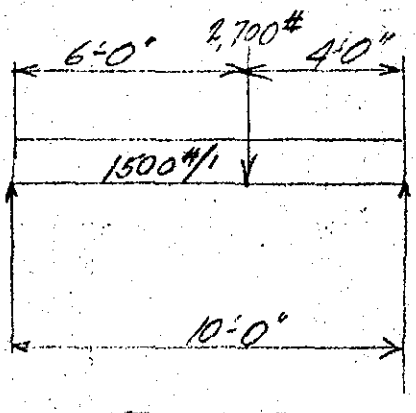


Beam B-7 1'-0" wide

Subject: Dwight Pumping Sta. - Chicopee C3b
Computation: Operating floor
Computed by: RSM Checked by: W. E. [illegible] Date: 3-27-40

U. S. GOVERNMENT PRINTING OFFICE 3—10598

Beam B-4



Uniform loading
Assume beam 12"x18"

D.L.	225#/'
L.L., say	1275
	1500#/'

$M = 1500 \times 10^2/8 = 18750$ '#

$\frac{2700 \times 6 \times 5}{10} - 2700 = 5400$

24150 '#

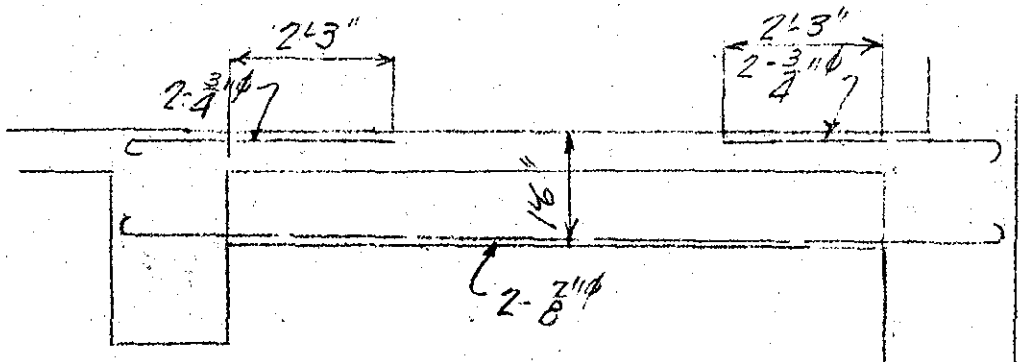
$d = \sqrt{\frac{24150}{123}} = 14"$; 15.5" supplied

$A_s = 24150 \times 12 / 18000 \times .884 \times 15.5 = 1.19$ □" Use 2-$\frac{7}{8}$"φ bars

$V = 1500 \times 5 + \frac{2700 \times 6}{10} = 9120$ #

$v = 9120/12 \times .884 \times 15.5 = 56$ #/□"

$u = 9120/5.50 \times .884 \times 15.5 = 122$ #/□" OK



Beam B-4

12" wide

WAR DEPARTMENT

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

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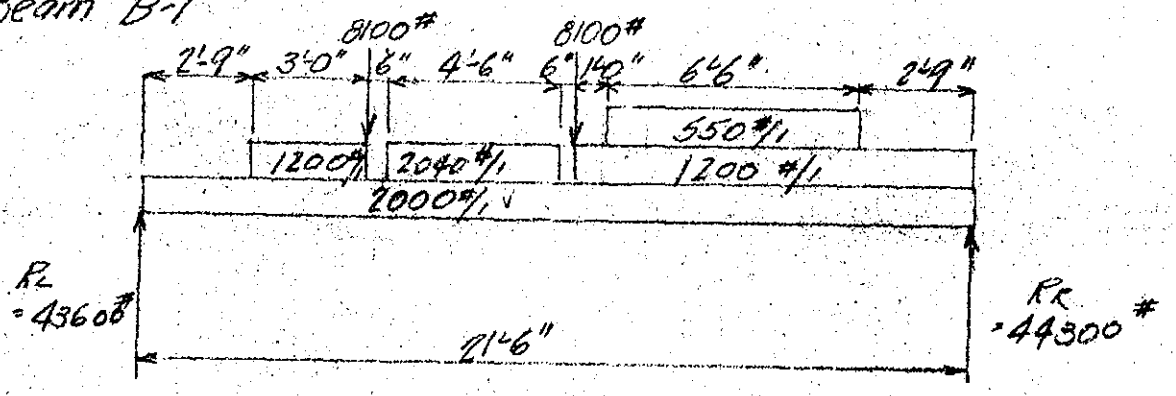
Project: Dwight Pumping Station - Chicopee Cab

Computation: Operating floor

Computed by: RSM Checked by: W. S. J. Date: 3-28-40

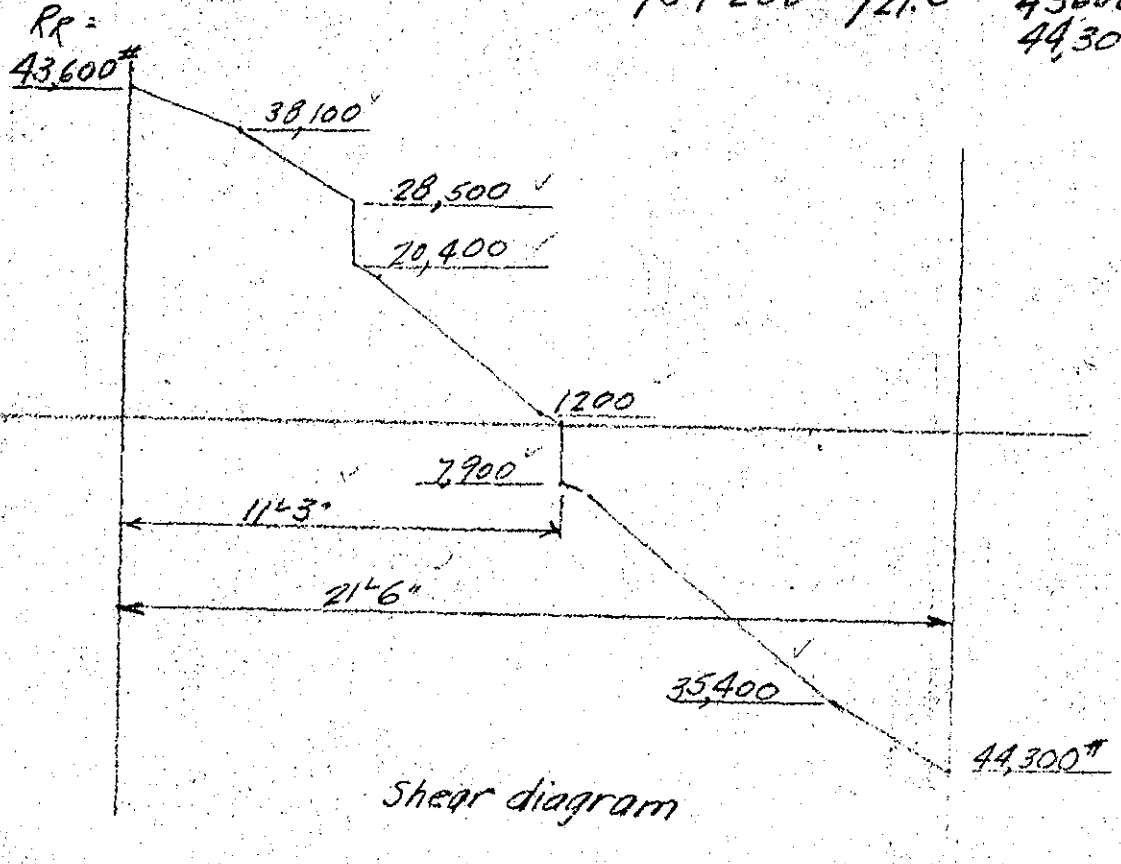
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Beam B-1



Assume beam 18"x40"

RL =	2000 x 21.5 2/2 =	462,500 '#
	3600 x 17.25 =	62,200
	16200 x 13 =	210,800
	9200 x 13 =	119,200
	1200 x 10.25 x 5.13 =	63,100
	550 x 6.5 x 6 =	21,400
		939,200 '#/21.5 = 43600# ✓
		44,300# ✓



Shear diagram

Subject: Dwight Pumping Station - Chicopee C3b
Computation: Operating floor
Computed by: RSM Checked by: W.C.B. Date: 3-29-40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Beam B-1 (Con)

M

44300 × 10.25 =	455,000 '#	
3200 × 10.25²/2 =		168,500 '#
550 × 6.5 × 4.25 =		15,200
	455,000 '#	183,700 '#
Net	271,300 '#	

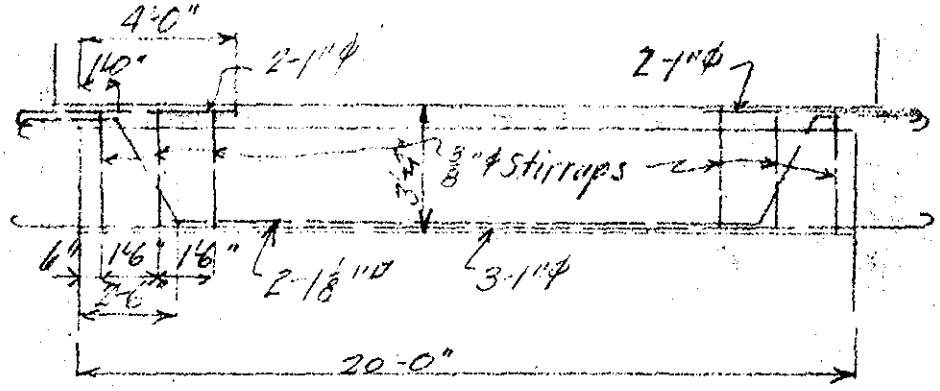
$d = \sqrt{\frac{271,300 \times 12}{18 \times 123}}$ = 38" reqd. 37.5" supplied O.K.

v = 44300/18 × .884 × 37.5 = 75 #/□" Anchor steel.

A_s = 271300 × 12/18000 × .884 × 37.5 = 5.52 □"

Use 3-1" □ & 2-1⅛" □ A_s = 5.53 □"
Bend up 2-1⅛" □

w = 44300/3 × 4 × .884 × 37.5 = 112 #/□" O.K. ✓



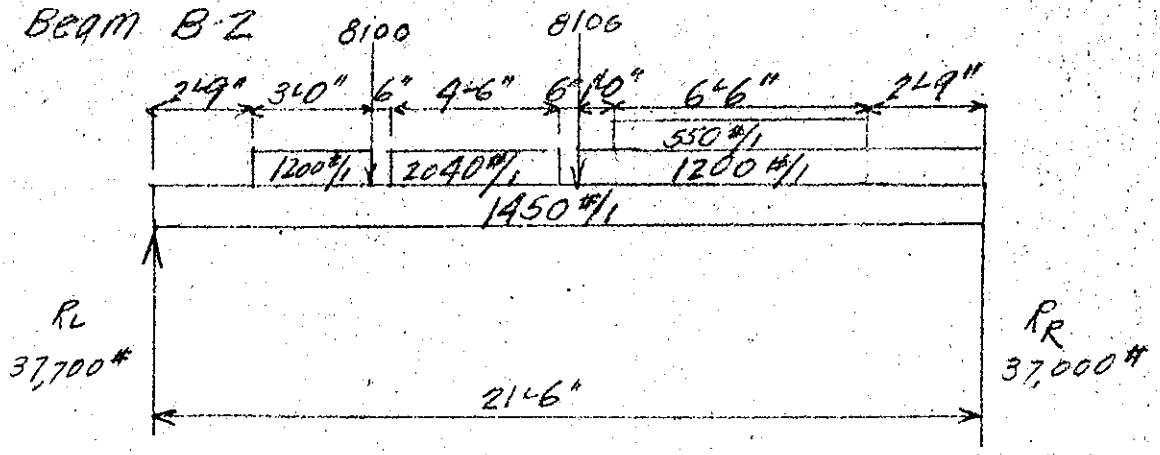
Beam B1

18" wide

Project: Dwight Pumping Station - Chicopee C3b
Computation: Operating floor
Computed by: RSM Checked by: W. S. Jr. Date: 3-29-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Beam B-2



Assume beam 18" x 40"

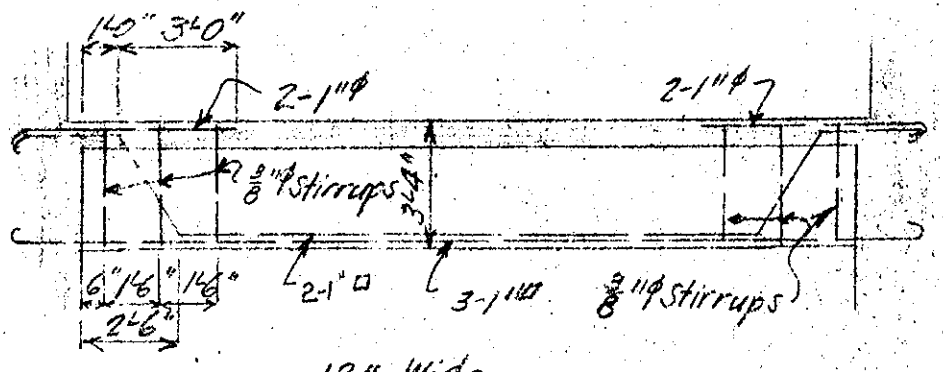
Refer to Beam B-1

$R_L = 43600 - 550 \times 10.75 = 37{,}700^{\#}$

$R_R = 44300 - 550 \times 10.75 = 37{,}000^{\#}$

$M = 271{,}300 - 550 \times 21.5^2/8 = 239{,}500'^{\#}$ ← Approx. (224,000'#. is actual M)

$A_s = 239{,}500 \times 12 / 18000 \times .884 \times 37.5 = 4.88\square''$.
Use 5-1"□ O.K.



18" Wide

Beam B2

WAR DEPARTMENT

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

Subject: Dwight Pumping Station - Chicopee C3b

Computation: Operating floor

Computed by: RSM Checked by: W. S. P. Date: 3-29-40

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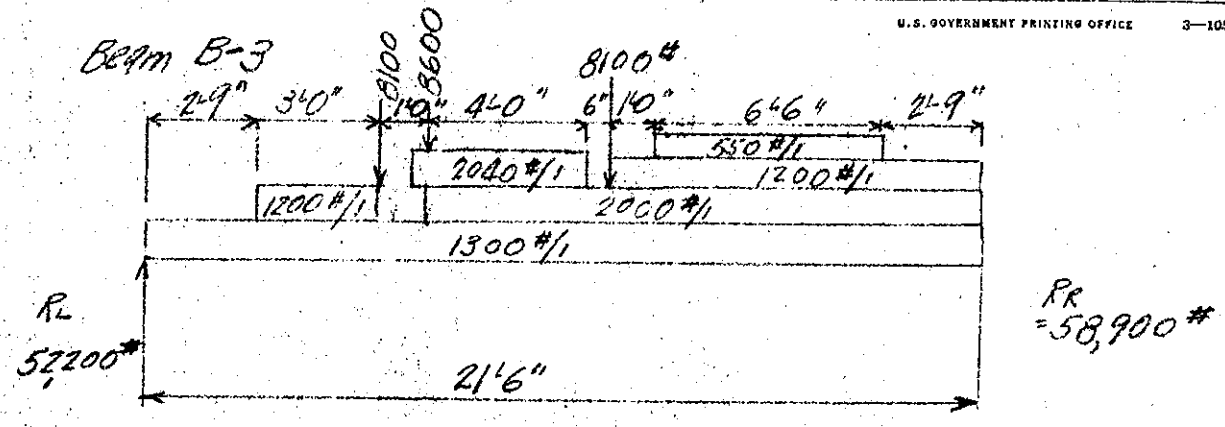
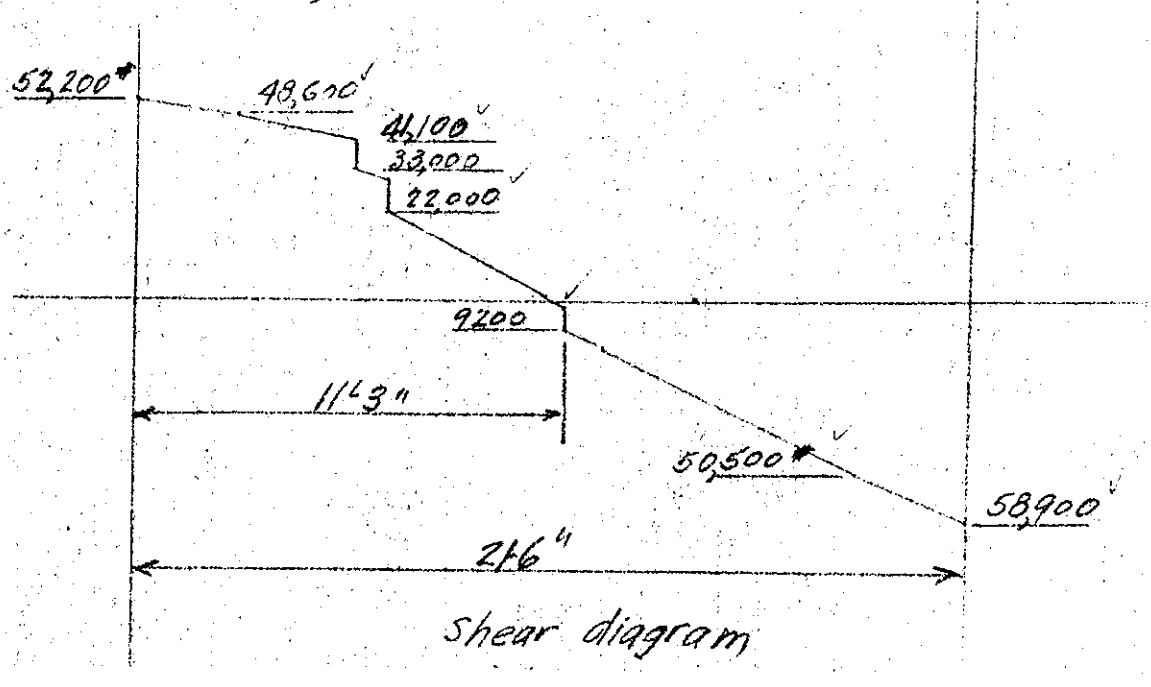


Assume beam 18"×40" N.G.

Assume beam 24"×40"

RL:	1300 × 21.5²/2 =	300,000'#
	1200 × 3 × 17.25 =	62,200
	16200 × 13 =	210,800
	9200 × 13 =	119,200
	8600 × 14.75 =	126,700
	2000 × 14.75²/2 =	218,000
	1200 × 10.25²/2 =	63,100
	550 × 6.5 × 6 =	21,400
		1121,400/21.5 = 52,200#

RR = 58,900#



Shear diagram

Subject: Dwight Pumping Station - Chicopee C3b
Computation: Operating floor
Computed by: RSM Checked by: W. S. J. Date: 3-29-40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Beam B-3 (Con.)

M

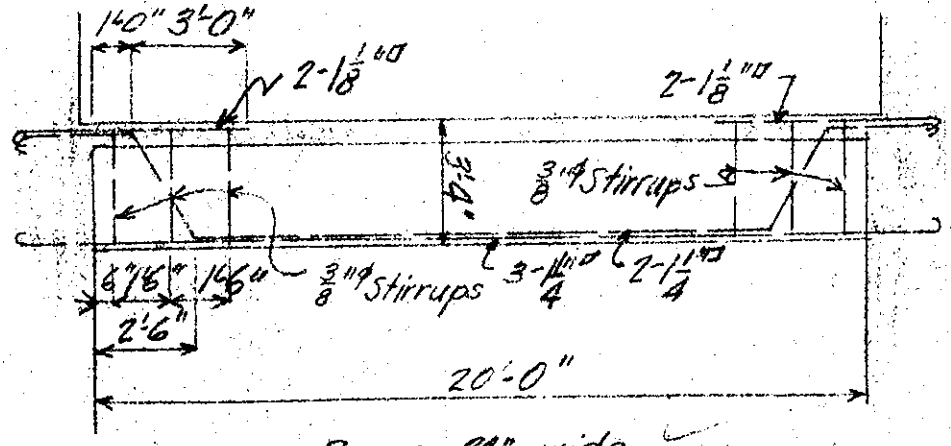
58900 × 10.25	=	605,000'#	
4500 × 10.25²/2	=		236,000
550 × 6.5 × 4.25	=		15,200
		605000	251,200
Net		353,800	

$d = \sqrt{\frac{353800 \times 12}{24 \times 123}} = 38$ " reqd., 37.5" supplied O.K.

$v = 58,900/24 \times .884 \times 37.5 = 75.5$ #/□" Special anchorage required

$A_s = 353800 \times 12/18000 \times .884 \times 37.5 = 7.23$ □"
Use 5-1¼"□ bars.
Bend up 2

$u = 58,900/15 \times .884 \times 37.5 = 119$ #/□" OK



Beam 24" wide

Beam B-3

WAR DEPARTMENT

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

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Subject: Dwight Pumping Station - Chicopee C3b

Computation: Walkway, rear

Computed by: RSM Checked by: Date: 4-10-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Loading on beam

$1.5 \times (50+100) = 225$ #/'

Assume beam 12" × 12

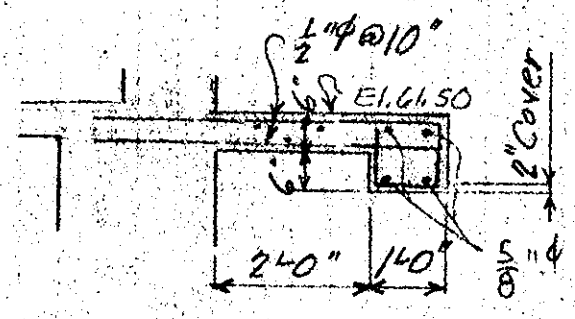
$150 \times 1 \times .75 = 90$

Total 315 #/'

$M = wl^2/12 = 315 \times \overline{10.5}^2/12 = 2900$ '#

$d = \sqrt{\frac{2900}{123}} = 4.9$" reqd.; 9.5" supplied.

$A_s = \frac{2900 \times 12}{18000 \times .884 \times 9.5} = .23$ □"



Subject: Dwight Pumping Station
Computation: Gate Stand Support - Chicopee C3b
Computed by: RSM Checked by: Date: 4-6-40

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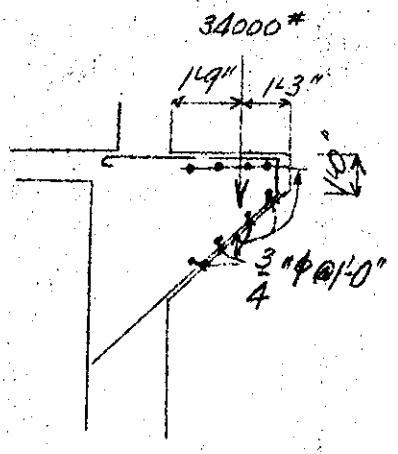
Gate stand



Assume 3' distribution

As cantilever

$M = 34000 \times 1.75/3 \quad 20{,}000'\#$

$A_s = \frac{20000 \times 12}{18000 \times .884 \times 44.5} = .34 \square''$

Use $\frac{3}{4}$"φ@1'-0"

As continuous beam

$M = 34000 \times 6/8 = 25{,}500'\#$

$A_s = 25500 \times 12 / 18000 \times .884 \times 20.5 = .95 \square''$

Use $\frac{3}{4}$"φ@1'-0"

WAR DEPARTMENT

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

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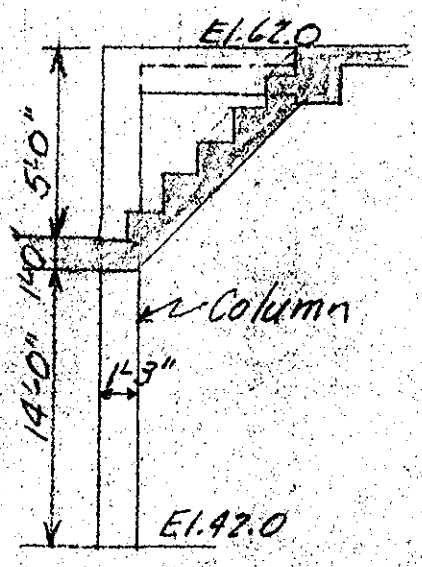
bject Dwight Pumping Sta. - Chicopee C3b

mputation Stair column

omputed by RSM Checked by W. S. Jr. Date

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Loading

from floor slab	5000#
from stairs	
1×1.5×2×150	450
1×1.5×7×150	1575
from curtain	
.5×5×10×120	3000
Total	10,025 #

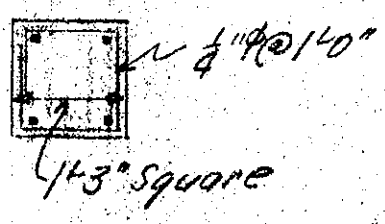
$$A = \frac{P}{f_c[1+(n-1)p_o]}$$

$$= \frac{10,025}{450(1+11\times.005)} = 22 \text{ □"} \text{ req'd.}$$

225 □" supplied

A_s = 225×.005 = 1.13 □" req'd.

Use 4-$\frac{5}{8}$"φ = 1.21 □"



Subject: Dwight Pumping Station - Chicopee C3b
Computation: Wet sump stairs.
Computed by: RSM Checked by: Date: 4-12-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stair spans as beam between El. 42 & El. 58.0 & is on 45° angle.

Loading
LL. 100#/ft
D.L. 150
Total 250#/ft

$M = 250 \times 16^2/8 = 8000\#$

$d = \sqrt{\frac{8000}{122}} = 8.1''$ reqd. Use 10" slab depth.

$v = 250 \times 8/12 \times .884 \times 8.3 = 23\#/\square''$

$A_s = 8000 \times 12/18000 \times .884 \times 8.3 = .73\square''$. Use $\frac{5}{8}''\phi$ @ $4\frac{1}{2}''$ c-c.

Make section between El. 58 & 62 same thickness with reinforcing $\frac{5}{8}''\phi$ @ 10" t.

WAR DEPARTMENT

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

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bject Dwight Pumping Sta. - Chicopee C3b

mputation Stability

Computed by RSM Checked by Date 4-1-40

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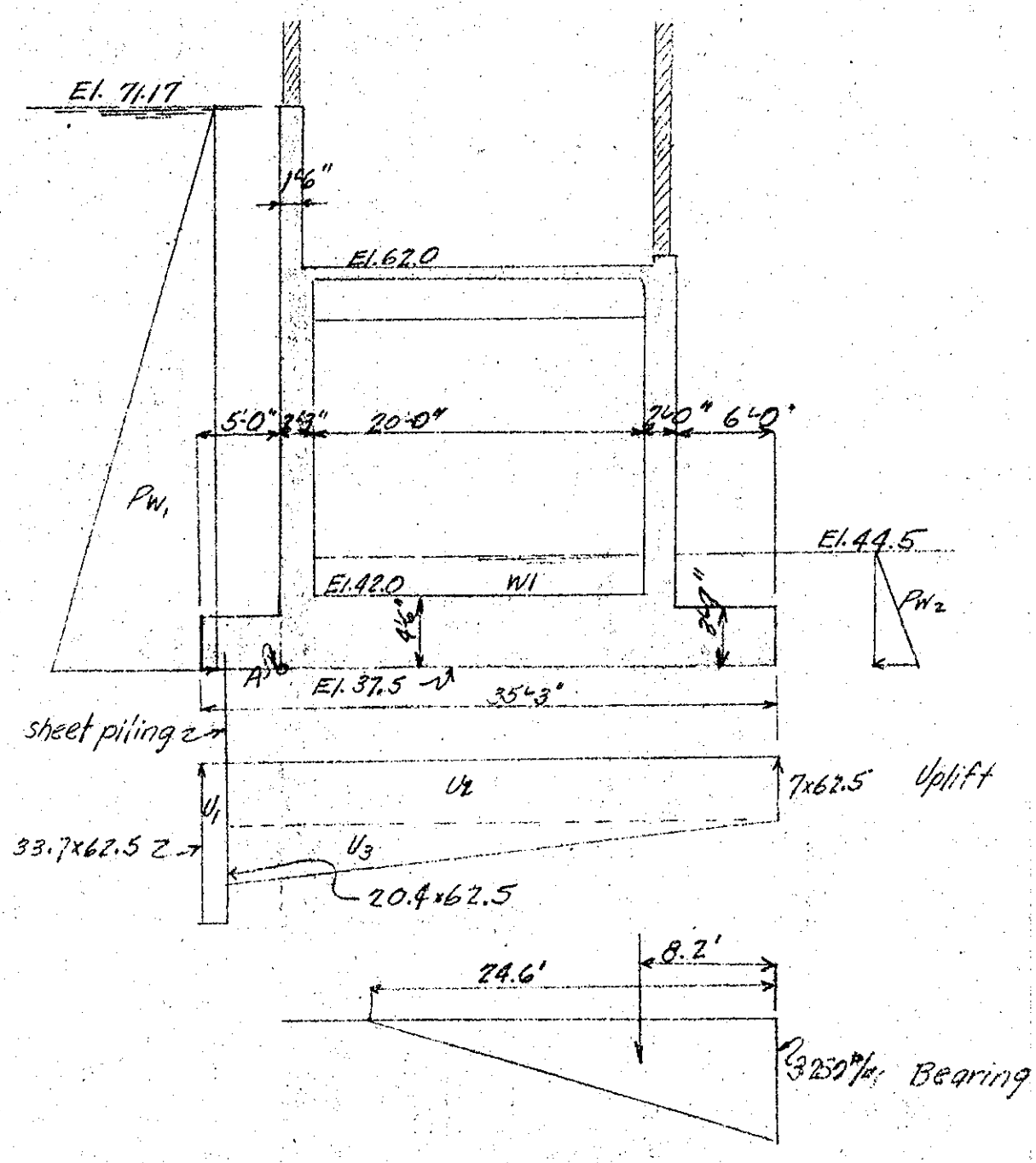


WAR DEPARTMENT

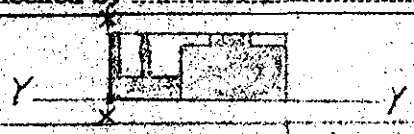
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Project: Dwight Pumping Sta. - Chicopee C3b

Computation: Stability

Computed by: RSM Checked by: W.H.F. Date: 3-29-40

U. S. GOVERNMENT PRINTING OFFICE 3—10538



Description	Size	Weight (kips)	Moment abt. X-axis (ft)	Moment abt. X-axis (ft. kips)	Moment abt. Y-axis (ft)	Moment abt. Y-axis (ft. kips)
Gate sect. piers-1	150×30.67×2.17×30	300.0	3.7	1110	15.0	4500
	150×15.67×2.6/2×30	92.0	1.7	156	15.0	1380
do -2	150×30.67×2.75×12	152.0	15.2	2310	6.0	913
	150×29.2×18×1.5/2	59.1	15.2	900	18.0	1063
	150×29.2×18×1.25×⅓	32.8	15.2	499	16.0	525
do. -3	150×12.0×.67×30.67	37.0	25.9	958	6.0	222
	150×13×.67×26.2/2	17.2	26.0	447	16.3	278
do - curtains	150×21.7×18×1.5	88.0	15.2	1337	4.0	352
	150×21.7×18×2.0	117.1	15.2	1781	9.5	111
do - platform	150×18.0×4×1.5	16.2	15.2	246	6.0	97
do - base	150×30×25.2×3.25	369.0	12.6	4650	15.0	5535
End walls -W	150×21×1.75×20	110.5	25.7	2837	12.0	1325
	150×12×9.2×1.75	29.0	25.7	745	6.0	174
	150×9.2×9.2×1.75/2	11.1	25.7	285	15.1	168
-E	150×21×1.75×20	110.2	68.6	7560	12.0	1323
R.S. wall	150×43.25×20×2	259.5	48.6	12610	1.0	259
	150×41.5×9.2×1.5	86.0	49.3	4245	.8	69
L.S. wall	150×43.25×20×2	259.5	48.6	12610	23.0	5970
Oper. floor	150×39.3×20×.63	74.4	48.6	3610	12.0	891
beams	150×2.7×1.5×20×6	72.9	48.6	3543	12.0	875
*Footing	150×43.25×24×4.5	700.7	48.6	34050	12.0	8410
Roof slab	150×42.0×22×.5	69.3	48.6	3370	12.5	867
Intake walls.	150×2×20×6×3	108.0	47.6	5140	27.0	2916
platform	150×4×6×1×2	7.2	47.6	343	26.5	191
Walkway	150×3×1×15	6.8	26.4	178	19.5	132
	150×3×1×12.5	5.6	34.1	192	25.5	143
Super. walls - R.S.	130×14×43×1.0	78.3	48.6	3810	.6	47
-L.S.	130×23.3×43×1.0	130.3	48.6	6333	23.4	3050
-Ends	130×21.8×23.3×1.0×2	132.0	48.6	6420	12.0	1584
Machinery		122.0	48.6	5930	21.0	2565
* Footing - R.S. toe	150×3.5×5×69.5	182.5	34.2	6250	-2.5	-457
* Footing - L.S. toe	150×43.25×6×3.8	147.8	48.6	7200	27.0	3990
Totals		3984.0		141,655		49468

WAR DEPARTMENT

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

Subject: Dwight Pumping Sta. - Chicopee C3b

Computation: Stability

Computed by: RSM Checked by: W M F Date: 4-1-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability abt. Y-Y axis

	Force	Amount (kips) ↓	↑	⇄	Arm	Moment (ft.kips) ↷	↶
	Bldg	3984.0				49,468	
W1	62.5×58×26.5×2.5	240.0			16.0	3,840	
W2	62.5×30.2×69.5×5	657.0			-2.5		1,642
U1	62.5×33.7×1.5×69.5		219.6		-4.2	923	
U2	62.5×7×33.5×69.5		1018.0		13.3		13,550
U3	62.5×13.3×33.5×69.5/2		970.0		7.7		7,460
Pw1	62.5×69.5×33.7²/2 →			2,467.0	11.2	27,680	
Pw2	62.5×69.5×7²/2 ←			106.7	2.3		245
		4,881.0	2,207.6	2,360.3		81,911	22,891
Σ		2,673.4				59,014	

Position of resultant $= \frac{59014}{2673.4} = 22.1'$ from A (Y-Y axis)

Bearing pressure = 2×2,673,400/3×8.2×69.5 = 3120 #/□' to O.

Stability abt. X-X axis

	Force	↓	↑	⇄	Arm	Moment ↷	↶
	Bldg.	3984.0				141,655	
W1		240.0			34.7	8,330	
U			2,207.6		34.7		76,600
Pw1	62.5×30×33.7²/2 →			1064.0	11.2	11,930	
PE	35×30×24.5²/2 ←			315.0	8.2		2580
W2		657.0			34.7	22830	
		4,881.0	2,207.6	1379.0		184,715	79,180
Σ		2,673.4		749.0		105,535	

Position of resultant: 105,535/2673.4 = 39.5

Bearing pressure $= \frac{2673400}{69.5\times30}\left(1 \pm \frac{6\times4.7}{69.5}\right) = 1807$ to 757 #/□'

ect Dwight Pumping Station - Chicopee C3b
ıtation Thrust piling - Stability
puted by A. K. Checked by Date 4/25/40

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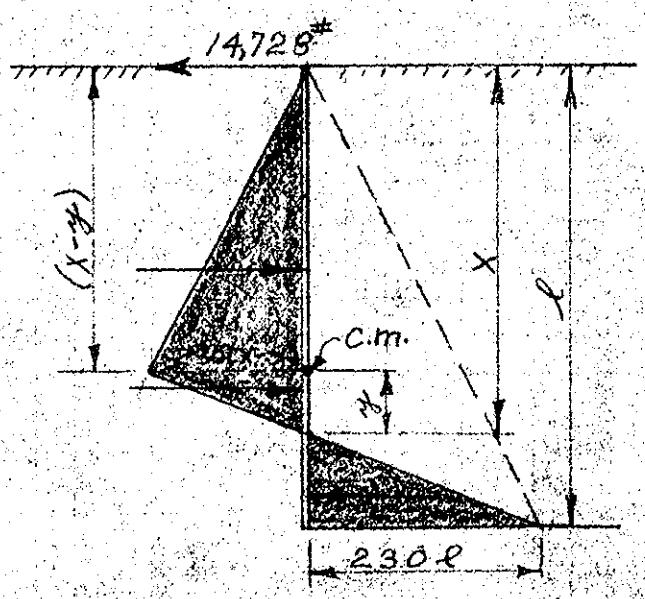


Surcharge load and active pressures neglected

From $\Sigma H = 0$

$$y = \frac{X(\ell - X)}{2\ell - X}$$

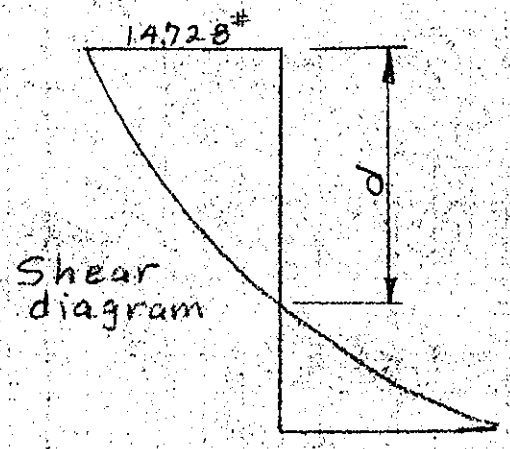
$$X = \frac{2\ell^3 + 256\ell}{3\ell^2 + 128}$$

By successive approximations of "ℓ" get $\Sigma M = 0$

ℓ	X	ΣH	ΣM
22	17	0	23,340 ↶
23	17.6	0	5,830 ↶
24	18.2	0	16,160 ↷
23.3	17.9	0	1,730 ↶

By interpolation $\ell = 23.4$ ft.

Use $\ell = 24$ ft.



Shear diagram

Location of max. moment

$$14728 = \frac{230\,d^2}{2}$$

$$d^2 = 128.1$$

$$d = 11.3'$$

$$(X - y) = 15\pm \quad \text{o.k.}$$

$$M = 14{,}728 \times 11.3 - 11.3(230)\left(\frac{11.3}{2}\right)\left(\frac{11.3}{3}\right)$$

$$M = +110{,}300 \text{ ft.\#}$$

$$S_{required} = \frac{110{,}300 \times 12}{18{,}000} = 73.6 \text{ in}^3 \text{ per ft}$$

MZ38 has $S = 46.8$ in³ per ft.

$$f = \frac{110{,}300 \times 12}{46.8} = 28{,}300 \text{ \#/□"}$$

Excessive stress allowable because of numerous safety factors and thrust value of riverside Key.

Project: Dwight Pumping Station - Chicopee C36
Computation: Thrust Piling - Stability
Computed by: A. K. Checked by: Date: 4/25/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Resultant horizontal load on pumping station over an assumed length of 69.5' = 2,360.3 kips#

Horizontal load per ft. = $\frac{2,360,300}{69.5}$ = 33,961#

Resultant normal load of pumping station over an assumed length of 69.5' = 2,673.4 Kips#

Normal load per ft. = $\frac{2,673,400}{69.5}$ = 38,466#

Resistance to sliding by friction, f = 0.5

38,466 × 0.5 = 19,233#/ft.

Total unbalanced horizontal load

33,961 - 19,233 = 14,728#/ft.

Load to be taken by a continuous line of steel sheet piling.

Allowable passive pressure:

Take wt. of submerged earth = 65#/c.f.

Angle of repose = 34°

$P_p = 65 \tan^2 (45 + \frac{34}{2}) = 65 \tan^2 (62°)$

$P_p = 65 (1.88)^2 = 229.7$ Use 230#/□'

WAR DEPARTMENT

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

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Subject: Dwight Pumping Station - Chicopee C3b

Computation: Design of Typical Transverse Section

Computed by: W. S. J. Checked by: PSM Date: 4/2/40

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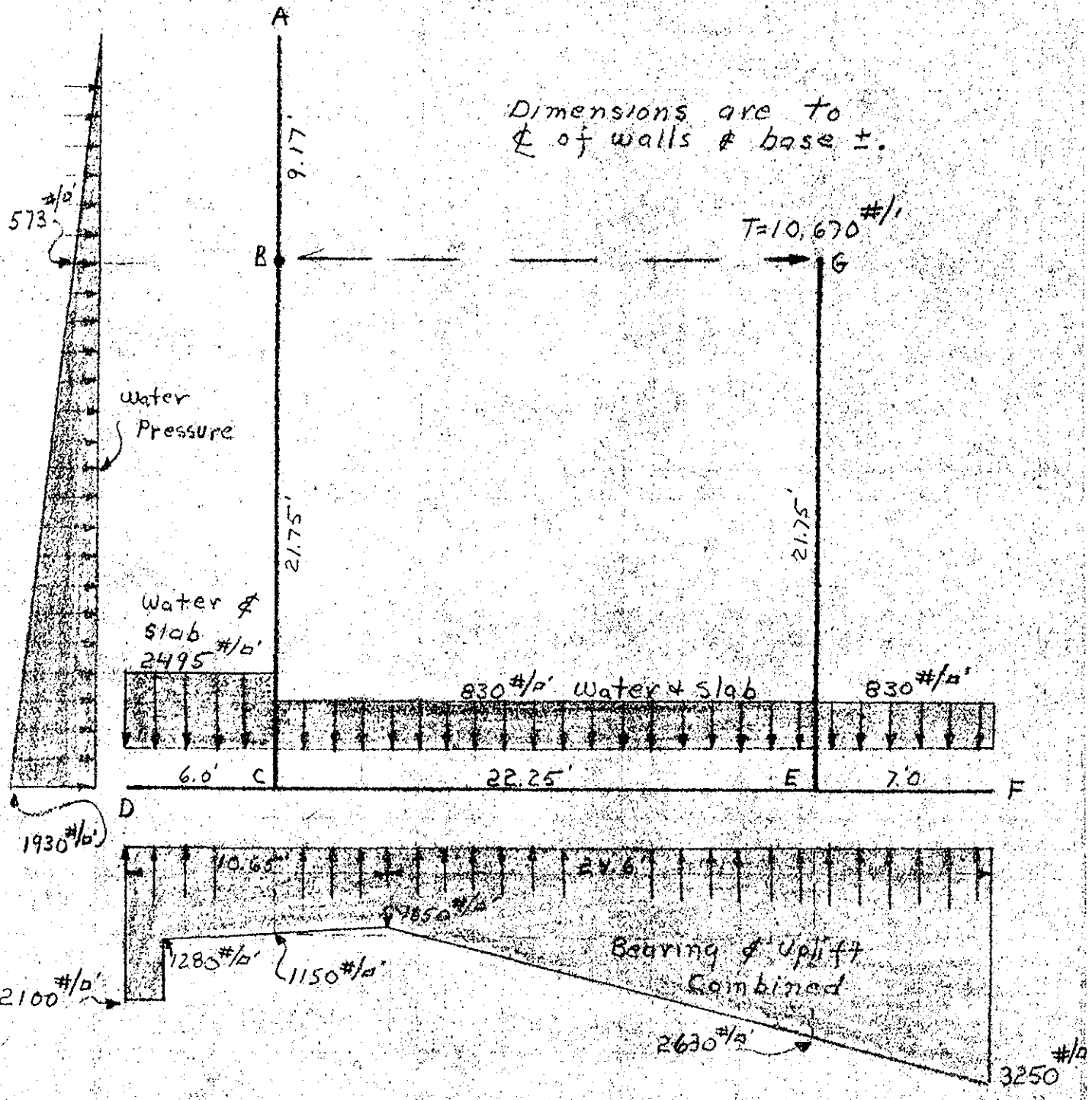
Loading Diagram - River Up



Subject: Dwight Pumping Station - Chicopee Cab
Computation: Design of Typical Transverse Section
Computed by: Checked by: RSM Date: 4/2/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Fixed End Moments

Mom BA $= 9.17^3 \times 62.5/6 = 8000'\#$

Mom BC $= \frac{wl^2}{12} + \frac{Wl}{15} = \frac{573 \times 21.75^2}{12} + \frac{1375 \times 21.75^2/2}{15} = 44{,}200'\#$

Mom CB $= \frac{wl^2}{12} + \frac{Wl}{10} =$ " $+ \frac{1375 \times 21.75^2/2}{10} = 55{,}100'\#$

Mom CD $= 2495 \times 6^2/2 - 2100 \times 1.5 \times 5.25 - 1280 \times 4.5^2/2 = 15{,}400'\#$

Mom CE $= \frac{wl^2}{12} + \frac{Wl}{15} = \frac{320 \times 22.25^2}{12} + \frac{1500 \times 22.25^2/2}{15} = 38{,}800'\#$

Mom EC $= \frac{wl^2}{12} + \frac{Wl}{10} =$ " $+ \frac{1500 \times 22.25^2/2}{10} = 51{,}500'\#$

Mom EF $= 3200 \times 7^2/2 - 830 \times 7^2/2 = 58{,}000'\#$

* Mom EG $= 10{,}673 \times 21.75 = 232{,}000'\#$

Mom GE $= 0'\#$

---

* As the rear wall is stiffened by the intake buttresses, it is assumed that the entire thrust from the riverside wall will be taken by the rear wall.

The thrust is assumed as 10,670 #/' and will be checked later. (see page 4)

Stiffness Factors $K = I/L$

$K_{BC} = \frac{bh^3/12}{L} = .044$ (.22)

$K_{CE} = \frac{bh^3/12}{L} = .160$ (.78)

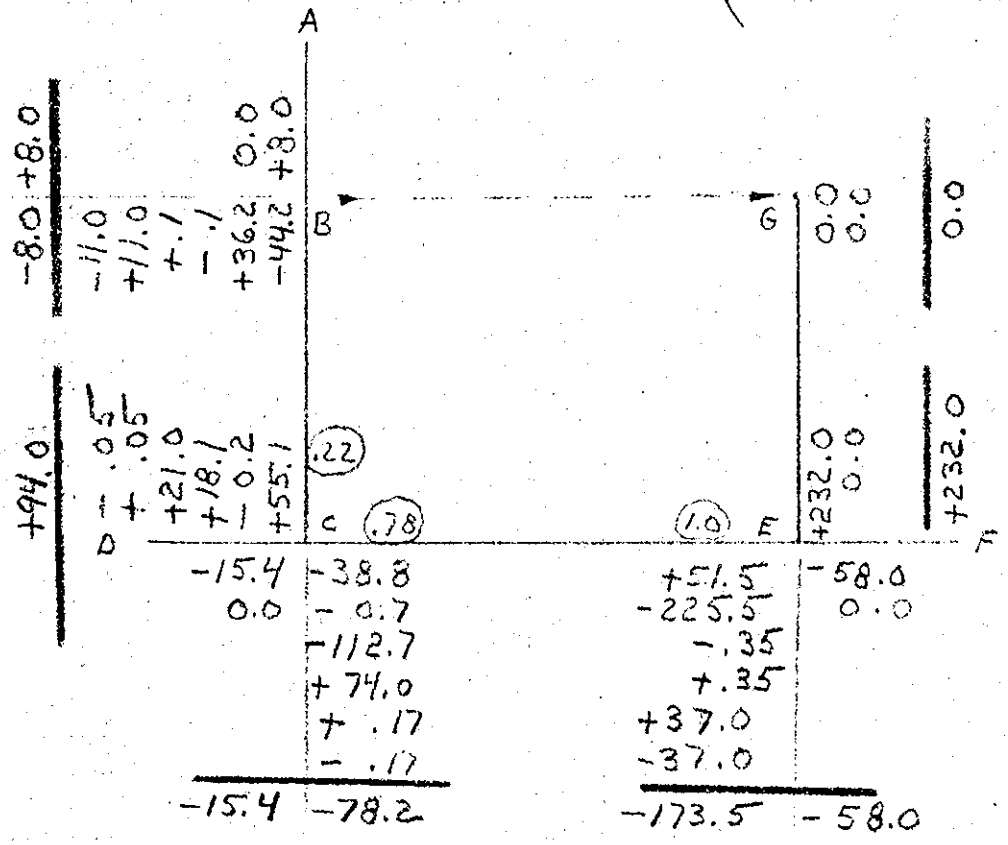
1.00

bject Dwight Pumping Station - Chicopee C3b
putation Design of Typical Transverse Section
mputed by W. E. Jr. Checked by RSM Date

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Analysis of Frame with Thrust at G.

(Thrust assumed as 10,670 #/')



Final Moments

$M_{BA} = +8000'\#$ $M_{BC} = -8000'\#$

$M_{CB} = +94,000'\#$ $M_{CD} = -15,400'\#$

$M_{CE} = -78,200'\#$ $M_{EC} = -173,500'\#$

$M_{EF} = -58,000'\#$ $M_{EG} = +232,000'\#$

Project: Dwight Pumping Station - Chicopee C3b
Computation: Design of Typical Transverse Section
Computed by: M. S. J. Checked by: RJM Date: 4/10/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Shears and Reactions

At B

Shear from AB $= 9.17^2 \times \frac{1}{2} \times 62.5 = 2620^{\#} \rightarrow$

Shear from BC $= \dfrac{(573 \times 21.75 \times 10.9) + \left(1357 \times \frac{21.75}{2} \times 7.25\right) + 8000 - 94000}{21.75}$

$= 7300^{\#} \rightarrow$

Shear BA $= 2620^{\#/'}$ Shear BC $= 7300^{\#/'}$

Reaction at B $= 9{,}920^{\#/'} \leftarrow$

Assumed reaction at B $= 10{,}670^{\#/'}$ O.K. ✓

At C

$\left(30.9^2 \times \frac{1}{2} \times 62.5\right) - 9{,}920 = \underline{20{,}077}^{\#/'}$ = Reaction ←

Shear CB $= 20{,}077^{\#}$

Shear CD $= (2495 \times 6) - (2100 \times 1.5) - (1280 \times 4.5) = \underline{6100}^{\#/'}$

Shear CE $= \dfrac{(320 \times 22.5 \times 11.10) + \left(1500 \times \frac{22.25}{2} \times 7.4\right) + 78200 + 173500}{22.25}$

" $= \underline{20{,}400}^{\#/'}$

↓ Reaction at C $= 26{,}500^{\#/'}$

At E

Shear EC $= (320 \times 22.25) + \left(1500 \times \frac{22.25}{2}\right) - 20{,}400$

$= \underline{3{,}400}^{\#/'}$

Shear EF $= (3200 \times 7) - (830 \times 7) = \underline{16{,}600}^{\#/'}$

Reaction at E $= 20{,}000^{\#/'}$

Shear EG $= 9{,}920^{\#/'}$

WAR DEPARTMENT

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

Dwight Pumping Station - Chicopee C3b

Computation: Design of Typical Transverse Section

Computed by: M. S. Ja. Checked by: RSM Date: 4/10/40

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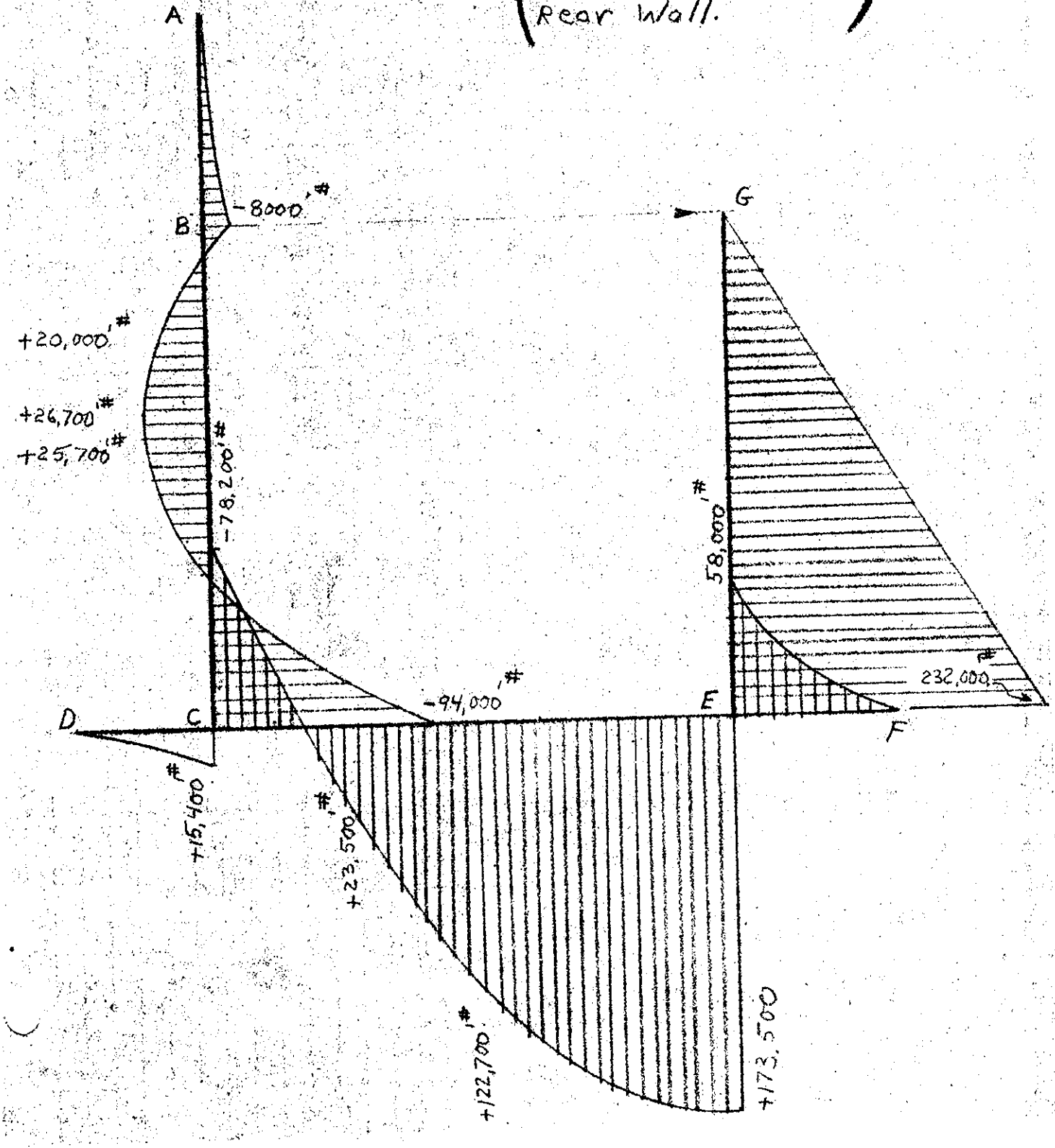
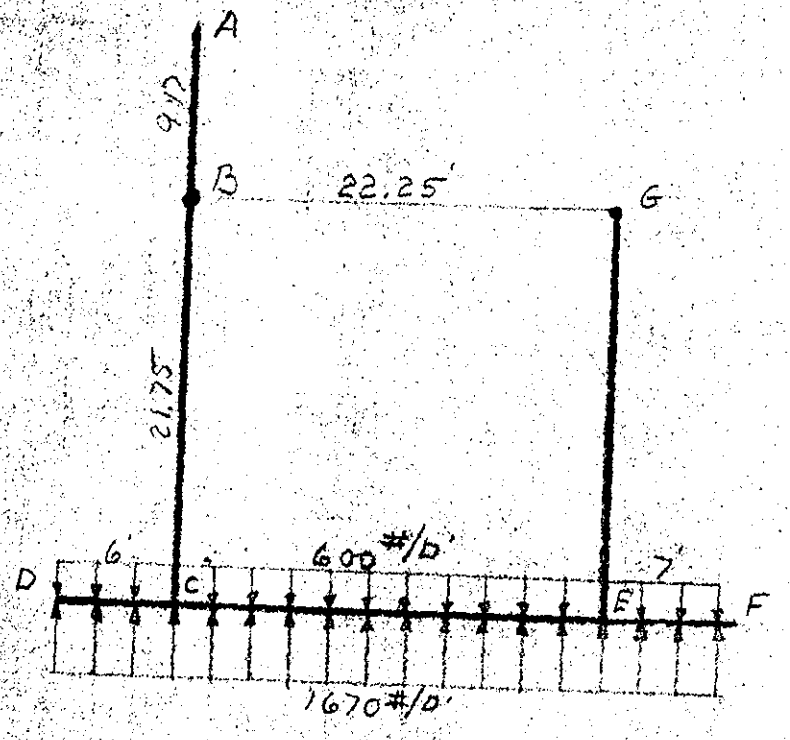
Moment Diagram - (River Up, Thrust carried thru to Rear Wall.)



Loading Diagram River Down



Fixed End Moments

$$\text{Mom } CD = \frac{1070 \times 6^2}{2} = 19{,}300'\#$$

$$\text{Mom } CE = \frac{1070 \times 22.25^2}{12} = 44{,}000'\#$$

$$\text{Mom } EC = \quad '' \quad = 44{,}000'\#$$

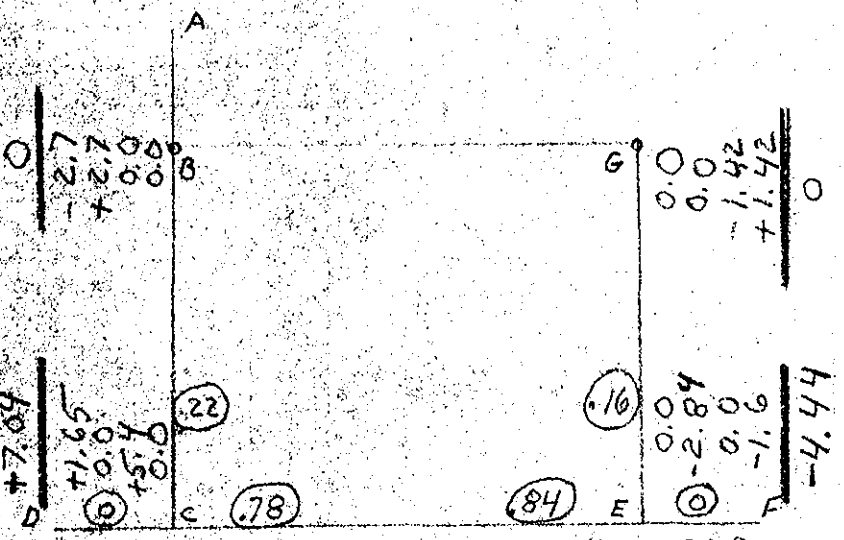
$$\text{Mom } EF = \frac{1070 \times 7^2}{2} = 26{,}200'\#$$

Stiffness factors same as previous figures.

Subject: Dwight Pumping Station - Chicopee C3b
Computation: Design of Typical Transverse Section
Computed by: M.E.J. Checked by: RSM Date: 4/4/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Moment Distribution



Final Moments

$M_{BA} = 0$ $M_{BC} = 0$ $M_{CB} = +7,040'^{\#}$

$M_{CD} = +19,300'^{\#}$ $M_{CE} = -26,450'^{\#}$

$M_{EC} = +30,600'^{\#}$ $M_{EF} = -26,200'^{\#}$

$M_{EG} = -4,440'^{\#}$ O.K.

Project: Dwight Pumping Station - Chicopee C3b
Computation: Design of Typical Transverse Section
Computed by: M. S. Jr. Checked by: Date: 4/4/40

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Shears and Reactions

Shear CB = $\frac{7,040}{21.75}$ = 320 #/'

Shear BC = 320 #/'

Shear CD = 1070 × 6 = 6420 #/'

Shear CE = $\frac{(1070 \times 22.25 \times 11.12) + 26,450 - 30,600}{22.25}$ = 11,700 #/'

Shear EC = 1070 × 22.25 − 11,700 = 12,100 #/'

Shear EF = 1070 × 7 = 7490 #/'

Shear EG = $\frac{4,440}{21.75}$ = 204 #/'

Shear GE = 204 #/'

Reaction at B = 320 #/' ←

Reaction at C = 6,420 + 11,700 = 18,120 #/' ↑

Reaction at E = 7,490 + 12,100 = 19,590 #/' ↑

Reaction at G = 204 #/' →

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Project: Dwight Pumping Station - Chicopee C3b

Computation: Design of Typical Transverse Section

Computed by: M. S. J. Checked by: Date: 4/4/40

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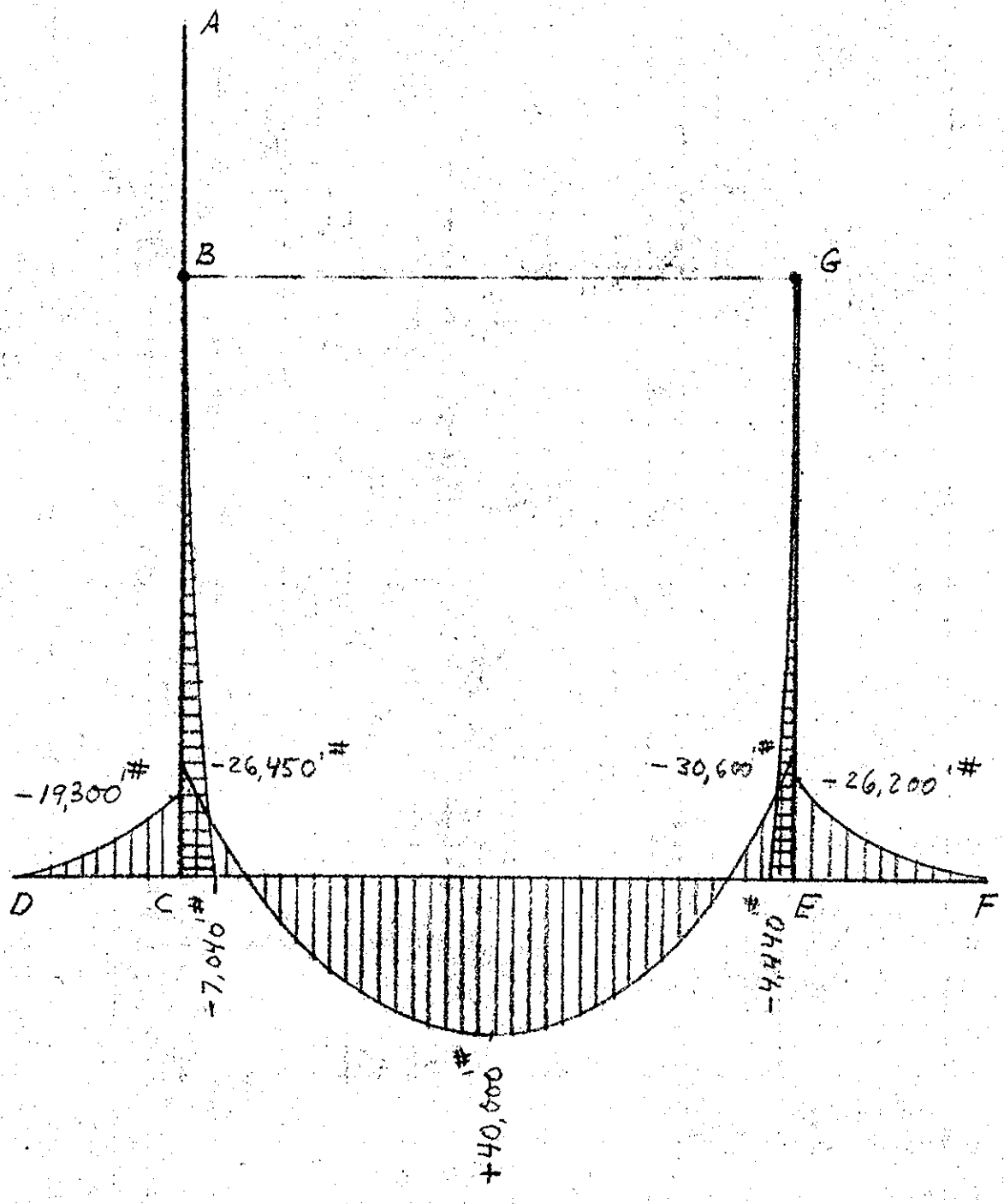
Moment Diagram River Down



Subject: Dwight Pumping Station - Chicopee C3b
Computation: Design of Typical Transverse Section
Computed by: M. S. P. Checked by: Date: 4/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10628

Unit Shears

max shear at B from BC = 7,300 #/' (River Up)

width of wall = 2'-3", d = 24" $\frac{7,300}{12 \times .884 \times 24} = 28$ #/□" O.K.

max shear at C from BC = 20,077 #/' (River Up)

$\frac{20,077}{12 \times .884 \times 24} = 79$ #/□" O.K.

max shear at C from DC = 6420 #/' (River Down)

width of slab = 3'-6", d = 38.5" $\frac{6420}{12 \times .884 \times 38.5} = 16$ #/□" O.K.

max shear at C from EC = 20,400 #/' (River Up)

d = 38.5" $\frac{20,400}{12 \times .884 \times 38.5} = 50$ #/□" O.K.

max shear at E from EG = 12,100 #/' (River Down)

d = 38.5 $\frac{12,100}{12 \times .884 \times 38.5} = 30$ #/□" O.K.

max shear at E from EF = 16,600 #/' (River Up)

d = 38.5 $\frac{16,600}{12 \times .884 \times 38.5} = 42$ #/□"

max shear at E from EG = 9,920 #/' (River Up)

width of wall = 2'-0" d = 21" $\frac{9920}{12 \times .884 \times 21} = 45$ #/□" O.K.

max shear at G from EG = 9,920 #/□' (River Down)

d = 21" Shear O.K.

Project: Dwight Pumping Station - Chicopee C36
Computation: Design of Typical Transverse Section
Computed by: W. S. P. Checked by: Date: 4/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel Required

$-$ Mom. at B = 8000'# d = 15" O.K.

$A_s = \frac{8000 \times 12}{18000 \times .884 \times 15} = .40 \square''$ Use 3/4" ϕ @ 1'-0" c.c.

$Bond = \frac{7300}{2.36 \times .884 \times 24} = 145 \#/\square''$

Max. + mom. in BC = 26,700'# d = 24" o.k.

$A_s = \frac{26,700 \times 12}{18000 \times .884 \times 24} = .84 \square''$ Use 1"□ @ 1'-0" c.c.

Bond O.K.

Max $-$ mom. in BC, at C = 94,000'#

d = 24" O.K.

$A_s = \frac{94,000 \times 12}{18000 \times .884 \times 24} = 2.97 \square''$ Use 1 1/4"□ @ 6" cc

$Bond = \frac{20,077}{10 \times .884 \times 24} = 96 \#/\square''$ O.K.

Max + mom at C from DC = 15,400'#

d = 38" $A_s = \frac{15,400 \times 12}{18000 \times .884 \times 38} = .34 \square''$ Use 3/4" ϕ @ 1'-0"

Bond OK

Max $-$ mom at C from DC = 19,300'#

d = 38" $A_s = \frac{19,300 \times 12}{18000 \times .884 \times 38} = .39 \square''$ Use 3/4 ϕ @ 1'-0"

Bond O.K.

Project: Dwight Pumping Station - Chicopee C3b
Computation: Design of Typical Transverse Section
Computed by: M. S. P. Checked by: Date: 4/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel Required

Max - mom. at C from EC = 78,200'#

$d = 38''$ $A_s = \frac{78,200 \times 12}{18000 \times .884 \times 38} = 1.56^{\square''}$

Use 1"φ @ 6" c.c.

Bond O.K.

Max + mom in CE = 173,500'# $d = 39''$ o. k.

$A_s = \frac{173,500 \times 12}{18000 \times .884 \times 39} = 3.33^{\square''}$ Use $1\frac{1}{4}''^{\square}$ @ 6" c.c.

(stress = 19,100)

Bond O.K.

---

max - mom. at E from EF = 58,000'#

$A_s = \frac{58,000 \times 12}{18000 \times .884 \times 38} = 1.15^{\square''}$ use $\frac{7}{8}''$φ @ 6" c.c.

Bond O.K.

Max + mom at E from EG = 232,000'#

See page 18 for design of rear wall.

-mom at E from CE (River Down) = -30,600'#

$d = 38''$ $A_s = \frac{30,600 \times 12}{18000 \times .884 \times 38} = .60^{\square''}$ Use $\frac{7}{8}''$φ @ 1'-0" c.

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Project: Dwight Pumping Station – Chicopee C3b

Computation: Design of Typical Transverse Section

Computed by: W. S. Jr. Checked by: Date: 4/11/40

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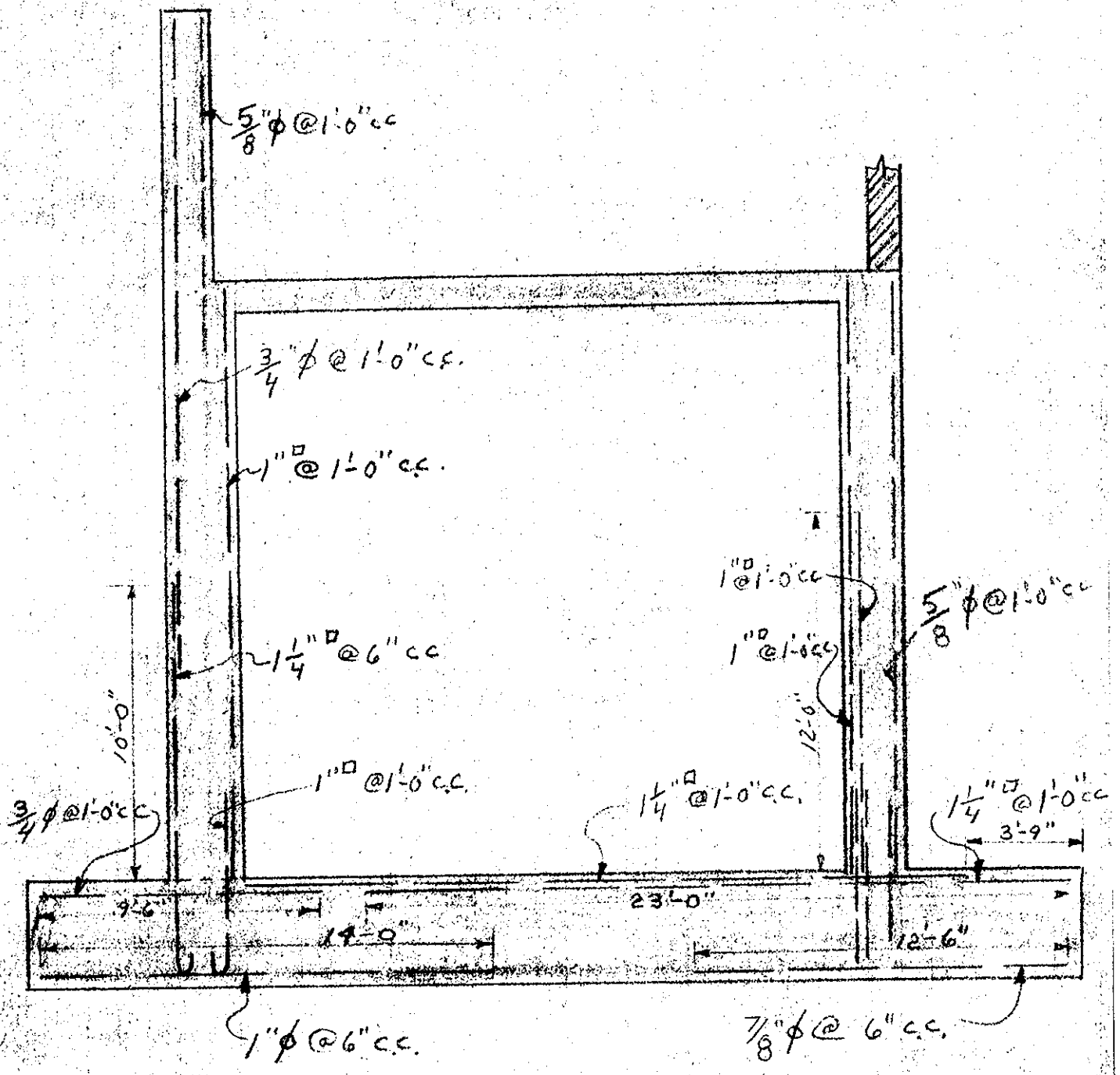
Designed Section



Project: Dwight Pumping Station - Chicopee C36
Computation: Design of Riverside Wall
Computed by: M. S. Y. Checked by: Date: 4/5/40

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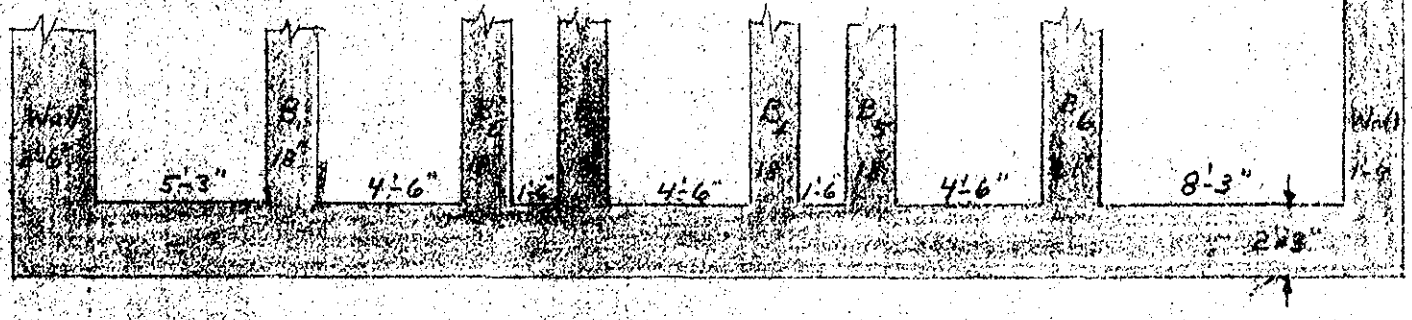
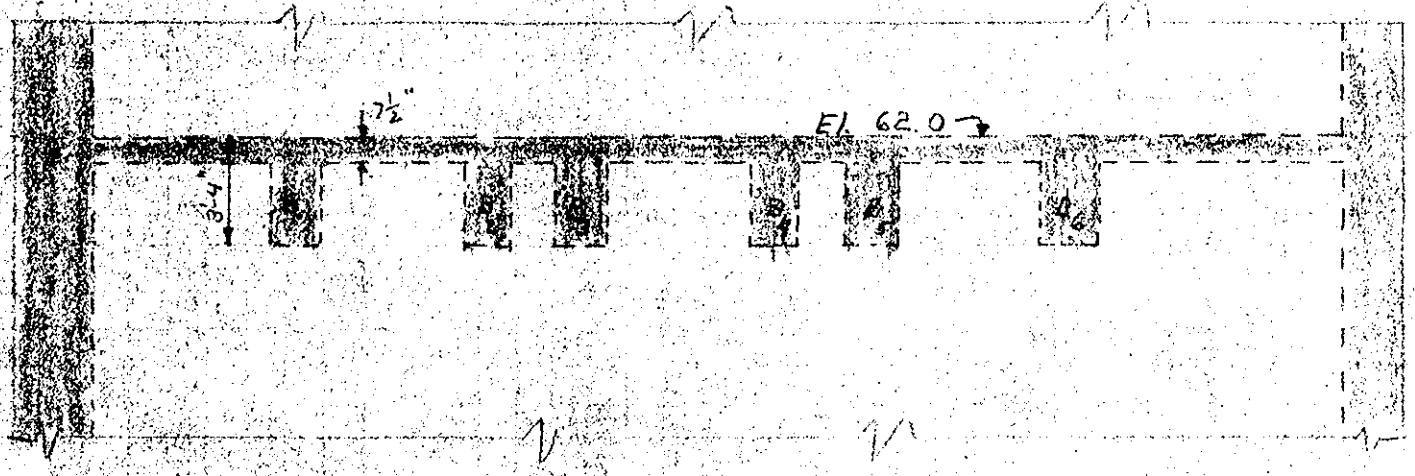
Part of the riverside wall acts as a continuous beam spanning across the ends of the transverse floor beams.

Plan of Floor Beams



Elevation of Wall



Assume 3'-4" of wall acts as a continuous beam.

Load = 10,673# per ft. (See page 4)

Assume load is distributed proportionally to each beam.

Max shear is at right wall, $\frac{8.25}{2} \times 10{,}673 = 44{,}000$#

$\frac{44{,}000}{40 \times .884 \times 24} = 52$ #/□" O.K.

Project Dwight Pumping Station - Chicopee Cab
Computation Design of Riverside Wall
Computed by W. S. Jr. Checked by Date 4/8/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Use $\frac{1}{10} wl^2$ for end spans and $\frac{1}{12} wl^2$ for interior spans.

max-mom. is in end span $= \frac{10673 \times 8.25^2}{10} = 72,500'^{\#}$

$d_{required} = \sqrt{\frac{72,500 \times 12}{123 \times 40}} = 13.2''$ actual $d = 24''$

$A_s = \frac{72,500 \times 12}{18000 \times .884 \times 24} = 2.43^{\square''}$ in beam

Use — 1"ø @ 1'-0" cc in each face of wall from El. 62 to El. 58.6

max. + mom is $\frac{wl^2}{24} = \frac{10673 \times 8.25^2}{24} = 30,000'^{\#}$

$A_s = \frac{30,000 \times 12}{18000 \times .884 \times 24} = .94^{\square''}$ See sketch on Page 17

Thrust on Beams

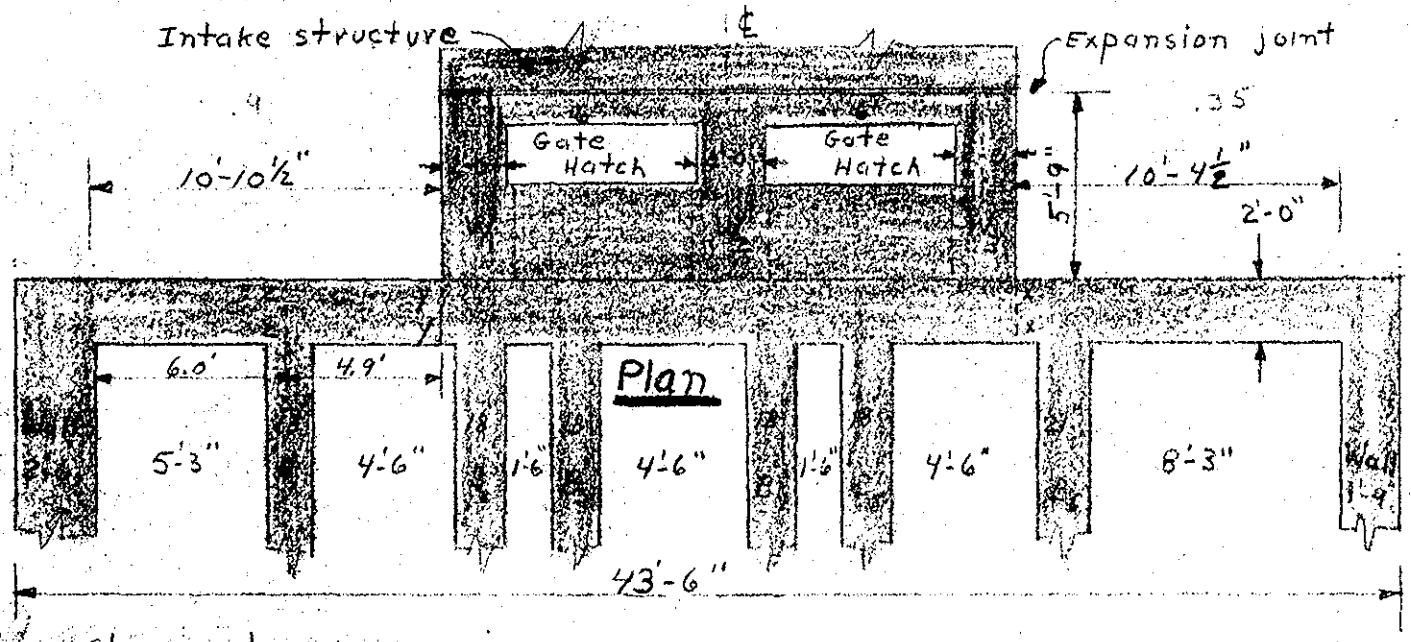
B_1	$6.5 \times 10,673 = 69,200$ #
B_2	$4.5 \times 10,673 = 48,000$ #
B_3	$4.5 \times 10,673 = 48,000$ #
B_4	$4.5 \times 10,673 = 48,000$ #
B_5	$4.5 \times 10,673 = 48,000$ #
B_6	$8.12 \times 10,673 = 86,600$ #

Check beams for additional compression.

Project: Dwight Pumping Station - Chicopee C3b
Computation: Thrust on Rear Buttresses
Computed by: M. S. Jr. Checked by: Date: 4/8/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Effect of Thrusts on Rear Wall



Shear at x-x (max. condition) $86,600 \times \frac{9.12}{10.35} = 76,500^{\#}$ $\frac{76,500}{40 \times .884 \times 21} = 103^{\#/\square''}$

The shear will be absorbed by more than 40" of wall so - O.K.

Shear at y-y

$$69,200 \times \frac{6}{10.9} = 38,000^{\#}$$ shear O.K.

Moment at z-z

$$(31,200 \times 6.0) - \left(69,200 \times \frac{6 \times 4.9^2}{10.9^2}\right) = 103,000'^{\#}$$

Moment at y-y

$$\left(69,200 \times \frac{6^2 \times 4.9}{10.9^2}\right) = 102,000'^{\#}$$

Moment at x-x

$$\left(86,600 \times \frac{9.1^2 \times 1.25}{10.4^2}\right) = 83,000'^{\#}$$

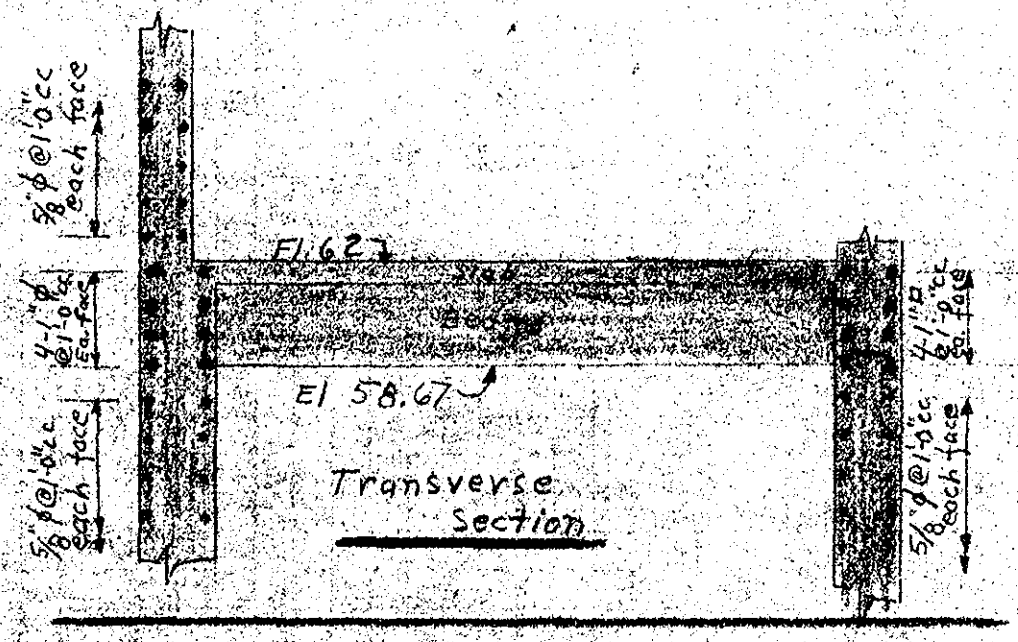
Subject: Dwight Pumping Station - Chicopee C3b
Computation: Thrust on Rear Buttresses
Computed by: M. S. Jr. Checked by: Date: 4/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

max mom. is 103,000'# $d = \sqrt{\frac{103,000 \times 12}{123 \times 40}} = 16''$ 21" O.K.

$A_s = \frac{103,000 \times 12}{18000 \times .884 \times 21} = 3.70''$ in 40" of wall

use — 1"□ @ 1'-0" cc in each face of wall from El. 62 to El. 58.67



Punch Shear of Beam on Rear Wall.

max beam thrust = 86,600# on B_6

$\frac{86,600}{2(18+40) \times 21} = 37\#/\square''$ O.K.

Effect of load on Intake Walls (W_1, W_2 & W_3) (see page 16)

Load on $W_1 = \left(B_1 \times \frac{6}{10.9}\right) + B_2 + \left(B_3 \times \frac{3.75}{6.0}\right)$

$= 69,200 \times \frac{6}{10.9} + 48,000 + 48,000 \times \frac{3.75}{6.0}$

Load on $W_1 = 116,000$#

Subject: Dwight Pumping Station - Chicopee C3b
Computation: Thrust on Rear Buttresses
Computed by: M. S. J. Checked by: Date: 4/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

$$\text{Load on } W_2 = \left(B_3 \times \frac{2.25}{6.0}\right) + B_4 + \left(B_5 \times \frac{2.75}{6}\right)$$

$$\text{"} = \left(48000 \times \frac{2.25}{6}\right) + 48{,}000 + \left(48000 \times \frac{2.75}{6}\right)$$

$$\underline{\text{Load on } W_2 = 88{,}000^{\#}}$$

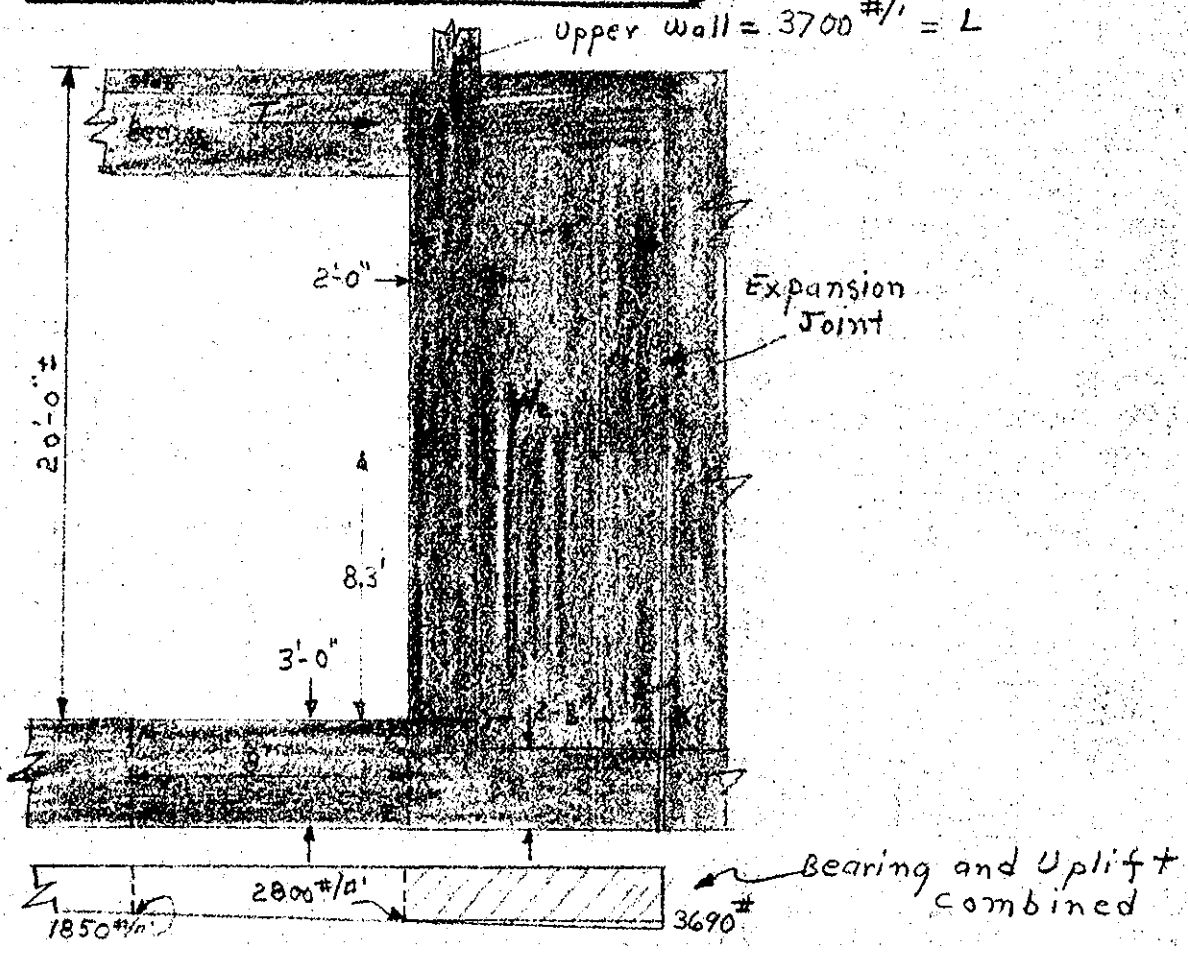
$$\text{Load on } W_3 = \left(B_5 \times \frac{3.25}{6}\right) + \left(B_6 \times \frac{9.12}{10.35}\right)$$

$$\text{"} = 48000 \times \frac{3.25}{6} + 86{,}600 \times \frac{9.12}{10.35}$$

$$\underline{\text{Load on } W_3 = 102{,}500^{\#}}$$

Max Load is on W_1 - **116,000#**

Transverse Section Thru W_2



Subject: Dwight Pumping Station - Chicopee C3b
Computation: Thrust on Rear buttresses
Computed by: W. S. J. Checked by: Date: 4/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Assume Intake Structure acts as a unit, and affects wall and base for 3'-0" on each side. Total length affected = 24'-0".

Max. moment at x-x (neglect L, this is on the safe side)

$mom = (T \times 18.3)$

$T = Tw_1 + Tw_2 + Tw_3$
$T = 116,000 + 88000 + 102,500$
$T = 306,500\#$

$mom = 306,500 \times 18.3$

$mom = 5,600,000'\#$

$d = \sqrt{\frac{5,600,000 \times 12}{.123 \times 72}} = 87''$ $\quad 72'' = W_1 + W_2 + W_3$

d provided $d = 7'-9'' = 93''$ O. K.

$A_s = \frac{5,600,000 \times 12}{18000 \times .884 \times 90} = 47\square''$ in 24' use 1"□ @ 6" c.c.

Max moment at y-y

$mom = (T \times 10.0)$

$mom = 306,500 \times 10 = 3,065,000'\#$

$A_s = \frac{3,065,000 \times 12}{18000 \times .884 \times 90} = 26\square''$ in 24'

Use 1"□ @ 1'-0" cc 13' up

Shear at x-x

$\frac{306,500}{72 \times .884 \times 90} = 53\#/\square''$ O. K.

Subject: Dwight Pumping Station - Chicopee C3b
Computation: East end wall
Computed by: RSM Checked by: W. S. J. Date: 4-3-40

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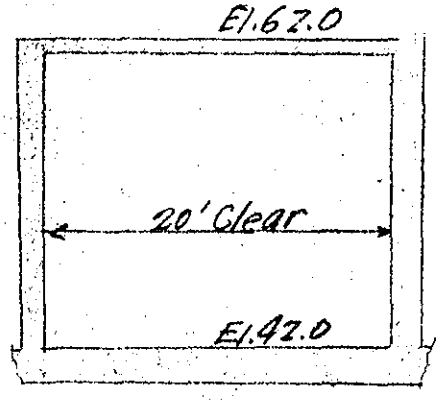

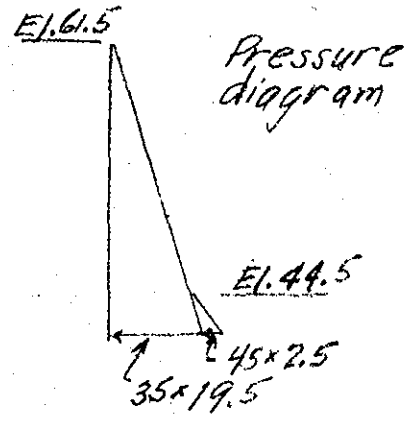

R (bott.) $(35 \times \overline{19.5}^2/2\times) \times \frac{2}{3} =$ 4550#

$45 \times \overline{2.5}^2/2$ approx 140

4690#

Assuming fixity at bottom, simply supported at top

$-M = .1333 \times 6970 \times 20 =$ 18600'# at bott.

$+M = .06 \times 6970 \times 20 =$ 8400'#

$d = \sqrt{\frac{18600}{123}} = 12.3''$ reqd.; 17.5" supplied

$-A_s = 18600 \times 12 / 18000 \times .884 \times 17.5 = .81''^2$ reqd.

$+A_s = 8400 \times 12 / 18000 \times .884 \times 17.5 = .36''^2$

$v = 4690/12 \times .884 \times 17.5 = 25.5$#/□"

WAR DEPARTMENT

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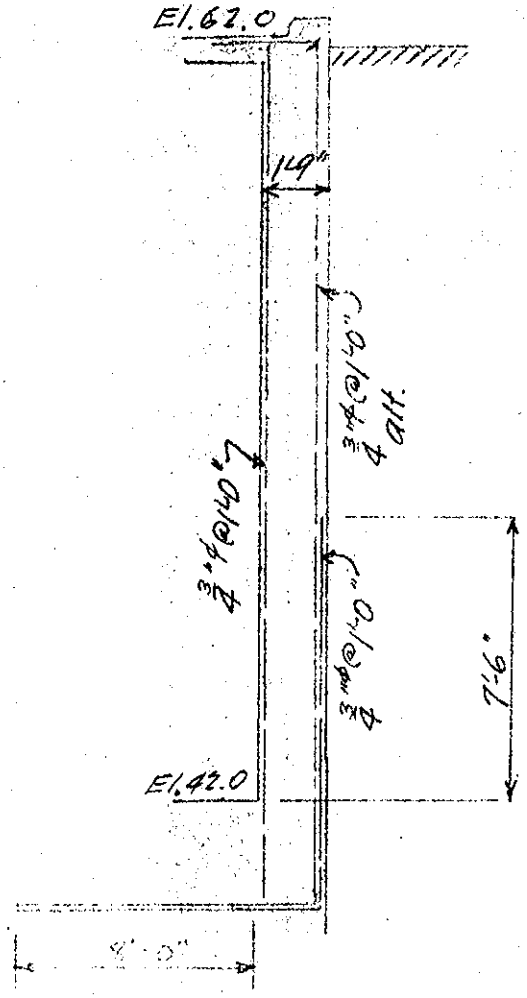
Subject: Dwight Pumping Sta. - Chicopee C3b

Computation: East End walls

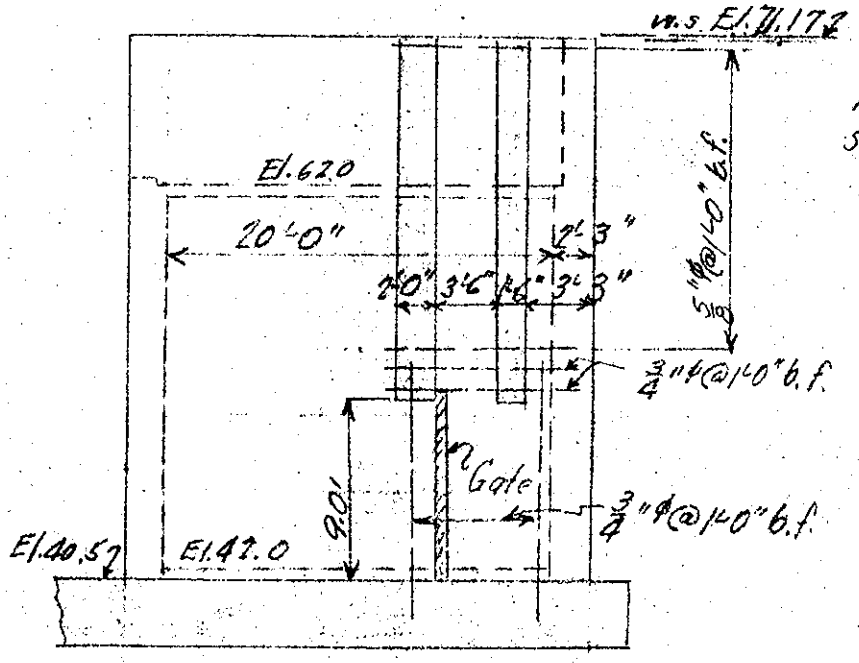
Computed by: RSM Checked by: W. S. P. Date: 4-3-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



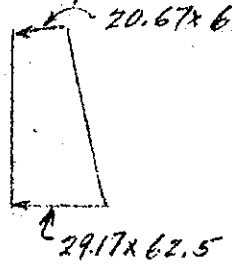
Subject: Dwight Pumping Sta. - Chicopee C3b
Computation: West end wall
Computed by: PSM Checked by: W. S. J. Date: 4-3-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Reinforcing not shown 3/4"φ@1'-0" b.f.

8'-6" Span - vertical



$-M = 20.67 \times 62.5 \times \overline{8.5}^2/12 = 7780$ '#

$\frac{8.5 \times 62.5}{2} \times 8.5/10 = 1920$

9700 '#

$A_s = 9700 \times 12/18000 \times .884 \times 18.5 = .40$ □"

$V(top) = 20.67 \times 62.5 \times 8.5/2 = 5500$ #

$\frac{8.5 \times 62.5}{2 \times 3} = 760$

6260 #

$d = \sqrt{\frac{9700}{123}} = 8.8$" reqd. 18.5" furnished.

3'-6" Span - horizonal - consider load from gate area distributed over 2' strip.

$-M = 62.5 \times 19.67 \times \overline{3.5}^2/12 = 1250$ '#

$6260 \times \overline{3.5}^2/12 = 6400$

7650 '#

$A_s = 7650 \times 12/18000 \times .884 \times 18.5 = .32$ □".

Subject: Dwight Pumping Station - Chicopee C3b
Computation: Outlet structure - Base slab
Computed by: RSM Checked by: Date: 4-4-40

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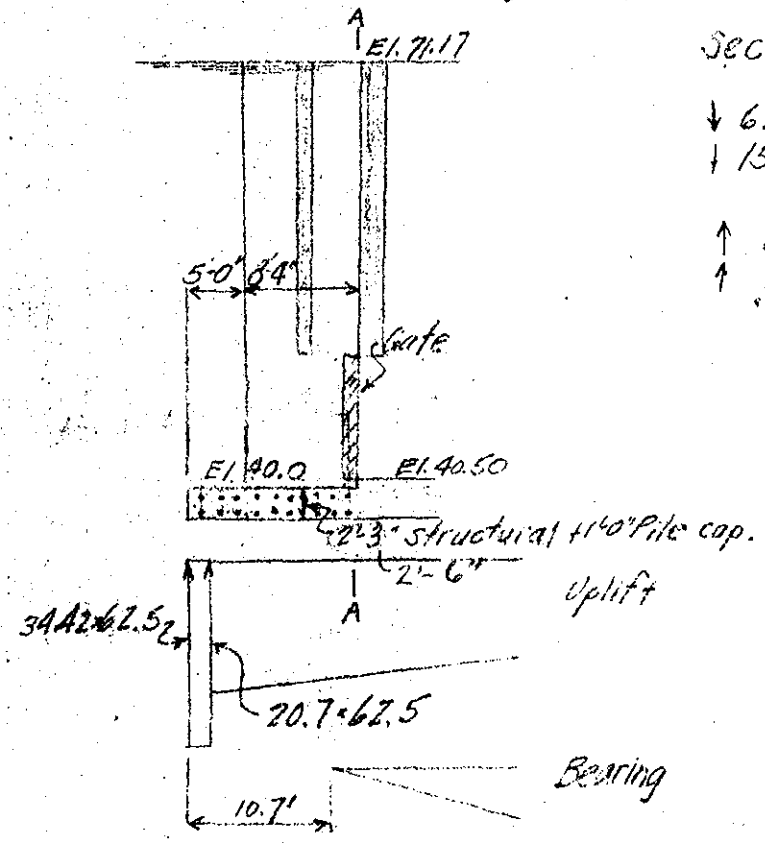
Section in front of gates - River up



Sect. A-A

↓ 62.5 × 30.17 = 1880 #/□'
↓ 150 × 3.3 = 495
2375 #/□'

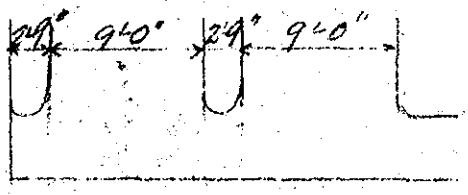
↑ Uplift 990
↑ Bearing 320
1310
Net 1065 #/□'

$M = 1065 \times \bar{9}^2/12 = 7200$ '#

$d = \sqrt{\frac{7200}{123}} = 7.8$" req'd., 22.5" supplied

$A_s = 7200 \times 12/18000 \times .884 \times 23.5 = .23$ □" Use 3/4" ⌀ @ 1'-0" b.f.

$u = 1065 \times 9.5/23.5 \times .884 \times 2.31 = 101$ #/□"



Cantilever footing

Loading, river down -
(1670 - 495) = 1175 #/□'

$M = 1175 \times \bar{5}^2/2 = 14{,}700$ '#

$d = \sqrt{\frac{14700}{3 \times 123}} = 11.0$" req'd.
23.5" supplied

$A_s = 14700 \times 12/18000 \times .884 \times 23.5 = .48$ □"

Project: Dwight Pumping Station - Chicopee C3b
Computation: Outlet Structure - Base slab
Computed by: RSM Checked by: Date: 4-5-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Section in front of gates (Con.)

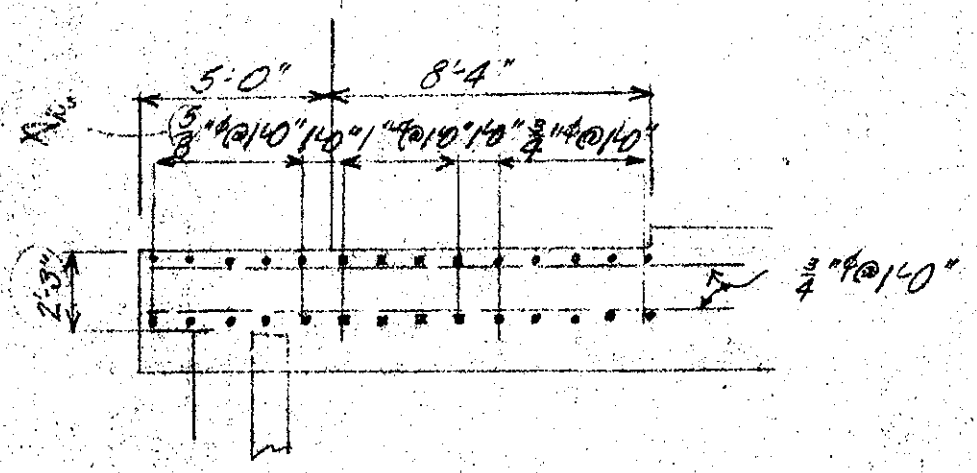
Assume 2' strip between piers carries cantilever loading from footing extension.

Loading $1175 \times 7 = 8225$ #/lin ft.

$M = 8225 \times 9^2/12 = 55{,}000$ '#

$d = \sqrt{55000/123} = 21.3''$ req'd. ; $23.5''$ supplied

$A_s = 55000 \times 12 / 18{,}000 \times .884 \times 23.5 = 1.78$ □" req'd.



ct Dwight Pumping Station - Chicopee C3b
utation Outlet Structure
puted by RSM Checked by Date 4-6-40

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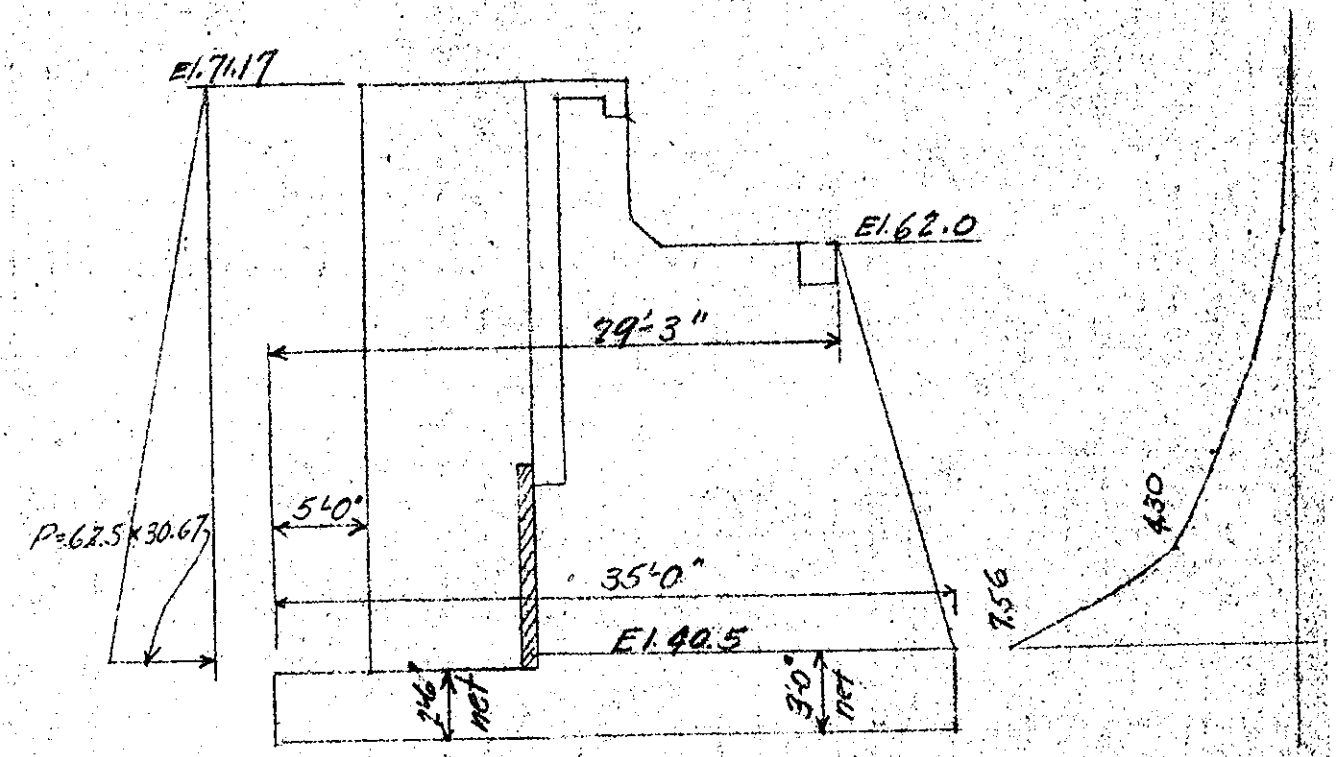

At bottom

$M = 11.75 \times 62.5 \times \overline{30.67}^3/6 = 3{,}535{,}000$ '#

$d = \sqrt{\dfrac{3535000 \times 12}{17 \times 123}} = 141''$ reqd., $356''$ supplied

$A_s = 3535000 \times 12/18000 \times .884 \times 356 = 7.56$ □". Use 5-1¼" □ bars

At	b	M	d	A_s
	25'	1,916,000 '#	340"	4.30 □"
	20	985,000	324	2.29
	15	424,000	308	1.04
	9.17	94,000	288	.25

$V = 11.75 \times 62.5 \times \overline{30.67}^2/2 = 345{,}500$ #

$v = \frac{3}{2}\frac{V}{bd} = \frac{3}{2} \times \frac{345{,}500}{30 \times 360} = 40$ #/□" maximum

$v = \frac{VQ}{Ib} = \frac{345500 \times 220 \times 12^3}{17 \times 5620 \times 12^4} = 38$ #/□" at gate slot.

Subject: Dwight Pumping Sta. - Chicopee C36
Computation: Outlet Structure
Computed by: RSM Checked by: Date: 4-8-40

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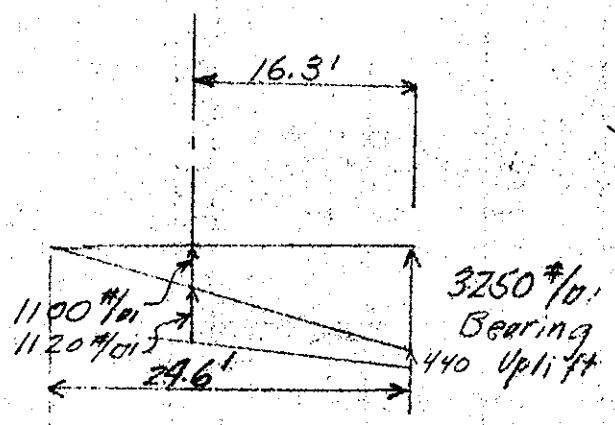


Taking vertical section at 16.3' from back face.

M $11.75 \times 1120 \times 16.3^2/2$ =	3,460,000 '#	↑
$11.75 \times \frac{1470 \times 16.3}{2 \times 3}$ =	686 000	↑
$4 \times 150 \times 11.75 \times 16.3^2/2$ =	936,000	↓
$2.5 \times 150 \times 21.5 \times 12.3^2/2$ =	1,070,000	↓
Net	2,140,000 '#	↑

$A_s = 2,140000 \times 12/18000 \times .884 \times 290 = 5.6 \square''$

Under pier, use 4-¼"□ bars @ 6" c-c. to supply steel required

WAR DEPARTMENT

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

Project: Dwight Pumping Station – Chicopee C3b

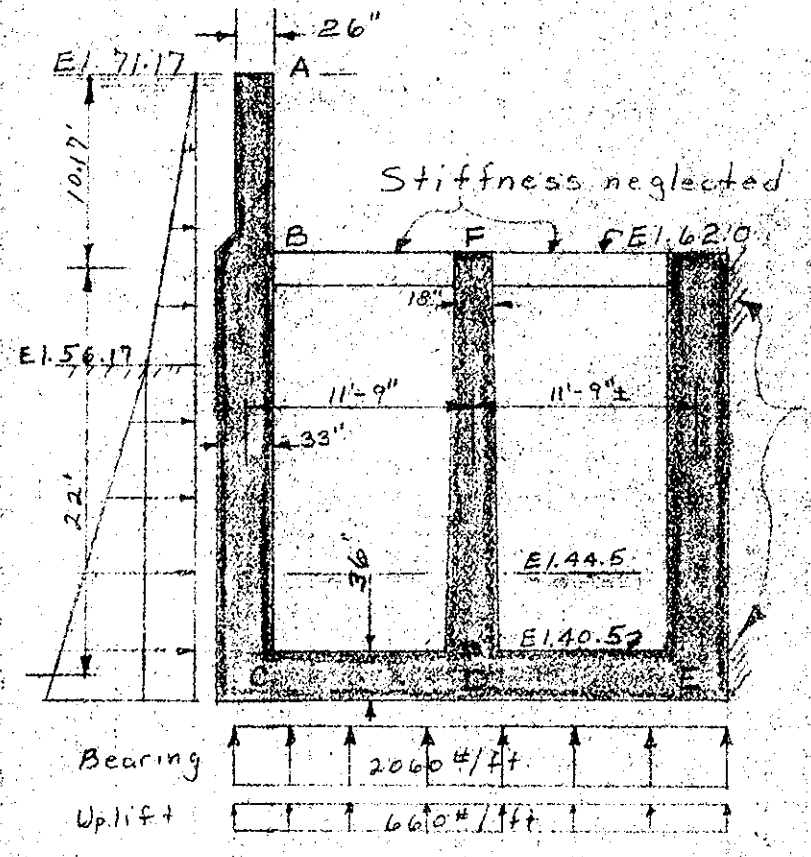
Station: Outlet Structure

Computed by: A.K. Checked by: RSM Date: 4/4/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Loads – Longitudinal Section Thru the Outlet Structure

Section I, Under Strut.



Considered fixed

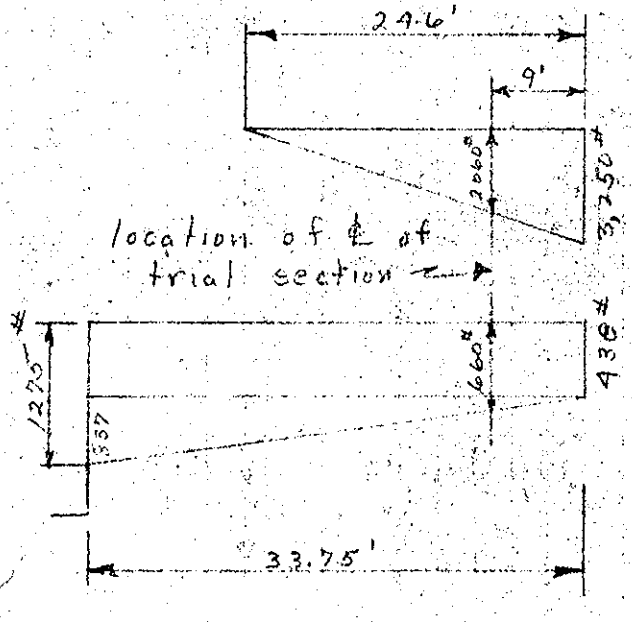
Vertical load of water and slab on CE

4 × 62.5 = 250

3 × 150 = 450

700# ↓ per ft

Resultant uniform load on CE. 2020# per ft ↑



Bearing see page 14

Uplift see page 14

Relative stiffness

$\frac{I}{L}$ for AB = 0

$I_{BC} = \frac{12(33)^3}{12} = 35{,}937$

$\frac{I}{L} = \frac{35{,}937}{22} = 1{,}634$

$I_{CD+DE} = \frac{12(36)^3}{12} = 46{,}656$

$\frac{I}{L} = \frac{46{,}656}{11.75} = 3{,}971$

$I_{DF} = \frac{12(25)^3}{12} = 15{,}625$

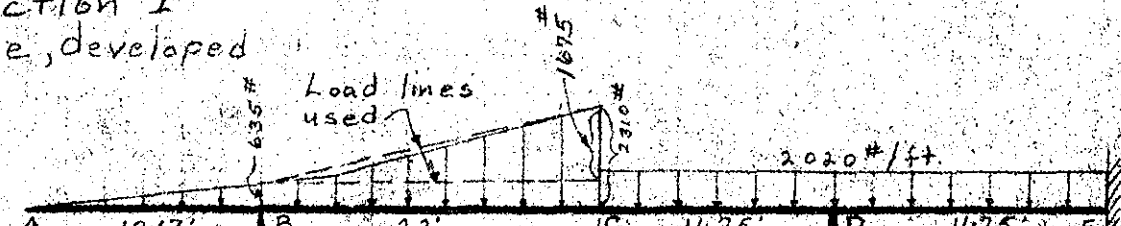
$\frac{I}{L} = \frac{15{,}625}{22} = 710$

Let $\frac{I}{L}$ of DF = 1

Subject: Dwight Pumping Station – Chicopee C3b
Computation: Moments – Outlet structure
Computed by: A. K. Checked by: RSM Date: 4/4/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Section I
Frame, developed



	-10.92	-52.60	-66.10	-23.25	-23.25	-23.25	-23.25
	0	+41.68	+12.50	-30.35	0	0	0
	0	-6.25	-20.84	0	+15.18	0	0
	0	+6.25	+6.07	-14.77	-6.96	+6.96	0
	0	-3.04	-3.12	+3.48	+7.38	0	-3.48
	0	+3.04	+1.93	-4.67	-3.38	+3.38	0
	0	-0.96	-1.52	+1.69	+2.34	0	-1.69
	0	+0.96	+0.94	-2.27	-0.92	+0.92	0
Moments	-10.92	-10.92	-70.14	-70.14	-9.61	+11.99	-28.42

	0	0	0	-1.25	0			
					-0.62			
						+0.31		
							-0.17	
								-1.23
	0	0	0	0	+0.62	-0.62	+0.31	-0.31	0

Fixed end moments to be used above.

$$M_{BA} = \frac{635 \times 10.17}{2} \times \frac{10.17}{3} = 10.92 \text{ Kips}'\#$$

$$M_{BC} = \frac{635\,(22)^2}{12} + \frac{1675 \times 11 \times 22}{16} = 52.60 \text{ Kips}$$

$$M_{CB} = 25{,}600 + \frac{1675 \times 11 \times 22}{10} = 66.10 \text{ Kips}$$

$$M_{CD} = M_{DC} = M_{DE} = M_{ED} = \frac{2020\,(11.75)^2}{12} = 23.25 \text{ Kips}$$

Summary of Moments

$M_B = -10{,}920'\#$ $\quad M_{DC} = -9{,}610'\#$

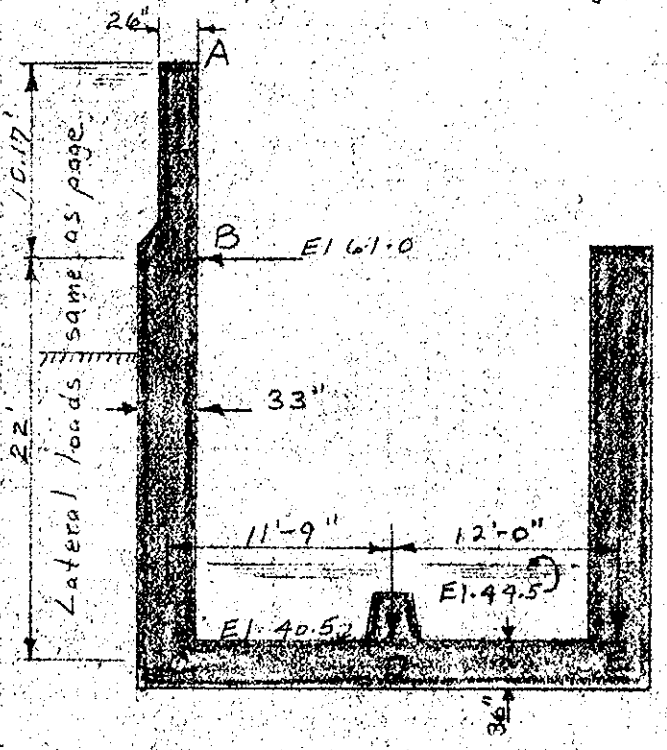
$M_C = -70{,}140'\#$ $\quad M_{DE} = -11{,}990'\#$

$M_{DF} = -1{,}730'\#$

Project: Dwight Pumping Station - Chicopee C3b
Station: Loads - Outlet structure
Computed by: A.K. Checked by: RSM Date: 4/5/40

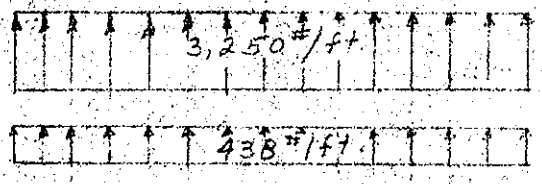
U.S. GOVERNMENT PRINTING OFFICE 3—10528

Section II, At landside edge of Gate Structure.



Vertical load of water and slab on CE (See sheet 1) = 700#/ft.

Resultant uniform load on CE = 2,988#/ft ↑



Bearing See page 1

Uplift.

Relative Stiffness

$\frac{I}{L}$ for AB = 0

$\frac{I}{L}$ for BC = 1,634

$\frac{I}{L}$ for CD = 3,971

$\frac{I}{L}$ for DE = $\frac{46,656}{12}$ = 3,890

Let $\frac{I}{L}$ for BC = 1

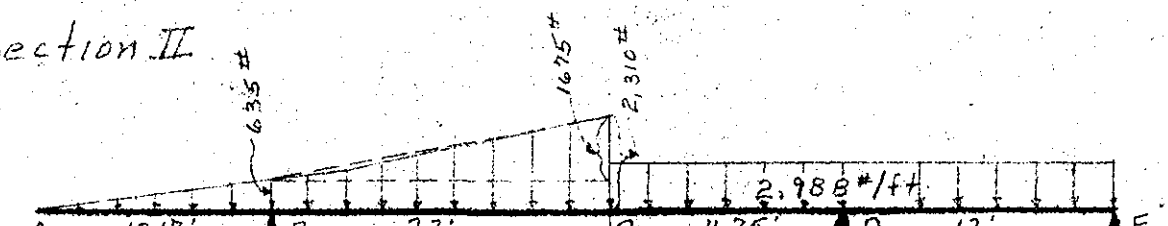
Then $\frac{I}{L}$ for CD = 2.43

" " DE = 2.38

Subject: Dwight Pumping Station - Chicopee C36
Computation: Moments - Outlet Structure
Computed by: A K Checked by: RSM Date: 4/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Section II



0	1		2.43		2.36	
-10.92	-52.60	-66.10	-34.40	-34.40	-35.90	-35.90
0	+41.68	+9.29	-22.46	-0.76	+0.74	+35.90
0	-4.62	-20.84	+0.38	+11.23	-17.95	-0.37
0	+4.62	+6.18	-15.04	-14.74	+14.44	+0.37
0	-3.09	-2.31	+7.37	+7.52	-0.18	-7.22
0	+3.09	+2.82	-6.86	-3.89	+3.81	+7.22
0	-1.41	-1.54	+1.94	+3.43	-3.61	-1.90
0	+1.41	+1.02	-2.46	-3.56	+3.48	+1.90
-10.92	-10.92	-71.53	-71.53	-35.17	-35.17	0

Summary of Moments

$M_B = 10,920'^{\#}$ $M_D = 35,170'^{\#}$

$M_C = 71,530'^{\#}$ $M_E = 0$

Fixed end moments to be used above

$M_{BA} = 10.92$ Kips'# (page 2)

$M_{BC} = 52.60$ Kips

$M_{CB} = 66.10$ Kips

$M_{CD} = M_{DC} = \frac{2988(11.75)^2}{12} = 34.40$ Kips

$M_{DE} = M_{ED} = \frac{2988(12)^2}{12} = 35.90$ Kips.

Subject: Dwight Pumping Station - Chicopee C3b
Computation: Shear - Outlet structure
Computed by: A. K. Checked by: RSM Date: 4/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Determination of shears

Section I

$$M_C = M_B + V_B(22) - 635 \times 22 \times \frac{22}{2} - \frac{1675 \times 22}{2} \times \frac{22}{3}$$

$$-70,140 = -10,920 + 22V_B - 153,900 - 135,100$$

$$22V_B = 229,780$$

$$V_{B_R} = 10,450^{\#}$$

Section II

$$22V_B = 228,390$$

$$V_B = 10,390^{\#}$$

Section I

$$M_B = M_C + V_C(22) - 153,900 - \frac{1675 \times 22}{2} \times \frac{44}{3}$$

$$-10,920 = -70,140 + 22V_C - 153,900 - 270,200$$

$$22V_{C_L} = 483,320$$

$$V_{C_L} = 21,930^{\#} \quad V_{C_R} = 17,020^{\#}$$

Section II

$$22V_C = 484,710$$

$$V_{C_L} = 22,000^{\#}$$

$$M_D = M_C + V_C(11.75) - 2988(11.75)\left(\frac{11.75}{2}\right)$$

$$-35,170 = -71,530 + 11.75V_C - 206,500$$

$$11.75V_C = 242,860$$

$$V_{C_R} = 20,700^{\#}$$

$$M_C = M_D + V_D(11.75) - 2988(11.75)\left(\frac{11.75}{2}\right)$$

$$-71,530 = -35,170 + 11.75V_D - 206,500$$

$$11.75V_D = 170,140$$

$$V_{D_L} = 14,480^{\#} \quad V_{D_R} = 20,850^{\#}$$

$$V_E = 2,988 - V_C - V_{D_R} - V_{D_L}$$

$$V_E = 14,970^{\#}$$

Subject: Dwight Pumping Station - Chicopee C3b
Computation: Shears - Outlet structure
Computed by: A. K. Checked by: RSM Date: 4/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Shears continued

Section I

$M_C = M_D + V_D(11.75) - 2020(11.75)\left(\frac{11.75}{2}\right)$

$-70,140 = -9,610 + 11.75 V_D - 139,700$

$11.75 V_D = 79,170$

$V_{D_L} = 6,740$ #

$M_E = M_D + V_D(11.75) - 139,700$

$-28,420 = -11,990 + 11.75 V_D - 139,700$

$11.75 V_D = 123,270$

$V_{D_R} = 10,500$ #

$M_D = M_E + V_E(11.75) - 139,700$

$-11,990 = -28,420 + 11.75 V_E - 139,700$

$11.75 V_E = 156,130$

$V_{E_L} = 13,300$ #

Check.

Total load $2020 \times 23.5 = 47,500$ # ✓

$V_{C_R} = 17,020$
$V_{D_L} = 6,740$
$V_{D_R} = 10,500$
$V_{E_L} = 13,300$

47,560 ✓

WAR DEPARTMENT

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

Subject: Dwight Pumping Station - Chicopee Cab

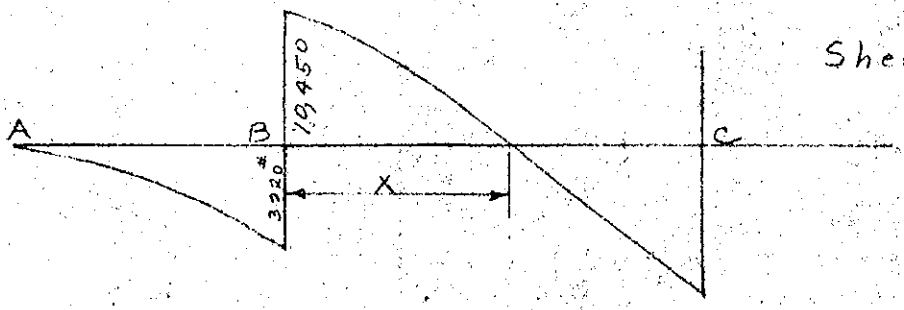
Computation: Moments - Outlet structure

Computed by: A.K. Checked by: RSM Date: 4/6/40

U. S. GOVERNMENT PRINTING OFFICE 3—10628

Determination of Positive Moments, Section I

Shear diagram



$$10,450 = 635X + \frac{1675}{2.2}(X)\left(\frac{X}{2}\right)$$

$$10,450 = 635X + 38.05X^2$$

$$X^2 + 16.69X + (8.34)^2 = 274.5 + 69.5$$

$$(X + 8.34)^2 = 344.0$$

$$X + 8.34 = \pm 18.52$$

$$X = \pm 18.52 - 8.34$$

$$X = 10.18$$

$$M_x = M_B + 10,450(10.18) - 635(10.18)\left(\frac{10.18}{2}\right) - \frac{1675}{2.2}(10.18)\left(\frac{10.18}{2}\right)\left(\frac{10.18}{3}\right)$$

$$M_x = -10,920 + 106,200 - 32,850 - 13,330$$

$$M_x = +49,100'\#$$ Max.

$$17,020 = 2020X$$

$$X = 8.43$$

$$M_x = M_C + 17,020(8.43) - 2020(8.43)\left(\frac{8.43}{2}\right)$$

$$M_x = -70,140 + 143,500 - 71,600$$

$$M_x = +1760'\#$$

$$10,500 = 2020y$$

$$y = 5.20$$

$$M_y = M_D + 10,500(5.2) - 2020(5.2)\left(\frac{5.2}{2}\right)$$

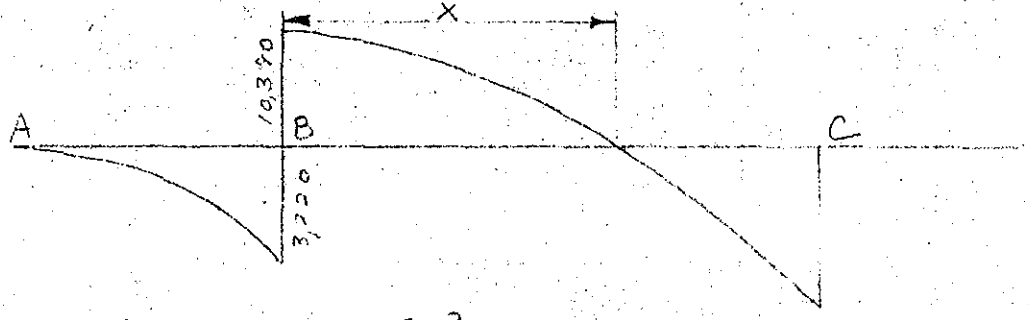
$$= -11,990 + 54,600 - 27,300$$

$$M_y = +15,310'\#$$ Max.

Subject: Dwight Pumping Station - Chicopee Cab
Computation: Moments - Outlet structure
Computed by: A.K. Checked by: RSM Date: 4/6/40

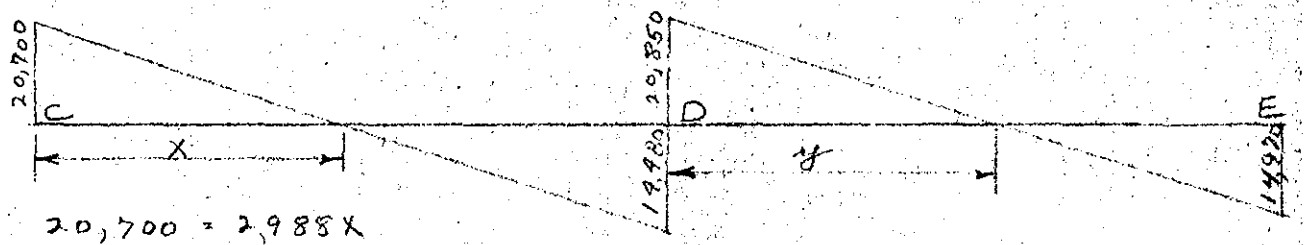
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Determination of Positive Moments. Section II



$$10,390 = 635X + 38.05X^2$$
$$X^2 + 16.69X + (8.34)^2 = 273.0 + 69.5$$
$$(X + 8.34)^2 = 342.5$$
$$X + 8.34 = \pm 18.50$$
$$X = \pm 18.50 - 8.34$$
$$X = 10.16$$

$$M_x = M_B + 10,390(10.16) - 635(10.16)\left(\frac{10.16}{2}\right) - \frac{16.75}{2\,2}(10.16)\left(\frac{10.16}{2}\right)\left(\frac{10.16}{3}\right)$$
$$= -10,920 + 105,500 - 32,700 - 13,290$$
$$M_x = +48,590'\#\ \text{Max.}$$



$$20,700 = 2,988X$$
$$X = 6.93'$$

$$M_x = M_C + 20,700(6.93) - 2,988(6.93)\left(\frac{6.93}{2}\right)$$
$$= -71,530 + 143,300 - 71,600$$
$$M_x = +170'\#$$

$$20,850 = 2,988y$$
$$y = 6.97'$$

$$M_y = M_D + 20,850(6.97) - 2,988(6.97)\left(\frac{6.97}{2}\right)$$
$$= -35,170 + 145,200 - 72,600$$
$$M_y = +37,430'\#\ \text{Max.}$$

WAR DEPARTMENT

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

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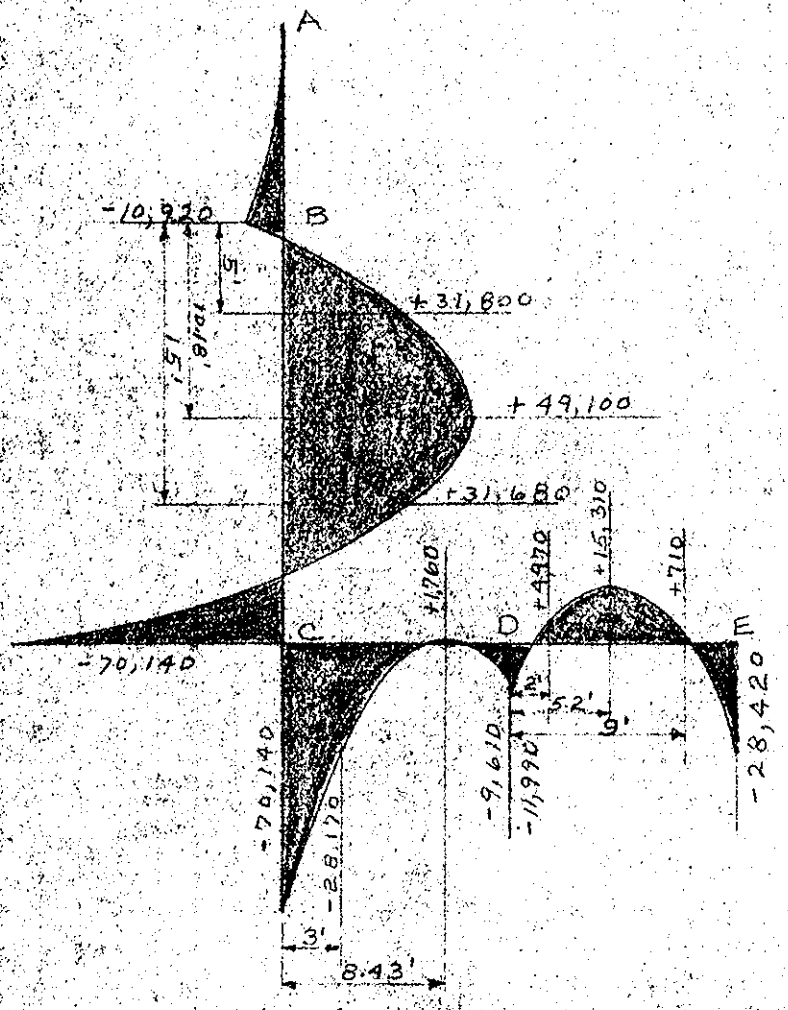
Subject: Dwight Pumping Station - Chicopee C3b

Computation: Moment Diagram - Outlet Structure

Computed by: A. K. Checked by: [illegible] Date: 4/6/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Section I



Moment Diagram

Scale: Moments 1" = 50,000'#
Structure 1" = 10'

WAR DEPARTMENT

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

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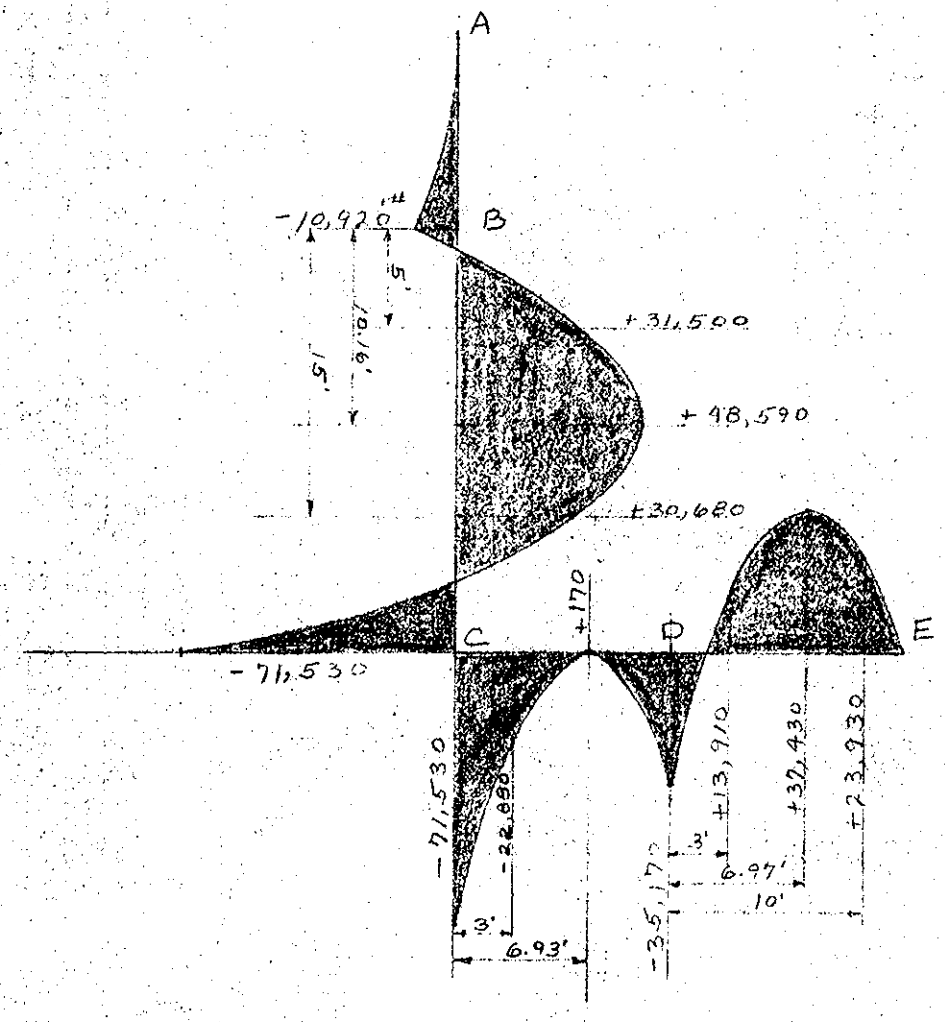
Subject: Dwight Pumping Station - Chicopee C36

Computation: Moment Diagram - Outlet Structure

Computed by: A. K. Checked by: RSM Date: 4/6/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Section II



Moment Diagram

Scale Moments 1" = 50,000'#
Structure 1" = 10'

WAR DEPARTMENT

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

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t Dwight Pumping Station - Chicopee Cab

nputation Steel - Outlet structure

nputed by A.K. Checked by RSM Date 4/8/40

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Base, Section II

Depth required $= \sqrt{\frac{71,530}{123}} = \sqrt{582}$

$= 24.2'' + 4.5$ cover $= 28.7''$

36" minimum used

$f_c = 800$
$f_s = 18,000$
$n = 12$
$v = 60$
$u = 150$
$R = 123$

$A_s = \frac{71,530 \times 12}{18,000 \times 7/8 \times 31.5}$

$d_v = \frac{20,700}{12 \times 7/8 \times 60}$

At "C" $A_s = 1.73\square''$

Use 1"□ @ 6" c.c.

$d_v = 32.8 + 3.5 = 36.3''$ O.K.

At "D" $A_s = \frac{35,170 \times 12}{18,000 \times 7/8 \times 31.5} = 0.851\square''$ use (1"φ @ 12" c.c.

$V_{DL} = 14,480^{\#}$ O.K.

Positive Steel In DE

$A_s = \frac{37,430 \times 12}{18,000 \times 7/8 \times 31.5} = 0.905\square''$

3/4"φ 6" c.c.

Positive Steel, DE Section I

$A_s = \frac{15,310 \times 12}{18,000 \times 7/8 \times 31.5} = 0.37\square''$

3/4"φ 12" c.c.

Wall

$d_v = \frac{22,000}{12 \times 7/8 \times 60} = 34.9'' + 3.5 = 38.4''$ at working line

Shear at corner $= 18,700^{\#}$

$d_v = \frac{18,700}{12 \times 7/8 \times 60} = 29.7 + 3.5 = 33.2''$ 33" is O.K.

Positive steel in BC

$A_s = \frac{49,100 \times 12}{18,000 \times 7/8 \times 29.5} = \cancel{1.058}\ 1.265\square''$ 1 1/8 (1")φ 12" c.c.

At "B"

$A_s = \frac{10,920 \times 12}{18,000 \times 7/8 \times 23} = 0.362\square''$

5/8"φ 10" c.c.

$d_m = \sqrt{\frac{10,920}{123}}$

$d_m = 9.47''$ have 26"

$d_v = \frac{3,220}{12 \times 7/8 \times 60} = 5.1''$

Base Section I

At "E"

$A_s = \frac{28,420 \times 12}{18,000 \times 7/8 \times 31.5} = 0.688\square''$

$V_E = 14,970^{\#}$ O.K.

At "D" $A_s = \frac{11,990 \times 12}{18,000 \times 7/8 \times 31.5} = 0.29\square''$

WAR DEPARTMENT

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

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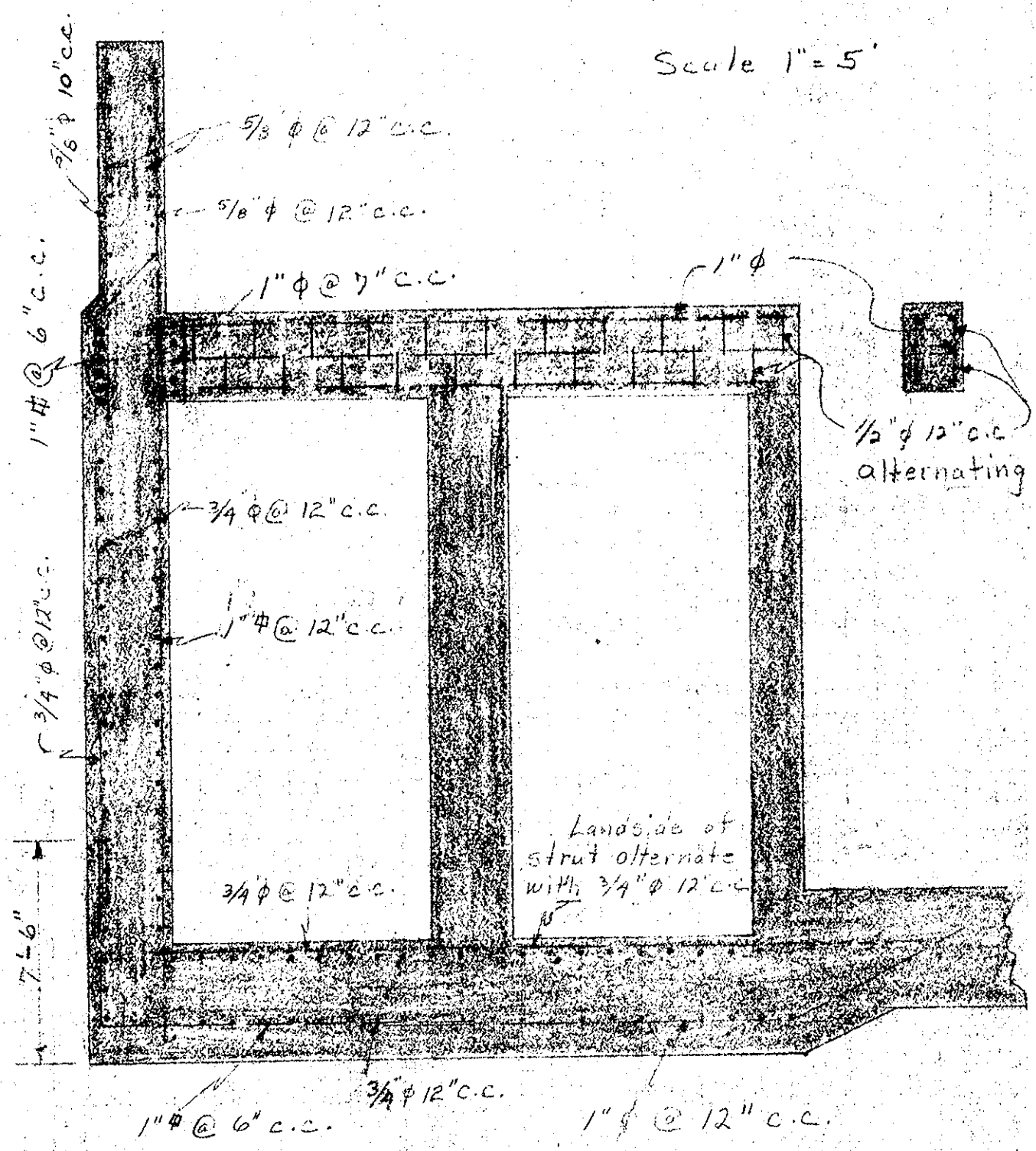
Subject: Dwight Pumping Station - Chicopee C3b

Computation: Steel - Outlet structure

Computed by: A. K. Checked by: Date: 4/8/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

Subject: Dwight Pumping Station - Chicopee C36

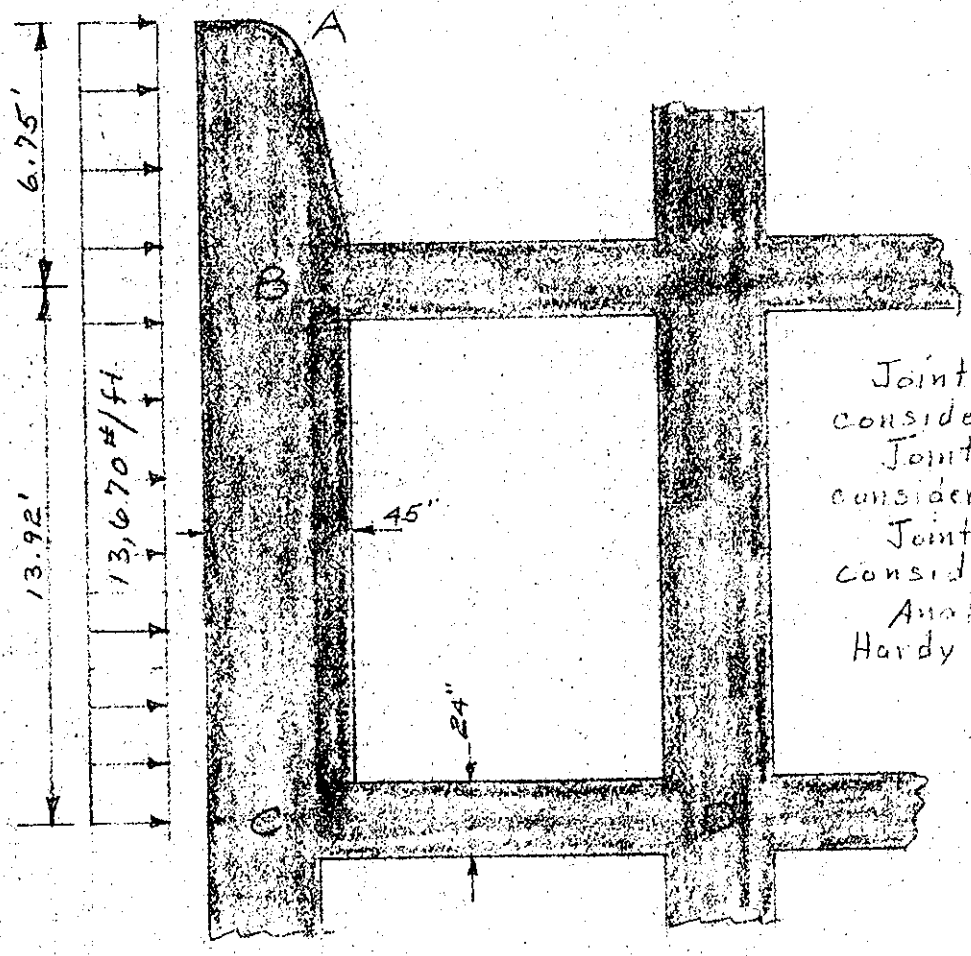
Computation: Loads - Outlet structure

Computed by: A.K. Checked by: RSM Date: 4/9/40

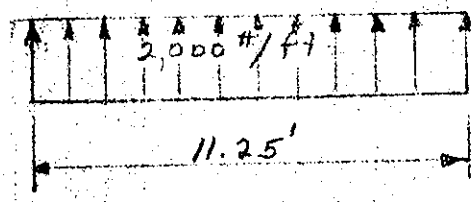
U. S. GOVERNMENT PRINTING OFFICE 3—10648

Loads at Horizontal Section at Strut Elev.

Sectional Plan at Local Beam in Wall



Joint at "B" considered free
Joint at "C" considered continuous
Joint at "D" considered fixed
Analyze by Hardy Cross method



$P = 62.5 \times 10.67 \times 3$
$= 2000\#/ft$

Depth of section analyzed = 3'

$I_{BC} = \frac{36(45)^3}{12}$ $\quad \frac{I}{L} = \frac{3(45)^3}{13.92} = 19800$

$I_{CD} = \frac{36(24)^3}{12}$ $\quad \frac{I}{L} = \frac{3(24)^3}{11.25} = 3,685$

Let $\frac{I}{L}$ for CD = 1

Then $\frac{I}{L}$ for BC = 54

WAR DEPARTMENT

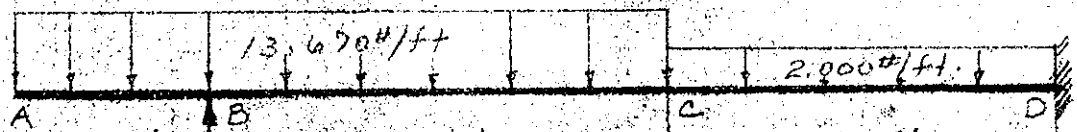
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Project: Dwight Pumping Station - Chicopee C36

Computation: Moments - Outlet Structure

Computed by: A. K. Checked by: RSM Date: 4/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



-311.0	-221.0	-221.0	-21.1	-21.1
0	-90.0	+167.4	-32.5	0
0	-83.7	+45.0	0	+16.3
0	+83.7	-38.0	+7.0	0
0	+19.0	-41.8	0	-3.5
0	-19.0	+35.2	-6.6	0
0	-17.6	+9.5	0	+3.3
0	+17.6	-8.0	+1.5	0
-311.0	-311.0	-51.7	-51.7	-5.0

Summary of Moments

$M_{BA} = M_{BC} = -311{,}000'\#$

$M_{CB} = M_{CD} = 51{,}700'\#$

$M_{DC} = 5{,}000'\#$

Fixed end moments

$M_{BA} = \frac{13{,}670(6.75)^2}{2} = 311{,}000'\#$

$M_{BC} = M_{CB} = \frac{13{,}670(13.92)^2}{12} = 221{,}000'\#$

$M_{CD} = M_{DC} = \frac{2{,}000(11.25)^2}{12} = 21{,}100'\#$

Project: Dwight Pumping Station - Chicopee C3b
Computation: Shears - Outlet Structure
Computed by: A.K. Checked by: RSM Date: 4/9/40

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Shears.

$V_{B_L} = 13,670(6.75) = 92,200^{\#}$

$M_C = M_B + V_{B_R}(13.92) - \frac{13,670(13.92)^2}{2}$

$-51,700 = -311,000 + 13.92 V_{B_R} - 1,326,000$

$13.92 V_{B_R} = 1,585,300$

$V_{B_R} = 114,000^{\#}$

$M_B = M_C + V_{C_L}(13.92) - 1,326,000$

$-311,000 = -51,700 + 13.92 V_{C_L} - 1,326,000$

$13.92 V_{C_L} = 1,066,700$

$V_{C_L} = 76,700^{\#}$

$M_D = M_C + V_{C_R}(11.25) - \frac{2,000(11.25)^2}{2}$

$-6,800 = -51,700 + 11.25 V_{C_R} - 126,600$

$11.25 V_{C_R} = 171,500$

$V_{C_R} = 15,250^{\#}$

$M_C = M_D + V_D(11.25) - 126,600$

$-51,700 = -6,800 + 11.25 V_D - 126,000$

$11.25 V_D = 81,100$

$V_D = 7,200^{\#}$

WAR DEPARTMENT

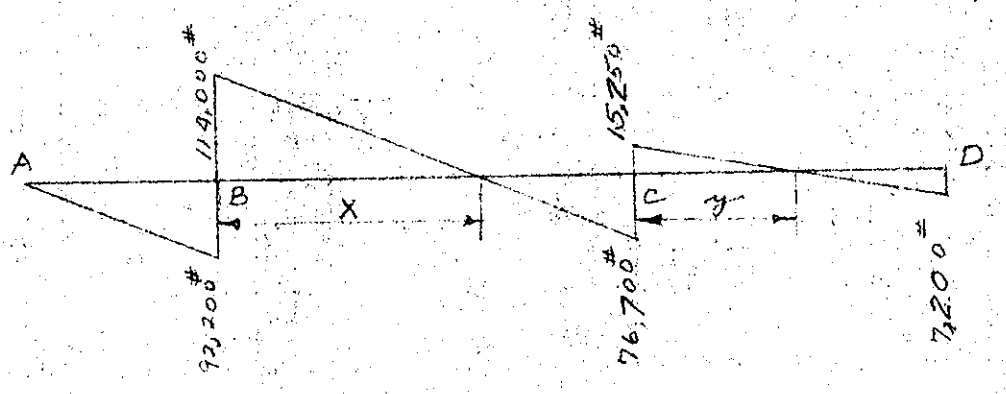
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Dwight Pumping Station - Chicopee C36

Computation: Positive Moments - Outlet Structure

Computed by: A.K. Checked by: RSM Date: 4/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



$114{,}000 = 13{,}670X$,

$X = 8.35$

$M_x = -311{,}000 + 114{,}000(8.35) - \frac{13{,}670(8.35)^2}{2}$

$M_x = -311{,}000 + 952{,}000 - 475{,}000$

$M_x = +167{,}000'\#$

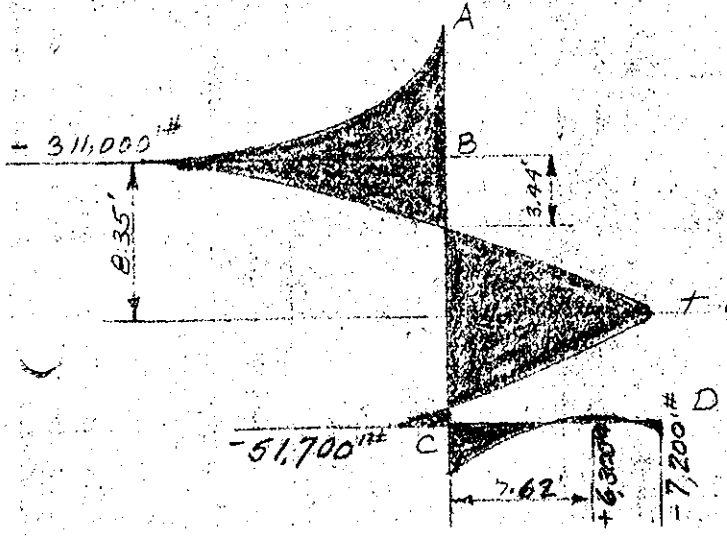
$15{,}250 = 2{,}000\,y$

$y = 7.62'$

$M_y = -51{,}700 + 15{,}250(7.62) - \frac{2{,}000(7.62)^2}{2}$

$M_y = -51{,}700 + 116{,}000 - 58{,}000$

$M_y = +6{,}300'\#$



Moment Diagram.
(Diagramatic only)

Scale
Structure 1" = 10'
Moments 1" = 40K'

WAR DEPARTMENT

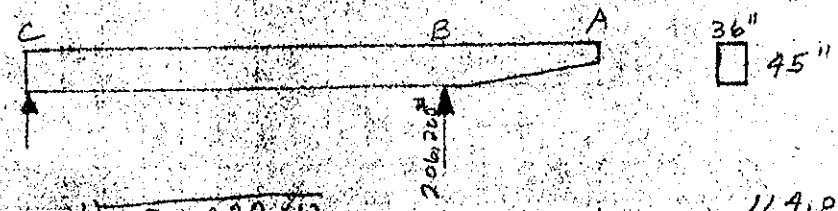
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Dwight Pumping Station - Chicopee Cab

Computation: Steel in Wall Beam - Outlet Structure

Computed by: A.K. Checked by: PSM Date: 4/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10525



$d_m = \sqrt{\frac{311,000 \times 12}{123 \times 36}}$ $\qquad d_v = \frac{114,000}{36 \times 7/8 \times 90}$

$d_m = 29.1" + 3.5 = 32.6"$ $\qquad d_v = 40.2" + 3.5 = 43.7"$

Use $d = 45"$ + special anchorag

At "B"

$A_s = \frac{311,000 \times 12}{18,000 \times 7/8 \times 41.5} = 5.71 \square"$ $\qquad$ 1"□ @ 6" c.c.

Positive Steel in BC

$A_s = \frac{167,000 \times 12}{18,000 \times 7/8 \times 41.5} = 3.07 \square"$ $\qquad$ 1" φ @ 7" c.c.

At "C"

$A_{s_L} = \frac{51,700 \times 12}{18,000 \times 7/8 \times 41.5} = 0.94 \square"$ $\qquad A_{s_R} = \frac{51,700 \times 12}{18,000 \times 7/8 \times 21} = 1.86 \square"$

3/4" φ @ 9" c.c.

Positive Steel in CD

$A_s = \frac{6,300 \times 12}{18,000 \times 7/8 \times 21} = 0.23 \square"$ $\qquad$ Use steel as determined on page 17

At "D"

$A_s = \frac{7,200 \times 12}{18,000 \times 7/8 \times 21} = 0.26 \square"$ $\qquad$ Use steel as determined on page

Reducing Depth of AB

At point 3' from A

$M = \frac{13,670(3)^2}{2} = 61,500'^{\#}$ $\qquad d_m = \sqrt{\frac{61,500 \times 12}{123 \times 36}} = 12.9" + 3.5 = 16.4$

$V = 13,670 \times 3 = 41,010^{\#}$ $\qquad d_v = \frac{41,010}{36 \times 7/8 \times 90} = 14.5 + 3.5 = 18"$

Projection may be removed in st. line

WAR DEPARTMENT

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

Subject: Dwight Pumping Station - Chicopee Cob

Computation: Wall above gate opening. - Outlet structure

Computed by: A. K. Checked by: RSM Date: 4/2/40

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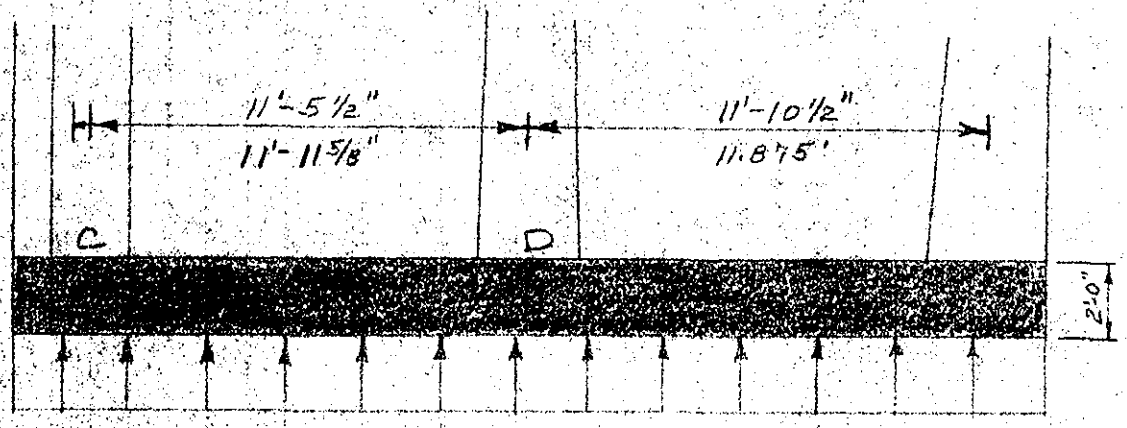
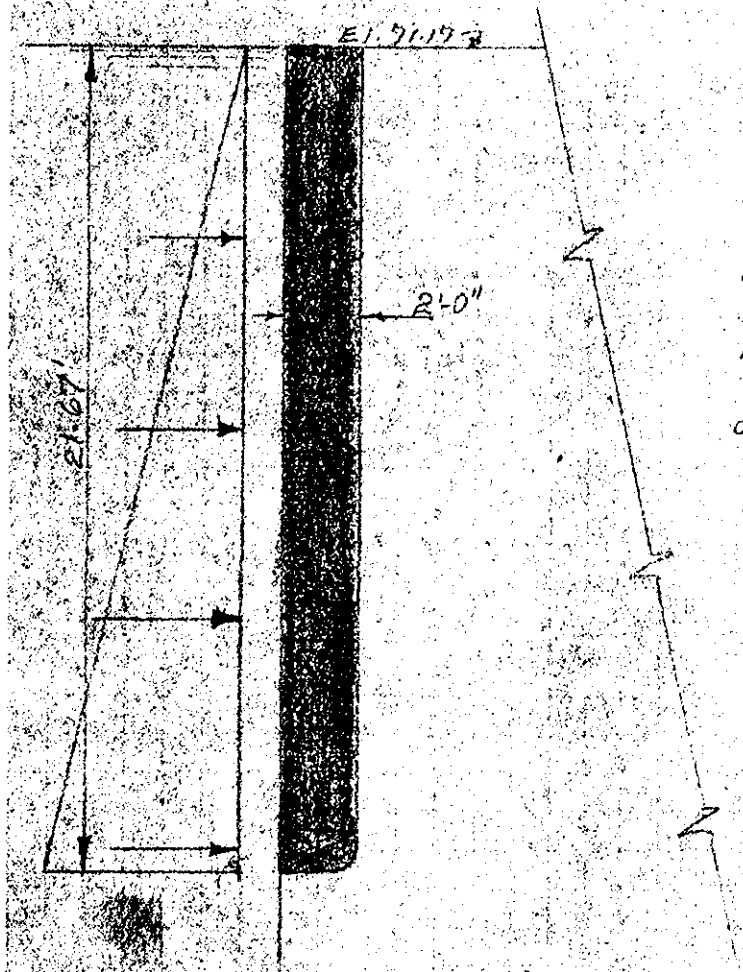


$f_c = 800$
$f_s = 18{,}000$
$n = 12$
$v = 60$
$u = 150$
$R = 123$



Use $l = 11.875'$ for both spans.

Design 1 ft beam at bottom of wall

$w = 62.5 \times 21.17 = 1323$ #/ft.

$M_B(+) = \frac{wl^2}{10} = \frac{1{,}323\,(11.875)^2}{10} = 18{,}650'^{\#}$

$M_B(-) = \frac{wl^2}{8} = \frac{1{,}323\,(11.875)^2}{8} = -23{,}300'^{\#}$

d req. for moment $= \sqrt{\frac{23{,}300}{123}} = 13.8''$

Actual $d = 21''$ cover $= 3''$

$M_B = A_s f_s jd$

$A_s = \frac{M \times 12}{18{,}000 \times 7/8 \times 21} = 0.00003625\,M$

$A_s(+) = 0.676\ \square''$

$A_s(-) = 0.845\ \square''$

In like manner.

Dist from top	$A_s(+)$	$A_s(-)$
5'	0.159 □"	0.199 □"
10'	0.319	0.398
15'	0.478	0.597
21.17'	0.676	0.845

Max shear at intermediate support of bottom beam $= 5/8\ wl$
$= 5/8\,(1{,}323)(11.875) = 9{,}810^{\#}$

Shear taken by Concrete
$V = 60\,(12)(7/8)(21) = 13{,}220^{\#}$ O.K.

WAR DEPARTMENT

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

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Subject: Dwight Pumping Station - Chicopee C3b

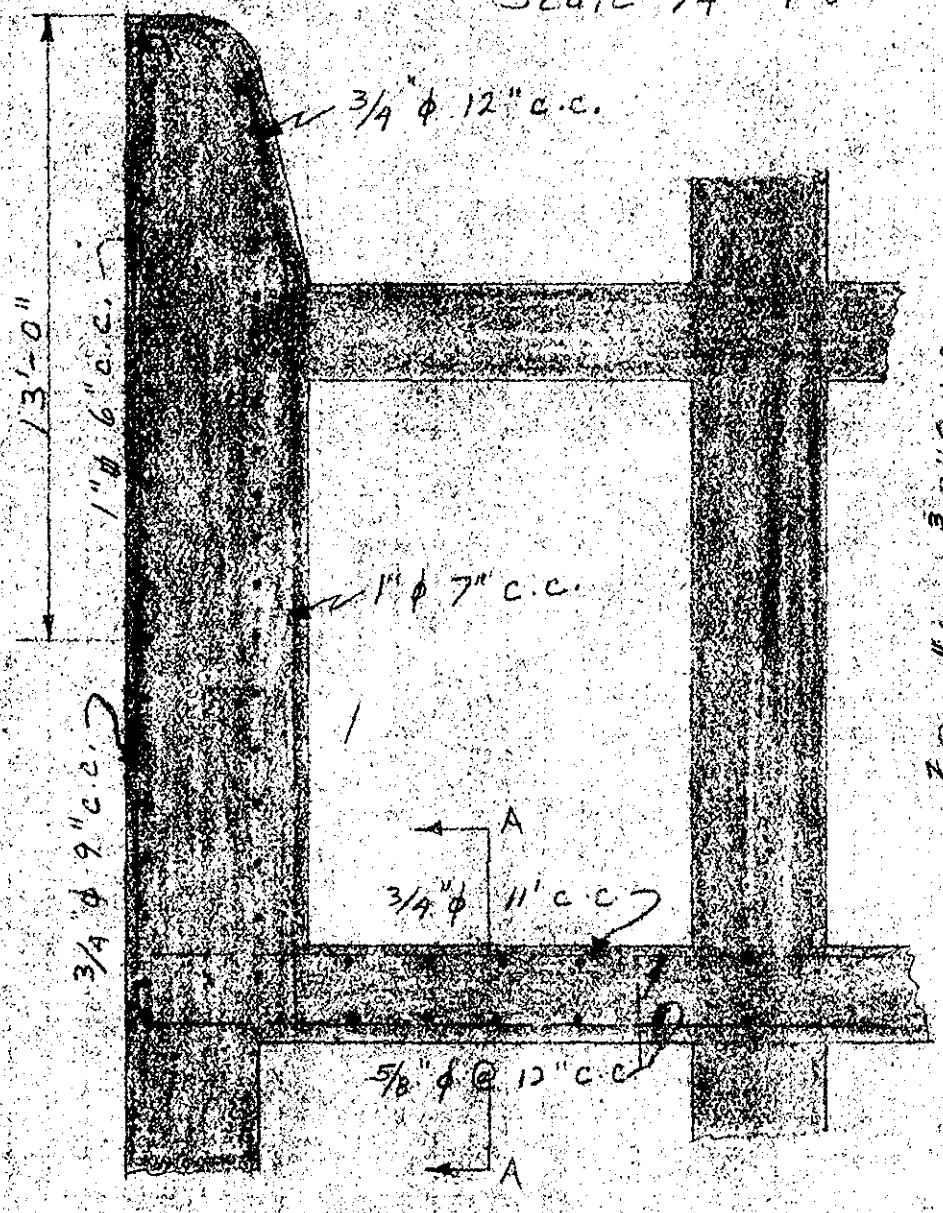
Computation: Steel - Outlet structure

Computed by: A.K. Checked by: PSM Date: 4/9/40

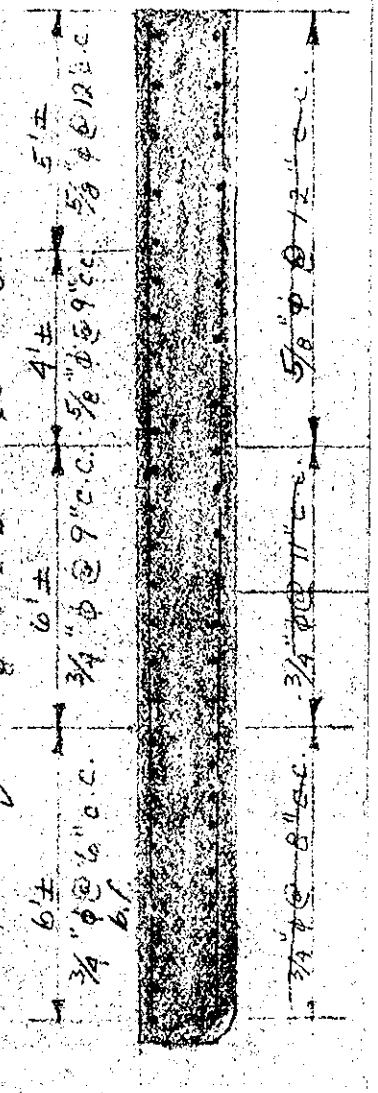
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Plan of Steel at Wall Beam

Scale 1/4" = 1'-0"



Section at Gate opening A-A



WAR DEPARTMENT

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

Page 198

Subject: Dwight Pumping Station - Chicopee C3b

Computation: Strut Steel. - outlet structure

Computed by: A. K. Checked by: FSM Date: 4/9/40

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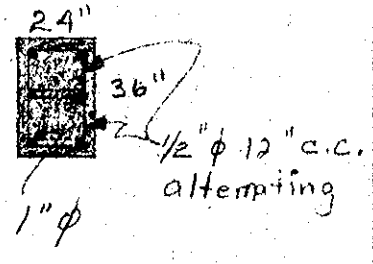
Strut Load 206,200# (page 68)

Minimum Steel

$0.005 \times 24 \times 36 = 4.32 \square''$



Use 6-1" φ bars

$A = 0.785 \times 6 = 4.710 \square''$

Allowable load.

$P = 0.225(2000)[859.3 + 4.71(12)]$

$= 450(915.8)$

$P = 412,000\#$

WAR DEPARTMENT

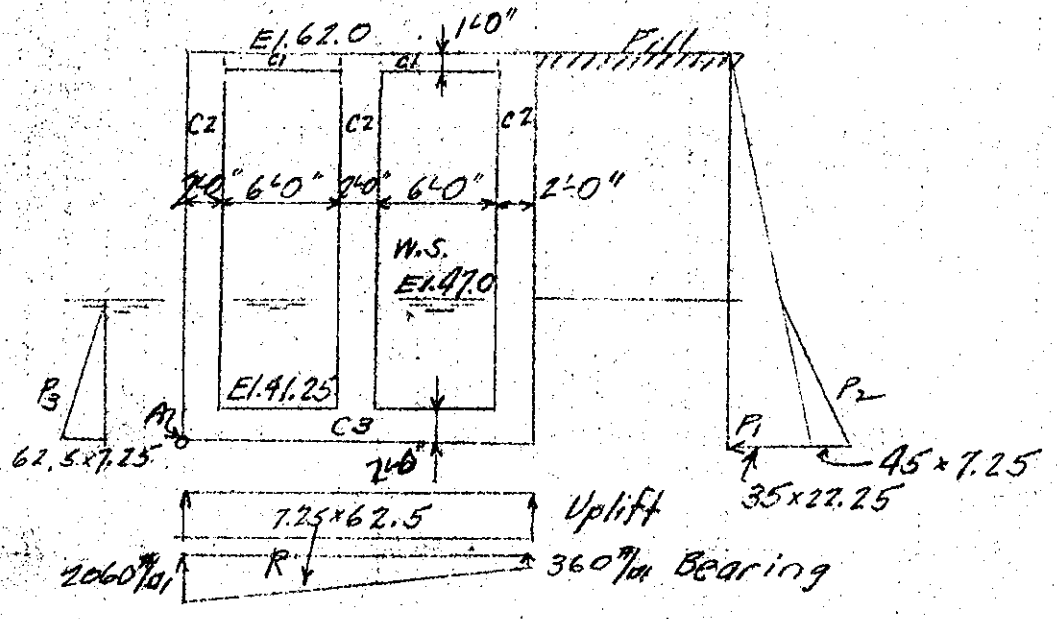
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Dwight Pumping Station - Chicopee C3b

Computation: Intake structure

Computed by: PSM Checked by: Date: 4-5-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



		↓↑	←	Arm	Moment about A ↻	↺
C1	150×1×6×6 ↓	5400		9.0	49	
C2	150×6×20.75×12.75 ↓	238,000		9.0	2140	
C3	150×18×1.5×12.75 ↓	51,600		9.0	465	
W1	62.5×5.75×12×12.75 ↓	55,000		9.0	495	
U1	62.5×7.25×18×12.75 ↑	82,500		9.0	743	
P1	35×12.75×22.25²/2 ←		110800	7.45		825
P2	45×12.75×7.25²/2 ←		15,000	2.42		36
P3	62.5×12.75×7.25²/2 →		20,900	2.42	51	
		277,500	104,900		3943	861
Σ					3081	

Position of resultant 3081,000 / 277,500 = 11.1

e = 2.1

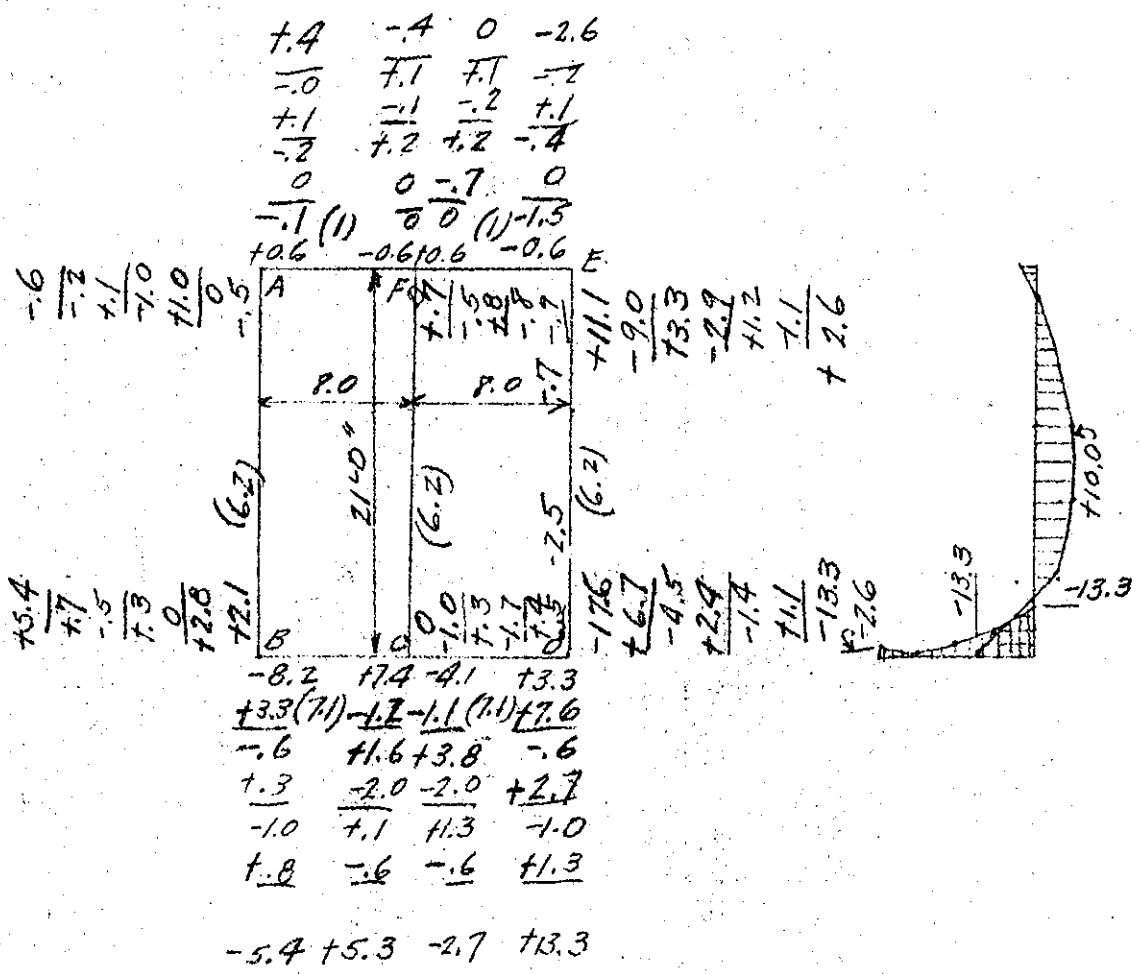
Bearing = $\frac{277,500}{12.75\times18}\left(1 \pm \frac{6\times2.1}{18}\right)$ = 2060#/□' to 360#/□'

Subject: Dwight Pumping Station - Chicopee Cb

Computation: Intake Structure

Computed by: PSM Checked by: Date: 4-5-40

U. S. GOVERNMENT PRINTING OFFICE 3—10628



CD

$A_s = 10300 \times 12 / 18000 \times .884 \times 14.5 = .54''^2$ Use $\frac{7}{8}''\phi$ at corner "D", neg. steel

BC

$A_s = 5400 \times 12 / 18000 \times .884 \times 14.5 = .28$ Use $\frac{5}{8}''\phi$ @ 1'-0"

DE

$V = 5900 + \frac{10,700}{21} = 6470^{\#}$

$v = 6470 / 12 \times .884 \times 20.5 = 30^{\#}/\square''$

$-A_s = 10,300 \times 12 / 18000 \times .884 \times 20.5 = .39''^2$ Use $\frac{7}{8}''\phi$ @ 1'-0"

$+A_s = \frac{10.0}{13.3} \times .50''^2 = .38''^2$ Use $\frac{3}{4}''\phi$ @ 1'-0"

bject Dwight Pumping Station - Chicopee C3b

Computation Intake structure

Computed by RSM Checked by Date 4-5-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

EF

$A_s = 2600 \times 12 / 18000 \times .884 \times 8.5 = .23$ □"

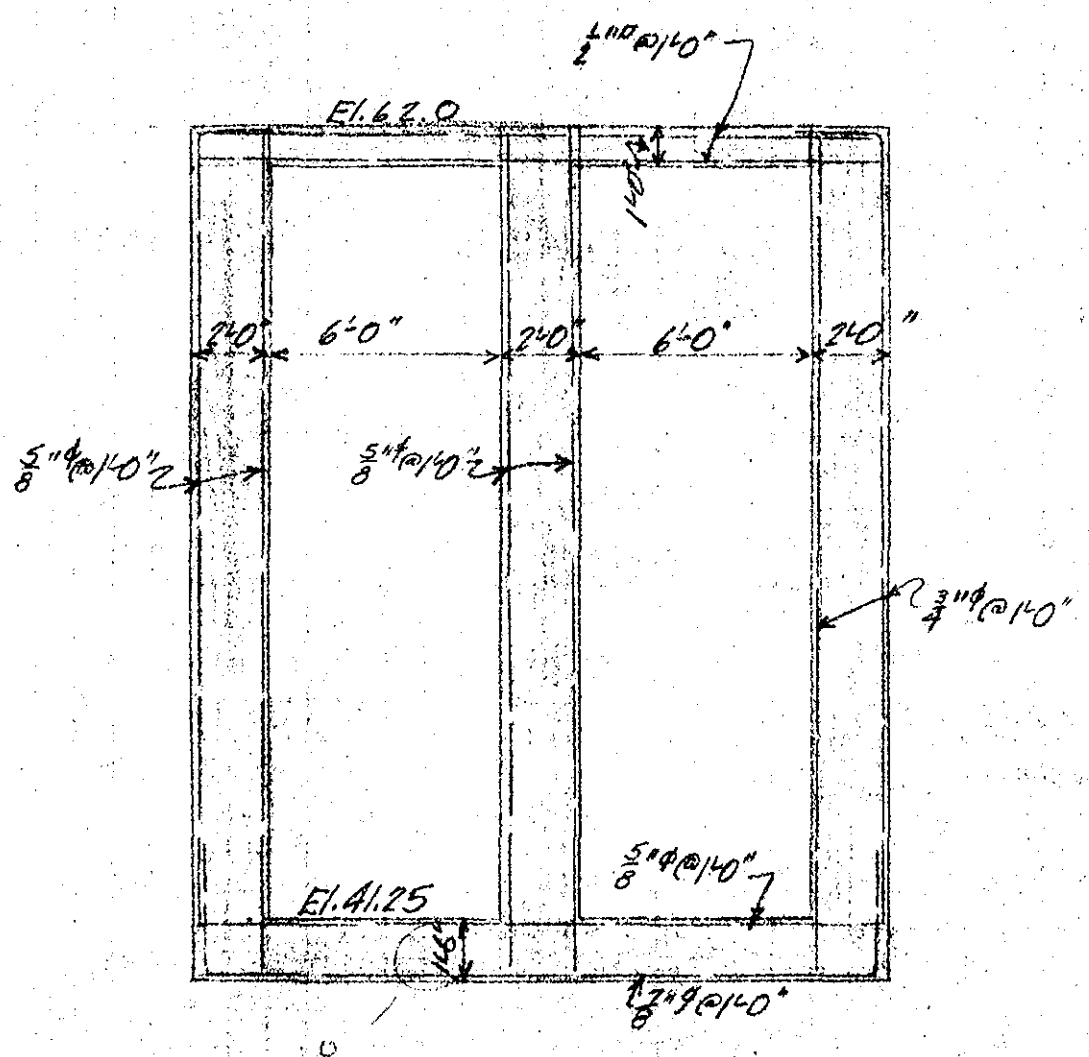
V = L.L 100#/□'

D.L 150

from fl. plates 200

450 #/□' × 6/2 = 1350 #

$v = 1350/12 \times .884 \times 8.5 = 15$ #/□"



WAR DEPARTMENT

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

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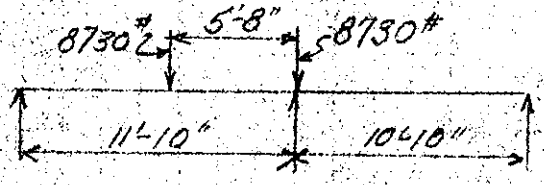
Subject: Dwight Pumping Sta. - Chicopee Cab

Computation: Crane bracket

Computed by: RSM Checked by: Date: 4-12-40

U. S. GOVERNMENT PRINTING OFFICE 3—10598

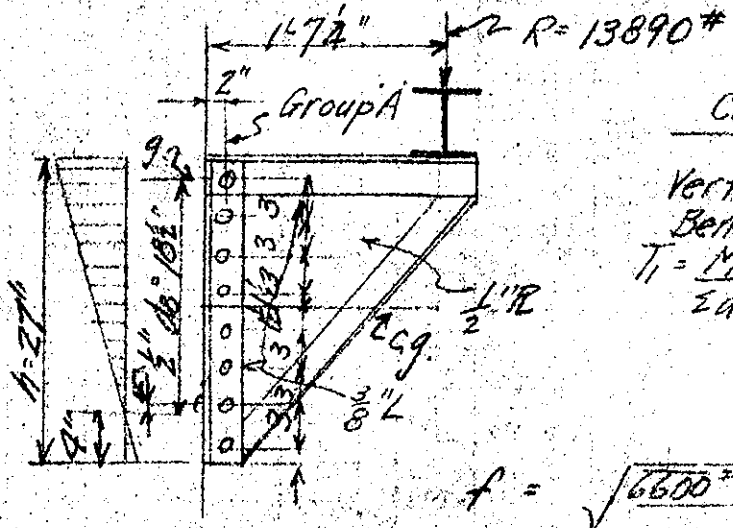
Reaction



Loading $11.33 \times 54 = 610^{\#}$

$8730 \times \frac{6.17}{11.83} = 4550$

Total reaction $13890^{\#}$



Consider rivet group "A".

Vertical stress $= 13890/8 = 1740^{\#}$ each

Bending stress

$$T_1 = \frac{Md}{\Sigma d^2} = \frac{17.26 \times 13890 \times 10.5}{2(1.5^2+4.5^2+7.5^2+10.5^2)} =$$

$$= \frac{2504000}{380} = 6600\ ^{\#}/\text{in}$$

$$f = \sqrt{6600^2 + 1740^2} = 6820\ ^{\#}/\text{in}.$$

$\frac{3}{4}$" ϕ rivet, enclosed bearing, $\frac{1}{2}$" plate, good for 7500 #/in.

Consider rivet group "B"

$$M' = \frac{M}{1 + \frac{2hΣd}{2ΣΣd^2}} = \frac{13890 \times 19.25}{1 + \frac{2 \times 27 \times 2(.5+3.5+6.5+9.5+12.5+15.5+18.5)}{2 \times 2 \times (.5^2+3.5^2+6.5^2+9.5^2+12.5^2+15.5^2+18.5^2)}}$$

$$= \frac{267500}{1 + \frac{2 \times 27 \times 133}{4 \times 1767.5}} = 224000\ ''\#$$

$$T_g = \frac{Md}{\Sigma d^2} = 224000 \times 18.5 / 1767.50 = 2350\ ^{\#}/\text{in}.$$

Value of $\frac{3}{4}$" ϕ rivet in tension $= .442 \times 13500 = 5950\ ^{\#}/\text{in}$ OK

Subject: Dwight Pumping Station - Chicago - C.S.L.
Computation: Trash Racks
Computed by: J.C.D. Checked by: Date: 7/1/40

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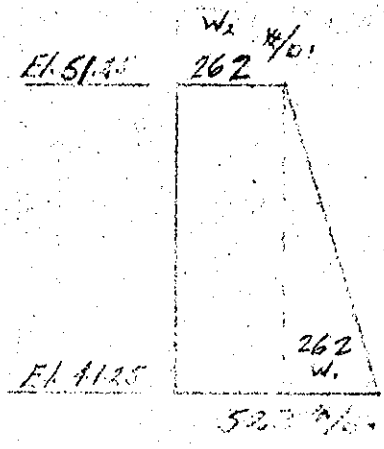
Trash rack bars.

Assumptions:—

Water to El. — — — — 58.0
Elevation floor — — — 41.25
Stoppage per cent — — — 50

Pressure at bottom of rack — $16.75 \times \frac{62.5}{2} = 523$ #/□'

First support at El. 51.25



523
174
349

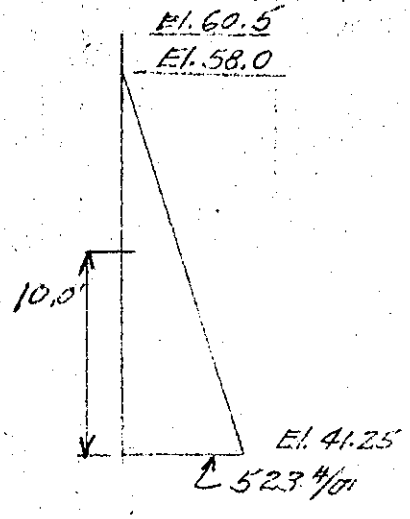
$$M_{max} = \frac{l^2}{16}(2W_2 + W_1)$$
$$= \frac{10^2}{16}(2 \times 262 + 262)$$
$$= 4910'\#$$

$$S(\text{reqd}) = \frac{4910 \times 12}{30000} = 1.97$$

Assume trash rack bars $3\frac{1}{2}'' \times \frac{3}{8}''$ @ 4" c-c.

$$S = bd^2/6 = 3 \times \frac{3}{8} \times 3\tfrac{1}{2}^2/6 = 2.3$$

Channel frames



Reaction on center support:

262×8.75 — 2290
$262\left(\frac{6.75 \times 2}{3} + \frac{10 \times 1}{3}\right) =$ — 2050
4340 #/lin. ft.

$$M = \frac{wl^2}{8} = \frac{4340 \times 6^2}{8} = 19500'\#$$

$S = 19500 \times 12/30000 = 7.8$
Use 8 I 20.5 $S = 15.1$

Make frame 8[13.75 $S = 9.0$
$M = 4340 \times 3 \times 3.5 \times 3.0/6.5 = 21{,}000'\#$
$S = 21{,}000 \times 12/30{,}000 = 8.4$

WAR DEPARTMENT

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

Page 204

bject Chicopee C3b

omputation Depot St. Stop log structure.

Computed by [illegible] Checked by [illegible] Date 4-9-40

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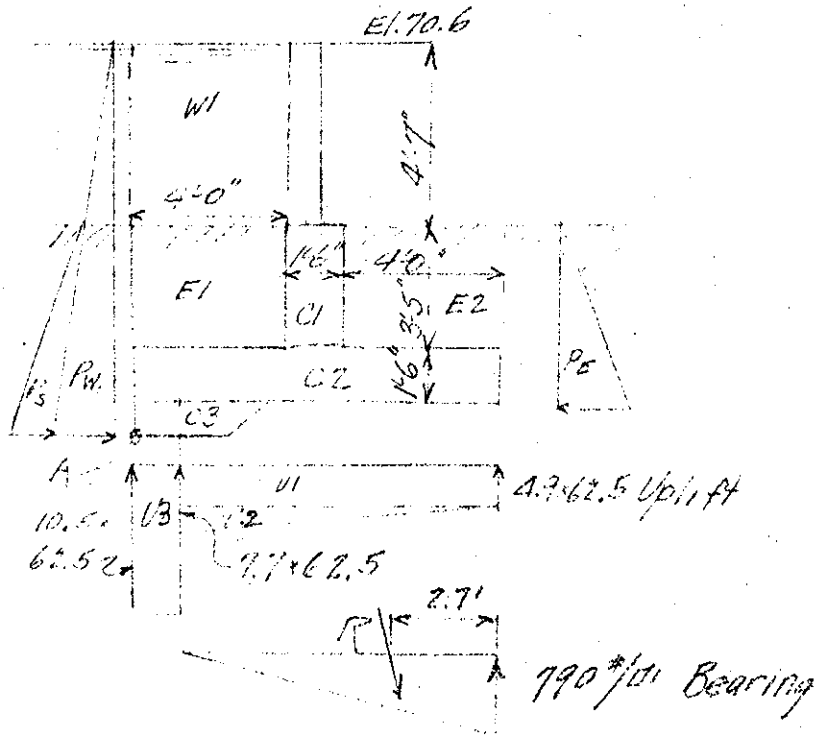


WAR DEPARTMENT

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

Subject: Chicopee C3b

Computation: Dep. St. stop log structure

Computed by: RSM Checked by: [illegible] Date: 4-9-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

			Force ↓↑	Force ⇄	Arm	Moment ↻	Moment ↺
C1	150 × 1.5 × 3.4	↓	770		4.8	3680	
C2	150 × 1.5 × 9.5	↓	2130		4.8	10250	
C3	150 × 1.0 × 3.0	↓	450		1.5	680	
W1	62.5 × 4.6 × 4.0	↓	1150		2.0	2300	
E1	125 × 4.0 × 3.4	↓	1700		2.0	3400	
E2	125 × 4.0 × 3.4	↓	1700		7.5	12750	
U1	62.5 × 4.9 × 8.0	↑	2450		5.5		13500
U2	62.5 × 2.8 × 8.0/2	↑	700		4.2		2940
U3	62.5 × 10.5 × 1.5	↑	980		.8		790
Pw	62.5 × $\overline{10.5}^2$/2	→		3450	3.5	12100	
Ps	17.5 × $\overline{5.9}^2$/2	→		300	2.0	600	
Pe	60 × $\overline{5.9}^2$/2	←		1390	2.0		2780
		↓	3,770	2360		45760	20010
Σ				→ 2360		25750	↻

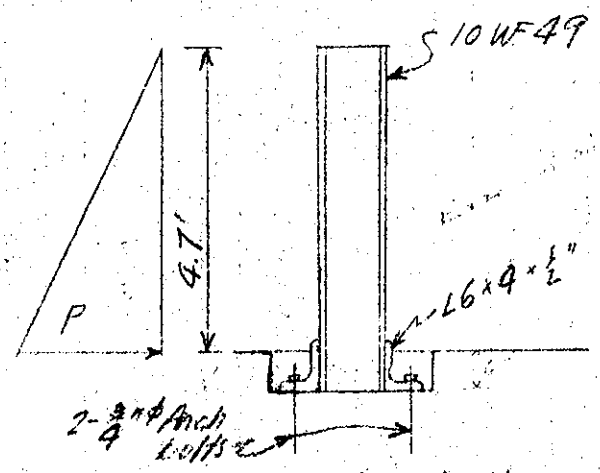
Position of resultant: 25750/3770 = 6.8; third pt. @ 32'

e = 2.05

$$\text{Pressure} = \frac{3770}{8.1}\left\{\begin{matrix}\frac{2.0}{0}\end{matrix}\right. = 466\left\{\begin{matrix}2 = 932\ \#/\square' \\ 0 \quad 0\ \#/\square'\end{matrix}\right.$$

Subject: Chicopee C3b
Computation: Depot St. Stop log structure
Computed by: RSM Checked by: Date: 4-9-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



$P = 18 \times 62.5 \times \overline{4.7}^2/6 = 16300^{\#}$

$S = \frac{16300 \times 12}{18000} = 10.8$ reqd.

$S = 54.6$ supplied.

Tension on anchor bolts $= \frac{16300 \times 12}{16} = 12200^{\#}$.

Use $2-\frac{3}{4}$"ϕ anch. bolts – $f_t = 16000^{\#}$

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
Page 207

Project: Chicopee C36
Computation: Depot St. Stop log structure
Computed by: RSM Checked by: [illegible] Date: 4-9-40

U. S. GOVERNMENT PRINTING OFFICE 3—10598

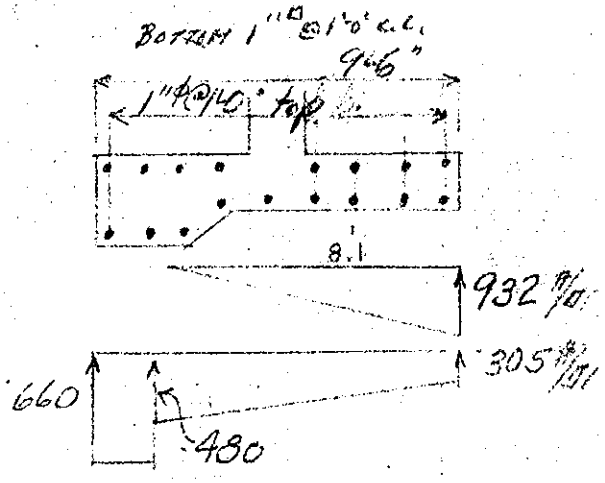
BASE STEEL

Downward loading
Landside

C	150×1.5 =	225 #/□'
E	125×3.4 =	425
	Total	650 #/□'

Riverside

	650
62.5×4.6	290
	940 #/□'



LANDSIDE

1237 - 650 = 587 #/□' net

$M = 587 \times \overline{17}^2/10 = 17000$ '#

$d = \sqrt{\frac{17000}{123}} = 11.8$ reqd.; 13.5" supplied

$A_s = 17000 \times 12/18000 \times .884 \times 13.5 = .95$ □" reqd. Use 1"□ @ 1'-0" [illegible]

RIVERSIDE

$M = 460 \times \overline{17}^2/10 = 13300$ '#

$A_s = \frac{13300}{12850} \times .73 = .75$ □" Use 1"φ @ 1'-0" [illegible]

WAR DEPARTMENT

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

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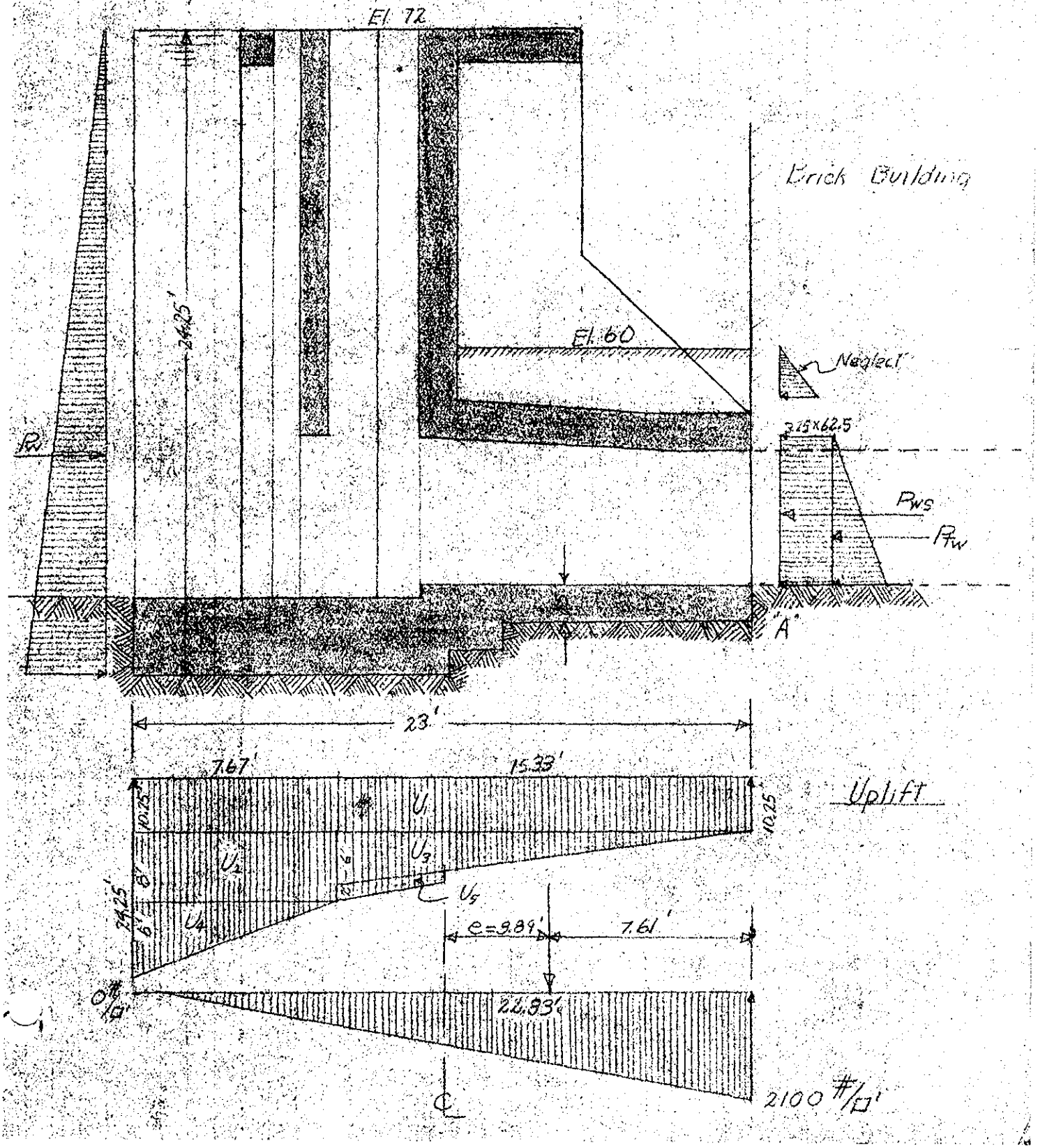
Project: Chicopee, Mass (C-3 b)

Computation: Tailrace Gate Structure No. 1.

Computed by: R.H.B. Checked by: Date: 1/23/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability Case I River Up



WAR DEPARTMENT

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

Project: Chicopee Mass (C-30)

Computation: Tailrace Gate Structure No. 1

Computed by: R.H.M. Checked by: Date: 1/23/40.

U. S. GOVERNMENT PRINTING OFFICE 3—10528

	Forces Acting	↓	↑	→	←	Arm	Moments about "A" ↺	Moments about "A" ↻
Structure	3×11.75×13×150	68740				18.12	1,245570	
	2×2×13×150	7800				10.25	78,000	
	1.5×9.25×13×150	27070				4.63	125,330	
	2×2.5×6.75×175×150	99980				15.62	1,561,690	
	13×12.75×1.5×150	37290				12.62	470,600	
	⊖ 1×9×1.5×150		2030			16.25		32,990
	⊖ 3.5×9×1.5×150		7090			14.0		99260
	1×8×14×150	16800				16.25	273,000	
	2×13×12×150	46800				11.25	526,500	
	2×2×12.25×4×150	29400				8.25	242,550	
	2×2×6×6×½×150	10800				4.00	43,200	
Conduit	53.5×3×150	24080				10.75	258,860	
	47.5×3×150	21380				7.75	165,700	
	47.8×6.25×150	44810				3.13	140,260	
	Gate & Hoist 3000	3000				13.0	39000	
Water Loads	4×13×21.25×62.5	69060				21.0	1,450,260	
	1.25×8×20×62.5	12500				18.37	229,630	
	1×9×21.25×62.5	11950				17.25	206,140	
	1×8×6×62.5	3000				16.25	48,750	
	2×8×21.25×62.5	21250				14.75	313,440	
	1.6×9×14.75×62.5	13280				13.0	172,640	
	43.3×6.25×62.5	16910				3.13	52,930	
	46.3×3×62.5	8780				7.75	68,050	
	44×3×62.5	8250				10.75	88,690	
Earth	1.25×10.25×10×125	16020				5.13	80580	
	.5×3.25×10×125	2030				1.63	3310	
	.5×7×½×10×125	2190				5.28	11560	
		623170	9120				7,896,240	132250

WAR DEPARTMENT

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

Project: Chicopee, Mass. (C-3b)

Computation: Tailrace Gate Structure No. 1

Computed by: R.H.M. Checked by: Date: 1/23/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Forces Acting		↓	↑	→	←	Arm	Moments about "A" ↺	Moments about "A" ↻
U_1	10.25×13×23×62.5		191550			11.5		2,202,830
U_2	8×13×7.67×62.5		49860			19.16		955,320
U_3	6×13×15.33×½×62.5		37370			10.22		381,920
U_4	6×13×7.67×½×62.5		18700			20.44		382,230
U_5	2×13×4×62.5		6500			13.33		86,650
P_W	24.25^2×½×13×62.5			238900		6.08		1,452,510
P_{WS}	3.25×62.5×8×5.5				8940	4.25	38000	
P_{TW}	5.5^2×½×8×62.5				7560	3.33	25170	
	(From previous page)	623170	9120				7,896,240	132250
		623170	313,100	238900	16500		7,959,410	5,593,710
		ΣV = 310,070 # ↓		ΣH = 222,400 # →			ΣM = 2,365,700 #⟲	

$$\frac{\Sigma M}{\Sigma V} = \frac{2,365,700}{310,070} = 7.61' \qquad \frac{1}{3}\text{ Base} = 7.67' \quad \text{OK}$$

$$e = 11.5 - 7.61 = 3.89'$$

$$B.P. = \frac{310,070}{3 \times 7.61 \times 13} \begin{cases} 2 \\ 0 \end{cases} = 1050 \begin{cases} 2 = 2100\ \#/\square' & \text{landside} \\ 0 = 0\ \#/\square' & \text{riverside} \end{cases}$$

Note: Since stability was figured certain concrete dimensions were changed which were assumed not to materially affect the stability. These changes are shown in the sketch. They are: Top slab of conduit from 2' to 1.5'; retrogate-well wall from 2' to 1.5'; Moreover 6" was added to the thickness of the side-walls of the conduit for the five end (landside) feet [illegible]

WAR DEPARTMENT

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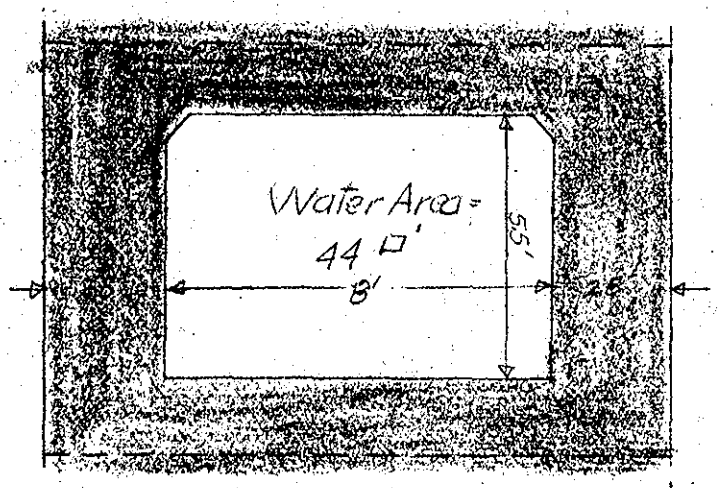
Project Chicopee, Mass - (C-3b)

Computation Tailrace Gate Structure No. 1. Design of conduit

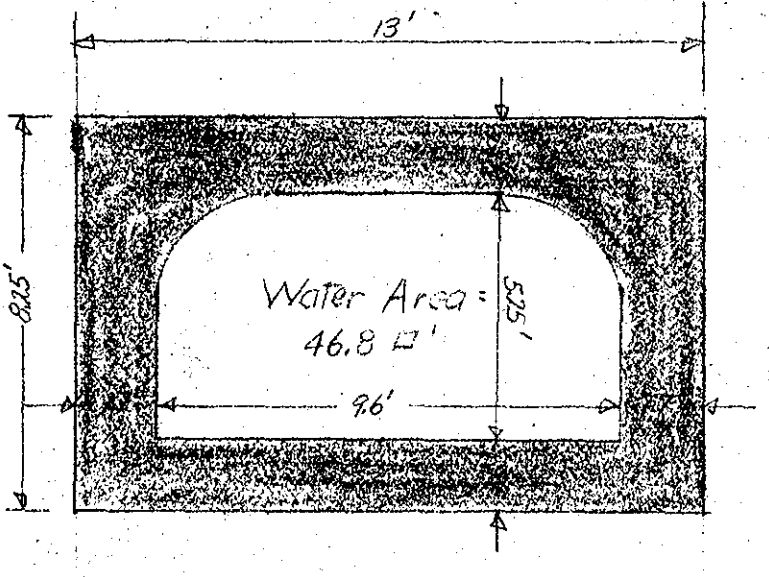
Computed by R.H.M. Checked by Date 1/23/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

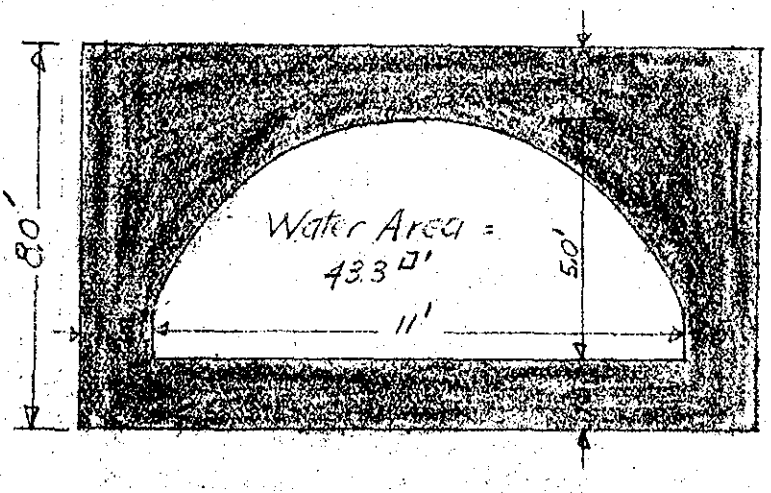
Transition



Section at gate



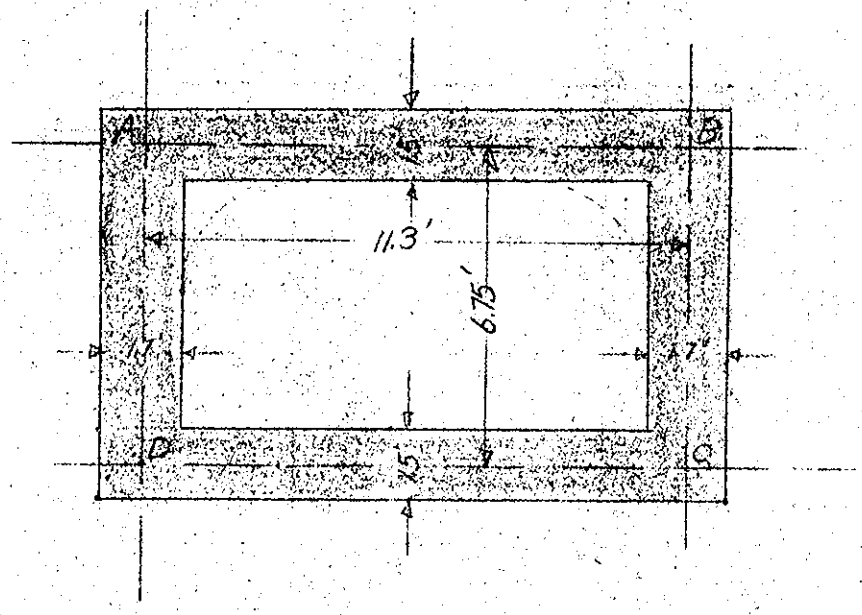
Mid-section of Transition



End - Section of Transition

Project: Chicopee, Mass (C-3b)
Computation: Tailrace Gate Structure No. 1. - Design of Conduit
Computed by: R.H.M. Checked by: Date: 1/24/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

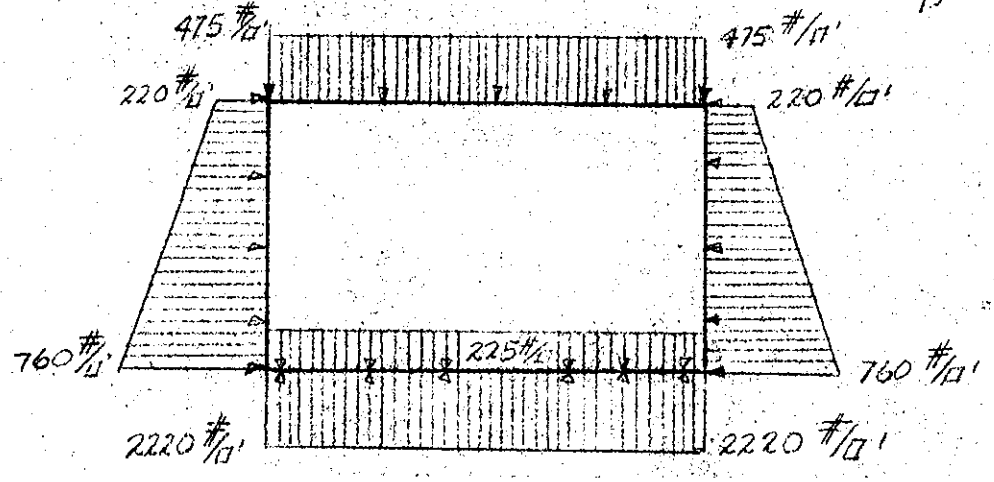


Relative Stiffness Factors

$$AB = \frac{1.5^3}{11.3} = .299 \quad , \quad AD \,\&\, BC = \frac{1.7^3}{6.75} = .728$$

$$CD = \frac{1.5^3}{11.3} = .299.$$

Loading Diagram (Consider conduit dry)



Project Chicopee, Mass (C-36)
Computation Tailrace Gate Structure No. 1 – Design of Conduit
Computed by R.H.M. Checked by ..... Date 1/24/40

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AB

$$+M = \frac{wl^2}{8} = \frac{475 \times 11.3^2}{8} = 7580 \text{ '\#}$$

$$-M = \frac{wl^2}{12} = \frac{475 \times 11.3^2}{12} = 5050 \text{ '\#}$$

CD

$$+M = \frac{2000 \times 11.3^2}{8} = 31920 \text{ '\#}$$

$$-M = \frac{2000 \times 11.3^2}{12} = 21280 \text{ '\#}$$

AD & BC

$$+M = \frac{6.75^2}{16}(2 \times 220 + 540) = 2790 \text{ '\#}$$

$$-M_A \text{ \& } -M_B = \frac{220 \times 6.75^2}{12} + \frac{270 \times 6.75^2}{15} = 1660 \text{ '\#}$$

$$-M_C \text{ \& } -M_D = \frac{220 \times 6.75^2}{12} + \frac{270 \times 6.75^2}{10} = 2070 \text{ '\#}$$

WAR DEPARTMENT

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

Project: Chicopee, Mass (C-3b)

Computation: Tailrace Gate Structure No. 1 Design of Conduit

Computed by: R.H.M. Checked by: Date: 1/24/40

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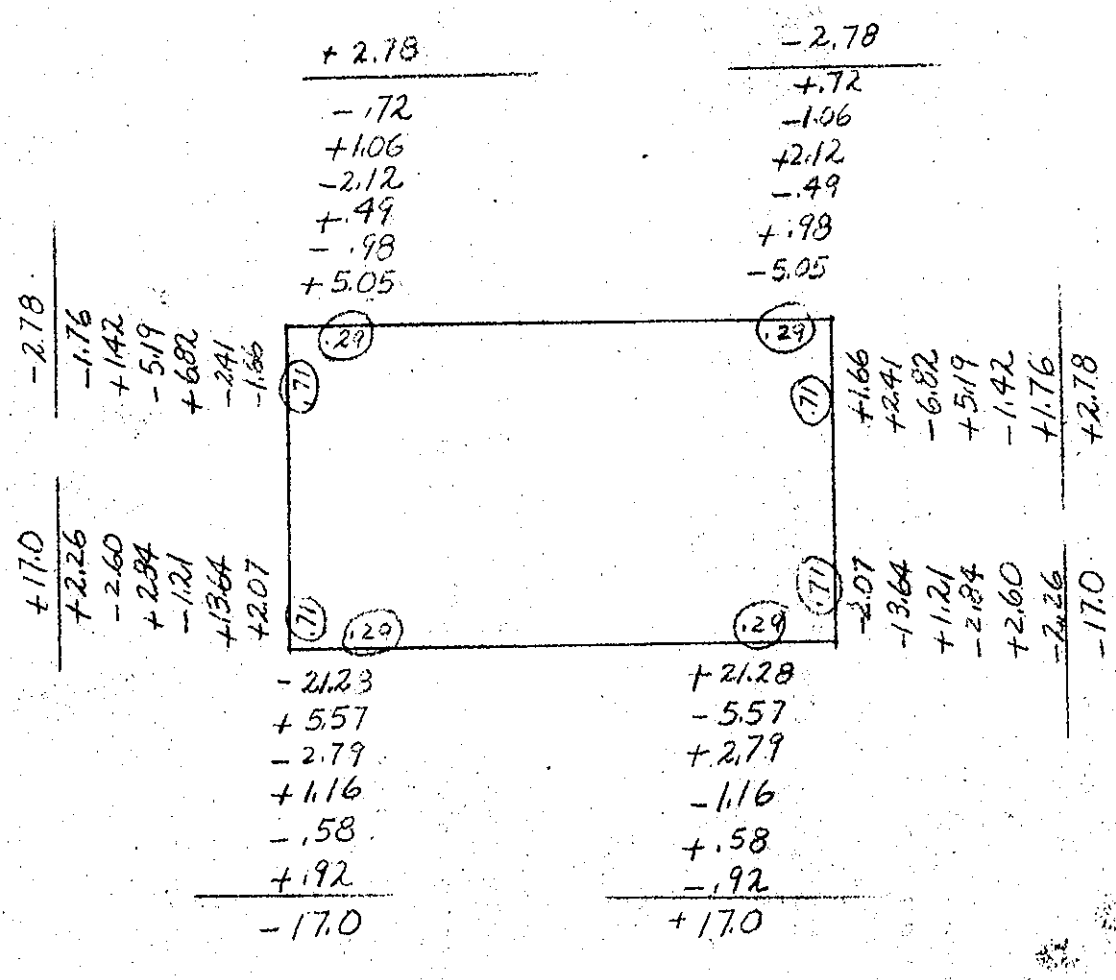
Moments are in ft-kips



Project: Chicopee Mass - (C-3b)
Computation: Tailrace Gate Structure No. 1 Design of Conduit.
Computed by: R.H.M. Checked by: Date: 1/25/40

U. S. GOVERNMENT PRINTING OFFICE: 3—10628

Slab AB

R_A & R_B = 475 × 11.3 ÷ 2 = 2680#

Slab CD

R_C & R_D = 2000 × 11.3 ÷ 2 = 11,300#

Slab BC & AD

$$R_A \ \& \ R_B = \frac{2780}{6.75} + 220 \times \frac{6.75}{2} + 540 \times \frac{6.75}{6} - \frac{17000}{6.75} = -760\#$$

$$R_C \ \& \ R_D = \frac{17000}{6.75} + 220 \times \frac{6.75}{2} + 540 \times \frac{6.75}{3} - \frac{2780}{6.75} = 4070\#$$

WAR DEPARTMENT

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

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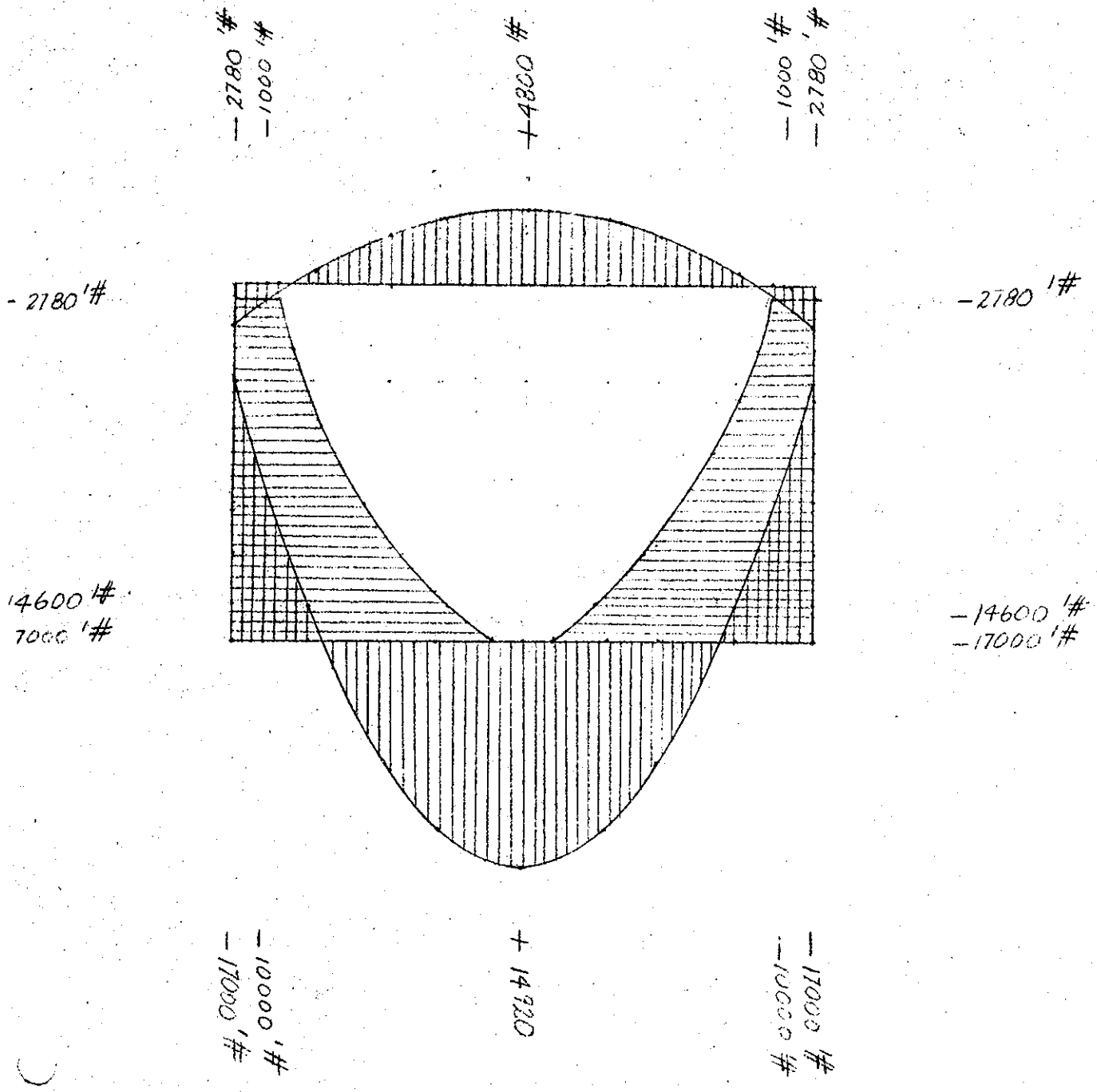
Subject Chicopee - Mass (C-3b)

Computation Tailrace Gate Structure No. 1 Design of Conduit

Computed by R.H.M. **Checked by** **Date** 1/25/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Moment Diagram



Subject: Chicopee Mass (C-3b)
Computation: Tailrace Gate Structure No. 1 Design of Conduit
Computed by: R.H.M. Checked by: Date: 1/26/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Max. Negative Moment is taken at point $\frac{1}{2}$ kd in from face of support.

Slab AB

$+M = 4800'\#$ $\quad -M = 1000'\#$

$+A_s = \frac{12 \times 4800}{18000 \times .884 \times 14.5} = .25 \square''$ Use $\frac{5}{8}''\phi$ @12" both faces.

$d_{(required)} = \sqrt{\frac{4800}{123}} = 6^{+}''$

Slab CD

$+M = 14920'\#$ $\quad -M = 10{,}000'\#$

$+A_s = \frac{12 \times 14920}{18000 \times .884 \times 14.5} = .78 \square''$ Use $1''\phi$ @12" (top)

$-A_s = \frac{12 \times 10{,}000}{18000 \times .884 \times 13.5} = .56 \square''$ Use $1''\phi$ @12" (bottom) (same as outside face of side walls)

$d = \sqrt{\frac{14920}{123}} = 11''$ required

Slabs BC & AD

$-M = 14600'\#$

$-A_s = \frac{12 \times 14600}{18000 \times .884 \times 14.5} = .76 \square''$ Use $1''\phi$ @12" c.c (outside)

$+A_s$ Use temperature steel Use $\frac{5}{8}''\phi$ @12" c.c (inside)

$d = \sqrt{\frac{14600}{123}} = 10.9''$

Subject: Chicopee - Mass (C-3b)
Computation: Tailrace Gate Structure No. 1. Design of conduit
Computed by: R.H.M. Checked by: Date: 1/26/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Shears

Slab AB

$$V = \frac{2680}{12 \times .884 \times 14.5} = 17.4 \ \#/\square''$$

Slab CD

$$V = \frac{11300}{12 \times .884 \times 13.5} = 79 \ \#/\square''$$ High but ok.

Slabs BC & AD

$$V = \frac{4070}{12 \times .884 \times 17} = 22.6 \ \#/\square''$$

Project Chicopee - Mass (C-3a)
Computation Tailrace Gate Structure No. 1 - Design of Conduit
Computed by R.H.M. Checked by Date 1/26/40

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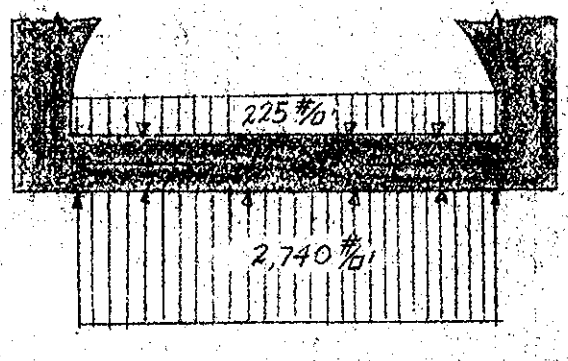
Steel for bottom slab at end of Transition



Design as beam with fixed ends

$$-M = \frac{W l^2}{12} = \frac{2510 \times 11 \times 11}{12} = 25300 \text{ '\#}$$

$$d = \sqrt{\frac{25300}{123}} = 14.4''$$

$$-A_s = \frac{12 \times 25300}{18000 \times .884 \times 13.5} = 1.41 \ \square''$$ Note "d" provided an inch too shallow but + steel may be considered as compression steel at points of maximum − moment

$$v = \frac{13800}{12 \times .884 \times 13.5} = 96.5 \ \#/\square''$$

$$+M = \frac{W l^2}{24} = 12650 \text{ '\#}$$

$$+A_s = \frac{12 \times 12650}{18000 \times .884 \times 14.5} = .67 \ \square''$$

For negative steel use 1"φ bars @ 6" c.c.
" positive " " 1"φ " @ 12" c.c.

Project Chicopee Mass (C-3b)
Computation Tailrace Gate Structure No. 1 - Design of counterforts
Computed by R.H.M. Checked by Date 1/27/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

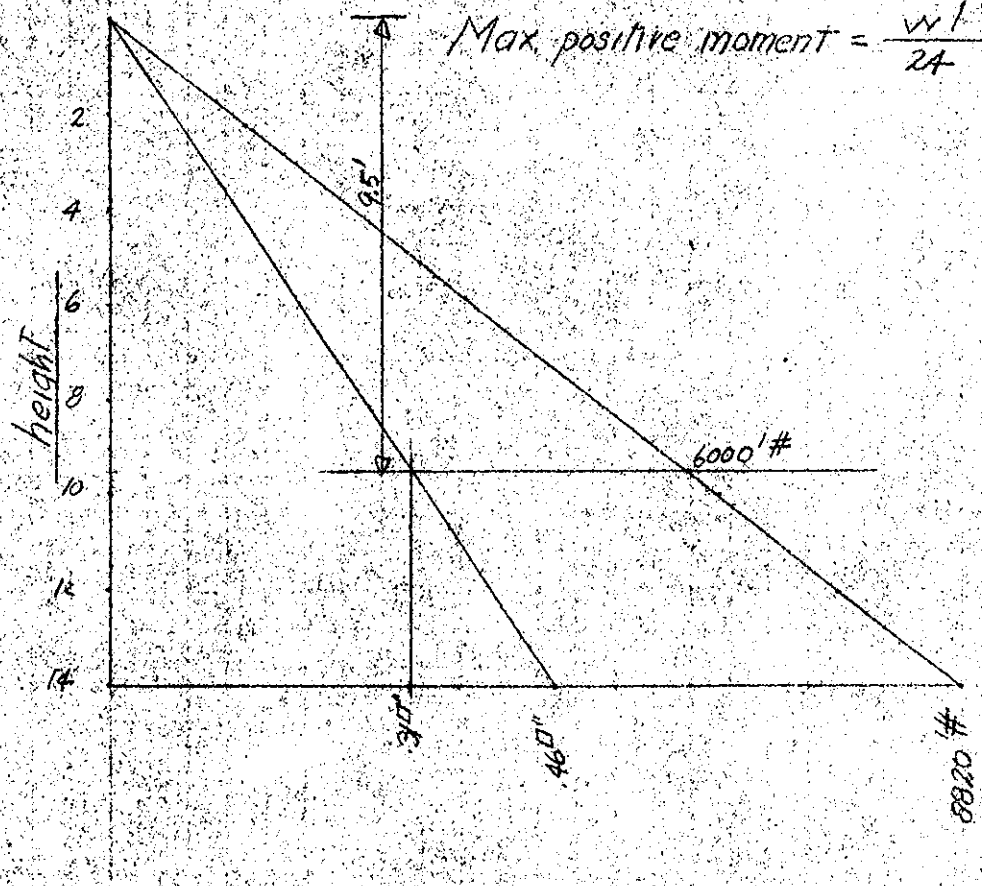
Design of wall between counterforts (considered acting as beam with fixed ends)

Span = 11'

Max neg. moment $= \frac{wl^2}{12}$, $w = h \times 62.5$

$= h\,K$ where $K = \frac{62.5 \times 11^2}{12} = 630$

Max positive moment $= \frac{wl^2}{24} = 4410$ #



Riverside face: Use 5/8"ϕ bars @ 12" c.c. for first 8' down from top, then 3/4" @ bars @ 12" c.c.

Landside face: Use 5/8"ϕ bars @ 12" c.c. throughout.

WAR DEPARTMENT

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

Project: Chicopee Mass -- (C-3b)

Computation: Tailrace Gate Structure No. 1 - Stability: Case II

Computed by: R.H.M. Checked by: Date: 1/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability - Case II - River down

			→	←		Moments at "A" ↻	Moments at "A" ↺
Structure:	334660				13.25	4,434,190	
Conduit:	90,270		Earth pressure neglected — too small		6.26	564820	
Gate & Hoist:	3000				13.0	39000	
Earth:							
1.25 x 10.25 x 10 x 100	12810				5.13	65720	
5 x 3.25 x 10 x 100	1630				1.63	2660	
5 x 7 x ½ x 10 x 100	1750				5.28	9240	
	444120	0				5,115,630	
	ΣV = 444120# ↓		ΣH = 0			ΣM = 5,115,630 ↺ #	

$$\frac{\Sigma M}{\Sigma V} = \frac{5,115,630}{444120} = 11.52'$$ ie. almost exactly on center line

$$B.P = \frac{444120}{23 \times 13} = 1490\ \#/\square''$$

Design of longitudinal base steel (Design as a beam with partially fixed ends) Case II governs by inspection

$$\text{Max. moment}(-) = \frac{wl^2}{10} = \frac{1040 \times 64}{10} = 6660'\#$$

$$-A_s = \frac{12 \times 6660}{18000 \times .884 \times 31.5} = .16\ \square''$$

Design of transverse base steel (Design as cantilever side walls) By inspection Case II governs

$$M = 4 \times 1040 \times 2 = 8320'\#$$

$$A_s = \frac{12 \times 8320}{18000 \times .884 \times 31.5} = .20\ \square''$$

Project Chicopee Mass (C-3a)
Computation Tailrace Gate Structure No. 1. Design of side walls
Computed by R.H.M. Checked by Date 1/29/40

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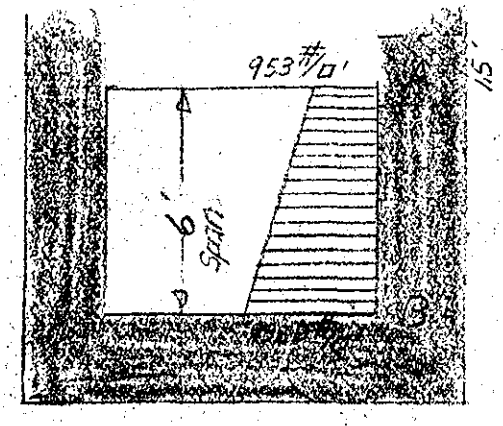


Lower 6' of side walls designed as vertical beams of 6' clear span. Ends are considered partially restrained

Moment =

$$\frac{Wl}{10}$$

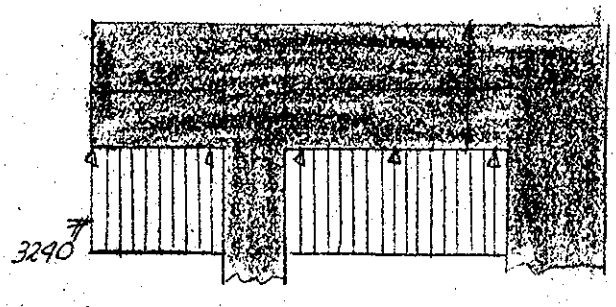
$W = 6840\#$

$$M = \frac{6840 \times 6}{10} = 4100 \text{ '}\#$$

$$A_s = \frac{12 \times 4100}{18000 \times .884 \times 20.5} = .15 \square''$$

Consider that reaction (from vertical beam AB) at A is taken by a horizontal beam 1.5' wide

$$\text{Load } (w) = R_A = \frac{953 \times 6}{2} + \frac{375 \times 6}{2 \times 3} = 2860 + 375 = 3240\#$$



$$\text{Beam moment} = \frac{Wl^2}{10} = \frac{3240 \times 3.5^2}{10} = 3970 \text{ '}\#$$

$$\text{Cantilever moment} = \frac{wl^2}{2} = \frac{3240 \times 2.25^2}{2} = 8200 \text{ '}\#$$

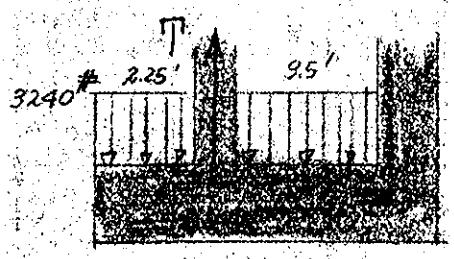
Cantilever moment governs

$$A_s = \frac{12 \times 8200}{18000 \times .884 \times 20.5 \times 1.5} = .20 \square'' \text{ (per foot of beam)}$$

Use $\frac{5}{8}''\phi$ @ 12"

Project Chicopee - Mass - (C-3b)
Computation Tailrace Gate Structure #1 - Front Gate well wall! bonding steel
Computed by R.H.M. Checked by Date 1/30/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528



At lower end of front gate well wall

$T = 3240 \times 2.25 + 3240\ 1.75$
$3240 \times 4 = 12960\ \#$

$A_s = \frac{12960}{18000} = .72\ \square''$ Use 2-$\frac{3}{4}$"ϕ bars to take care of reaction of horizontal beam.

Above this point $\frac{15 \times 625 \times 4}{18000} = \frac{3750}{18000} = .21\ \square''$ is required with the max. condition. $\frac{5}{8}$"ϕ bars @ 12" c.c. in each face will be used

In general, through out the structure $\frac{5}{8}$"ϕ bars will be the minimum steel used.

WAR DEPARTMENT

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

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Project: Chicopee Mass. C-3b

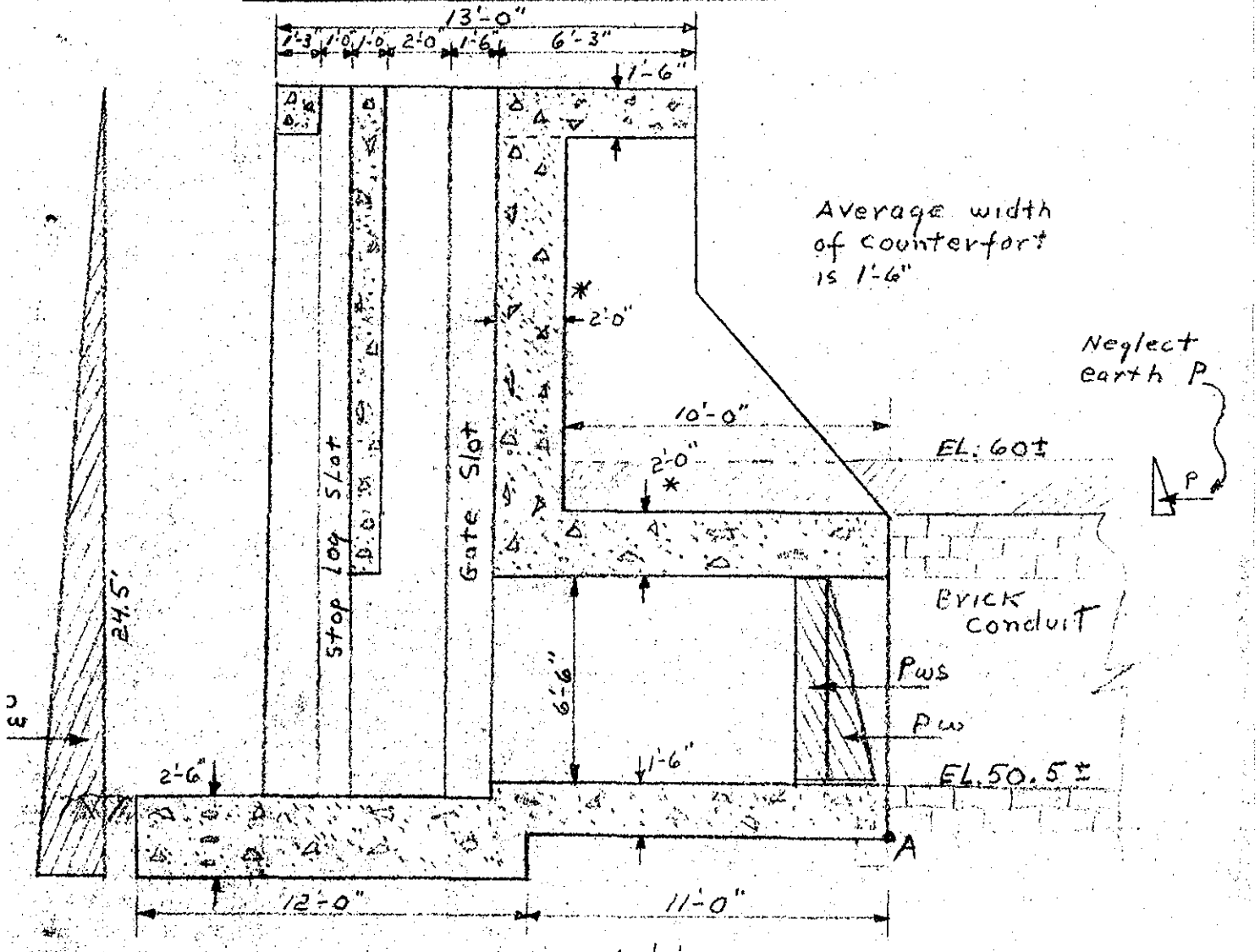
Computation: Tailrace gate structure No. 2

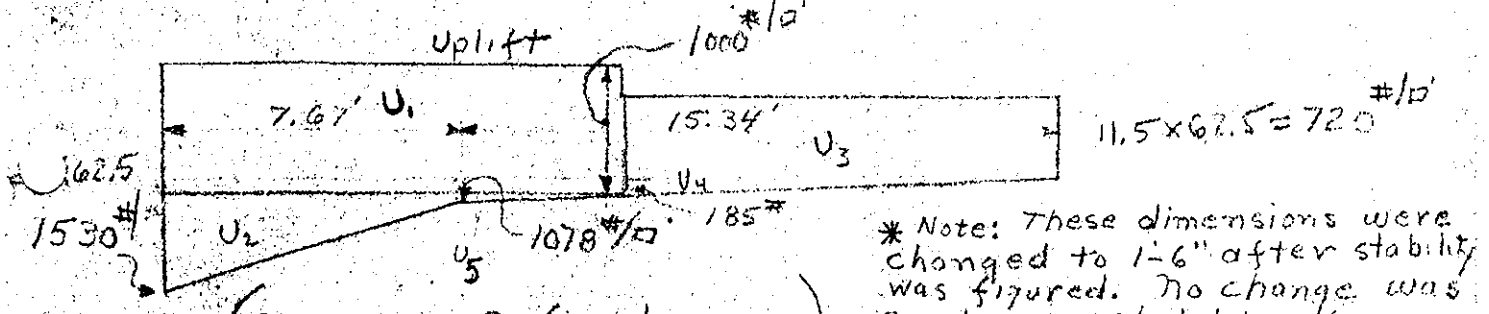
Computed by: W. S. Jr. Checked by: Date: 1/23/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Stability

Section Thru Tailrace





(see page 3 for bearing)

* Note: These dimensions were changed to 1'-6" after stability was figured. No change was made in stability figures.

WAR DEPARTMENT

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

ect Chicopee, Mass. C-3b

omputation Tailrace gate structure No. 2

omputed by W. S. J. Checked by [illegible] Date 1/23/40

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Stability

FORCES ACTING	↓	↑	→	←	ARM	MOMENTS AT "A"	
C_1 2(9×22×2.5×150)	149,000				14.5	2160,500	
C_2 1.25×1.5×9×150	2,530				18.38	46,501	
C_3 1×15×9×150	20,200				16.25	328,250	
C_4 2×9×11.5×150	31,000				11.25	348,750	
C_5 4.25×1.5×14×150	13,400				8.12	108,808	
C_6 2(4.3×11.5×1.5×150)	22,300				8.12	181,076	
C_7 2(6×7×½×1.5×150)	9,400				4.0	37,600	
C_8 11×2.5×14×150	58,000				17.5	1,015,000	
C_9 1×1×150×14	2,100				11.5	24,150	
C_{10} 79.5×12.25×150	146,000				6.08	887,680	
W_1 14×4×22×62.5	77,000				21.0	1,617,000	
W_2 9×7×22×62.5	87,000				15.5	1,348,500	
− C_3 1×15×9×62.5		8450			16.25		137,312
− C_2 1.25×1.5×9×62.5		1050			18.38		19,299
E_L 10×9×1.5×125	16,800				5.0	84,000	
Gate & Hoist	3000				12.75	38,250	
P_w 24.5²×½×62.5×14			263,200		6.6		1,735,200
P_{w_s} 4×62.5×6.5×9				14580	4.75	69,255	
P_w 6.5²×½×62.5×9				11880	3.6	42,768	
U_1 1000×12×14		168,000			17.0		2,856,000
U_2 530×7.67×½×14		28,420			20.5		582,610
U_3 720×11×14		110,600			5.5		608,300
U_4 185×½×11×14		14,280			7.3		104,244
U_5 78×4.3×½×14		2,852			13.9		32,692
Σ =	637,730	333,150	263200	26460		8,338,088	6,067,377
	304,580		ΣH = 0			2,320,711 ##	

STRUCTURE POURED ON ROCK. UNBALANCED SLIDING TAKEN UP BY FRICTION.

$\frac{\Sigma M}{\Sigma V} = 7.6'$ O.K. on middle third

$$\text{Bearing} = \frac{304,580}{23 \times 14}\left(1 \pm \frac{6 \times 3.8}{23}\right) = \begin{matrix} 1900 \ \#/\square' \\ 0 \ \#/\square' \end{matrix}$$

Project Chicopee Mass C 3b
Computation Tailrace gate structure No. 2
Computed by M.S.J. Checked by O.C. Date 1/25/40

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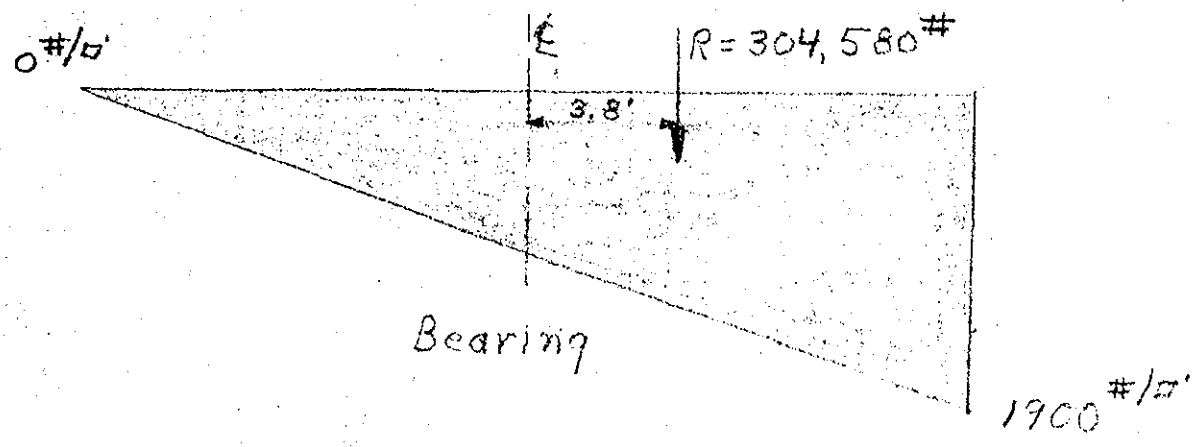

Conduit Design

See Sections on page 4

For worst condition assume conduit dry and river up.

Loads on Conduit

Lateral loads from 2'-0" of sat. earth at top of conduit, and 11'-6" of sat. earth at bottom.

Top loads from 2'-0" of sat. earth at 125 #/□' plus 1'-6" of concrete at 150 #/□'.

Bottom loads from bearing pressure, minus 1'-6" of concrete at 150 #/□'; plus uplift.

WAR DEPARTMENT

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

Subject: Chicopee Mass C 3b

Computation: Tailrace gate structure No. 2

Computed by: W. S. Jr. Checked by: [illegible] Date: 1/25/40

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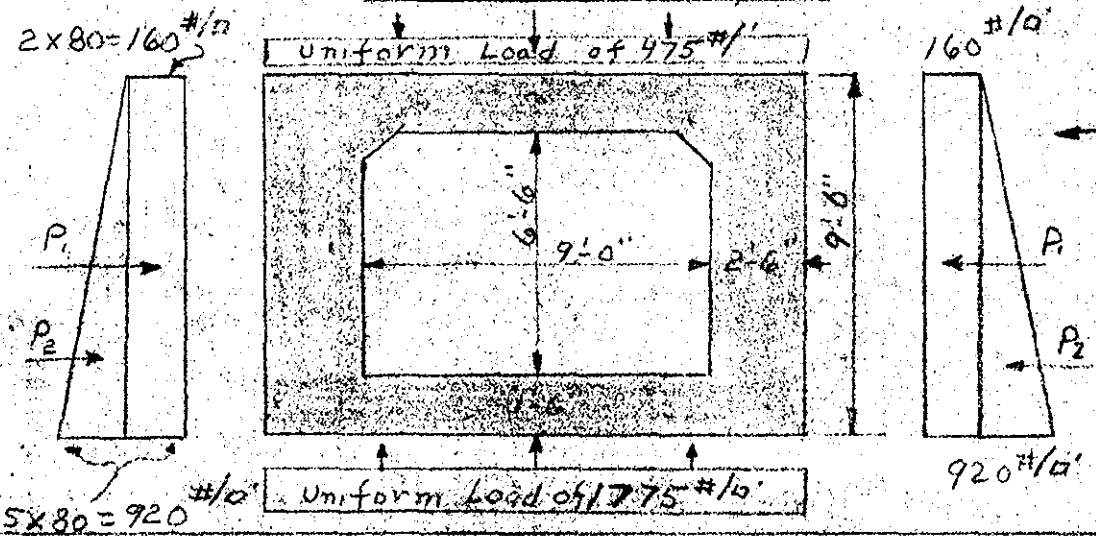
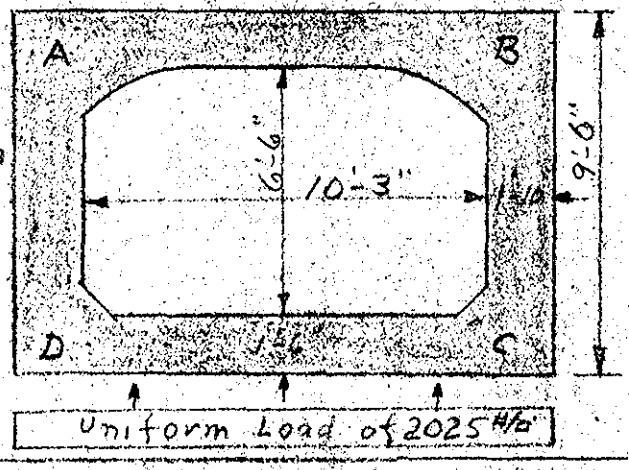
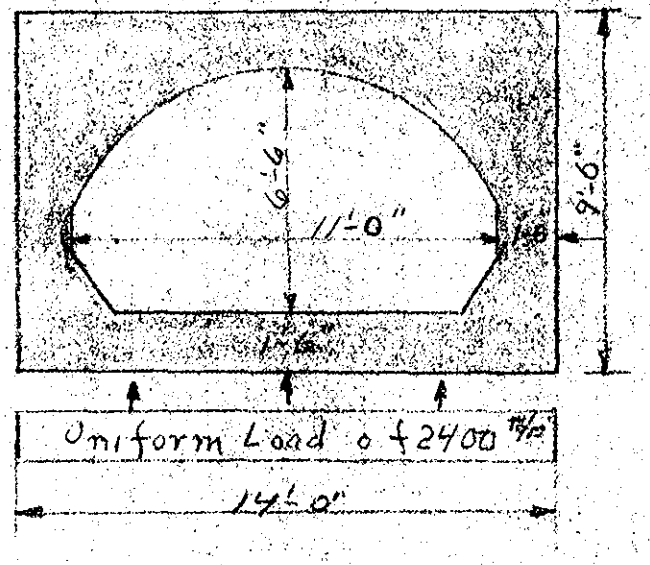
Conduit Design





Section "B" at midpoint of conduit

Note:
With the exception of the base pressures, all loads on the sections are the same as section A



Section "C" at brick conduit

Project Chicopee Mass. C3b
Computation Tailrace gate structure No. 2
Computed by W. S. J. Checked by [illegible] Date 1/26/40

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Conduit Design

Section "A" will not be designed, as it can be seen by inspection that the design for section "B" will govern both cases.

Section B (see page 4)

Relative stiffness $= \frac{I}{L} = \frac{bh^3}{L}$ ("b" is constant so omit)

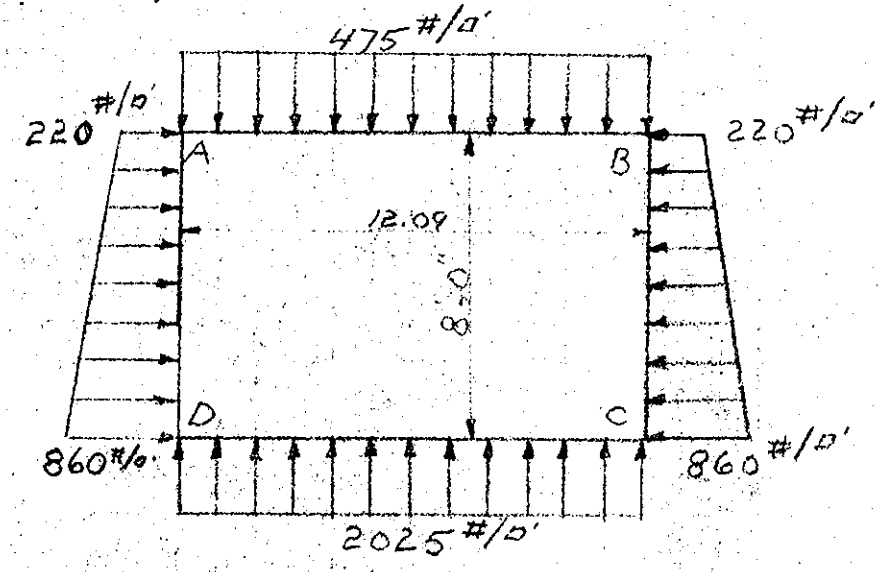
$AB = \frac{1.5^3}{12.09} = .281$

$BC = \frac{1.83^3}{8.0} = .766$

$CD = .281$

$AD = .776$

Loading Diagram



Subject: Chicopee Mass. C. 3-b
Computation: Tailrace gate structure No. 2
Computed by: M. S. J. Checked by: R. S. W. Date: 1/26/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Conduit Design (Moments for distribution)

AB

$$+M = \frac{475 \times 12.09^2}{8} = 8650'^{\#} \text{ (simple beam M)}$$

$$-M = \frac{475 \times 12.09^2}{12} = 5780'^{\#}$$

BC & AD

$$-M_A \;\&\; -M_B = \frac{220 \times 8^2}{12} + \frac{640 \times \frac{1}{2} \times 8^2}{15} = 2549'^{\#}$$

$$-M_C \;\&\; -M_D = \frac{220 \times 8^2}{12} + \frac{640 \times \frac{1}{2} \times 8^2}{10} = 3222'^{\#}$$

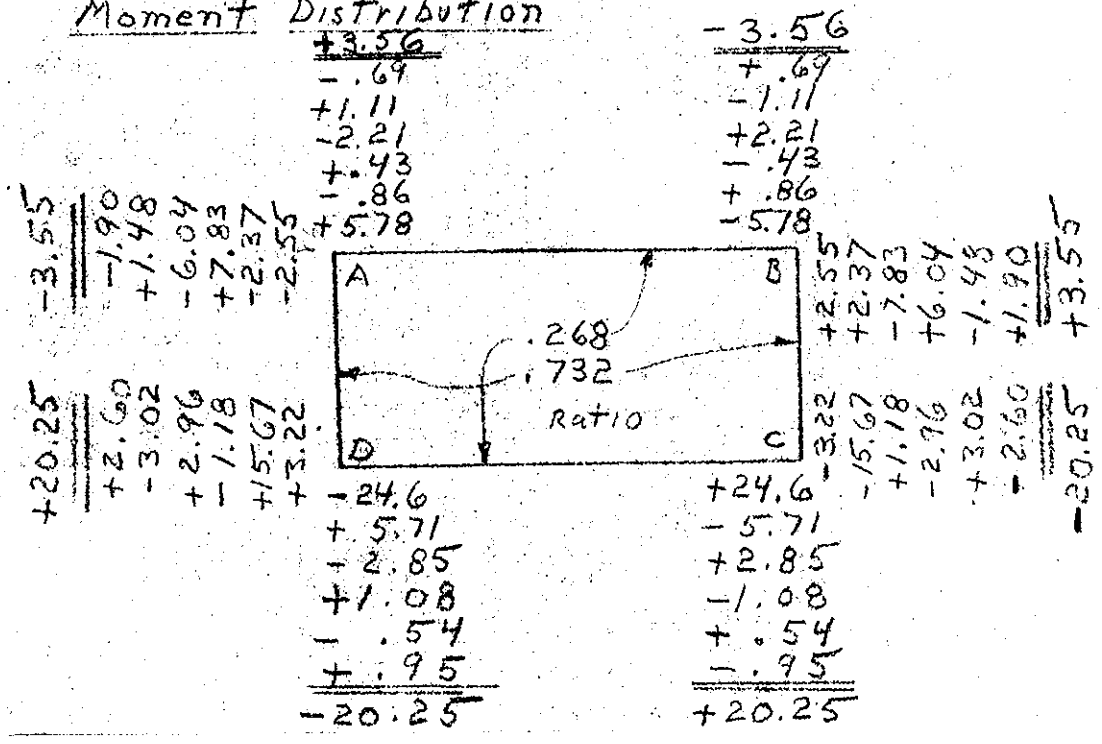
$$+M = \frac{8^2}{16}(2 \times 220 + 640) = 4320'^{\#} \text{ (Simple beam M)}$$

CD

$$+M = \frac{2025 \times 12.09^2}{8} = 36{,}900'^{\#} \text{ (simple beam M)}$$

$$-M = \frac{2025 \times 12.09^2}{12} = 24{,}600'^{\#}$$

Moment Distribution



Subject Chicopee, Mass C 3-b
Computation Tailrace gate structure No. 2
Computed by W. S. J. Checked by [illegible] Date 1/27/40

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Conduit Design Reactions

Slab AB

$$R_B = R_A = \frac{3,560}{8'} - \frac{3,560}{8'} + \frac{475 \times 12.09}{2} = 2870^{\#}$$

Walls BC & AD

$$R_B = R_A = \frac{3,550}{8} - \frac{20,250}{8} + \left(220 \times \frac{8}{2}\right) + \left(640 \times \frac{8}{6}\right) = -356^{\#}$$

$$R_C = R_D = \frac{20,250}{8} - \frac{3550}{8} + \left(220 \times \frac{8}{2}\right) + \left(640 \times \frac{8}{3}\right) = 4660^{\#}$$

Slab DC

$$R_D = R_C = \frac{20250}{8'} - \frac{20250}{8'} + \left(2025 \times \frac{12.09}{2}\right) = 12,200^{\#}$$

Check Shear on DC

$$V = \frac{12,200}{15 \times 12 \times .984} = 78^{\#/\square''} \text{ O.K.}$$

By inspection, other shears are O.K.

See next page for moment diagram.

WAR DEPARTMENT

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

Page 232

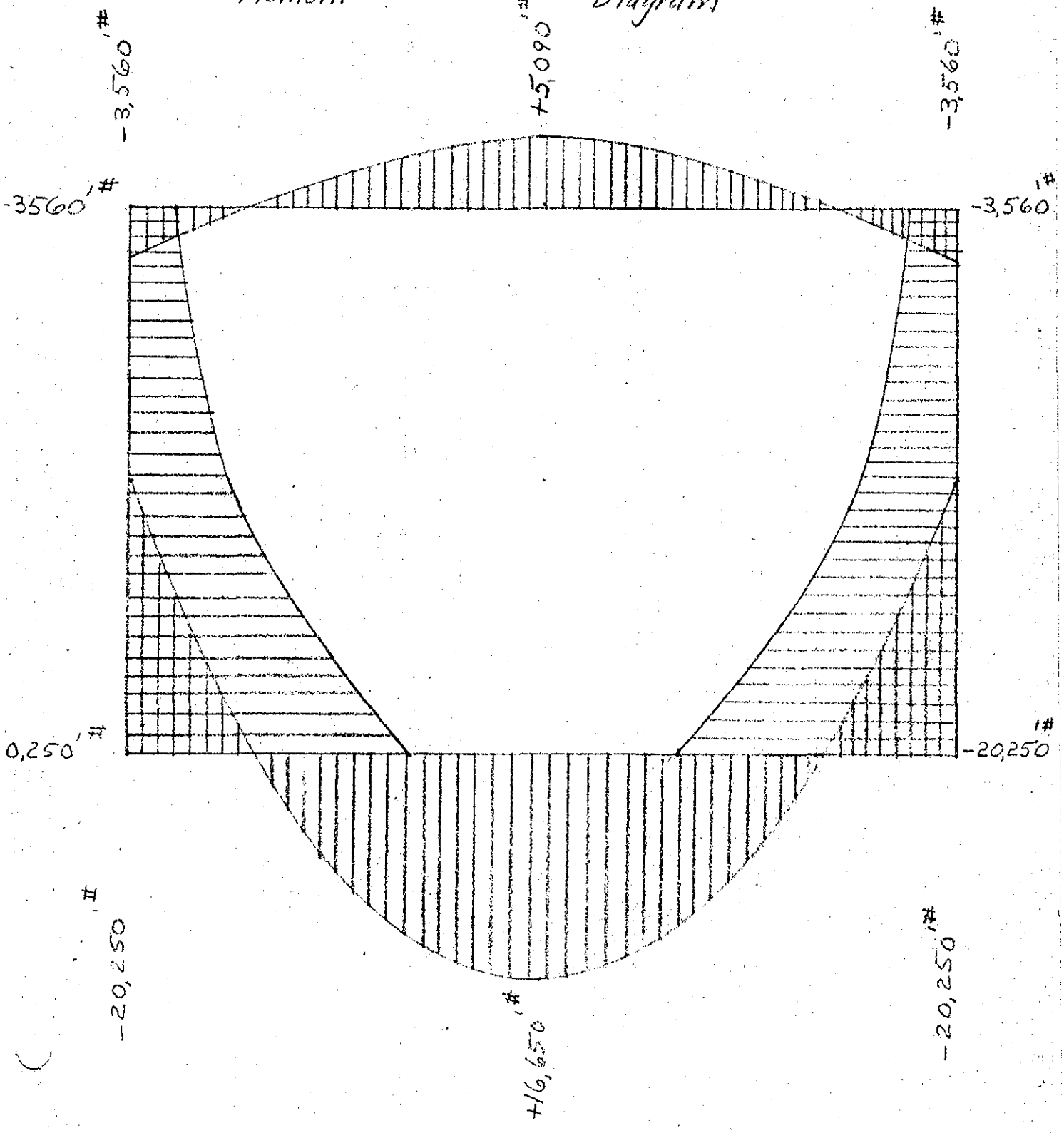
Project Chicopee, Mass. C-3b

Computation Tailrace gate structure No. 2

Computed by W. S. Jr. Checked by ..... Date 1/29/90

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Moment Diagram



Project Chicopee, Mass. C-3b
Computation Tailrace gate structure No. 2
Computed by W. S. Jr. Checked by [illegible] Date 1/29/40

U. S. GOVERNMENT PRINTING OFFICE 8—10528

Conduit Design

Slab AB $+M = 5,090'^{\#}$ $-M = 3,560'^{\#}$

$$+A_s = \frac{5,090 \times 12}{18000 \times .884 \times 14.5} = .266^{\square''} \qquad (d = 18'' - 3.5'' = 14.5'')$$

$$-A_s = \frac{3560 \times 12}{18000 \times .884 \times 14.5} = .185^{\square''}$$

$$d_{required} = \sqrt{\frac{5090 \times 12}{123 \times 12}} = 6.7''$$

Slab BC & AD $-M = 20,250'^{\#}$

$$-A_s = \frac{20,250 \times 12}{18000 \times .884 \times 18.5} = .826^{\square''} \qquad (d = 22'' - 3.5'' = 18.5'')$$

$$d_{required} = \sqrt{\frac{20,250 \times 12}{123 \times 12}} = 13''$$

Slab CD $+M = 16,650'^{\#}$ $-M = 20,250'^{\#}$

$$+A_s = \frac{16,650 \times 12}{18000 \times .884 \times 14.5} = .870^{\square''} \qquad (d = 18'' - 3.5'' = 14.5'')$$

$$-A_s = \frac{20,250 \times 12}{18000 \times .884 \times 14.5} = 1.05^{\square''}$$

$$d_{required} = \sqrt{\frac{20,250 \times 12}{123 \times 12}} = 13''$$

Note:
This design is for the critical section of the conduit. The steel required will be used for the entire conduit, with the exception of the base.

Project Chicopee, Mass C-3b
Computation Tailrace gate structure No. 2
Computed by M. S. J. Checked by [illegible] Date 1/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Conduit Design

At End of Conduit, (Section C, Page 4)

The steel for the walls and top slab of "section B" will be o.k. in "section C" as the concrete depth has increased.

The bottom slab of "Section C" will be assumed as a fixed beam.

$$M = \frac{2400 \times 11^2}{12} = 24{,}200'^{\#}$$

$$d = \sqrt{\frac{24200 \times 12}{123 \times 12}} = 14'' \quad \text{O.K.}$$

$$A_s = \frac{24{,}200 \times 12}{18000 \times .884 \times 14.5} = 1.25^{\square''} \quad \text{Use } 7/8''\phi \text{ @ } 6'' \text{ cc}$$

$$\text{Shear} = \frac{2400 \times 5.5}{12 \times .884 \times 14.5} = \frac{13{,}200^{\#}}{154} = 85^{\#/\square''} \quad \text{O.K.}$$

$$\text{Bond} = \frac{13{,}200}{5.5 \times .884 \times 14.5} = 185^{\#/\square''} \quad \text{O.K.}$$

Design of Rear Gate Well Wall

Pressure on bottom foot $= (13 \times 62.5) = 810^{\#/\square'}$

Clear span $= 14 - 2(1.5) = 11.0'$ (Assume fixed ends)

$$\frac{wl^2}{12} = \frac{810 \times 11^2}{12} = 8{,}200'^{\#} \qquad d = 14.5'' \text{ O.K.}$$

$$A_s = \frac{8{,}200 \times 12}{18000 \times .884 \times 14.5} = .43^{\square''} \quad \text{Use } 3/4\phi \text{ @ } 1'\text{-}0'' \text{ cc}$$

Pressure on a foot strip 8'-0" down $= 500^{\#/\square'}$

$$\frac{wl^2}{12} = \frac{500 \times 11^2}{12} = 5{,}050'^{\#}$$

$$A_s = \frac{5050 \times 12}{18000 \times .884 \times 14.5} = .28^{\square''} \quad \text{Use } 5/8''\phi \text{ @ } 1'\text{-}0'' \text{ cc}$$

Project Chicopee Mass C 3-b
Computation Tailrace gate structure No. 2
Computed by M. S. J. Checked by [illegible] Date 1/29/40

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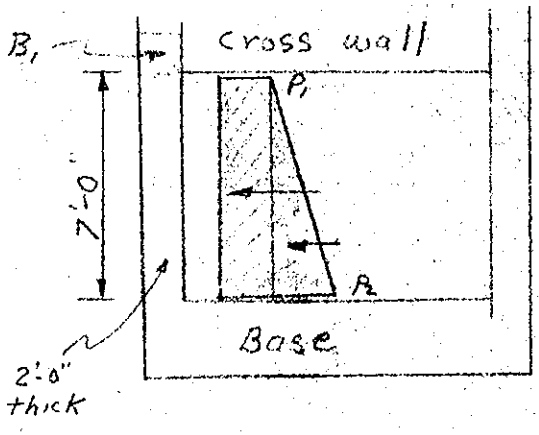
Design of Side Gate Well Walls

By inspection, temp steel ($\frac{1}{2}$"□) will be O.K. down to bottom of cross beam at EL. 57±. (Wall is a beam 2'-0" deep and 3'-6" span)

From here down, wall is a vertical beam between El. 57 and the base.

Load on vertical beam



$P_1 = 15 \times 62.5 = 940$ #/□'
$P_2 = 22 \times 62.5 = 1370$ #/□'

$M = \frac{WL}{10} \pm$ $\quad W = (940 \times 7) + (430 \times \frac{7}{2})$

$W = 8090$

$M = \frac{8090 \times 7}{10}$

$M = 5,660$ '#

$A_s = \frac{5,660 \times 12}{18000 \times .884 \times 21.5} = .20$ □"

Consider sidewall acts as a beam (B_1) to support the vertical walls.

Reaction on $B_1 = \frac{940 \times 7}{2} + \frac{430 \times 7}{6} = 3800$ #/'

Moment in B_1 between rear wall & cross wall (Assume 1'-6" of sidewall as beam)

$\frac{3800 \times 3.5^2}{10 \times 1.5} = 3100$ '#

Moment in B_1 cantilevering from cross wall

$\frac{3800 \times 2.5^2}{2 \times 1.5} = 7,900$ '#

$A_s = \frac{7900 \times 12}{18000 \times .884 \times 20.5} = .26$ □" Temp. steel O.K.

Project Chicopee Mass
Computation Tailrace gate structure No. 2
Computed by M. S. Jr. Checked by [illegible] Date 1/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Base

Stability of structure, River Down.

From Page 2

ΣV plus uplift & minus water load

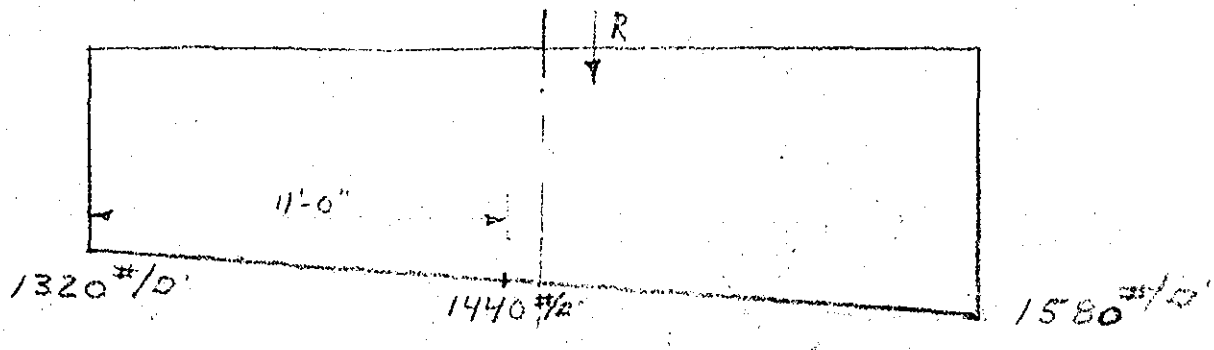
$= 464,232$

ΣM plus uplift moments, water pressure moments & minus water load moments

$= 5,274,057$

$\frac{\Sigma M}{\Sigma V} = 11.4'$ .35' from middle

$$\text{Bearing} = \frac{464,232}{23 \times 14}\left(1 \pm \frac{6 \times .35}{23}\right) = \begin{matrix} 1580 \ \#/\square' \\ 1320 \ \#/\square' \end{matrix}$$



This case governs base. (Excluding conduit base)

Assume slab is a beam between sidewalls.

$1440 - 2.5(150) = 1066 \ \#/\square'$ span $= 9'-0"$

$$\frac{1066 \times 9^2}{10} = 8600'\#$$

$$A_s = \frac{8600 \times 12}{18000 \times .894 \times 26.5} = .24 \ \square'' \quad \text{O. K.}$$

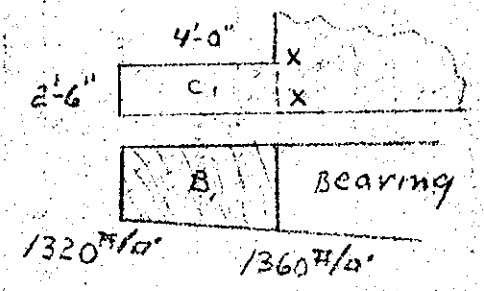
ct Chicopee, Mass. C3-b
omputation Tailrace gate structure, No. 2
omputed by W. S. J. Checked by [illegible] Date 1/30/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Design of Base

4'-0" of base cantilevers on riverside.

Case II Governs



moments at x-x

$C_1 = 2.5 \times 4 \times 150 = 1500 \times 2 = 3000$ '#

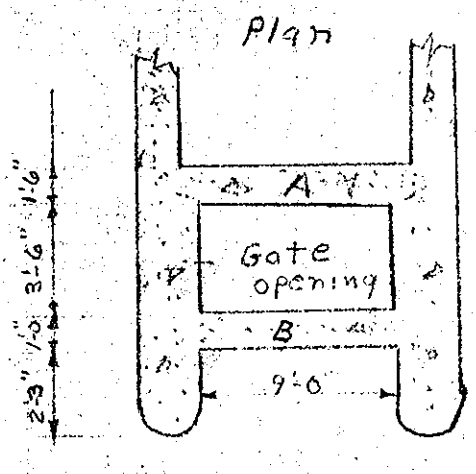
$B_1 = 1340 \times 4 = 5350 \times 2 = 10700$ '#

$\Sigma V = 3850^{\#}$ $\Sigma M = 7{,}700$ '#

$$\text{Shear} = \frac{3850}{12 \times .884 \times 26.5} = 14^{\#/\square'} \quad \text{O.K.}$$

$$A_s = \frac{7{,}700 \times 12}{18000 \times .884 \times 26.5} = .22^{\square''} \quad \text{O.K.}$$

Steel in cross wall behind stop log slots (Direct Tension)



Wall B

Assume bottom 1'-6" holds reaction from B_1 (page 11).

$$3800 \times \left(2.25 + \frac{3.5}{2}\right) = 15{,}200^{\#} \longleftrightarrow 1^{\square''} \text{ O.K.}$$

Load on a 1'-0" strip of B, 15' down

$15 \times 62.5 = 940$

$$940 \times \left(2.25 + \frac{3.5}{2}\right) = 3{,}750^{\#}$$

5/8" ϕ Temp steel will be O.K. for the direct tension in B.

Wall A is O.K. by inspection.

WAR DEPARTMENT

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

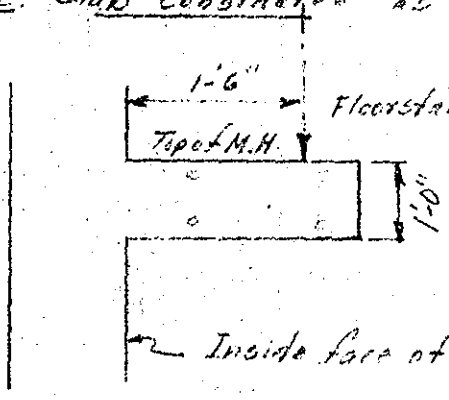
Object: Chicopee C3b

Computation: Investigation - Steel in top of Manhole

Computed by: JAC Checked by: ____ Date: ____

U. S. GOVERNMENT PRINTING OFFICE 3—10528

I. Slab considered as Cantilevered from Manhole wall.



Floorstand load = 12,000#± (Refer to Chapman Value Booklet)

Assume this as distributed over 3 lin. ft. of slab.

$\therefore \frac{12,000}{3} = 4,000^{\#}$ Load/ft. conc. 18" from face of Manhole

$4000 \times 18 = 72,000''\#$

$150 \times 18 = 2,700''\#$

Total Mom. = $74,700''\#$

$d = \sqrt{\frac{74700}{12 \times 123}} = \sqrt{50.6}$

$= 7.1''$

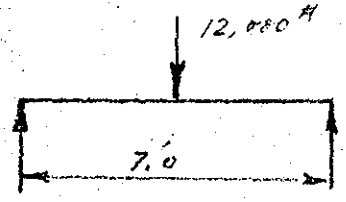
$A_s = \frac{74,700}{18,000 \times .884 \times 10.5} = 1.44''$ 2" cover

$Z_o = \frac{4,150}{300 \times .884 \times 10.5} = 1.5''$

$v = \frac{4,150}{12 \times .884 \times 10.5} = 37^{\#/\square''}$

Use $\frac{3}{4}''\phi$ @ 1'-0" c.c. Hooked one end

II. Slab considered as continuous for Span of Manhole ie { 6'-0" Clear span / 7'-0" ℄ to ℄ span



$M = \frac{Wl}{8}$

$= \frac{12,000 \times 7}{8} \times 12 = 126,000''\#$

$d = \sqrt{\frac{126,000}{12 \times 123}} = \sqrt{85.4} = 9.25''$

$A_s = \frac{126,000}{18,000 \times .884 \times 10.5} = .76''$

$Z_o = \frac{6,000}{300 \times .884 \times 10.5} = 2.1$

$v = \frac{6,000}{12 \times .884 \times 10.5} = 54^{\#/\square''}$

Use - 2 - $\frac{3}{4}''\phi$ T. & B.

Hooked Both ends